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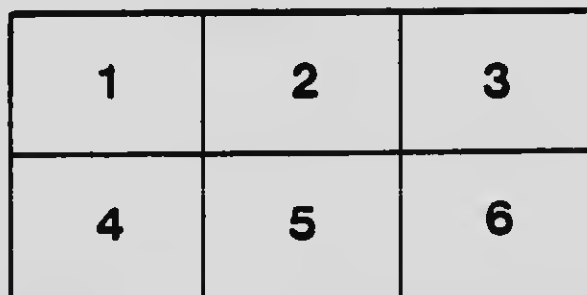
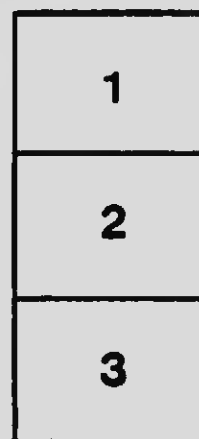
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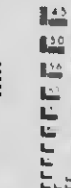
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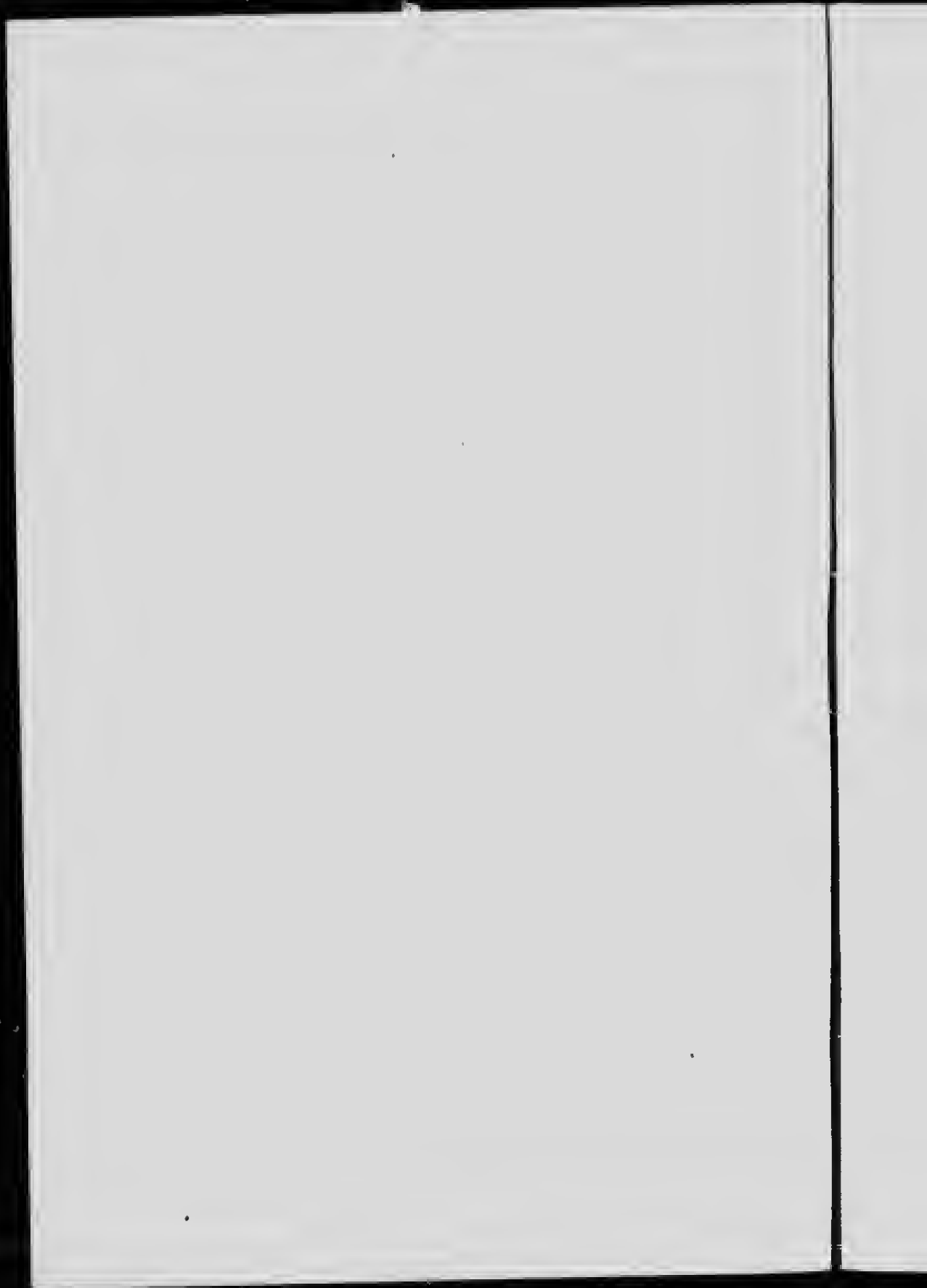
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THE PRACTICE OF SURGERY

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THE PRACTICE OF SURGERY

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WITH 8 COLOURED PLATES AND 523 ILLUSTRATIONS
IN THE TEXT

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PREFACE

This Textbook on Surgery has been written at the request of many past and present students of the London Hospital, and it embodies as far as possible in a textbook the surgical teaching received by the writer at that Medical School.

The main objects of the book are to give the student an introduction to surgery, and to prepare him for the final examinations in that part of the medical curriculum; but, as special emphasis has been laid on diagnosis and treatment, it is hoped that it will prove useful to him in his career after leaving hospital work.

The author has drawn help from many sources, but his special thanks are due to the Honorary Staff of the London Hospital for permission to use cases; the College Board of the London Hospital Medical College for permission to reproduce specimens and photographs in the Museum of the College as illustrations; Dr. William Bulloch, Bacteriologist of the Hospital, for help in the bacteriology and for many of the reproductions of micro-photographs; Dr. Turnbull, Director of the Pathological Institute, for several specimens; Dr. Western, of the Inoculation Department of the London Hospital; Dr. Gilbert Scott, Radiographer of the Hospital, for the reproductions of X-ray photographs; Dr. Morris, of the London Hospital, for most of the excellent outline illustrations, and Mr. Suggars, Photographer to the London Hospital, for his care and trouble in photographing the various patients and specimens.

R. H.

LONDON,
January, 1914.

CONTENTS

CHAPTER	PAGE
I. INFECTION—IMMUNITY—SERUM THERAPY	1
II. INFLAMMATION	16
III. WOUNDS	36
IV. INFECTED WOUNDS	69
V. SPECIFIC INFECTIONS—TUBERCULOSIS AND SYPHILIS	108
VI. ULCERATION AND GANGRENE	150
VII. HÆMORRHAGE—SHOCK—DELIRIUM—LEUCOCYTOSIS	181
VIII. TUMORS AND CYSTS	208
IX. DEFORMITIES	250
X. INJURIES AND DISEASES OF THE BLOODVESSELS	301
XI. INJURIES AND DISEASES OF THE LYMPHATICS, TENDONS, MUSCLES, AND BURSE	335
XII. INJURIES AND DISEASES OF NERVES	365
XIII. AFFECTIONS OF THE SKIN	390
XIV. INJURIES OF BONES—FRACTURES	405
XV. DISEASES OF BONE	480
XVI. INJURIES OF JOINTS—DISLOCATIONS	522
XVII. DISEASES OF JOINTS	550
XVIII. ABDOMINAL SURGERY	610
XIX. INJURIES AND DISEASES OF THE STOMACH AND DUO- DENUM	646
XX. INJURIES AND DISEASES OF THE INTESTINES	672
XXI. HERNIA	714
XXII. INJURIES AND DISEASES OF THE ANUS AND RECTUM	746
XXIII. INJURIES AND DISEASES OF THE PANCREAS, SPLEEN, LIVER, GALL-BLADDER, AND BILE-DUCTS	776
XXIV. INJURIES AND DISEASES OF THE SCALP—INJURIES AND DISEASES OF THE CRANIUM AND ITS CONTENTS	806
XXV. INJURIES AND DISEASES OF THE SPINE	863

CONTENTS

vii

CHAPTER	PAGE
XXVI. SURGERY OF THE NECK	890
XXVII. INJURIES AND DISEASES OF THE NOSE	910
XXVIII. AFFECTIONS OF THE LIPS, MOUTH, SALIVARY GLANDS, GUMS, AND JAWS	930
XXIX. AFFECTIONS OF THE TONGUE, PHARYNX, TONSILS, AND ESOPHAGUS	965
XXX. AFFECTIONS OF THE ORBIT AND EAR	1000
XXXI. AFFECTIONS OF THE LARYNX AND TRACHEA—INJURIES AND DISEASES OF THE THORAX	1014
XXXII. DISEASES OF THE THYROID GLAND	1045
XXXIII. DISEASES OF THE BREAST	1057
XXXIV. INJURIES AND DISEASES OF THE KIDNEYS AND UTERUS	1077
XXXV. INJURIES AND DISEASES OF THE URINARY BLADDER	1108
XXXVI. INJURIES AND DISEASES OF THE URETHRA, PROSTATE, AND VESICLE SEMINALES	1128
XXXVII. INJURIES AND DISEASES OF THE PENIS, SCROTUM, AND TESTES	1168
INDEX	1205

LIST OF COLOURED PLATES

PLATE		
I	MELANOMA OF THE ANUS	<i>facing page 230</i>
II.	SECONDARY MELANOTIC DEPOSITS IN LYMPHATIC GLANDS	342
III.	MASS REMOVED FROM THE STOMACH OF A LUNATIC, CONSISTING OF HUMAN HAIR, HORSE HAIR, AND STRIPS OF CLOTH	648
IV.	GANGRENE OF THE SMALL INTESTINE AND MESENTERY DUE TO THROMBOSIS OF THE SUPERIOR MESENTERIC VEIN	698
V.	EDGE OF A CARCINOMATOUS ULCER SEEN WITH THE SIGMOIDOSCOPE	772
	ULCERATION IN THE COLON SEEN WITH THE SIGMOIDOSCOPE	772
VI.	DILATED GALL-BLADDER (<i>Hydrops</i>), WITH SEVERAL STONES IMPACTED IN THE CYSTIC DUCT	800
VII.	CHRONIC SUPERFICIAL GLOSSITIS (<i>Leucoplakia buccalis</i>)	968
VIII.	A. NORMAL URETERIC ORIFICE	
	B. PHOSPHATIC STONE	
	C. SMALL PAPILLOMA NEAR THE URETERIC ORIFICE	
	D. "GOLF HOLE" URETERIC ORIFICE	
	}	1112

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THE PRACTICE OF SURGERY

CHAPTER I

INFECTION, IMMUNITY, AND SERUM THERAPY

INFECTION

By *infection* is understood the entrance and growth in the body of certain of the lowest forms of vegetable and animal life, which, when they are capable of producing disease, are termed "pathogenic."

The pathogenic organisms may be classified into—

1. Fission fungi, or bacteria (schizomycetes).
2. Fungi, or moulds (hyphomycetes).
3. Yeasts (saccharomycetes, blastomycetes).
4. Mycetozoa, protozoa, and trypanosomes.

By far the most important are the fission fungi, or bacteria, and this class of micro-organism will be considered first.

BACTERIA

The bacteria may be divided into lower and higher forms, the lower forms being again divided into (1) cocci, (2) bacilli, (3) spirilla.

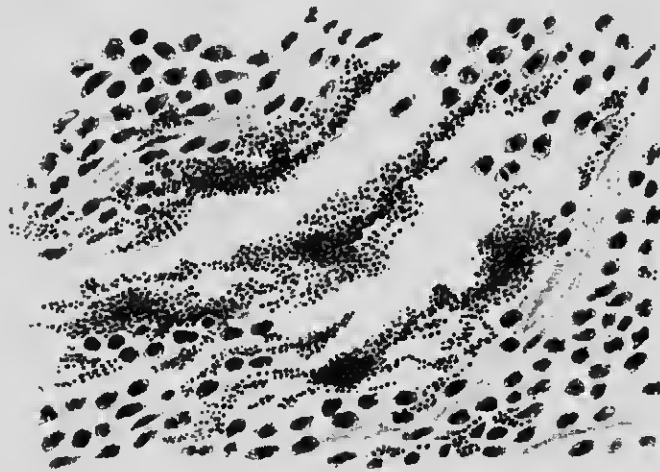
Lower Bacteria

1. The **cocci** are small rounded bodies which occur as (a) isolated organisms, (b) in pairs (diplococcus), (c) in groups (staphylococcus), (d) in chains (streptococcus), or (e) in large colonies, bound together by a mucoid material (zoogloa). These organisms always multiply by simple fission, and spore formation has not been observed.
2. The **bacilli** form long or short rods, with rounded or rectangular ends. They may be motile, with flagella, or non-motile; may multiply by simple fission or by spore formation. The spores may be central or terminal.
3. The **spirilla** are spiral or wavy bodies which are motile, the motility usually being due to the possession of flagella, although some spirilla without flagella possess motility. Multiplication occurs by simple fission or by spore formation.

STRUCTURE.—The bacteria are small masses of protoplasm surrounded by a gelatinous envelope, the protoplasm containing albuminoid matter, fats, salts, and water. Pigments are found in many of them, giving the cell a characteristic colour. Many of the bacteria are motile, their motility mostly depending upon the possession of long threadlike appendages, the flagella, the recognition of which requires special staining methods. The flagella may either be grouped at the ends of the bacteria or may extend all round. When terminal, they may be single.

Higher Bacteria

These differ from the lower forms in consisting of definite filaments resembling the mycelium of the moulds. The terminations of the filaments in some of the higher forms produce chains of cocci-like



Collings, p. 1.

FIG. 1.—STAPHYLOCOCCI IN PUS.

bodies which are capable of reproducing the organism. They differ from true spores in their staining reactions and their low-resisting powers to adverse circumstances.

The most important of the pathogenic higher bacteria is the streptothrix group, to which the *Streptothrix actinomyces*, the cause of actinomycosis, belongs. Some authorities also include the tubercle bacillus among the streptothrices.

MULTIPLICATION of the bacteria occurs by simple division or by spore formation. If the conditions of growth are favourable, division takes place very rapidly, many bacteria reaching maturity and dividing in half an hour; in twenty-four hours, therefore, about seventeen millions of bacteria may result from the presence of one organism. In other forms multiplication takes place more slowly. This is also the case

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when the conditions as regards food and temperature are unfavourable, and aberrant forms are frequently seen.

Spore formation only occurs in the bacilli and spirilla. It is indicated by the appearance in the body of the bacteria of a small refractile body, with special staining reactions. The remainder of the protoplasm of the organism disappears, and the spore is set free. It is capable of reproducing an organism similar to the mother organism if the conditions for growth are favourable. Two views are held as to the conditions under which bacteria form spores—viz., that (a) spore formation occurs when the conditions of growth are most favourable, during the height of development of the bacteria, and represents a resting stage of the organism; (b) spore formation occurs when the conditions of growth are unfavourable, and is a protective action of the bacterium. Spores are much more capable of withstanding adverse conditions, such as dryness, heat, cold, and antiseptics, than the bacteria; therefore the life of the organism is better preserved. Spores have been known to retain their vitality for over a year in the dry condition; this vitality is probably due to the tough character of their enveloping membrane. In practical surgery it is important to remember that the spore-bearing bacteria take longer to kill by boiling and by the action of antiseptics than the non-sporing bacteria.

Condition of Growth.—Except in the case of healthy men and animals, the bacteria are of almost universal occurrence, but only a small minority are pathogenic—i.e., capable of producing disease in man. In order to grow, they require a food-supply, moisture, and a certain temperature.

Food.—The bacteria break up organic matter into simpler constituents, and require chiefly nitrogen and compounds of carbons. From the point of view of surgery, two classes can be distinguished—the *saprophytes*, which live on dead organic matter, and the *parasites*, which invade the body and produce disease. No hard-and-fast line can, however, be drawn between these two classes of bacteria. Organisms, which are normally saprophytic, can under certain conditions produce pathogenic effects. It is also quite possible that certain parasites are derived from saprophytes.

Moisture.—All organisms require moisture for their growth, the majority of the pathogenic bacteria being killed by a few days' drying. Spores resist drying for much longer than the bacteria, anthrax spores living for over a year in the dry state.

Temperature.—Each organism has a temperature at which its growth is most active, and this is spoken of as the "optimum" temperature. For the pathogenic bacteria the optimum temperature is about the body temperature—viz., 98.7° F. If the temperature rises or falls much above or below the optimum temperature, growth ceases, and the bacteria are ultimately killed. Heat is more harmful than cold. Spores resist extremes of temperature for a longer period than the bacteria.

THE PRACTICE OF SURGERY

Oxygen.—Oxygen plays an important part in the growth of bacteria, which, from their behaviour to it, may be classified into—

1. Obligate aerobes. These organisms can only grow in the presence of free oxygen.
2. Obligate anaerobes. Growth is inhibited by the presence of free oxygen.
3. Facultative anaerobes. These organisms grow better with free oxygen, though they are capable of existing without it.

Light.—Direct sunlight has a deleterious effect upon certain bacteria and their spores. Anthrax spores are killed in one and a half hours of direct exposure to sunlight, and the typhoid bacillus in about the same time. A powerful electric light has the same effect, and is therefore used in the treatment of skin lesions due to the tubercle bacillus (see *Lupus*, p. 398).

Products of the Metabolism of Bacteria.—Many bacteria produce *ferments* which are capable of changing complex insoluble substances, as albumin and starch, into soluble peptones and sugars, thus acting in the same way as the digestive ferments of the alimentary canal. The process is usually carried to a further stage than in digestion, and simpler products are produced. This peptonizing action of bacteria is utilized as a means of distinguishing the various organisms. A growth is made on a gelatin medium which is liquefied by certain of the bacteria.

Besides producing the ferments which act locally in liquefying the tissues, the bacteria produce toxins or poisons which, by absorption into the body, produce the general symptoms of disease. These toxins are produced by the saprophytes as well as by the parasites, and may be introduced into the body by the food, causing the condition spoken of as "ptomaine poisoning."

These toxins may be divided into two groups—the *intracellular*, which are found in the bodies of the bacteria, and the *extracellular*.

Intracellular toxins are present in the tubercle bacillus. The lesions of this disease may be produced by the injection of the dead bodies of the bacilli, the toxins acting in the same way as the organisms.

Extracellular toxins may be studied by growing the bacilli in culture media, and then killing the bacteria by heat, or by removing them by filtration. The most important are the toxins of tetanus and diphtheria.

The products of bacterial growth are inimical to the bacteria producing them, and if they are not removed, growth ceases and the bacteria die.

Attenuation of Bacteria and Death.—If deleterious influences, as excess of sunlight, absence of moisture and the use of antiseptics, are allowed to act on cultures of bacteria, the organisms become weakened or attenuated, and the pathogenic bacteria may, partly or completely, lose their virulence. Cultures of these attenuated bacteria are employed for the purpose of producing an artificial immunity against infectious diseases (see later).

If the deleterious influences act too intensely or for too long a period, the organisms die, death being judged by absence of growth when the bacteria are transferred to a fresh medium under suitable conditions for growth.

Bacteria may be killed by—(1) absence of food and moisture, (2) exposure to the direct rays of the sun or to a powerful electric light, (3) by the presence of antagonistic bacteria, (4) failure to remove the products of their activity, (5) exposure to abnormally high or low temperatures, and (6) the presence of certain chemicals spoken of as antiseptics. Spores are more resistant to all varieties of deleterious influences than bacteria.

The most effective way of destroying bacteria is by subjecting them to the action of boiling water or super-heated steam. Either of these requires from five to fifteen minutes to kill most of the pathogenic bacteria and their spores; dry heat at a temperature of 284° to 320° F. requires three hours to kill the same bacteria.*

Methods of studying Bacteria.—The methods of studying bacteria are—microscopical examination combined with various staining methods, cultivation, and inoculation into susceptible animals.

MICROSCOPICAL EXAMINATION.—The organism can be examined alive or dead in fluids, in film preparations, or in sections of tissue; and in the last two methods advantage is taken of the affinity of the bacteria for stains.

The stains most commonly used are basic aniline dyes, which stain both the bacteria and the cell nuclei. A classification of bacteria is made on their ability to retain stains in the presence of certain decolorizing agents.

GRAM'S METHOD.—After the organism has been stained with gentian violet, and treated with Gram's solution (iodine, 1 part; potassium iodide, 2 parts; and water, 300 parts), absolute alcohol is added, when certain of the bacteria retain the stain and are spoken of as "Gram-positive," and others become decolorized and are termed "Gram-negative."

DECOLOURIZATION BY ACID.—After the organism has been stained with an aniline dye such as carbol fuchsin, it is treated with 25 per cent. sulphuric acid. If the colour is retained, the organism is called "acid-fast." The best known acid-fast pathogenic bacillus is tubercle. Flagella and spores require special methods of staining for their demonstration.

CULTIVATION.—Bacteria can be cultivated on artificial media, both solid and fluid, and can be identified by the appearance and behaviour of the growth. Some bacteria can be recognized by the colour or shape of the colonies, some by their ability or inability to grow in the presence of free oxygen, and some by the special media—*e.g.*, blood-serum required for their growth. In the case of some organisms, a gelatin medium is liquefied, while in others it remains unchanged.

* Under experimental conditions spores may resist the action of boiling water for hours. Boiling can be made more efficacious by adding 2 per cent. lysol to the water.

Cultivation on solid media is also an excellent method of separating the various bacteria in a mixed infection, and is essential for the proper carrying-out of inoculation experiments.

INOCULATION.—A susceptible animal, after being inoculated with the fluid removed from the diseased tissue or from a culture of organisms grown on an artificial medium, is carefully watched. When the animal dies, an autopsy is carried out as soon as possible, and the tissues examined for the obvious signs of disease; or part of the organs are removed for cultivation of the organism or for microscopical examination. Inoculations are made subcutaneously, intraperitoneally, and intravenously.

Mode of Action of the Pathogenic Bacteria.—The bacteria produce disease in the human body mainly in two ways—(1) by the entrance and growth in the body of the organisms, (2) by the production of toxins which are absorbed into the body, leading to a general poisoning of the tissues.

1. The mode of entrance of the organism into the body in surgical diseases is almost invariably through a wound, which, however, may be very minute. When the organism gains entrance and finds the conditions suitable for growth, it multiplies locally, producing a definite local reaction by the products of its activity. This local reaction is always of an inflammatory nature, but its degree varies considerably with the different organisms. For example, infection with the tetanus bacillus leads to very little local reaction, while the diphtheria bacillus and the streptococci cause very marked local inflammatory changes. If the inflammation is severe, the peptonizing action of the bacteria may be brought into play, and the insoluble proteids changed into soluble peptones, so that the tissues are liquefied. Peptonization may also be brought about by ferments set free by the destruction of the leucocytes. This peptonization occurs in the formation of pus.

The organism may remain local, spreading only by continuity of tissue, and producing a *local infective disease*; or it may enter the blood-stream, being carried to the various organs and causing a *general infective disease*. In the latter cases, the organisms may be cultivated from the blood-stream. On post-mortem examination, large numbers of the organisms may be seen lying in the capillaries of the various organs of the body. If the organisms are stationary in any of the tissues of the body, a secondary inflammatory lesion is produced, which, in the case of certain bacteria, may end in suppuration.

2. The toxins occasioned by the growth of the organisms in the body are produced partly by the direct action of the bacteria, and partly through the medium of ferments. These toxins, circulating in the blood, cause cloudy swelling, followed by fatty degeneration of the secretory cells of the various organs, and if these changes are severe, death follows. Capillary hæmorrhages may also be present, especially in the subserous and submucous tissues and in the skin. Certain toxins, as those of diphtheria and tetanus, have a special affinity for the central nervous system, where they produce degenerative changes.

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In chronic forms of toxæmia, hyaline or amyloid change occurs in the walls of the arterioles.

The most striking and constant symptom following toxic absorption is fever, with its disturbances in metabolism and disorganization of the functions of all the organs in the body. Many of the specific bacteria, however, produce toxins which act chiefly on one of the tissues of the body, producing corresponding specific symptoms—*e.g.*, the muscular convulsions due to the specific action of the tetanus toxin on the motor cells of the brain and spinal cord.

IMMUNITY.

Power possessed by the Animal Organism of protecting itself against

Bacteria.—So far, the bacteria and their action have been alone considered; it is now necessary to consider the body in which the bacteria grow and produce their deleterious effects. As these organisms are constantly present on the surface of the body, on the mucous membranes, in the inspired air, and in the food taken into the stomach, how is it that infection is not constantly occurring in every individual? And how, after the organisms have once gained entrance into the body, is their growth checked, the organisms destroyed, and the effects of their toxins removed?

The healthy body possesses various means of rendering itself immune against the entrance of bacteria, and this immunity may be natural or acquired.

Natural Immunity is that form of immunity which is present in the body at the time of birth, and is *perhaps* inherited from ancestors, who themselves have suffered from bacterial diseases. This natural immunity, which may be absolute or relative, varies with (1) the variety of the organism, (2) the race of the individual, and (3) the individual, his age, and environment.

1. *Variety of the Organism.*—Natural immunity from the attacks of any bacteria may be absolute, one of the best examples being the immunity of the great majority of the lower animals from the gonococcus. In man the immunity from the pathogenic bacteria is, of course, relative; some diseases, as diphtheria, being relatively easy to inoculate and acquire, while others, as leprosy, are acquired with great difficulty.

2. *Race of the Individual.*—Relative immunity from the various bacterial diseases varies with the race of the patient. Tetanus and tuberculosis are more virulent in the negroid than in the white races, though no race is absolutely immune from any of the pathogenic bacteria.

3. *Individual.*—Every individual varies in his degree of immunity to the various bacteria, and this depends to some extent on his family history. Certain individuals cannot be inoculated with vaccinia, while the degree of reaction to vaccination varies considerably in different individuals. The variability of immunity from the tubercle bacillus

has been carefully studied, and it is known that the members of certain families are particularly prone to infection by this organism, while members of other families appear to be almost immune. This natural immunity from bacterial invasion may be considerably modified during life, the danger of infection being greater under certain conditions. These conditions may be general or local:

(1) *General Conditions diminishing Immunity.*—Malnutrition, associated with bad hygienic surroundings and deficiency of food in quality or quantity, is a powerful factor in lowering the resistance to attacks of organisms. Individuals who are transferred from the country to towns, and live in unhealthy surroundings, become more prone to invasion by the tubercle bacillus. A temporary lowering of the vitality from starvation or unhealthy conditions of life also lowers the standard of immunity.

Exposure to cold and damp, in some way not yet explained, predisposes to invasion by the pneumococcus and the organism of rheumatism. The administration of an anæsthetic also is sometimes followed by a pneumonic infection.

Chronic poisoning of the tissues by alcoholism, lead, etc., diminishes the natural immunity from bacterial action. Various general diseases, as diabetes, anæmie, chronic nephritis, and the cancerous cachexia, have the same effect.

(2) *Local Conditions diminishing Immunity.*—The most important of these are injury and chronic inflammation. Injury of a part diminishes its vitality, thus making it more prone to bacterial invasion. The extravasation of blood that is frequently associated with injury is also an important factor. This extravasated blood forms a culture medium for the growth of the bacteria, and is a means of localizing disease.

Chronic inflammation of a tissue, due to the presence of one organism, often lowers its resistance to the attacks of another organism. For example, lymphatic glands which are already chronically inflamed are predisposed to invasion by the tubercle bacillus, and a broncho-pneumonia associated with measles often becomes tuberculous.

The age of the individual plays an important part in natural immunity, young subjects being much more susceptible to the infectious fevers, such as measles, scarlet fever, and diphtheria, than adults. In early life infections of bones and joints with the staphylococcus and the tubercle bacillus are much more common than in adult life.

Cause of Natural Immunity.—The cause of natural immunity, both absolute and relative, is unknown. The modern theory is that it is due to certain bodies circulating in the blood-plasma which are inimical to the growth of the organisms. What these bodies are, or even their nature, is not known, though it is assumed that they are the products of activity of the cells of the body. Whether these constituents of the blood-plasma have a specific action against the various bacteria, or whether they are inimical to the growth of all bacteria, is a matter of dispute.

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important bearing on natural immunity. It is believed by some authorities that if the dosage is very big, and the natural immunity lowered, organisms usually non-pathogenic may become pathogenic, and cause a general infection. The natural immunity of animals cannot be used as a therapeutic agency, for it has been found that inoculation of the serum of an immune animal into a susceptible animal does not confer immunity.

Acquired Immunity.—It has been seen already that when bacteria gain entrance into the body, they produce poisons (toxins) which act on the cells of the various organs, causing degeneration of them, and that it is the absorption of toxins that causes the general symptoms of infection. If this process were uninterrupted, bacterial infection would invariably lead to the death of the patient. It is necessary, therefore, to consider the conditions that bring about recovery.

The presence of bacterial and other toxins in the body stimulates the tissues to produce chemical substances which are able to neutralize the action of the toxins, and these substances are specific for the infecting bacteria. The new bodies are poured into the blood-serum, and enter into chemical combination with the toxins, producing inert substances, and the general symptoms disappear. These antibodies are of various kinds. In addition to those which neutralize the toxins, there are others which are inimical to the growth of the infecting bacteria, and so bring about their death. The dead and dying bacteria are then ingested by the leucocytes which have been brought to the site of infection by the local inflammatory reaction due to the presence of the bacteria. The bacterial invasion is then over.

In those cases which end in the death of the patient, the production of toxins is so rapid that death occurs from toxæmia before the tissues have time to form antibodies in sufficient quantity; or the bacteria are so virulent or abundant, and the resistance of the patient's tissues is so lowered, that the bacteria invade the blood-stream, and grow in every part of the body (general infection).

Recovery from an infectious disease depends, therefore, upon the production by the tissues of antibodies to the specific bacteria present. After recovery, the blood-serum contains a large number of these antibodies, and the patient is immune from further attacks of the disease. This immunity is spoken of as *active immunity*, and is acquired by the activity of the tissues of the patient in response to the presence of the toxins of the particular bacterial disease from which he is suffering. The length of time these antibodies remain in the blood varies with the different diseases. In the case of measles, smallpox, scarlet fever, and the other exanthemata, the immunity generally lasts for some years; but with the pneumococcus, staphylococcus, and other pyogenic organisms, and the tubercle bacillus, the immunity is of very short duration.

The antibodies produced by the tissues owing to the stimulation of the toxins are of various kinds, but two of them are of special interest to the surgeon—viz., antitoxins and opsonins. The *antitoxins*, as their name implies, are concerned in the neutralization of the toxins, and are produced mainly through the stimulus of the extra-

cellular toxins. The *opsonins*, on the other hand, are chiefly concerned in preparing the bacteria for ingestion by the phagocytes.

Opsonins.—The blood-serum of all healthy individuals contains, practically, the same amount of opsonin. If the tissues are invaded by a micro-organism, it will be found that the amount of protective substances present in the blood-serum at first falls (negative phase). This fall is then succeeded by a rise in the protective power (positive phase), due to the production of opsonins. So far, it has not been possible to isolate and estimate the amount of opsonins in the blood-serum, but the protective power of the blood can be estimated in the following manner:

An emulsion of living leucocytes, free from blood-serum, is obtained from a healthy person, and a pure culture of the organism under investigation. Two samples of blood-serum are taken, one from a healthy person (for a control), and one from the patient whose blood is being investigated. The healthy leucocytes and the bacteria are added to the two specimens of serum, which are then incubated at body temperature for fifteen minutes. A microscopical film is next prepared from each specimen, and examined under the microscope. In each specimen, some of the bacteria will have been ingested by the leucocytes. A count is made in each case of the number of bacteria ingested by a certain number of leucocytes (50 to 100), and the two figures obtained are expressed as a fraction, which is termed the *opsonic index* of the patient's serum for the particular bacterium under investigation. For example, if the tubercle bacillus is used, and in the normal serum 100 leucocytes have ingested 300 bacteria, and with the serum being investigated the leucocytes have ingested 240 bacteria, the patient's opsonic index for tubercle is $\frac{240}{300} = 0.8$; while if the leucocytes in the patient's serum have ingested 500 bacteria, the opsonic index will be $\frac{500}{300} = 1.6$.

The following deductions would be drawn from such an investigation — that the patient is suffering from tuberculosis, and in the first case the patient's serum had been investigated in a negative phase, and in the second case in a positive phase.

Experimentally, it has been found possible to establish an active immunity in the following ways:

1. By inoculating the bacteria of the disease into a susceptible animal, causing it to suffer from the disease.
2. By inoculating into a susceptible animal either the bacteria in an attenuated form (see p. 4), or a mitigated virus of the disease. This is done in the prevention of smallpox (vaccination) and hydrophobia.
3. By injection of dead cultures of the organism.
4. By injection of the extracellular toxins of the bacteria. This last method is not used therapeutically, but in the preparation of actidiphtheritic and antitetanic sera.

Passive Immunity.—The serum of an animal who has suffered from certain of the bacterial diseases, such as diphtheria, or who has been

rendered actively immune to a bacterial invasion by one of the methods mentioned above, contains a large quantity of the specific antitoxin to that disease. If this serum is injected into a second animal, so that its blood-serum receives the antitoxin, the second animal will be rendered immune to attacks of the particular bacterium for a certain length of time. (In diphtheria the period of immunization is about two months.) The second animal will have acquired an immunity from the disease passively, this immunity being spoken of as *passive immunity*, in contrast to the active immunity acquired by the activity of the tissues in the case of the first animal.

The production and use of diphtheritic antitoxin affords an excellent example of the two forms of immunity. A horse is injected with a non-lethal dose of a culture of diphtheria bacilli from which the organisms have been removed by filtration—*i.e.*, it is injected with the extracellular toxins of diphtheria. The temperature of the horse rises, and it suffers from poisoning by the toxin, but after a short period the tissues respond to the stimulus of the toxin, and produce diphtheria antitoxin, which neutralizes the toxin, and the symptoms then subside. Fresh injections are subsequently made with stronger and stronger doses of toxin, so that ultimately the blood-serum is flooded with antitoxin. The horse has now become *actively immune*, and is able to tolerate a large dose of toxin, which in the unprotected state would have been fatal.

If the immunized serum is taken from the horse, and injected into a human being, he becomes *passively immune* from diphtheria by virtue of the antitoxin contained in the horse's serum.

THERAPEUTIC USES

These facts and theories of immunity are made use of in the prevention and treatment of disease.

Prevention

1. *Natural Immunity*.—It is not possible to establish immunity from a disease in an animal by the injection of the serum of an animal which is naturally immune from that disease. On the other hand, a relative natural immunity from disease may be maintained by avoiding those conditions which break down such immunity. Practically the whole of modern personal hygiene and the rules for a healthy life tend towards the maintenance of the body in the best possible manner to withstand the attacks of bacteria—*i.e.*, to maintain the natural immunity from disease.

2. *Active Immunity*.—Acquired immunity in the prevention of disease is used in the following ways:

(a) The patient is inoculated with a culture of attenuated organisms or the attenuated virus of the disease, so that he suffers from a mild attack of the disease, being protected for a certain period against a natural infection. This method is used in the preventive treatment of smallpox by vaccination, and of hydrophobia by Pasteur's treatment.

(b) The patient is injected with dead cultures of the organism; he therefore receives both the intracellular and extracellular toxins. There is a local inflammatory reaction associated with a rise of temperature and general malaise. The patient is subsequently found to be relatively immune from the disease. This method is used in the preventive treatment of plague and typhoid fever. Two or three injections of increasing strengths are used. It is also used before operations in which infection by bacteria—*e.g.*, *Bacillus coli communis*—is feared.

3. *Passive Immunity*.—A patient is rendered passively immune by the injection of a dose of serum obtained from an actively immunized animal. This method is used in the prevention of diphtheria and tetanus, the two diseases in which extracellular toxins play such an important part.

Curative Serum Therapy

1. *Vaccines*.—The term "vaccine" applied to bacterial disease means a sterilized culture of the dead bacteria causing the disease, containing their intracellular toxins.

At first sight it would appear irrational to inject into a patient who is suffering from a bacterial disease an emulsion of the dead bacilli with their intracellular toxins; but if the effects of the injections are examined by means of the opsonic index, the following train of events is found to occur:

After the injection (which causes a slight local inflammatory reaction), the patient's temperature rises, and he suffers from general malaise. If the blood-serum is examined, the opsonic index is found to be low (negative phase), the serum being less antibacterial. This is succeeded by a rise in the opsonic index (positive phase), at which the serum becomes more antibacterial.

If a second injection is given during the *negative phase*, the index falls still lower; and if the injections are repeated in this phase, the protective power of the serum is so far lost that there is grave danger of a local infection becoming general, and death following. On the other hand, if the injection is given just before the height of the *positive phase*, after a slight fall the index rises still higher, and if the injections are continued in this phase, the protective power of the blood-serum is steadily increased. The bacteria are then more readily ingested and removed by the phagocytes, cure of the disease resulting. This may be represented in graphic form (see p. 13).

These experiments show that the antibacterial power of the blood-serum can be increased by giving injections of the dead bacteria causing the disease if the injections are repeated at the proper time and in proper doses. The dose of the dead bacteria given varies with each organism, some cases requiring as much as 500,000,000. The best source of the vaccine is from a culture of the organism obtained from the patient. As these cultures are somewhat difficult to prepare, and time is also required for their growth, stock vaccines may be used, but they are not as efficacious. The culture must be carefully sterilized, and the dosage accurately measured.

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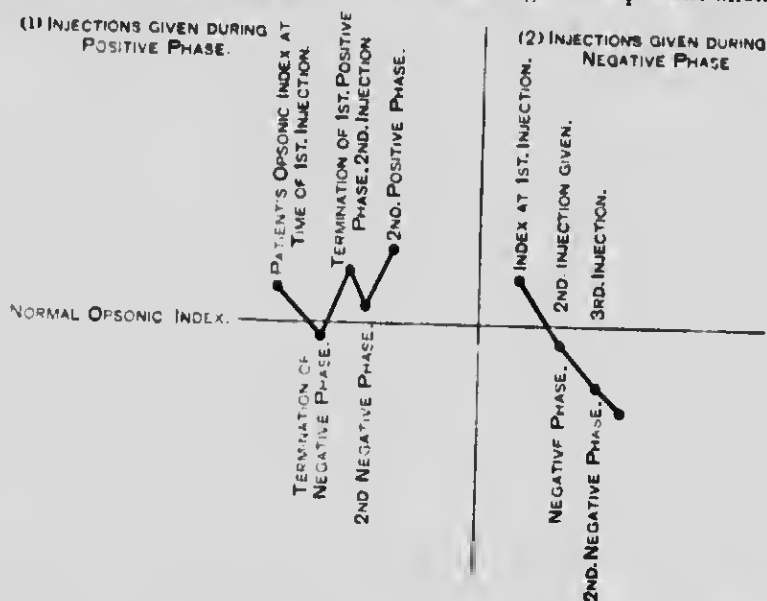
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the injections were carefully controlled by examination of the opsonic index; but with increasing experience it has been found safe to dispense with this examination, controlling the injections by the clinical aspects (temperature, pulse, etc.) and the experience of the operator.

The use of these injections, as has been shown above, is not without danger, and at present this form of treatment should be largely left in the hands of specialists, more especially as the preparations of vaccines and estimation of dosage requires expert knowledge.

In the case of mixed infections, a vaccine prepared from the dominant organism should first be used, and after this has been removed, vaccines prepared from the other organisms present should



be given. The vaccine method of treatment is most useful in cases of infection by tubercle, staphylococcus (boils, carbuncles), *Bacillus coli*, gonococcus (gleet, arthritis), and the pneumococcus.

2. **Antitoxin.**—An antitoxin, as already explained, is a chemical substance which will enter into combination with the toxins of bacteria and render them inert. The preparation of these antitoxins has been described.

Therapeutically, antitoxins are given in large doses, and it is important that they should be given early in the disease before degeneration of the cells is advanced. They may be administered subcutaneously or intravenously, the latter being the better method, for the antitoxin is thus more rapidly brought into contact with the toxin, and a speedier effect is produced. In the case of tetanus antitoxin, the injection is sometimes made into the cerebro-spinal fluid or into the nerve trunks.

It has not been found possible to prepare antitoxins for the intracellular toxins, and at present antitoxic sera are only known for diphtheria and tetanus.

These antitoxins are prepared commercially, and sold in sealed tubes. For subcutaneous injection the skin is cleaned as for an operation, and the injection made by means of a sterilized syringe, the serum being drawn directly from the tube. Intravenous injection is made into a vein in the arm after the skin has been sterilized. The serum must be warmed to the body temperature. Care should be taken that there is no air in the syringe. The injection is made by thrusting the needle of the syringe directly into the vein.

After-Effects.—The antitoxin contained in the serum is non-toxic, but the injection of the serum itself may be followed by a train of symptoms termed **serum disease**. The incubation period varies from a week to a fortnight, and the chief symptoms are rise of temperature with general malaise, skin rashes, the most common being an urticaria with œdema and intense itching of the skin, pains in the joints, and enlargement of the lymph glands. In some cases the rash resembles scarlet fever, in others measles. On examination of the blood a leucocytosis is found to be present. The symptoms disappear in a few days, and beyond rest in bed, no treatment is necessary. The preventive treatment of serum disease consists of giving 10 grains of calcium lactate three times a day from the third to the sixth day after the injection of the serum.

Antistreptococcic Serum.—Antistreptococcic serum is certainly not an antitoxin, but it is claimed to be antibacterial. As there are many different strains of streptococcus, a serum is prepared by inoculating a horse with many varieties of streptococcus. A serum prepared in this way is termed "polyvalent," and should always be used if antistreptococcic serum is given. The serum has very little antibacterial power. If it does possess any it is probably due to its action as a vaccine. Vaccine treatment, the vaccine being prepared from the streptococcus obtained from the patient, has superseded the use of this serum.

Antipneumococcic Serum.—The same remarks apply to this serum, and it is little used therapeutically.

Sclavo's Serum.—This serum is used in the treatment of anthrax, and acts probably by inducing a defensive phagocytosis. It is more antibacterial than antitoxic. Its use is considered on p. 100.

The use of vaccines and antitoxins is, of course, an adjunct to other forms of medical and surgical treatment, and should not replace them. Vaccines are particularly useful in cases of chronic infection, and shorten considerably the time occupied in the healing of a sinus, or in bringing about cure of a chronic inflammation of a mucous membrane. They have also been found useful in the treatment of septicopyæmia and some of the specific fevers.

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the foetus can occur through the placenta, though it is probable that in every case the placenta is first diseased or injured; the healthy placenta will not transmit organisms. In the case of the *Spirochæta pallida*, it is probable that in many cases infection of the foetus from the mother occurs at birth during the time that the placenta is separating.

HYPOMYCETES, OR MOULDS

The moulds consist of two distinct parts, a mycelium and the hyphæ. The mycelium is a mass of branching and jointed threads, which anastomose with each other to form a feltlike network in the nutrient medium. The hyphæ spring from this mycelium and bear spores, by means of which the mould is reproduced.

The moulds are found on all kinds of dead substances, and they can be grown on almost any kind of medium, to which acid should be added, as they have an acid reaction, and the presence of the acid prevents the growth of bacteria. Oxygen is essential for their growth. The most important of the moulds causing disease in man are—

Oidium albicans, growing on mucous membranes and causing thrush.

Achorion Schönleinii, the cause of favus.

Tinea microsporon and *T. trichophyton*, giving rise to the various forms of ringworm, including the *Microsporon furfur*, the cause of *pityriasis rubra*.

Some forms of *aspergillus*, which are capable of growing in the lungs (*pneumomycosis*), in the external auditory meatus (*otomycosis*), and on the cornea (*keratomycosis*).

BLASTOMYCETES (YEASTS)

The yeasts consist of oval cells of different sizes, which multiply by budding out daughter cells. The majority of them are capable of changing grape-sugar into alcohol and carbonic acid—i.e., causing fermentation.

In man they may be found in the fluid which collects in a dilated stomach; a skin lesion, *blastomycetic dermatitis*, is attributed to them.

MYCETOZOA, PROTOZOA, TRYPANOSOMES

These organisms are the lowest forms of animal life, and consist of one cell containing a nucleus. They are frequently motile, either by means of flagella, or by pulling out and drawing in protoplasmic processes (pseudopodia). The most important of these organisms which are pathogenic to man, are, the *Spirochæta pallida*, causing syphilis; the *plasmodium* of malaria; the *ameba*, causing one form of dysentery; and the *trypanosomes*, causing sleeping-sickness and other forms of tropical diseases.

These organisms cannot be cultivated on artificial media.

CHAPTER II

INFLAMMATION

INFLAMMATION is the series of changes that occur in a tissue which is injured, provided that the injury is not sufficient to cause death of the tissue; or, more simply, it is *the reaction of tissue to injury*. These changes vary in degree only, and not with the nature of the injury nor with the tissue injured. The changes in the tissues that take place in an inflamed joint due to a wrench are precisely the same as arise in the joint if the inflammation is due to infection by the gonococcus, although the termination of the two conditions may be different. Variation is only in degree and chronicity. In the same way the reaction of the tissues of the liver to injury is precisely similar to the reaction of the tissues of the central nervous system or the reaction of the muscular tissue.

CAUSES.—The causes of inflammation may be divided into *exciting* and *predisposing*.

The *exciting* causes may again be divided into two groups—non-microbic and microbic.

The *non-microbic* causes of inflammation include mechanical trauma, heat, cold, electricity, the effects of altered metabolism, as in gout, and possibly abnormal internal secretion. From a clinical point of view, they may be considered as *trauma*, *gout*, and an indefinite group of conditions commonly referred to as *rheumatism*. There can be no doubt that many of the conditions classed under this last heading are microbic in origin, but it is not possible to prove this in every case, and the organism even of acute rheumatic fever has not yet been isolated.

Microbic causes of inflammation include all the pathogenic microorganisms. It is not the mere entry of these organisms into the body that excites inflammation, but the production of toxins owing to their growth or destruction. It often happens that inflammation is started in a tissue by trauma, but that subsequently it is invaded by microorganisms, and the cause of the inflammation changes.

Predisposing causes of inflammation may be divided into general and local. The most important general causes are—

1. The age of the patient. Generally speaking, young subjects are more liable to inflammatory processes than patients who have passed the period of growth.

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2. The general state of health of the patient. Subjects who are debilitated in health from any cause are more susceptible to the attacks of organisms than those in vigorous health. Inflammatory processes are, therefore, more likely to occur.
3. Inherited tendencies. The vulnerability of the tissues to attacks of organisms largely depends on the inherited resisting powers of the patient. In many cases vulnerability to the attacks of certain organisms—*e.g.*, tubercle bacillus—is directly inherited, and the soil is almost, or quite, as important in the production of inflammatory processes as the bacillus itself.

Local predisposing causes are—

1. Previous inflammation. A tissue which has been previously inflamed, and in which some damage has already occurred, is much more liable to subsequent attacks of inflammation than healthy tissue. An excellent example of this is the appendix vermiformis, which, when it has once been inflamed, is almost certain to suffer from repeated attacks.
2. Chronic inflammation of a tissue predisposes that tissue to acute attacks of inflammation, and also to inflammatory conditions from other causes than the primary one. A patient suffering from a chronic epididymitis due to the gonococcus is liable to acute or subacute attacks, and the epididymis is more vulnerable to the tubercle bacillus than a healthy epididymis.
3. Active growth of the tissue. Inflammatory conditions in bone are most common in childhood during the period of active growth, the inflammatory condition generally affecting the juxta-epiphyseal bone when growth is most active.
4. Trauma. Mechanic injury is itself a cause of inflammation, but the inflammatory process is usually transient and, in cases of slight injury, unappreciable. It predisposes the tissue to invasion by micro-organisms, however, by offering a site of lowered resistance. Tubercular infection of the hip-joint in children is frequently preceded by a slight injury to the joint.
5. Exposure to damp and cold predisposes to inflammation probably by lowering the resistance of certain tissues to the invasion of micro-organisms.
6. Inherited predisposition. It is probable that, in addition to a general inherited predisposition to the attacks of organisms, there is also a local predisposition. The patient has certain tissues—the arteries, for instance—which are more liable to earlier degeneration and chronic inflammatory processes than the rest of the body. Some inherited weakness of a particular organ may make it more liable to invasion by certain of the micro-organisms, and inflammation is the result.

varieties.—Inflammation is divided into acute and chronic forms.

ACUTE INFLAMMATION

Pathological Histology.—The pathological histology is similar in every case of acute inflammation, and if the changes that occur in one tissue are known, the changes that occur in all tissues are likewise known. The reaction of the tissues to injury has been carefully studied in living tissue, and also by means of microscopic sections of portions of inflamed tissues, killed and fixed in every stage of inflammation, and our knowledge of the phenomenon of inflammation is fairly complete. The changes affect the blood-stream, the blood-vessels and their contents, the connective tissue, and the essential cells of the inflamed part.

1. **CHANGES IN THE BLOODVESSELS.**—As soon as a tissue is injured, there is a momentary contraction of the bloodvessels of the part. After this first spasm of the muscular coat, the vessels gradually dilate, and remain dilated until the inflammatory condition passes off, they then return to their normal size. In cases of severe inflammation, especially if the inflamed tissue is soft and vascular, the dilatation is so extreme that some of the vessels rupture, and the blood is extravasated. If a large number of the vessels of an inflamed part rupture, and the extravasation of blood is extensive, the condition is spoken of as a hamorrhagic inflammation.

2. **CHANGES IN THE BLOOD-STREAM.**—When inflammation arises in a tissue, the blood-stream is quickened at first, thus bringing, with the dilated vessels more blood to the part, and making it hotter and redder than usual. As the inflammation increases in severity, the blood-stream grows slower and slower, until it only oscillates forwards and backwards with the pulse-wave, and finally, in cases of severe inflammation, the stream stops. Four stages are therefore recognized: (1) Acceleration of the stream, (2) slowing of the stream, (3) oscillation, and (4) stasis. As the inflammation passes off, the order of these phenomena is reversed.

3. **EXUDATIONS**—(1) *Inflammatory Lymph.*—While the vessels are dilating, and the rate of the blood-stream changing, exudation of the contents of the bloodvessels is taking place. At first the exudation is the fluid part of the blood, and the character of this exudation varies with the acuteness of the inflammation, and to some extent with the cause. In mild inflammatory conditions the fluid exudate closely resembles blood-serum (serous exudate), and little or no coagulation takes place. In severe inflammation the exudate closely approximates to the blood-plasma, and, after leaving the vessels, the fibrinogen of the blood-plasma coagulates into fibrin, which is deposited in the tissues (fibrinous inflammation). In all cases this fluid exudate is called *inflammatory lymph*, and causes the inflamed part to become swollen and œdematous.

(2) *White Corpuscles.*—As soon as a part is inflamed, the white blood-corpuscles (mainly the polynuclear neutrophiles) tend to gravitate towards the sides of the capillaries at the edge of the blood-stream. As the blood-stream gets slower and slower, the white cor-

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puscles begin to cling to the walls of the vessels, finally becoming stationary. They then pass through the walls of the capillaries without breaking their continuity. This phenomenon is called *diapedesis*. Once free of the bloodvessels, the cells wander into the inflamed area, which becomes crowded with cells.

4. **CHANGES IN THE CONNECTIVE TISSUE.**—The exudation of inflammatory lymph and white blood-corpuscles causes the connective tissue to be swollen and cloudy. There is a degeneration, with multiplication of the fixed connective-tissue cells in the part. The bundles of fibrous tissue are swollen and indefinite, some of them even disappearing. The elastic fibres are also swollen and cloudy, and may disintegrate. In loose connective tissue the amount of swelling is extreme.

5. **CHANGES IN THE ESSENTIAL CELLS.**—The essential cells of the part—*i.e.*, liver cells in the liver, secretory cells in the kidney, etc.—undergo a change termed “cloudy swelling.” The protoplasm of the cell is swollen, and the granules indefinite and hazy. The nucleus is not so distinct as in normal cells, and the cells do not take up stains readily. If the inflammation is severe or prolonged, many of the cells disintegrate and disappear, and there is a certain amount of proliferation of the remaining cells. With the degeneration of these cells their functions are for the time being disorganized or in abeyance.

Symptoms of Acute Inflammation.—The symptoms of acute inflammation are divided into two groups—local and general.

The **LOCAL SYMPTOMS** depend on the pathological processes of inflammation, and are redness, swelling, heat, pain, and loss of function.

The *redness* and *heat* depend on the dilatation of the bloodvessels, and the increase of the amount of blood flowing into the part. *Swelling* is due partly to vaso-dilatation, and partly to the exudations from the bloodvessels. *Pain* results from pressure and inflammation of the nerve terminals in the swollen area, and *loss of function* ensues on the disorganization of the essential cells of the part.

These five symptoms are invariably present in every case of inflammation due to any cause and in any tissue; they vary only in degree. In deep-seated inflammation, however—*e.g.*, acute inflammation of the kidney—it may not be possible to demonstrate redness, swelling, or heat clinically.

The **GENERAL SYMPTOMS** of acute inflammation depend on the absorption into the blood of certain poisons or toxins, which are produced at the site of inflammation. These toxins circulating in the blood are carried to all the tissues of the body; there is therefore a general poisoning in which all the organs share, and which brings about a general disorder of function of the whole body. This absorption of toxins is associated with a rise in the body temperature, and the condition is spoken of as *fever*.

Two great groups of toxins may be recognized—(1) those produced by alteration and destruction of the body tissue, and (2) those produced by the growth or destruction in the body of micro-organisms.

1. In inflammatory conditions due to mechanical trauma it is

probable that the toxin which causes the general symptoms is fibrin ferment. This condition is spoken of as aseptic traumatic fever.

Aseptic Traumatic Fever.—The symptoms of this condition are a slight rise in temperature, increased pulse and respiration rate, headache, loss of appetite, and a feeling of general malaise. The condition lasts from twenty-four to forty-eight hours, and is typically seen in cases of simple fracture associated with considerable extravasation of blood. No special treatment is necessary, but after a severe accident or operation the patient should be confined to bed, put on a light diet,

and given an aperient in order that the bowels may be well opened.

2. When inflammation depends on the invasion of the tissues by micro-organisms, the general symptoms of inflammation depend on the absorption into the bloodstream of toxins produced by the organism. These toxins are being constantly manufactured at the site of the lesion, and constantly absorbed into the blood; therefore the symptoms continue until the organisms are destroyed or until the products of their activity are directly conveyed outside the body.

The symptoms produced by these toxins are spoken of as **infective fever**, and if due to one of the organisms that commonly infect wounds and produce pus, septic traumatic fever or non-specific infective fever. The symptoms of non-specific infective fever are

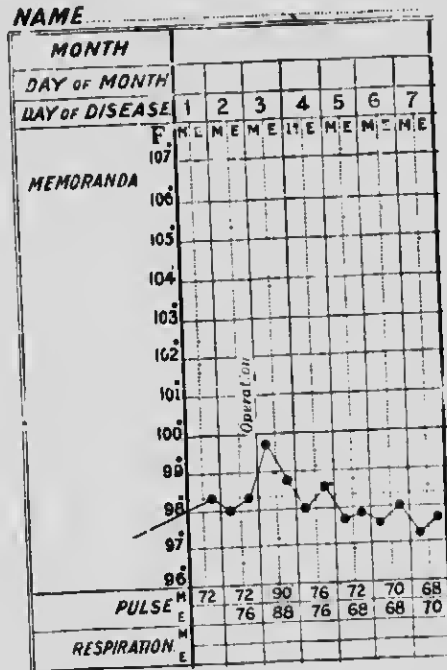


FIG. 2.—TEMPERATURE CHART OF AN OPERATION FOR HERNIA THAT HEALED BY FIRST INTENTION (ASEPTIC TRAUMATIC FEVER).

similar to those of aseptic traumatic fever, but are usually of much greater severity and longer duration. They are—rise of temperature, often associated with rigors; increased pulse and respiration rate, with increasing weakness of the heart's action; constipation, or in some cases diarrhoea; hæmolysis resulting in anaemia and a sallow tint to the skin; dryness of the skin, or excessive sweating; rapid wasting and loss of strength; dry tongue; and loss of appetite and power of digesting food. The urine is scanty and high-coloured, sometimes containing a trace of albumin. Delirium or mental confusion are often present. An examination of the blood shows a leucocytosis (see p. 206).

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If the absorption of toxins continues and is severe, the pulse becomes still more feeble, and loss of muscular strength still more pronounced. The patient sinks down into the bed, urine and faeces are passed involuntarily, the mind is clouded, desire for food is completely lost, the tongue is dry and furred, and sordes collect on the teeth. This condition, sometimes spoken of as the "typhoid state," is usually a forerunner of death.

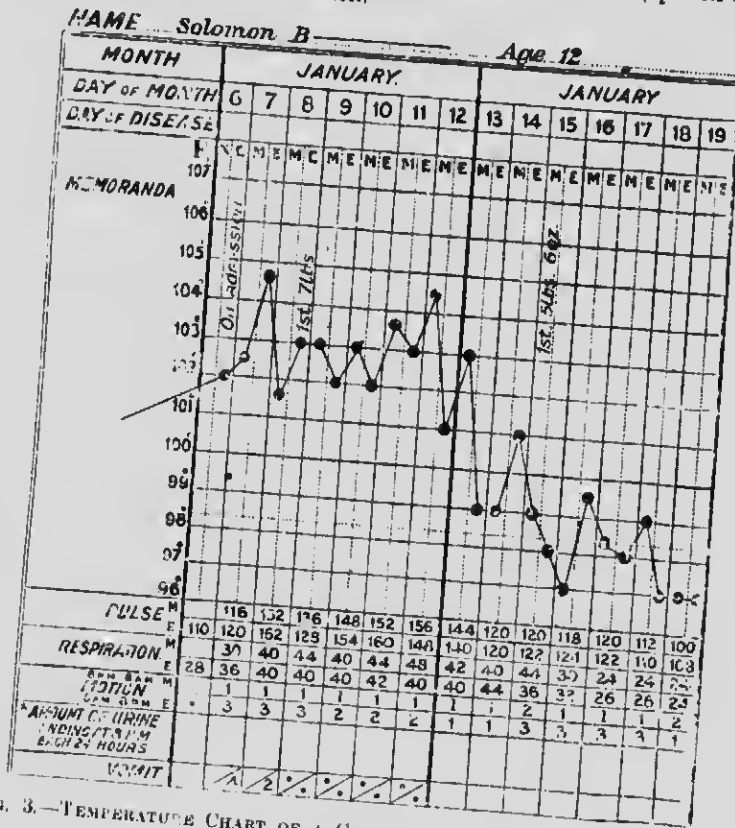


FIG. 3.—TEMPERATURE CHART OF A CASE OF ACUTE INFECTION WITH FALL BY LYSIS.

These general symptoms of inflammation vary in degree with the organism causing them, the extent of the inflammatory process, and the resistance of the patient. In such a condition as puerperal septicemia, in which absorption of virulent toxins is taking place from the large vascular placental site, the symptoms are very severe, and the typhoid state is reached in a day or two; while in infection by tubercle, the general symptoms are often so mild as to pass almost unnoticed, and the condition lasts for years.

Treatment of Acute Inflammation.—The object of the treatment of acute inflammation is to bring about resolution—that is, a return

of the tissue to its normal condition—when the phenomena of inflammation will disappear, and leave no after-effects. Like the symptoms, treatment is divided into two parts, general and local.

GENERAL TREATMENT consists of—(1) Rest under the best hygienic conditions, (2) a light and nutritious diet, (3) attention to the natural functions, (4) use of drugs, and (5) serum therapy.

1. *Rest under the Best Hygienic Conditions.*—In the majority of cases of acute inflammation with high temperature and general toxæmia, the patient must be kept in bed in order that the whole of the body is rested and no energy used. It is obvious that attention should be paid to the maintenance of the room at a proper temperature (65° F.) and to the general sanitary surroundings. Fresh air and sunshine are important factors in the maintenance of health and the curing of organismal disease; the more healthy the surroundings of the patient, the better chance he has of combating the effects of the toxins produced at the site of inflammation.

2. *Diet.*—The increased metabolism of the tissues associated with the rise of temperature demands a corresponding increase in the food supplied; but the stomach and alimentary canal share in the general toxæmia, being unable to assimilate the food that is taken in health. The diet, therefore, must be of a kind that is easily digested and yet of high nutritive value; milk, eggs, albumin water, and concentrated meat juices are all good. These should be given freely as long as they are digested and absorbed. Water may always be given.

3. *Attention to the Natural Functions.*—The bowels should be kept well open by means of aperients; and the kidneys, the great channels for the excretion of toxins from the blood, should have their action increased by the use of diuretics. If the skin is dry, diaphoretics to increase the amount of sweating may be used. Sleep should be obtained by the use of anodynes to relieve pain, and, if necessary, by the giving of hypnotics: absolute rest and quiet will often relieve mental confusion and delirium.

4. *Use of Drugs.*—Drugs, except for the above rational use in the treatment of symptoms, are at present little used in the treatment of acute inflammation. In inflammation due to certain causes drugs are used empirically, as in the treatment of acute gouty arthritis by colchicum, or in the treatment of rheumatic arthritis by salicylates. In a few cases drugs are known to destroy the micro-organisms causing the inflammatory condition, such as mercury or salvarsan in the treatment of syphilitic inflammation.

5. *Serum Therapy.*—Serum therapy is used in the treatment of inflammatory conditions to bring about the chemical neutralization of the toxins circulating in the blood. Both antitoxin and vaccine treatment are used. The inflammatory condition most generally treated with *antitoxin* is that due to the diphtheria bacillus. Large doses of diphtheritic antitoxin contained in horse serum are injected into the patient, who thus acquires a passive immunity from diphtheria, while the local reaction of the tissue is able to deal with the bacteria at the site of inflammation. In *vaccine* treatment, which is more

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largely used in the treatment of chronic than of acute inflammation, sterilized cultures of the organism causing the disease are injected into the patient, and an active immunity is established by increasing the rate of production of antitoxins by the tissues generally (see p. 12).

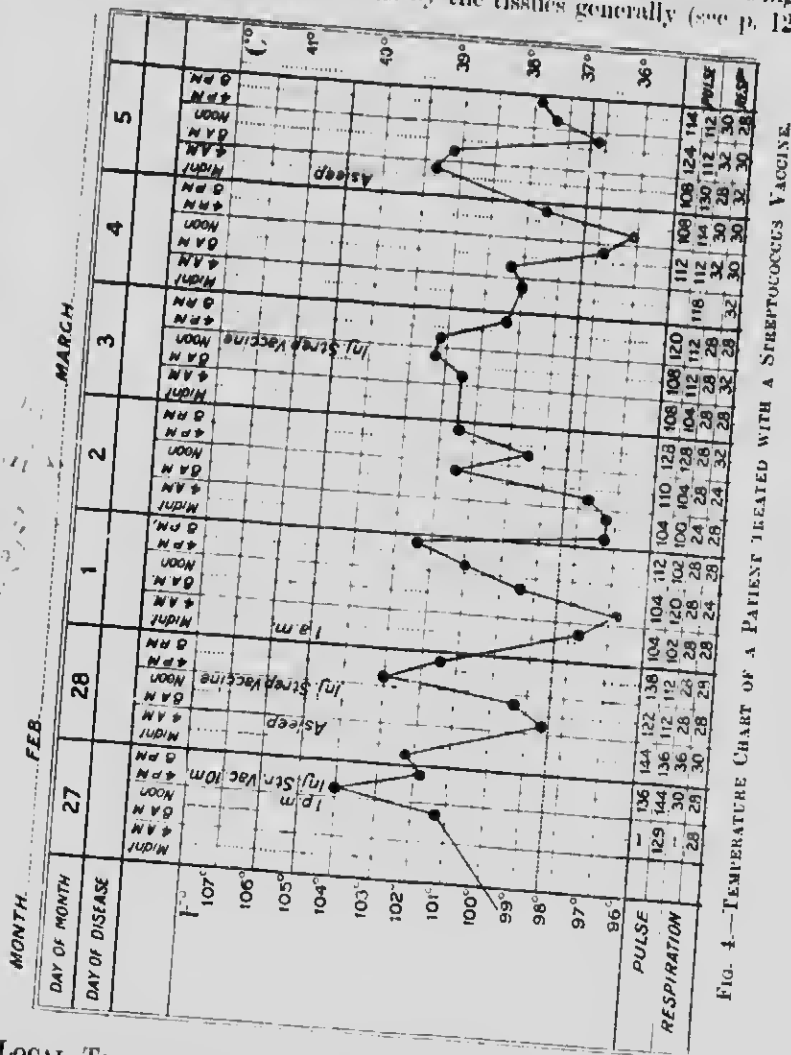


FIG. 1.—TEMPERATURE CHART OF A PATIENT TREATED WITH A STREPTOCOCCUS VACCINE.

LOCAL TREATMENT.—The local treatment of acute inflammation consists of removal of the cause, rest, elevation of the part, application of cold, application of heat, local blood-letting, and Bier's method of passive congestion.

1. *Removal of the Cause.*—This should, if possible, always be the first step in treatment; conjunctivitis due to a foreign body in the conjunctival sac must be treated by removal of the foreign body, or

if a stone in the bladder is causing cystitis the stone must be removed before the treatment of the inflammation is begun. In the case of inflammation due to micro-organisms, it is seldom possible to remove the cause entirely; but excision of the inflamed part, or the use of strong antiseptics, come under this heading, and are sometimes correct treatment.

2. *Rest.*—The inflamed part should always be put at physiological rest. An inflamed stomach must be rested by giving it little to digest, and an inflamed joint by preventing movement. Rest is perhaps the most important of all the means of treating inflammation, and should be continued until the acute inflammation subsides.

3. *Elevation of the Part.*—This is only possible when the inflammation is situated on one of the limbs. The elevation of the part favours venous return, thus lessening the pain, and helps lymphatic drainage of the part; the products of inflammation are therefore removed and rendered harmless by the natural filtration of the lymphatic glands.

4. *Cold.*—Cold is not so much used as formerly in the treatment of inflammation, though it is useful for the relief of pain in the early stages of the process. It also lessens the amount of dilatation of the bloodvessels, and decreases the exudation from them. It can be applied by means of icebags, evaporating lotions, Leiter's coils, or ice poultices. The application of cold must be continuous, care being taken that the cold is not too intense, particularly when applied to old people and infants. Intense cold may result in gangrene of the part, especially if it is not well nourished.

If used at all, it should be in the early stages of inflammation, for later, by contracting the bloodvessels, it limits the amount of blood flowing through the part, thus hindering the removal of the products of inflammation, and lessening the activity of repair.

5. *Heat.*—Heat is largely used in the treatment of acute inflammation, and is applied by means of hot fomentations, poultices, and baths. In the early stages of inflammation it is used to promote resolution and relieve pain; while, if suppuration is inevitable, it is of value in hastening the process, so that sloughs are rapidly removed, and the formation of healthy granulation tissue is quickened. The heat causes dilatation of the bloodvessels and quickened blood-flow; therefore the products of inflammation are quickly removed, and healthy blood-plasma brought to the part, saturating the inflamed area with opsonins, which render the micro-organisms inert. If suppuration has occurred and sloughs have to be removed, the heat not only quickens the peptonizing action of the organisms and so liquefies the tissues more quickly, but stimulates the process of repair by hastening the blood-flow. The application of heat should be continuous. The tissues can withstand dry heat at a much higher temperature than moist.

6. *Local Blood-Letting.*—This, again, is a method of treating acute inflammation that is at present little used in surgery, although in some cases it may be of value. The methods of removing blood from a part are by leeches, scarification, wet-cupping, or free incisions. The

removal of blood from the inflamed area lessens the congestion and relieves pain; the fresh blood which comes to replace the old will aid in the destruction of micro-organisms, and promote resolution. It is chiefly used in such situations as the tongue and larynx, where the intense congestion may be dangerous by obstructing the airway. One great objection to its use is, that the wounds caused are liable to infection, which will interfere with any surgical procedure that may be necessary later.

7. *Bier's Method of Passive Congestion.*—This method of treatment, which is only used in inflammation due to micro-organisms, is founded on the theory that the antitoxins, which neutralize the bacterial toxins and render the organism inert, are contained in the blood-serum. It is, therefore, obviously an advantage to flood the inflamed area with blood-serum, and to encourage exudation of blood-serum into the part. An elastic bandage is placed round the inflamed limb, well above the



FIG. 5.—KLAPP'S SUCTION APPARATUS APPLIED TO AN INFLAMED BREAST.

level of inflammation, tightly enough to constrict the veins and not the arteries. The part below the bandage should be reddish-blue, and the colour should return quickly after it has been removed by slight pressure. Cyanosis, or whiteness of the part, shows that the bandage has been applied too tightly, and harm is being done. The application of the bandage should be followed promptly by relief of pain; if the pain is increased, the bandage is harmful. The bandage in acute inflammation should be left in position for twenty-two out of the twenty-four hours; during the remaining two hours the arm should be elevated and gently massaged. As the inflammation subsides, the length of time the bandage is applied is gradually diminished, but the application should be continued until all the signs of inflammation have disappeared.

Active Hyperæmia.—When it is impossible to apply an elastic bandage above the part, as in inflammation of the mamma, the neck, or the necks, active hyperæmia may be induced by suction. A glass bell-jar

of appropriate shape is placed over the inflamed area, and the air exhausted in the bell-jar by connecting it with an air-pump. The bell-jar is made to fit firmly over the part by smearing the edges with vaseline, and as a vacuum is created the tissue swells owing to blood rushing into the part. The congestion is maintained for about five minutes, and after the pressure has been relieved for a few minutes it is reapplied.

The sittings last about half an hour, and are continued daily until the inflammation has subsided.

This method of treatment is used before and after suppuration has occurred.

Acute suppuration is nearly always treated by free incision into the part; passive hyperemia by means of the elastic band or suction apparatus is only an adjunct to free incision and drainage.

Results of Acute Inflammation.—The terminations of acute inflammation are *resolution, fibrosis, suppuration, and gangrene.*

1. Resolution

Resolution occurs when the inflammation passes off and the tissue returns to the condition it was in before the injury.

The cloudy swelling of the essential cells and of the fixed connective-tissue cells disappears, and the cells resume their normal appearance and function. The red blood-corpuscles that have left the blood-vessels break up, and their stroma is absorbed as effete material, while the hæmoglobin remains for a variable period staining the tissues before it is finally absorbed.

Many of the white corpuscles in the exudate also disintegrate, but some return to the blood-stream either directly through the walls of the capillaries or by means of the lymph channels.

The fibrin is broken up and disappears, while the serum of the inflammatory lymph is absorbed into the capillaries and lymphatics, and the œdema disappears from the part.

The blood-stream passes through the reverse stages to those of the phenomena of inflammation, the stream first oscillating and then beginning to move slowly, gradually getting more and more rapid until the normal rate of flow is reached. The dilated bloodvessels gradually contract to their normal size, beginning with those at the periphery of the inflamed part. All dead cells and degenerated fibrous and elastic tissues are removed, and if resolution is complete, examination of the part will fail to find any evidence that the tissue has been inflamed.

Clinically, if resolution occurs, the symptoms of inflammation, both general and local, disappear. The temperature and the pulse and respiration rate become normal, the appetite returns, and the feeling of general malaise passes off. Locally, the redness, swelling, heat, and pain of the part vanish, and the function is fully restored.

2. Fibrosis

If an acute inflammation leads to disintegration of a large amount of tissue, this tissue is replaced by fibrous tissue, and fibrosis is said to occur. Fibrosis also results from chronic inflammation, and the two terms are sometimes used as synonyms; a distinction should, however, be made. An acute inflammation in the synovial membrane of a joint may lead to fibrous adhesions in the joint, but the inflammatory process ceases, and the condition is one of *old* synovitis. A chronic inflammation may also result in the formation of adhesions, but the condition is progressive until the cause of the inflammation ceases. The method of production of the adhesions is the same in both cases.

PATHOLOGICAL HISTOLOGY.—The earliest pathological change seen under the microscope in fibrosis is the crowding of the inflamed area with small round cells. These small round cells are partly extravasated leucocytes of the blood and partly the progeny of the fixed connective tissue, but principally the result of proliferation of the endothelial cells of the bloodvessels. At the same time as this proliferation is taking place, solid buds of endothelial cells are growing out of the capillaries and joining with one another to form a network amongst the small round cells. These buds become canalized and form new capillaries uniting with the old; therefore in the inflamed area there are masses of small round cells produced from the endothelial cells, and nourished by a network of new bloodvessels formed from the old capillaries. This tissue is called *granulation tissue*, and is the forerunner of fibrous tissue.

The next change is the formation of the fibrous bundles, and these appear in the ground substance as a product of the activity of the newly formed endothelial cells. The young fibrous tissue thus formed is very cellular and vascular, appearing as a swelling in the inflamed area. The fibrous bundles soon begin to contract, and this contraction brings about the obliteration of many of the newly formed capillaries, together with the degeneration of the cells, and as a consequence, the tissue becomes firmer, less vascular, and less cellular. The final result is a dense mass of fibrous tissue containing few cells and bloodvessels which is whiter and smaller than the original tissue. The contraction of the fibrous tissue may cause deformity of the part.

The clinical features of fibrosis and its treatment are considered under Chronic Inflammation, p. 31.

3. Suppuration.

Suppuration, apart from laboratory experiments, is always the result of the action of micro-organisms. The ferments produced by the organisms convert, by a process of peptonization, the solid tissues into a semifluid material termed "pus."

Pus.—The fluid part of pus is partly the serum of the inflammatory lymph exuded from the bloodvessels, and partly the result of peptonization of the tissues. It contains serum albumin, para-globulin.

leucin, tyrosin, and salts. The solid element consists of dead and dying leucocytes—in acute inflammations chiefly the polymuclear neutrophiles—endothelial and fixed connective-tissue cells, and a molecular débris of disintegrated blood-corpuscles, fibrous tissue, elastic tissue, and essential cells of the part. In the early stages of pus formation, micro-organisms are always found; but later they may die out, and, on examination, the pus is found to be sterile. Pus is sometimes green or blue, its colour being due to the presence of the *Bacillus pyocyaneus*. Red pus, owing to the presence of a specific bacillus, has also been seen.

If a section be made through an area in which acute suppurative inflammation is taking place, it will be found that the tissue in the centre, in which the micro-organisms are actively growing, has broken down into pus, and the pus cells can be recognized. The tissue in the immediately surrounding zone is rapidly disintegrating, and no definite structure can be made out. Round this the tissues are in a state of acute inflammation, with coagulation of the blood in the vessels; so that when, in their turn, they break down into pus, no extravasation of blood occurs. In very acute inflammation the vessels may be opened up before thrombosis has sufficiently advanced, and hemorrhage into the inflamed area follows (secondary hemorrhage). The next zone consists of tissue in a state of acute inflammation, and on examination of the successive surrounding zones, all the stages of inflammation may be traced until normal tissue is reached. The suppuration spreads by the successive disintegration of the inflamed tissue at the centre, with spread of the zones of inflammation at the periphery, until a free surface is reached. Pus formation continues until the overlying tissue is destroyed and the pus discharged.

With more chronic suppuration, granulation tissue has time to form round the focus of suppuration, and this in its turn may disintegrate into pus; but if the process of suppuration ceases, the granulation tissue changes into fibrous tissue and encloses the pus in a capsule. In this way pus may remain quiescent in the body for a long time, or the fluid part may be absorbed and calcareous salts deposited in the dead tissue, so that a little nodule of calcareous material, lying in a capsule of fibrous tissue, finally represents the focus of suppuration. Besides spreading and reaching a free surface where it is discharged, or becoming encapsuled by fibrous tissue, pus may be absorbed. The process of the absorption of pus can be readily watched on a small scale when pus forms in the anterior chamber of the eye (hypopyon); but there is no doubt that the peritoneum, pleura, and other tissues are capable of absorbing a considerable quantity of pus. When this takes place, there is seldom a complete resolution of the inflammation; the formation of granulation tissue, and later of fibrous tissue, leaves a permanent record of what has occurred.

Clinical Features of Acute Suppuration.—When suppuration is taking place in an inflamed part, the *general* symptoms continue, and may become pronounced. If a tissue is acutely inflamed, there is, as has already been described, a rise of temperature and respiration and

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pulse rate. As the inflammation becomes somewhat localized, there is generally a fall in all these, with improvement of the general condition. Should pus begin to be formed, however, the temperature again rises, and the other general symptoms return. The temperature in the case of suppuration is usually remittent, the ordinary evening and morning rise and fall being exaggerated. The patient wastes, rigors may occur, and the general condition steadily deteriorates.

In some cases the intermission of the symptoms after the first onset is omitted, and there is no change to indicate that suppuration has occurred.

The local symptoms of suppurative inflammation are those already given; it is only after pus has formed in considerable amount that the one certain local sign of suppuration is present. This physical sign is termed *fluctuation*, and is a sensation of movement imparted to the fingers of one hand placed lightly on the swelling, while another part of the swelling is pressed with the fingers of the other hand. The sensation is caused by a fluid wave passing between the two hands.

TREATMENT.—The early treatment of acute suppurative inflammation has already been given under the treatment of acute inflammation, p. 22. When pus has definitely formed, it should, with few exceptions, such as hypopyon, be given a free exit from the body. The skin over the suppurating focus should be as carefully cleaned as in an aseptic operation, and a free incision made into it; such important structures as nerves and vessels being avoided. The pus should be allowed to escape by its own tension, and the cavity then carefully wiped out. Squeezing or vigorous treatment of an acute suppurating focus must be avoided. A strong antiseptic, as pure carbolic acid, may then be applied to the cavity, which should be efficiently drained by a tube or gauze. The treatment, both local and general, of acute inflammation, should be continued until the cavity is filled with healthy granulations, and repair is progressing.

Immediately after the evacuation of the pus and the establishment of drainage, all the general symptoms of inflammation ought to be relieved; if this is not the case, the inflammation must be spreading further, or the drainage is not efficient.

Acute Suppuration on a Mucous Membrane.—If suppuration occurs on a mucous membrane, the membrane must be kept free from pus by frequent irrigation; it is generally advisable to use some weak, warm, antiseptic lotion. If the mucous membrane lines a cavity such as the gall-bladder, and the pus is under tension, efficient drainage of the cavity must be established.

Acute Suppuration in a Serous or Synovial Membrane.—When suppuration occurs in a serous or synovial membrane, the cavity lined by this membrane becomes rapidly distended with pus, and the symptoms of toxæmia are usually severe. The cavity must be freely opened and efficiently drained until suppuration ceases.

The further treatment of suppuration will be considered under **Chronic Inflammation, Infective Conditions, and Ulceration.**

4. Gangrene

In cases of very severe inflammation or in very poorly nourished tissue, the stasis of blood in the bloodvessels may be so extensive as to interfere seriously with the blood-supply of a large piece of tissue. The tissue so deprived of its blood-supply dies, and the inflammation is said to terminate in gangrene. This result of inflammation will be considered with other varieties of gangrene on p. 176.

CHRONIC INFLAMMATION

PATHOLOGY.—No essential difference exists between acute and chronic inflammation. There is a complete series of intermediate cases between the most acute and the most chronic forms. A chronic inflammation implies the presence of a chronic cause, and this, as in acute inflammation, may be non-bacterial or bacterial. The non-bacterial causes, with a few exceptions—such as the presence of an aseptic foreign body in the tissue—are chronic intoxications associated with errors of metabolism, leading to a degeneration of the essential cells of the part and a proliferation of the connective-tissue elements. In these cases there is very little vascular dilatation or formation of new bloodvessels, and the exudate consists chiefly of lymphocytes which are grouped round the bloodvessels. The inflammatory condition is, as a rule, diffuse, and the whole of the organ affected is gradually replaced by fibrous tissue. This variety of inflammation usually occurs in such glandular organs as the kidneys, liver, and pancreas, and is of medical rather than of surgical interest; but in certain cases—for example, chronic inflammation of the breast—the condition is treated by surgery.

Chronic inflammation of bacterial origin ends either in fibrosis or in suppuration. The histology of fibrosis in chronic inflammation is precisely similar to that described under fibrosis as a termination of acute inflammation, and many chronic inflammations start with an acute attack. The condition is, however, progressive, and as long as the cause of the inflammation persists, fibrous tissue continues to be formed, and there is a steady destruction of the essential cells of the part until the whole of the tissue is replaced by fibrous tissue.

Chronic inflammation ending in suppuration is invariably due to the presence of micro-organisms. The most common are the tubercle bacillus and the *Spirochæta pallida* of syphilis; but many other organisms, as the *Staphylococcus albus*, actinomyces, glanders bacillus, etc., may be the exciting cause, and in every case bacteriological examination of the pus is essential to diagnosis.

The histology of chronic suppuration is similar to that of acute suppuration, but, on the whole, the pus contains many more lymphocytes and a fewer number of the polymuclear leucocytes, and there is a more abundant formation of granulation tissue. (The histology of chronic inflammation due to the tubercle bacillus and the *Spirochæta pallida* is considered in the section on these diseases, p. 108.)

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Clinical Features of Chronic Inflammation.—The *local* symptoms of chronic inflammation are similar to those of acute inflammation—viz., redness, swelling, heat, pain, and loss of function—but the following differences in degree may be noted. Owing to the slight degree of vascularization in chronic inflammation, *heat* and *redness* are not marked features; and in the terminal stages the inflamed tissue is colder, less red and vascular than normal tissue, owing to the contraction of the fibrous tissue. Marked *swelling* is only present if the inflammation ends in suppuration, and in the terminal stages the inflamed part is smaller and firmer than normal. In many cases of chronic inflammation *pain* is absent. It will, therefore, be seen that the diagnosis of a chronic inflammatory process depends mainly on a recognition of *loss of function*. This loss of function is due to the destruction of the essential cells of the part, and to interference with the circulation, together with the deformity caused by the contraction of the fibrous tissue which is formed. For example, chronic inflammation of the kidney is diagnosed by the alterations in the urine, due to the loss of function of the excretory cells; chronic inflammation of a joint is recognized chiefly by the loss of mobility due to the formation of fibrous tissue in the structures that surround the joint cavity. When suppuration occurs as the result of chronic suppuration, the usual clinical symptoms of swelling and fluctuation are present; or if the suppuration is taking place on a free surface, there is a discharge of pus.

The *general*, like the local, symptoms of chronic inflammation are not so marked as in acute inflammation, and if the cause of the chronic inflammation is non-bacterial, they are often entirely absent. In cases of chronic inflammation due to micro-organisms, especially if the condition ends in suppuration, the general symptoms of a toxæmia are always present, though they may be very mild. The symptoms are loss of appetite, loss of flesh, irregular pyrexia, and anæmia.

TREATMENT.—The GENERAL treatment of chronic inflammation follows the same lines as that of acute inflammation, and in many cases the treatment of the condition is mainly general, local treatment being of little use. In the chronic suppurative inflammations, fresh air, sunshine, and good hygienic surroundings are of the first importance. Two methods of treatment require fuller consideration—viz., drugs and serum therapy.

1. *Drugs.*—In addition to the use of drugs for the relief of symptoms, and the specific action of certain of them, such as mercury in syphilis, some drugs are exceedingly valuable in the treatment of chronic inflammation, owing to their power of bringing about the absorption of inflammatory products and granulation tissue. The most important of these drugs are iodide of potassium and fibrolysin, the former being much the more valuable of the two. In chronic inflammatory processes, iodide of potassium is given in steadily increasing doses. In some instances, especially if the inflammation is due to syphilis, the results are striking. Large masses of granulation tissue, with broken-down products of inflammation, are rapidly

absorbed, and repair is hastened. Fihrolysin has the property of causing the absorption of inflammatory fibrous tissue, but its action is not so certain or so well marked. It should be given by intramuscular injection; 2.3 c.c. of a 15 per cent. solution in alcohol may be given every two or three days.

2. *Serum Therapy* is more valuable in the treatment of chronic inflammatory processes due to micro-organisms than in acute inflammations, and in many cases the results are excellent. The method employed is vaccine treatment, which is only possible if the organisms causing the inflammation can be cultivated. A culture is made from the inflammatory focus, and from this a vaccine is prepared, and the patient inoculated. In some cases such as tubercle a stock vaccine can be used, but the best results are obtained from freshly prepared vaccines made from the infecting organism.

LOCAL TREATMENT.—Rest, elevation, cold, heat, and local blood-letting, are all used in the treatment of chronic inflammation, but other methods of treatment are added. They are—counter-irritation, pressure, massage, passive movements, active hyperæmia, electricity, and baths.

Counter-Irritation.—This consists of inducing an active hyperæmia in the skin over the inflamed part. It can be carried out by the application of stimulating ointments or lotions, such as compound mercury ointment (Scott's dressing), tincture of iodine, liquor epispasticus, tincture of capsicum, stimulating liniments, or dry-cupping. This method of treatment is not very largely used, and it probably owes all its value to the increased flow of blood to the part.

Pressure.—Pressure is of great value in bringing about the absorption of fluid in inflamed joints and tendon sheaths. It may be used in the treatment of chronic inflammation in such solid organs as the testicle.

Pressure can be applied by means of elastic and other bandages, but it is best maintained by carefully strapping the part with lead strapping. Strips of strapping large enough to encircle the part are firmly applied from below upwards, each piece of strapping overlapping by one-third the piece below. As soon as the strapping becomes loose it should be removed and fresh strapping applied.

Massage.—Massage is the scientific manipulation of the skin, muscles, and fasciæ of the body, and in the treatment of chronic inflammation has for its objects—(1) to remove adhesions and the products of inflammation, (2) to quicken the flow of blood and lymph through the part, (3) to relieve congestion of the inflamed area by attracting the blood to the surface, (4) to increase the nutrition of the part.

It is generally used in conjunction with *passive movements* which prevent the formation of adhesions in the part.

These two methods of treatment are very largely used in the treatment of chronic inflammation of joints when the inflammation is terminating in fibrosis. They should *never* be used if suppuration is likely to occur, as in chronic tuberculosis.

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Active Hyperæmia.—The object of this method of treatment is to bring fresh arterial blood to the inflamed area, and thus help to remove the products of inflammation. It is best induced by hot air. The inflamed part is encased in a suitable apparatus, and the air in the apparatus is heated to any temperature, dry heat being much more easily borne than moist heat. There are many forms of apparatus for carrying out this treatment—Tyrnauer baths, Tallermann apparatus, Bier's apparatus, Dowsing light, Baritsu light, etc. In the Tyrnauer apparatus the temperature can be raised to 300° or 400° F. without burning the patient, as light is excluded. It is, perhaps, the best form of apparatus. The results of active hyperæmia in the early stages of chronic inflammation of joints are often excellent.

Electricity.—Electricity is used in the treatment of chronic inflammation in many ways. Electrical light baths, water baths with an electric current running through the water, electrolysis by the introduction of needles into the inflamed part and passing a current through them, the induction coil, high-frequency currents, etc., have all their advocates in the treatment of chronic inflammation, especially of joints. These methods of treatment are useful if combined with the other methods of treatment given above.

Baths.—Baths of all kinds—water baths, vapour baths, salt baths, sulphur baths, peat baths, electric baths, needle baths, etc.—are all used with more or less success in the treatment of chronic inflammatory conditions at the various spas. The treatment is often supplemented by the drinking of the medicinal water natural to the spa, by massage, passive movement, careful dieting, and exercises, and a routine method of living. All are of benefit in removing the effects of inflammation. Electricity and baths are not used in the treatment of chronic inflammations due to bacterial infection, which are likely to terminate in suppuration.

The local treatment of **chronic suppurative inflammation** consists mainly of rest to the inflamed part. It is further considered under the treatment of tuberculosis and the other infective diseases.

INFLAMMATION OF MUCOUS, SEROUS, AND SYNOVIAL MEMBRANES

Although the pathological changes that occur in these membranes, when they are inflamed, are precisely similar to the changes already described, there are certain phenomena connected with their inflammation that require a separate description.

Inflammation of Mucous Membranes.—When a mucous membrane becomes inflamed, there is at first a diminished activity of the mucous cells of the part, and the membrane is swollen, red, and dry. This gives place to an increased disintegration of the mucous cells, and there is an abundant discharge of mucus and an exudation of serum from the inflamed surface. This is sometimes spoken of as *catarrh*, or catarrhal inflammation of the membrane.

In certain cases of inflammation of mucous membranes, and particularly in that due to the presence of the diphtheria bacillus and other similar organisms, there is a rapid destruction of the cells of the mucous membrane, which undergo a process of coagulation necrosis. At the same time an exudate rich in fibrinogen is poured out from the bloodvessels and lymph channels, and coagulation into fibrin occurs on the surface of the mucous membrane. This fibrin, with the necrosed cells and masses of micro-organisms, forms a white *false membrane* over the surface of the mucous membrane, from which it can only be detached by force. When this is done, a bleeding surface is left. If the membrane is left, it is detached by suppuration occurring in the mucous membrane.

The pathological processes of suppuration of a mucous membrane are similar to those already described under suppuration, and the pus is discharged from the surface of the mucous membrane. If the suppuration is mild and soon ended, the mucous membrane can return to its normal condition, and resolution is complete; but in severe or long-continued suppuration the covering epithelium of the mucous membrane is destroyed, and is replaced by granulation tissue. This granulation tissue changes into fibrous tissue, which, by its contraction, causes puckering of the mucous membrane, and in those cases in which the mucous membrane lines a canal, such as the urethra or oesophagus, stricture of the tube follows.

Gangrene, as a result of inflammation, may also occur in mucous membranes, and the dead tissue must be removed by suppuration in the surrounding tissue. The dead tissue or slough is separated, leaving a raw surface termed an "ulcer." This ulcer may spread by destruction of the surrounding tissue if the inflammation continues, or may heal by the formation of granulation tissue, which later changes to fibrous tissue. This, again, will be associated with puckering of the mucous membrane, and the formation of a stricture.

Chronic inflammation of a mucous membrane is always associated with the presence of micro-organisms, and the inflammation is most likely to continue if the inflammatory exudates cannot escape, as in inflammation of the gall-bladder. It may be due primarily to repeated irritation, as in chronic inflammation of the tongue caused by constant friction against a sharp decayed tooth, but infection always occurs. The cells of the surface epithelium become irregular in outline, flattened, and heaped up on one another, and the mucous cells disappear. There is a round-celled infiltration of the submucous tissue, with the formation of granulation tissue and fibrous tissue. The subepithelial tissue, therefore, becomes less vascular and more fibrous than normal, and the mucous membrane is thin and anæmic. The loss of the mucous cells results in dryness of the membrane, which is exceedingly liable to subacute attacks of inflammation and to ulceration from slight causes. If fibrosis of the submucous tissue occurs in canals, such as the urethra, it may lead to stricture.

Inflammation of Serous and Synovial Membranes.—The changes that take place in an inflamed synovial or serous membrane resemble

those that occur in the other tissues. At first the membrane is red-
dened and swollen, and the opposing surfaces do not move freely on
each other, owing to the exudate of fibrin. In the majority of cases
fluid—either serous, fibrinous, or purulent—is rapidly poured out into
the cavity lined by the membrane.

Serous fluid is straw-coloured, and contains a varying amount of
albumin. It may be absorbed without causing marked constitutional
symptoms, and the membrane return to its normal condition. If the
exudate is fibrinous, a thin layer of fibrin is spread over the membrane,
or large masses of fibrin are found in the fluid. It is quite possible
for the whole of this exudate to be absorbed, and a return to the
normal condition to follow; but, as a rule, fibrinous inflammation is
severe and associated with loss of many of the endothelial cells lining
the cavity. These are replaced by granulation tissue, changing later
into fibrous tissue; and if the two surfaces of the membrane remain
in contact, bands of fibrous tissue (adhesions) join the two surfaces
together, and the cavity is more or less obliterated. The denseness
of the adhesions depends upon the severity and duration of the in-
flammation and the amount of movement taking place between the
opposed surfaces, rest favouring the formation of dense close ad-
hesions.

Suppuration in serous and synovial membranes occurs in the same
way, and has the same results as suppuration in other tissues. The
cavity of the membrane is filled with pus or sero-pus, which may
possibly be absorbed, but which generally has to be removed by sur-
gical interference. Adhesions between the opposing serous or synovial
surfaces form almost inevitably after suppuration.

With *chronic inflammation* there is degeneration of the lining endo-
thelial cells, with round-celled infiltration, followed by granulation-
tissue and fibrous-tissue formation in the subendothelial tissue. At
first there may be an increased secretion of morbid serous or synovial
fluid, causing the cavity to be distended with fluid; later, this ceases,
and the cavity becomes dry. If the degeneration of the endothelial
cells ends in total destruction, adhesions form between the opposing
surfaces, and the cavity may be completely obliterated.

Chronic inflammation may, however, end, as in other tissues, in
suppuration, and the cavity be distended with pus, with extensive
destruction of the membrane. This is most common in the chronic
inflammation due to tubercle.

CHAPTER III
WOUNDS—CONTUSIONS—ASEPTIC AND ACCIDENTAL
WOUNDS—SCARS

WOUNDS

WOUNDS are divided into two great groups:

1. Wounds of the deeper structures without involvement of the superficial structures—*i.e.*, skin or mucous membranes. These wounds are commonly spoken of as "contusions" or "lacerations."
2. Wounds in which the skin or mucous membrane is involved. These can be spoken of as "open wounds," and are exceedingly liable to become infected by any of the pathogenic bacteria.

CONTUSIONS

A contusion is due to external violence, which lacerates the tissues beneath the skin or mucous membrane; the chief effect produced is an extravasation of blood from laceration of the bloodvessels. The amount of blood effused depends on—

1. The severity of the violence.
2. The vascularity of the tissue injured.
3. The laxity of the tissue, the extravasation being greater in such loose tissue as the scrotum and eyelids than in dense tissue such as the scalp or bone.
4. The general condition of the patient. Women and children as a rule bruise more easily than men, and men who lead sedentary lives than men in vigorous muscular training.
5. The presence of certain diseases; scurvy, hæmophilia, and purpura may lead to great extravasation of blood from slight violence.

SYMPTOMS—LOCAL.—The symptoms of a contusion are—(1) Pain, (2) Swelling due to the extravasated blood. (3) Discoloration of the part or bruising; when the hæmorrhage takes place in the subcutaneous tissue, it shows itself as a "bruise" in a few minutes, but when extravasation occurs into the tissues below the deep fascia, it may be three or four days before the bruise appears on the skin. (4) Loss of function of the damaged part.

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LOCAL RESULTS—(1) Resolution.—The part which is at first black or purplish-black passes through various shades of blue, brown and green to yellow, which gradually fades. This change in colour is due to alteration in the extravasated hemoglobin, which finally is absorbed. The lacerated tissues heal in the usual way by scar tissue (see p. 50).

2. Formation of a Hematoma.—When a large amount of blood has been extravasated, it collects in the tissues, forming a fluid swelling which may be mistaken for an abscess. Such a collection of blood is called a *hematoma*. A hematoma may undergo various changes: (a) It may be absorbed. (b) After the blood has extravasated, it undergoes coagulation, and separates into fibrin and blood-serum. The fluid serum may be absorbed and the solid clot remain indefinitely, forming a tumour. (c) The solid clot may be absorbed, and the fluid part remain as a *blood-cyst*. The wall of such a cyst is formed of fibrous tissue, produced by the inflammation of the surrounding tissue, owing to the irritation of the extravasated blood which acts as a foreign body. These blood-cysts are most often seen in the meninges, and usually contain hæmatin crystals. (d) Suppuration may occur in the hematoma.

3. Gangrene.—As a result of a severe contusion, gangrene of the part may take place (see Direct Traumatic Gangrene), owing to depression of the vitality of the part and interference with the blood-supply.

4. Suppuration.—Infection of the damaged tissue by micro-organisms frequently occurs through the blood-stream or by direct invasion of the part. The latter mode of infection is most frequently seen in contusions of the alimentary canal, the infecting organism being the *Vacillus coli communis*.

GENERAL.—The general symptoms of a severe contusion are those of aseptic traumatic fever (see p. 20). A rise of temperature and a feeling of general malaise, lasting for a few days, are generally present.

TREATMENT—LOCAL.—If the patient is seen at once, the part should be put at rest, and cold applied by means of an icebag, Leiter's tubes, or evaporating lead lotion, until the extravasation of blood has ceased; usually, however, bleeding has ceased when the patient is first seen, and cold is then useless.

The part should be put at rest, if possible in the elevated position, and treated by massage. Massage should be employed two or three times a day, and by its means the extravasated blood is carried widely through the tissues and quickly absorbed. The absorption may be hastened and the pain relieved by the application of heat. In those cases of severe contusions in which bullæ containing blood-stained serum form on the skin, massage must not be attempted. The part should be elevated, and the bullæ pricked and dressed aseptically. Massage should be begun as soon as the bullæ dry up.

GENERAL.—After a severe contusion, the patient should be kept in bed on a light diet, and a brisk purge administered.

TREATMENT OF A HEMATOMA.—The treatment of a hematoma is similar to that of a contusion, and in the majority of cases it will be

absorbed. If the hamatoma is very tender and painful, it may be aspirated, and a firm dressing applied; or if very large, it may be incised and the blood-clot removed (see Aneurysm). The treatment of a blood-cyst is excision. Suppuration of a hamatoma demands the usual treatment of opening and establishing free drainage.

ASEPTIC WOUNDS

Open wounds may be divided into incised, lacerated, contused, and punctured wounds; but a much more important classification is—Aseptic wounds; accidental wounds; infected wounds.

An aseptic wound is produced by an aseptic instrument on aseptic tissues through aseptic skin or mucous membrane. Such wounds are practically only met with in surgical operations, and the whole of the elaborate technique of operative surgery is devised to render and keep wounds aseptic in spite of the almost universal presence of pathogenic bacteria. At the present time two methods are relied upon to prevent wound infection—viz., *antisepsis* and *asepsis*.

Antisepsis aims at killing or at least preventing the growth and development of all organisms likely to infect a wound by the use of certain chemical agents called antiseptics, of which the most important are carbolic acid, perchloride of mercury, biniodide of mercury, iodine, iodoform, formalin, boracic acid, lysol, and peroxide of hydrogen.

Carbolic Acid was the first and is still the most widely used of the antiseptics. It is a crystalline substance, which can be liquefied by heating with 10 per cent. of water, and in this form is generally spoken of as pure carbolic acid. It is commonly used in surgery for antiseptic purposes in strengths of 1 in 40 to 1 in 80. Anthrax spores are only killed by a solution of 1 in 20 acting for twenty-four hours, but the bacilli are killed by a solution of 1 in 100 acting for five minutes. Carbolic acid, if used with soap, or made into a solution with oil, has no antiseptic properties. Carbolic acid may be absorbed from open wounds in sufficient quantities to cause symptoms (headache, dizziness, nausea, and vomiting) of carbolic acid poisoning. The change of colour in the urine to olive green or black is an important symptom in making the diagnosis. The intensity of the discoloration of the urine; for with very dark urine the patient may be quite well. In some cases the urine contains albumin, or even blood, and this symptom was sometimes seen in the operator in the days when the carbolic spray was in use.

TREATMENT OF CARBOLIC ACID POISONING.—The use of the drug should be discontinued immediately, and the symptoms treated as they arise. Sodium sulphate may be given in order to hasten the excretion of the carbolic acid by the kidneys. If the poisoning is produced by swallowing carbolic acid, the stomach should be washed out, as carbolic is not one of the corrosive acids.

Locally, carbolic acid produces anaesthesia, with numbness, lasting for some hours; and if applied in a strong solution, it acts as a caustic, causing a burning pain and sloughing. Weak solutions applied for wounds of the fingers and toes may cause gangrene (see p. 176).

Perchloride of Mercury is one of the most powerful antiseptics known, and is used in strengths of 1 in 500 to 1 in 5,000. Anthrax spores are killed in a quarter of an hour by a solution of 1 in 1,000, and the bacilli in one minute in a solution of 1 in 15,000. It combines with albumin to form an inert albuminate, and its antiseptic properties are lost; but this change can be prevented by combining it with 5 parts of hydrochloric acid to 1 of the perchloride. Surgical instruments should not be placed in solutions of this antiseptic, as the mercury is deposited upon them, and they turn black.

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Biodide of Mercury is used largely in alcoholic solution (1 in 500) of 70 per cent. spirit) for the disinfection of the surgeon's hands or of the skin of the patient. It can also be used in aqueous solution, 1 in 2,000. Instruments are not so easily blackened by the biodide as by the perchloride.

Either of these antiseptics may cause symptoms of mercurial poisoning, but toxic effects are most frequently seen after the use of perchloride gauze as a moist dressing. The local symptoms of mercurial poisoning consist of an eczema, with persistent itching and burning of the skin. Pustulation sometimes occurs. The general symptoms are a feeling of dizziness, restlessness, general malaise, and vomiting. The mouth is sore, the gums inflamed, and there is a copious secretion of saliva. Later, severe diarrhoea, which is often blood-stained, may be present. The urine, in which the mercury can be detected, contains albumin.

TREATMENT.—*Prevention.*—Perchloride gauze, if used as a dressing, should be applied dry. If one of the lotions is used for syringing out a cavity, all excess must be carefully wiped away and the wound left dry.

If poisoning should occur, the use of the mercury must at once be stopped; the rest of the treatment is symptomatic.

Iodine has always been used as an antiseptic, but recently its use has superseded all other antiseptics in the preparation of the skin of the patient. For this purpose it is used in alcoholic solution (2 per cent. of iodine in rectified spirit), and is painted on to the skin. In some cases it may cause irritation of the skin, which results in vesiculation, but this is rare. It is also used in aqueous solution (1 of the tincture to a pint of water) for washing out such cavities as the uterus, vagina, or a large abscess.

Iodoform.—This is a lemon-coloured, crystalline powder, with a characteristic odour, which contains about 80 per cent. of iodine. It is soluble in oils, ether and chloroform, but only slightly in water. It is not a powerful antiseptic. Before use it must be sterilized, for commercial iodoform is found to contain living germs. It is chiefly used in the treatment of tubercular lesions, soft sores, and foul-smelling septic conditions; but it is much less extensively used than formerly. It is particularly likely to cause toxic symptoms if used for old people, children, or patients suffering from anaemia, morbus cordis, or chronic nephritis.

The local lesion in iodoform-poisoning consists of a severe eczema, with great itching and burning, and a copious serous exudate. The general symptoms in a mild case are a rapid and irregular pulse, want of appetite, nausea and vomiting, headache, general malaise, and mental depression. In the more severe forms, the symptoms may follow one of two types: (1) The pulse is rapid and small; the patient refuses to take food, and suffers from sleeplessness, delirium, and hallucinations. Recovery usually follows if the use of the drug is discontinued. (2) After a brief period of excitement there follows a general paralysis of the central nervous system, loss of consciousness, coma, and incontinence of urine and faeces. These cases generally end fatally.

TREATMENT.—After the immediate removal of the iodoform dressing, the treatment of iodoform-poisoning is purely symptomatic, and in the severest cases no treatment is of any avail. The symptoms may continue long after the use of the drug has been stopped. One case of death occurring twenty-nine days after the onset of the symptoms is on record, although the use of the drug was immediately discontinued. The smell of iodoform may be disguised by dissolving it in volatile oil of camphor or in balsam of Peru, or by adding musk to it.

Formalin, an aqueous solution of 40 per cent. formaldehyde, is a very powerful antiseptic. It is largely used in the preservation of specimens for museums and for dissecting purposes; and the vapour is employed in rendering and maintaining catheters aseptic. It is very toxic, and is not used in the treatment of wounds.

Boracic Acid is a crystalline powder which is used in saturated aqueous solution (4 per cent.) for syringing out septic cavities when a more powerful antiseptic might be harmful. It is used in ophthalmic work; in such operations as skin-grafting; in the form of fomentations for the relief of inflammation, both before and after incision and drainage have been carried out; and in operations on children. It has no toxic effects.

Lysol, a proprietary drug distilled from coal tar, is useful for disinfecting the hands and skin of the patient, as it can be used with soap. It is very commonly used for rendering needles and knives aseptic, these instruments being soaked for twenty-four hours in a solution of 1 of lysol and 3 of rectified spirit. In aqueous solutions of 1 in 100 to 1 in 400 it is employed for rendering the skin aseptic.

Peroxide of Hydrogen.—This is a fluid containing oxygen in such slight concentration that it immediately gives up ten to twenty times its volume of nascent oxygen in the presence of any oxydizable substance. It is largely used in the disinfection of septic cavities, being one of the best of the antiseptics for this purpose. It has no toxic properties, so that its use is entirely without danger.

Asepsis.—In asepsis the elimination of bacteria is brought about by the use of dry or moist heat as a sterilizing agent. There can be no doubt that this is the ideal method. There is always a certain amount of risk in the use of antiseptics, and apart from toxic symptoms, the tissues are always more or less damaged by these chemical agents, which in themselves are capable of causing inflammation. If used in strong solution antiseptics may cause death of the cells of the body as well as of the bacteria. With asepsis, bacteria do not need to be killed, for they are eliminated from the field of operation. Aseptic methods cannot, however, be carried out entirely, for the skin of the patient and the hands of the surgeon cannot be sterilized by heat. In the case of the surgeon, the use of sterilized gloves has largely overcome this difficulty; but the skin of the patient must be prepared by antiseptic methods. In actual practice a combination of asepsis and antiseptics gives the best results. Everything that can be sterilized by heat should be rendered aseptic in this way, and weak solutions of antiseptics used in order to prevent wound contamination during the actual operation.

In the case of wounds that have already been infected, aseptic methods are used in preparing instruments, etc., in order that further contamination is prevented, while antiseptics are applied to the wound to kill and prevent the growth of the bacteria already present.

In considering the making of aseptic wounds in surgical operations, it is necessary to recognize the avenues by which bacteria may gain entrance to the wound in order that infection may be prevented. These avenues are—(1) the air of the operating-room; (2) the surgeon and his assistants; (3) the skin of the patient; (4) instruments and drainage-tubes; (5) ligatures and sutures; (6) sponges; (7) bowls, trays, etc.; (8) coats, towels, swabs, and dressings; (9) Mackintoshes; (10) water and lotions.

1. *The Air of the Operating-Room*

Danger of infection of a wound through the air-borne micro-organisms—although not so important as it was considered to be in the early days of antiseptics (the days of the carbolic spray)—is not quite a negligible quantity. Air is dangerous in proportion to the amount of dust in it; therefore the amount of danger varies with the number and activity of the people moving to and fro in an operating-room. Dust-free air is sterile air; therefore it is obvious that as few people as possible should enter the operating-room, and that none should leave until the operation is over. In hospital theatres and special operating-rooms the air is kept germ-free by elaborate systems of ventilation and purification. At the London Hospital the air is washed by passing it through water, and then filtered through seventy-two screens of asbestos wool. After being warmed by a steam radiator, it enters the theatres through a special shaft, and is practically sterile.

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Before operations, superheated steam is blown over the theatre in order that any micro organisms may be killed, and the surfaces of the walls, benches, tables, etc., are made damp. This dampness prevents the dust from being disturbed by people moving about.

When it is necessary to turn a room into an operating theatre these elaborate precautions are impossible, but with care little danger is to be feared from air infection. The superfluous furniture and ornaments, curtains and blinds, should be removed, and the carpet taken up. The room should be thoroughly cleaned and dusted. The walls and all the necessary furniture should be wiped over with 1 in 60 carbolic solution, and this should be repeated on the morning of the operation. As few people as possible should be allowed to enter the room after it is ready in order that the dust may not be disturbed.

In cases of emergency operations, when the room has to be rapidly prepared, it is not well to do much disturbing of furniture and dusting, or the air will be full of dust at the time of operation, and infection of the wound may occur. The furniture should be damped with 1 in 60 carbolic solution, and a damp sheet spread on the carpet to prevent the dust from rising.

2. *The Surgeon and his Assistants*

1. *Sterilization of the Hands.*—It may be taken as an axiom that it is impossible to sterilize the hands completely. If, after the most careful preparation, a culture taken from the skin remains sterile, it does not prove that the skin is aseptic. If a second culture is taken five minutes later, numerous colonies of micro organisms may grow. The surface of the skin has been rendered aseptic by the thorough washing, but numerous bacteria are found in the sweat glands, the sebaceous follicles and hair roots, and these come to the surface in the course of natural secretion. During an operation, therefore, as there is a constant reinfection of the surface of the skin taking place, this surface must be very frequently cleaned.

It is of the utmost importance that the hands of those taking part in surgical operations should receive constant attention. The nails should be kept short, and cleaned as a rule by the repeated use of the nail-brush, instead of introducing any instrument under the nail for this purpose, as this latter method causes a cavity to form under the nail, in which dirt readily re-collects. Cleaning the nails with an instrument may be absolutely necessary if they have not been scrupulously looked after, or if there is obvious dirt underneath them when it is necessary to clean them for an operation. In the routine care of the hands it is important to remember that the worst form of dirt to allow to contaminate the skin is infected material. As far as possible, the hands should never be allowed to come into contact with pus or other infected discharges. All dressings, especially dressings of wounds that are not aseptic, should be removed with forceps. If the discharge has soaked through the handages, these also should be removed with forceps, and pus should be wiped away with swabs held in forceps. If it is impossible to do the dressing without bringing the

hands into contact with purulent discharges, they should be protected from actual contact with the pus by the use of india-rubber gloves. This rule applies to routine rectal and vaginal examinations, or to any examinations necessitating the touching of infected discharges.

In the actual preparation for an operation, the arms as far as the elbows should be cleaned as well as the hands.

There is almost an infinite number of methods of cleaning the hands for an operation, nearly every surgeon having his own particular method; but numerous experiments have proved that the simpler methods give as good results as the more elaborate, and the simplification of surgical technique is most desirable.

METHOD A.—The hands are washed for five minutes in *running* hot water, or in hot water frequently changed. The water is as hot as can be conveniently borne, and plenty of pure soap is used. The hands and forearms are freely brushed with a sterilized nail-brush, special care being given to the nails and the clefts between the fingers. After this thorough soaping the hands are rinsed in a solution of biniodide of mercury and spirit (1 in 500).

METHOD B.—The hands are washed with soap and warm water, and then in a 2 per cent. solution of lysol, using ether soap and a nail-brush. They can be rinsed in perchloride of mercury (1 in 1,000), and finally in biniodide of mercury and spirit (1 in 1,000).

After the hands have been prepared for the operation, nothing that is not aseptic should be touched. If this rule is violated, the hands must again be washed with hot water and soap, and rinsed in the biniodide solution.

During the operation the hands should be repeatedly cleansed with some warm aseptic or antiseptic solution to wash away the bacteria which are constantly coming to the surface with the natural secretions. The following lotions may be used for this purpose: Sterile water, sterile normal saline solution, solution of carbolic acid (1 in 40 to 1 in 80), solution of perchloride of mercury (1 in 1,000 to 1 in 5,000), saturated solution of boracic acid, solution of lysol ($\frac{1}{2}$ drachm to a pint), or many other antiseptic solutions. The solution must be as non-irritating as possible, for the mechanical washing is of much more value than the antiseptics.

The Use of Gloves.—To prevent the contamination of the wound with the bacteria which appear constantly upon the hands of the surgeon, imperishable rubber gloves are now usually worn. These can be easily sterilized by boiling, and will retain within them any impurity exuding from the hands until the end of the operation.

This method of keeping the skin of the surgeon from contact with the wound is being extensively used with great success, but it has a serious objection. The gloves are very easily pricked or torn without the fact being recognized. The sweat from the hands, which is loaded with bacteria, will escape through the minute puncture, and the wound will be infected with a highly infective material.

Gloves are of the greatest value in keeping the hands from contact

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with infective material, and the surgeon may make such investigations as rectal or vaginal examinations during the course of an operation without soiling his hands. If he has a small abrasion on the hand or arm about the asepticity of which he is not sure, gloves are indispensable.

The hands and arms must be sterilized even if gloves are used, and if a glove is discarded during an operation, the hands must again be thoroughly washed with soap and water, and rinsed in biniodide lotion. A pricked or torn glove must on no account be used, or if pricked or torn during an operation, it must be discarded at once, and the hands thoroughly washed. The gloved hands also should be repeatedly rinsed during the operation in an aseptic or antiseptic lotion.

Care of the Gloves.—Before sterilizing the gloves, they should be filled with water, the opening closed with the fingers, and the glove gently squeezed. In this way small punctures are readily detected. The gloves, still filled with water, are then placed in the sterilizer, care being taken that there is enough water to cover them, and that they are not resting against the sides. There must be no soda in the water. The gloves may conveniently be put in a perforated metal box into the sterilizer, or they may be wrapped in lint. They should be boiled for five minutes, or if they have been in contact with septic material, for fifteen minutes. Before putting on the gloves, a little soap solution or sterile glycerine should be rubbed over the hands. After the operation, the gloves should be well washed and hung up to dry. A little powdered soap and alum is then rubbed into them before they are put away. The soap prevents the insides from sticking together. French chalk will do equally well.

Dry Sterilization of Gloves.—The gloves are powdered inside and out with talc powder, and a double fold of gauze is placed in each. They are then sterilized by steam for ten minutes at a temperature of 240° F., and dried in a vacuum in the sterilizer for one hour. Before putting them on, the hands are powdered with sterilized talc powder. After using, the gloves should be boiled in the usual way, allowed to dry, and again sterilized before use.

2. *Care of Operator's Mouth, Nose, and Hair.*—The experiments of Mikulicz have established beyond doubt the danger of infecting wounds from the expired breath of the operator, especially if talking is indulged in during the operation, or if the surgeon sneezes or coughs. It is important, therefore, for the surgeon to see that he has no carious teeth that have not been stopped. He should not operate if he is suffering from an influenza cold, or has any source of sepsis in his mouth or air passages. Before operating, it is well for him to use some antiseptic mouth-wash. If any source of sepsis be present in the mouth or nose, they should be covered with a fourfold sterile gauze bandage tied behind the head. Some surgeons prefer to err on the side of safety, and say this should be done in any case.

The experiments of Mikulicz show that four thicknesses of gauze will render the breath innocuous.

The surgeon's hair should be kept short. It is advisable to cover it with a sterile linen cap. Special masks are made for the head, nose, and mouth.

3. Skin of the Patient

It is impossible to render the skin of the patient absolutely sterile, but proper preparation will make it sufficiently aseptic to insure primary healing. It is important to realize that harm may be done in the preparation of the skin for operation either by the too vigorous use of antiseptics producing inflammatory reaction, or even vesication in the skin, or by too vigorous mechanical rubbing causing excoriation and subcuticular hemorrhage. These remarks apply more particularly to the delicate skin of women and infants. As in the preparation of the hands of the surgeon, numerous methods have been used for the preparation of the skin of the patient, but they have all been superseded by the iodine method.

The skin over the site of the operation is thoroughly washed and, if necessary, shaved twenty-four hours before the operation. Three hours before the operation the skin is painted with a 2 per cent. solution of iodine in rectified spirit, and then covered with a piece of sterile lint. When the patient is under anæsthesia, the skin is again painted with the iodine solution, and the operation immediately performed. After the wound is stitched up, another coat of iodine is applied. This is again repeated when the drainage-tube or stitches are removed.

For emergency operations the skin is *dry-shaved*, and a good coat of 2 per cent. solution of iodine in rectified spirit is applied and allowed to dry. A second coat is then applied, and directly it is dry the operation is performed. After the wound is closed it is again painted with the iodine solution, and the usual dressing applied.

In operations on the head, if the exact scope of the operation is not known, it is as well to have the whole head shaved, and the skin prepared as above. When the operation is of limited extent, as in a mastoidectomy, a wide area should be shaved, and the rest of the hair, which has been washed, covered with a sterilized india-rubber cap.

4. Instruments and Drainage-Tubes

All instruments should be made entirely of metal, so that they can be rendered absolutely sterile by boiling. The time taken to do this by boiling depends upon the organism to be killed, and whether spores are present. Although five minutes' exposure to boiling water will kill all cocci and non-sporing bacilli, it will take fifteen minutes to kill anthrax spores.

Instruments for an operation or dressing, however trivial, should be boiled for fifteen minutes in a sterilizer. If it is necessary to sterilize an instrument during an operation, three minutes may be considered enough if the instrument has not been in contact with any virulent spore-forming bacteria, and is already reasonably clean. A drachm of washing soda should be added to each pint of water in the sterilizer,

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as it helps in the removal of grease and fat, and prevents the instruments from rusting. The addition of the soda also slightly raises the boiling-point of the water; therefore disinfection is more certain and rapid. The instruments are removed from the sterilizer in a special tray, or with freshly boiled forceps, and placed in 1 in 40 carbolic lotion. Many surgeons prefer to use their instruments dry, in which case they should be placed in a dish on a sterile towel when taken from the sterilizer.

Knives.—The edge of a knife is rendered dull by boiling, especially if placed in the sterilizer loose with the other instruments. If the only means of sterilizing a knife is by boiling, it should first be wrapped in a piece of lint or gauze. The lint prevents contact with the side of the sterilizer and the other instruments. Knives may also be made sterile by the following methods:

1. Boiled by themselves in a sterilizer for thirty seconds. After boiling, they are kept in a solution of lysol and rectified spirit (1 in 3). When wanted, they are removed from the solution with sterilized forceps, dipped into a weak solution of carbolic or sterile water, and placed in the instrument tray.
2. The knives are washed with hot water and soap, and then immersed for a quarter of an hour in methylated spirit. They are then removed from the spirit, and placed in 1 in 40 carbolic lotion.
3. The knives are soaked for twenty-four hours in a solution of lysol and spirit (1 in 3), and at the time of the operation rinsed in a weak antiseptic solution.

Needles.—These are also blunted by prolonged boiling in the sterilizer. They should be stuck into a piece of lint before being placed in the sterilizer. They can also be rendered sterile by standing in lysol and spirit (1 in 3) for twenty-four hours. They should be rinsed in a weak antiseptic solution before use.

After the operation is over, all instruments should be cleaned in hot water with a nail-brush, special care being taken of the joints and the teeth, if any. They should then be sterilized, washed in water to remove the soda, placed in methylated spirit, dried, and put away. A freshly sharpened knife should, if possible, be used for every operation. Drainage-tubes are sterilized by boiling. They should be placed in 1 in 40 carbolic lotion until used.

5. Ligatures and Sutures

The following are the most commonly used ligatures and sutures—catgut, silkworm gut, silk, horsehair, and kangaroo tendon.

Catgut can be sterilized in the following ways. It should always be first wound on glass reels, or a hopeless tangle will result:

1. Chemical Method:

- (1) Soak in ether twenty-four hours.
- (2) Transfer to 1 per cent. solution of biniodide of mercury in methylated spirit for twenty-four hours.
- (3) Pour off the solution and rinse well in methylated spirit.
- (4) Soak in 1 per cent. solution of biniodide for forty-eight hours.
- (5) Store in 3 per cent. carbolic in methylated spirit.

2. Xylol Method:

Place catgut in a brass or gun-metal cylinder, and cover with xylol. Screw down the lid lightly, and place the cylinder in boiling water for ten minutes. Store in 1 in 40 carbolic and methylated spirit.

3. Chromic Acid Method:

Place the catgut in a mixture of 20 per cent. aqueous solution of chromic acid to 5 parts of glycerine. Keep the catgut in this for one to ninety-six hours, according to the durability required. After having soaked for a sufficient time, rinse in sterile water, dry on sterile towel and then place in 20 per cent. solution of carbolic acid and glycerine. It is ready for use in fourteen days.

4. Claudius's Method:

One ounce of powdered iodine crystals and $1\frac{1}{2}$ ounces of potassium iodide are dissolved in 10 ounces of water (hot); water is then added to make 5 pints. Ordinary commercial catgut is soaked in this for eight days, and is then ready for use. It may be kept in the original solution or in alcohol. It will be absorbed in a week or ten days.

Silkworm Gut.—There are five sizes—thick, medium, fine, very fine, extra fine. Tie it up into small bundles of ten strands each, and boil for thirty minutes in sterilizer. Remove it with forceps, and keep in 1 in 20 carbolic lotion. During the operation it should be placed in 1 in 60 carbolic lotion, and any strands left should be resterilized.

Silk.—To sterilize silk, boil in the hank for twenty minutes, and place it in absolute alcohol for twenty-four hours; then wind on sterilized glass reels, and boil again for ten minutes. Store in absolute alcohol.

After each case the silk can be boiled for ten minutes, and put back into store.

Silk is sold in hanks of 15 yards, and is of varying thicknesses.

Horsehair is sterilized by boiling in the same way as silkworm gut. It should be prepared as it is wanted. It is used for suturing wounds in the face and neck, where little sear is desired. Silkworm gut, however, is now prepared in very fine strands, and horsehair has been largely superseded.

Kangaroo Tendon.—This can be sterilized in the same way as catgut, the chemical method (1) or the chromic acid method (5) being used.

6. Sponges

Before sterilizing commercial sponges, they should be placed in warm water, and the small pieces of calcareous matter carefully picked out with forceps. They are then washed in water, which is changed fifty or sixty times, every part of the sponge being carefully inspected until the minutest grain of sand has been removed. They are next washed in a strong solution of common soda and lukewarm water, and transferred to jars containing a 5 per cent. solution of carbolic acid and water. They will be ready for use in twenty-two days.

Before use, they should be taken out of the 1 in 20 carbolic solution with sterilized forceps, and wrung out in sterilized water or some weak antiseptic solution.

Sponges that have been used for a clean case—that is, when they have not been contaminated by pus or faeces—may be used again

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after they have been resterilized. They are soaked for twenty-four hours in a 2 per cent. solution of soda, and washed in plain sterilized water, which is changed many times. They are then placed in 1 in 20 carbolic lotion, and in twenty-two days are ready for use.

7. *Bowls, Trays, etc.*

These should all be boiled for ten minutes before use. If this is impossible, they should be thoroughly cleaned, and a little methylated spirit should be poured into them. This is lighted, and after it has burnt out boiling water should be poured over the bowls and trays.

8. *Overalls, Towels, Dressings, Swabs, etc.*

These articles should be loosely packed in small tins, and sterilized by heating to 280° F. in a dry sterilizer for twenty minutes. The lids of the tins should be left open. They can also be rendered aseptic by subjecting them to the influence of steam under 15 pounds pressure for twenty minutes, or by exposing them to the action of steam at 100° C. for forty minutes.

After sterilizing, the tins containing them should be sealed with paper slips, and not opened until the time of operation. Any dressings left over from an operation must be reesterilized before use. If the conditions of operating are such that the towels cannot be sterilized, clean ones fresh from the laundry should be wrung out in 1 in 40 carbolic lotion before use. Sterilized towels may be used dry or wrung out in an antiseptic solution.

9. *Mackintoshes*

Mackintoshes are not now so much used as formerly. They are always covered with sterilized towels or cloths at the time of the operation. They should be scrubbed thoroughly on both sides, first with soft soap and hot water, to which a drachm of lysol has been added, and then with 1 in 40 carbolic lotion. After this they should be wiped with a sterile towel, and dried before the fire.

Such patent substitutes as pegamoid and Baptiste cloth can be boiled, and are therefore to be preferred to ordinary mackintoshes.

10. *Water*

Water for making lotions, etc., to be used at operations should always be sterile, particularly so if it is to be used for intravenous or subcutaneous infusion. In hospitals it is generally sterilized by boiling under pressure at 240° F. If it is not possible to obtain water sterilized in this way, freshly boiled water should be used for lotions.

Water drawn from a hot-water tap is, however, little likely to contain harmful bacteria, and may be used in case of emergency or when boiled water is not obtainable.

These methods of asepsis and antisepsis having been carried out and the patient anesthetized, the area of the operation is surrounded by the mackintoshes covered by the aseptic towels, which are fastened

with clips to prevent slipping. During the operation the surgeon and his assistants should avoid touching the skin as far as possible, and the fingers should be kept out of the wound. Dissection should be carried out chiefly by the knife, and all tearing, bruising, and laceration of the tissue avoided, for those tend to increase the amount of exudate. The surgeon's and assistant's hands should be washed from time to time in a weak solution of an antiseptic, but it is unwise to batho the wound in antiseptics, as they irritate the tissue and necessitate drainage. The blood should be sponged away with dry sterile swabs.

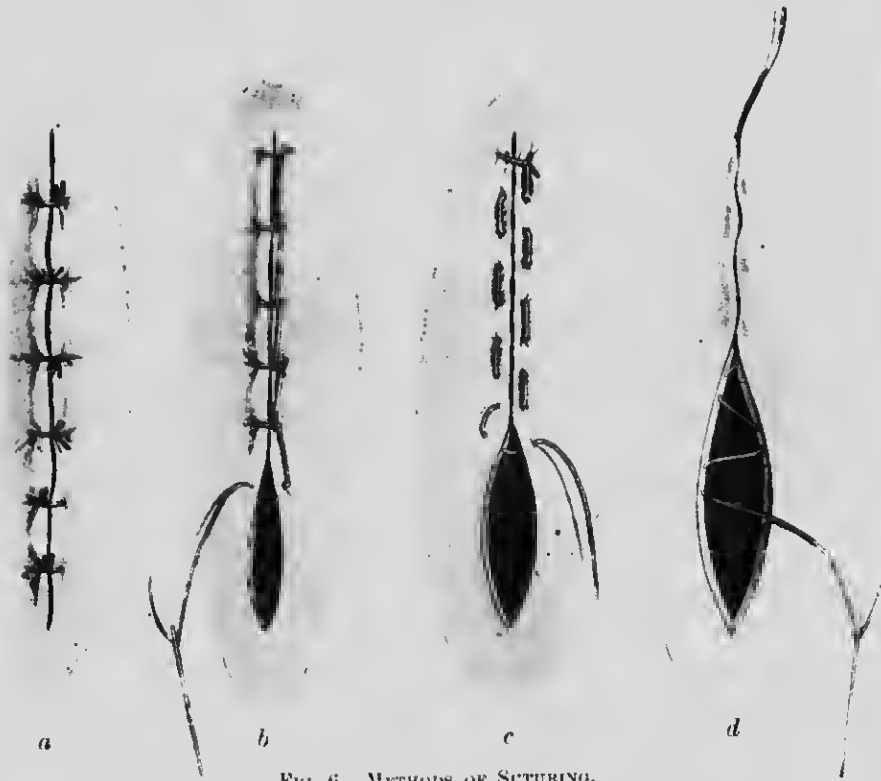


FIG. 6.—METHODS OF SUTURING.
(a) Interrupted; (b) blanket; (c) mattress; (d) subcuticular.

The operation should be performed as quickly as possible, consistent with care and neatness, in order that the time that the patient is under anæsthesia may be as short as possible. The shock and risk of infection will also be less.

Hæmostasis.—Directly the actual operation is over all bleeding should be carefully stopped, or it may be necessary to reopen the wound in order to do so, for the presence of blood in the wound may interfere with primary union of the wound. After all the bleeding vessels have been secured, buried sutures should be introduced to

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mitte the deep structures that have been divided, and to obliterate the "dead" spaces in the wound which would enable blood and serum to accumulate. These sutures should be made of absorbable material.

Sutures.—The skin wound should be sutured with silkworm gut, or the edges may be fastened together with Michel's clips. There are various methods of introducing the sutures:

1. *Interrupted.*—Each suture is introduced separately, tied and finished, the knot being adjusted away from the line of incision. This is the most commonly used method, and the sutures are very easy to remove.

2. *Continuous Glover's Suture.*—The suture is introduced at one end of the wound and tied; then the thread is carried continuously along the whole length of the wound, and tied at the other end. This method of suture is quick, efficacious, and economical, but it is not easy to remove, and the skin edges may be turned in.

3. *Blanket Suture.*—In this method the needle is carried through the loop of the thread at each stitch, and the suture is continuous. It is better than the Glover's stitch, for the approximation of the skin edges is usually more perfect, but it is not so quickly inserted.

4. *Halsted's Subcuticular Stitch.*—This method of suture is chiefly employed on the face and neck, where it is important to have as little scar as possible. It is a continuous suture, something like the Glover's stitch, but the needle passes through the deeper layers of the skin only. The two ends of the suture must be pulled tight, and then fastened down with collodion. The suture is removed by unsealing the ends, cutting one of them close to the skin, and pulling on the other.

Michel's metal clips bring the edges of the skin into close apposition, are easily applied and removed, and leave little mark. They are used at the whim of the operator.

Drainage of Aseptic Wounds.—Before the wound is completely closed, the question of drainage must be considered. An operation wound should be drained under the following conditions:

1. If there has been tearing and laceration of the tissues during the operation.
2. If it is impossible to obliterate all the "dead spaces."
3. If much oozing of blood is expected.
4. If there are doubts as to the asepticity of the wound.
5. If strong antiseptics have been introduced into the wound.
6. If it is impossible to apply a firm bandage, as in the case of some wounds in the neck and scrotum.

Wounds are generally drained with india-rubber tubes. Strips of gutta-percha tissue or strands of silkworm gut are useful in small wounds. The drainage-tube should be removed in twenty-four or forty-eight hours.

After the wound has been closed, a piece of dressing is placed over it and the surrounding skin cleaned. The line of the suture is painted with iodine solution if this method of rendering the skin aseptic has been adopted. A dressing is then applied.

Dressings.—The dressing should consist of sterilized gauze covered with absorbent cotton-wool. It should be secured by a bandage evenly and firmly applied. If necessary, the part should be kept at rest by placing it on a splint.

HEALING OF WOUNDS

PATHOLOGY.—It may be stated broadly that, from the pathological point of view, the method of healing of all wounds in all tissues is the same. Healing of wounds always occurs by the formation of granulation tissue, which is subsequently changed into scar tissue. In certain tissues, however, especially in young subjects, there may be some regeneration of the injured tissue. For example, regeneration of striped muscle may to a slight extent take place after an injury involving a muscle. The main bulk of the repair, however, is by scar tissue. If a nerve is divided and the ends are united, regeneration of the nerve takes place, but this is due to a downgrowth of the axis cylinder from the proximal portion of the nerve. If the ends of the nerve are not united, healing occurs by the formation of scar tissue. In the central nervous system regeneration of nerve cells never takes place. It will, therefore, only be necessary to consider the pathological changes that occur in a wound in any tissue.

If a wound is examined immediately after all hæmorrhage has ceased, it will be found that the severed bloodvessels are thrombosed as far as their next branch, and that all the interstices of the wound are filled with blood-clot, which sticks the two surfaces together.

The tissues at the edge of the wound are always contused, no matter how sharp the knife which made the incision, and a certain amount of destruction of the tissue must ensue. If this destruction is slight, as in incised operation wounds, the disintegrated tissue is quickly absorbed, and healing is not interfered with. If, however, the destruction is excessive, as in very contused wounds, the destroyed tissue must be removed by anæmic ulceration; or if organisms are present, by a line of demarcation (see Gangrene, p. 160) before healing can take place.

Inflammatory Reaction.—Immediately after the injury an inflammatory reaction sets in, and inflammatory lymph and white cells are poured out from the bloodvessels. At the same time the tissue surrounding the wound becomes hyperæmic and slightly swollen, owing to dilatation of the bloodvessels. The lymph coagulates, and forms a bond of union between the two surfaces, while the leucocytes remove those cells which have been destroyed by the passage of the instrument.

Small Round-Cell Infiltration.—The tissue round the wound becomes invaded with small round cells, containing vesiculated nuclei, which are in part the white cells of the blood, but are mainly derived from the endothelial cells lining the bloodvessels and lymph spaces of the part. The leucocytes wander back into the bloodvessels and lymphatics, or are disintegrated and take no part in the process of repair, this being the function of the endothelial cells.

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Vascularization.—Now loops of bloodvessels begin to appear among the small round cells, giving the surface of the wound a granular appearance. These new vessels, produced by the budding of columns of endothelial cells from the old capillaries of the part, grow together, and finally become canalized, thus forming new blood-channels. At first these processes have no lining membrane, but later they are lined with endothelial cells, and the walls are thickened by the formation of connective tissue round them. These new bloodvessels stretch across the gap of the wound, uniting the two surfaces; so that if the edges of the wound are separated, bleeding occurs from rupture of the newly formed bloodvessels. This mass of small round cells, lying in a

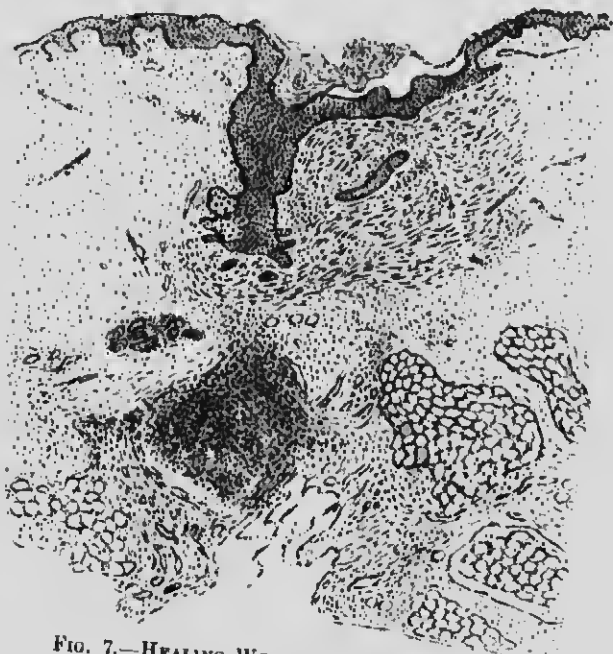


FIG. 7.—HEALING WOUND, ONE WEEK OLD.

homogeneous matrix and nourished by newly formed bloodvessels, is spoken of as *granulation tissue*, and is the basis of the material by which all repair takes place.

Fibrosis.—The next step in the process of repair is the elongation of the small round cells with flattening of their nuclei, and the appearance of bundles of fibres in the homogeneous matrix. The origin of these fibres is a matter of some dispute; according to some authorities they are an extracellular secretion of the endothelial cells, and others consider them to be processes of the detached cells, the body of the cell remaining as a fixed connective-tissue cell. These fibres stretch across the gap of the wound, and the edges are now united with young fibres and now capillaries—*i.e.*, by young scar tissue. This young

scar tissue is more vascular than the surrounding tissue; the scar, therefore, is red, and raised above the surface of the surrounding skin.

Scar Tissue.—The fibres of this young scar tissue contract steadily, drawing the edges of the wound closer and closer together. This contraction strangles the newly formed bloodvessels, causing them to disappear, and the scar becomes white, sufficient bloodvessels only being left to nourish the fibrous tissue. The small round cells also mostly disappear, so that the adult scar contains few bloodvessels and cells, and is hard, dense, and white, and depressed below the surrounding surface.



FIG. 8.—HEALING WOUND, TEN DAYS OLD.

Growth of Epithelium.—If the wound involves the skin or a mucous membrane, the fibrous tissue is covered with a layer of epithelium. As the deeper parts of the wound are healing by the formation of granulation tissue, the surface of the wound is gradually covered by a growth of epithelium, derived chiefly, in the case of the skin, from the cells of the rete Malpighii. This growth of epithelium finally covers the whole of the granulation tissue, and the wound has healed.

The new epithelium contains no sweat glands, sebaceous glands, or hair follicles—except at the edges of the wound—and is depressed below the surrounding skin by contraction of the fibrous tissue beneath.

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A scar is always smaller than the wound which produced it, owing to the contraction of the fibrous tissue.

Clinical Aspects of Healing.—Clinically, wounds heal in one of four ways: (1) By the first intention, (2) by the second intention or granulation, (3) under a scab, (4) by blood-clot.

1. **HEALING BY THE FIRST INTENTION.**—A wound heals by the first intention when its edges are brought closely together, and not subsequently separated by blood-clot, exudates, suppuration, gangrene, or other causes. When a wound heals in this way, the amount of scar tissue formed is a minimum, and the epithelium has to grow a minimum of distance. There is practically no exudation from the

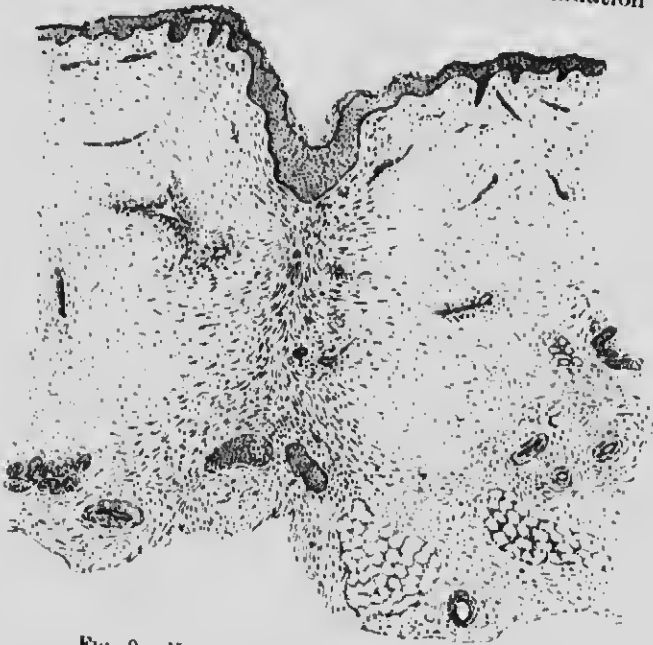


FIG. 9.—HEALING WOUND, TWO WEEKS OLD.

cut surface, and union is complete in about ten days. No severe constitutional disturbance takes place, no matter how large the wound may be (see Constitutional Effects of Wounds, p. 70). Healing by the first intention only occurs in incised wounds that are treated surgically. The primary dressing need not be disturbed for eight or nine days, by which time the wound will have healed sufficiently for the stitches to be removed. In cases of wounds of the face or neck, where little scar is desired, the stitches should be removed as early as the fourth or fifth day. Very slight wounds heal without scarring—for example, scratching and slight cuts on the face and hands—and it is stated that large wounds, such as a laparotomy wound, have healed so completely that the scar cannot be detected (Adami).

Dressing of a Wound which has healed by the First Intention.—The first dressing of an aseptic operation wound, whether to remove a tube or the stitches, must be conducted under the most careful aseptic conditions. The dissecting forceps, probe, and scissors should be sterilized, placed in a bowl of weak carbolic (1 in 80), or on a sterile towel. The site of the operation is well exposed, and the bandage and outer layer of cotton-wool removed. The surgeon should wash his hands as for an operation, put on gloves, and touch nothing that has not been sterilized until the bandage has once more been applied. Before removing the dressing, the surrounding skin and the bed-clothes must be covered with sterile towels, that nothing infective may come in contact with the wound.

The dressing should be removed with dressing forceps, the use of water to loosen it from the wound being avoided if possible, for moisture is favourable to the growth of micro-organisms. The stitch holding a drainage-tube in position should be first cut, and the tube removed. Unless there is abundant exudation from the wound, there is seldom any necessity for a smaller tube or a gauze drain to be placed in the wound.

Stitches should be pulled gently on one side till the part that has been buried in the skin is seen. This is cut through, and the stitch pulled out on the opposite side along the wound, thus preventing the edges from gaping. There is no necessity to remove catgut stitches, for the portion buried in the tissues becomes absorbed. Steel clips should be removed at the same time as sutures.

Sometimes after the removal of stitches the wound gapes if the union is not very firm. If this should occur, the edges of the wound should be strapped together, a layer of gauze being placed beneath the strapping, as this cannot be sterilized.

Occasionally, when a wound has not been drained, a quantity of clear serum collects in the wound, which superficially has healed perfectly. This condition is diagnosed by finding a fluctuating swelling under the wound without any of the local or general signs of suppuration. The wound should be broken down in one place with a probe, the serum squeezed out, and the dressing again applied with firm pressure in order to prevent a reaccumulation.

After the stitches have been removed, the wound should be painted with a 2 per cent. solution of iodine in spirit, and the fresh dressing applied. This should be aseptic, light, absorbent, and small, for it is used merely to protect the wound for the next few days, after which healing will be complete. The best dressing is some form of dry antiseptic or aseptic gauze placed next the wound, covered with cotton-wool. The dressing should be fixed with a bandage applied evenly and smoothly, in order to exert a light uniform pressure over the whole wound.

When the wound has been dressed in order to remove a drainage-tube, it must be dressed again on the eighth to the tenth day, and the stitches removed. After this, it need only be kept covered for a few days, unless healing is delayed at the site of the tube.

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2. **HEALING BY THE SECOND INTENTION OR BY GRANULATION** occurs when the edges of a wound cannot be brought together, or if they are subsequently separated by hæmorrhage, gangrene, or suppuration. In these wounds the gap between the sides of the wound has to be filled with granulation tissue, which, after changing into fibrous tissue, contracts, thus bringing the sides of the wound together. The epithelium gradually grows over the surface of these granulations, but on account of the contraction of the fibrous tissue, the scar is always smaller than the original wound. In the great majority of cases, healing by the second intention takes place on account of suppuration supervening in a wound, for the pus which accumulates must be evacuated. Failure of union by the first intention is, therefore, usually due to infection of the wound by micro-organisms, and is more common in accidental and contused wounds than in surgical wounds. Occasionally, when an aseptic wound is made, and the skin edges cannot be brought together on account of loss of substance, aseptic healing by granulation may occur. It is, however, unusual. A description of a granulating surface and the method of treatment is described in the chapter on Ulceration (p. 154).

3. **HEALING UNDER A SCAB** is merely a modification of healing by granulation. It only occurs in the case of small superficial wounds. The scab is composed of coagulated blood and inflammatory lymph. This forms a natural dressing for the part, and if the wound remains aseptic, healing has occurred when the scab is removed. On the other hand, if the wound becomes infected, ulceration may occur under the scab, and healing has to take place later by granulation.

4. **HEALING BY BLOOD-CLOT.**—This is another modification of healing by granulation tissue. It occurs when an artificial cavity such as a hole made in a bone is allowed to become filled with blood-clot, the tissues over it being carefully closed, and healing by the first intention. If there is no infection of the blood-clot, it is invaded by granulation tissue from the sides of the wound, and gradually replaced by scar tissue. The blood-clot takes no part in the process of repair beyond forming a pabulum for the endothelial cells and the blood-vessels to grow in during the formation of the granulation tissue. Other materials, such as sterilized wax, nutton-fat, spermaceti and iodoform, decalcified bone, etc., have been employed to take the place of blood-clot to fill the cavity; and the success of this treatment depends on perfect asepsis. This method of treating wounds will be further considered under Diseases of Bones.

ACCIDENTAL WOUNDS, OR WOUNDS LIKELY TO BECOME INFECTED

This variety of wounds comprises all wounds other than those afflicted during surgical operations. All are liable to be invaded by micro-organisms. If this invasion occurs, the wounds pass into the category of infected wounds. These wounds may be incised, punc-

tured, contused, gunshot wounds, wounds containing foreign bodies, stings of insects, bites of animals, and snake-bites.

1. Accidental Wounds (Incised, Punctured, or Contused).

The diagnosis of these wounds is obvious.

TREATMENT—FIRST AID.—The first consideration in these accidental wounds is the arrest of hæmorrhage, if profuse, and this must be carried out by the methods described under Hæmorrhage (p. 186). The second consideration is to render and keep the wound as aseptic as possible. In the absence of proper aseptic and antiseptic dressings, it may be taken as an axiom that all interference with the wound beyond the arrest of hæmorrhage is to be deprecated. The most that should be done, therefore, is to cover the wound with some such simple dressing as a perfectly clean handkerchief, for this is reasonably aseptic. Washing the wound with casual water is, as a rule, harmful, and should never be done unless the wound contains actual dirt. In this circumstance, if proper attention cannot be given to the wound for some hours, it should be washed out with water drawn directly from a tap, for the earth may contain the tetanus bacillus or the bacillus of malignant œdema, while the risk of infection from the use of tap-water is very slight. An aseptic blood-clot is the best dressing for an accidental wound in the absence of a proper aseptic or antiseptic absorbent dressing.

DELIBERATE TREATMENT.—The question of amputation has first to be decided, and the rules for answering this question are given under the heading of Traumatic Gangrene (p. 168). If amputation is not necessary, an accurate diagnosis should be made as to the extent of the wound, especially whether nerve trunks have been divided. This examination for a divided nerve *must always be made before the administration of an anæsthetic*, as the surgeon is dependent upon the help of the movements and sensations of the patient in establishing a diagnosis of nerve injury. In regard to other injuries, it is often advisable to leave the making of an accurate diagnosis until the patient has been placed under a general anæsthetic, on account of the pain caused.

In treating these wounds, the hands of the surgeon and all instruments, swabs, and dressings must, of course, be sterilized, and the treatment of the wound carried out with strict observance of the rules of aseptic operating. The temporary dressing being removed, the wound and the surrounding skin are painted with a 2 per cent. solution of iodine in spirit. This application is painful, but the pain soon passes off. If the iodine solution is not obtainable, or if the wound is very dirty, it may be lightly packed with aseptic gauze, and the surrounding skin carefully washed and, if necessary, shaved. An ethereal solution of soap and turpentine is used to remove the dirt. After washing with soap, ether is applied to the skin to remove the fat, and the part then washed in some such antiseptic as carbolic (1 in 60), perchloride of mercury (1 in 1,000), biniodide of mercury (1 in 500), or lysol (1 drachm to a pint).

* If eye solution.

When the skin has been rendered aseptic, the wound should be surrounded by sterilized towels, and the surgeon must again wash his hands and turn his attention to the wound. The gauze packing is removed, and the wound carefully examined. It must be ascertained that there is no foreign body in the wound, or if the wound is in the region of a joint, tendon sheath, or one of the body cavities, it must be definitely found out whether the wound is penetrating in order that appropriate treatment may be carried out. Penetration of a joint or synovial sheath can often be diagnosed by the escape of synovial fluid. If the wound is one of the scalp, the presence or absence of fracture of the skull must be definitely determined.

All loose or crushed tissue should be removed, and all the bleeding vessels secured and ligatured.

The question will now arise as to whether the wound should be closed at once. When the crushing of the tissues has not been great, and the amount of dirt is slight and readily removed from the wound, immediate suturing should be undertaken. If tendons have been severed, the divided ends should be exposed by dissection, and sutured together with chromicized catgut. The tendon should be wrapped in Cargile tissue to prevent adhesion taking place between it and its sheath, and, if possible, the sheath should be repaired by suturing with catgut. Nerves, if severed, should have their ends exposed and sutured with catgut, and wrapped round with Cargile membrane. Ligaments, if cut, should also be repaired by suturing with catgut, and a rent in a fascia or in a muscle sheath should be closed in the same way.

If much lacerated, or if a strong antiseptic has been applied, the wound should be drained for twenty-four to forty-eight hours, for a copious exudate of serum will occur, and, in addition to preventing healing, will form a favourable nidus for the growth of micro-organisms. Drainage should also be carried out if there is any doubt about the asepticity of the wound.

The skin should be drawn together by interrupted sutures of silk-worm gut, so that, if there is much tension, one or two can be removed without the entire wound opening. In exposed parts, as the head and neck, especially fine suture material should be chosen, and the sutures removed on the third, fourth, or fifth day, that the resulting scar may be slight. An aseptic dressing* should be applied with firm,

* If cyanide gauze be used as a dressing, it should be wrung out in 1 in 40 carbolic solution.

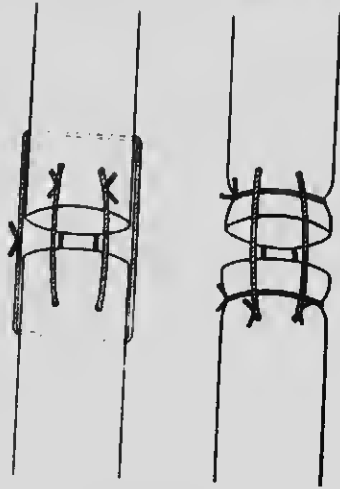


FIG. 10.—METHODS OF SUTURING TENDONS.

even pressure, and if tendons or nerves have been sutured, or if the wound is near a joint, a suitable splint is necessary to keep the part at rest. In the case of divided tendons or nerves in the forearm, malleable metal splints are useful, as they can be bent into any shape, thus keeping the injured tendon or nerve in the relaxed position.

If no drainage has been employed, the wound will not need dressing for eight days, when the stitches will be removed; but if the wound has been drained, it should be dressed in twenty-four to forty-eight hours, and the drain removed, the stitches not being removed till the eighth, ninth, or tenth day. If a tendon has been divided and sutured, passive movements may be begun on the fourth day; but strong, active movement should not be allowed till the sixth week.

When there is much laceration of the wound, especially if dirt is ground into it, making it almost impossible to render it surgically clean, the wound should not be closed immediately. The part should be fomented with some weak antiseptic lotion, or kept in a continuous bath (lysol, $\frac{1}{2}$ drachm to a pint) for forty-eight hours. At the end of this time, suture of the divided tissues should be performed, and the wound drained. In these very dirty cases tetanus is to be feared as a complication, and a prophylactic injection of tetanic antiserum may be given.

2. Gunshot Wounds

Gunshot wounds may be divided into three types—(1) Those caused by such high-velocity bullets as are fired by Lee-Metford and Mauser rifles or from Browning pistols; (2) those caused by explosivo and expanding bullets, usually also of high velocity; (3) those caused by low-velocity bullets, fired from shotguns or rifles of an old type.

In all three types, if the weapon is fired close to the patient, the skin is scorched and blistered; and if the old-fashioned black powder is used, the grains are driven into the skin, and a permanent stain remains.

A. High-Velocity Bullets.—These are fired from the modern rifles used by all civilized armies, and are conical in shape, being made of a central core of lead and antimony covered by a hard casing of copper and nickel. These bullets travel at a very high velocity in the direction of their long axis, doing damage only to the parts that lie directly in their track. The clothing is generally cleanly pierced, and no particle of it carried into the wound. The entrance wound is smaller than the bullet, and may easily be overlooked, but its edges are slightly contused. Hæmorrhage is usually very slight. The track of the bullet, especially where it passes through muscles, is very hard to trace on post-mortem examination, and even most important structures may be pierced with apparently little harm done. In one case seen by the author the pericardium and right auricle were pierced by a bullet fired from a Browning pistol at close range, and yet there was practically no hæmorrhage along the track of the bullet.

The wound of exit is slitlike, and, as a rule, slightly larger than the wound of entrance. Its edges are not contused.

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Effect on Bones.—A bone may be pierced by one of these bullets, especially if it is cancellous bone, such as the lower end of the femur, or the bullet may remain embedded in it; but more commonly a badly comminuted fracture results.

Effects on the Skull, and Brain, and Cord.—The skull is fractured, and the inner table is generally more damaged than the outer. If the bullet passes right through the head, the exit wound is usually large. Bullet wounds of the brain are, as a rule, fatal, but it is surprising how a high-velocity bullet may traverse, or even remain in, the brain, with little disturbance of the cerebral function.

The symptoms presented depend upon the path of the bullet through the brain. If it passes only through the "silent" area, no symptoms beyond concussion may be present. Later, abscess of the brain or hernia cerebri may develop.

If the vertebræ are struck, the spinal cord opposite the site of impact is usually disintegrated. It will, therefore, no longer conduct impulses, and the usual symptoms of a complete cord lesion are present. These symptoms are, of course, also present if the bullet traverses the cord itself. In a case seen by the author of a bullet embedded in a vertebra, the patient was completely paralyzed below the site of injury.

Effect on the Bloodvessels.—These wounds are associated with very little bleeding or damage to bloodvessels, unless the bullet passes through a large artery or vein. In one described case the bullet passed between the aorta and vena cava, neither being injured; and in another the kidney was shot through, and no hæmaturia ensued. Damage to the coats of an artery may result in the formation of an aneurysm. Aneurysmal varix and varicose aneurysm from simultaneous injury of an artery and a vein were common sequelæ after bullet wounds received in the Boer War.

Effect on the Abdomen.—Judging from the experience gained in the Boer War, a surprising number of high-velocity bullet wounds of the abdomen recover without operation, although there can be no doubt that the intestinal canal has been perforated. The bullet wounds in the intestinal wall are small, and are plugged with prolapsed mucous membrane. Escape of intestinal contents is therefore prevented, especially



FIG. 11.—BULLET EMBEDDED IN THE FEMUR.
(London Hospital Medical College Museum.)

as the shock of the wound seems to inhibit peristalsis. On the other hand, wounds of the mesentery resulting in fatal hæmorrhage and escape of intestinal contents, with subsequent peritonitis, are frequent sequelæ of abdominal gunshot wounds. If a solid abdominal viscus as the liver, spleen, or pancreas, is injured, the bleeding is, as a rule, very slight, and the wounds almost insignificant.



FIG. 12.—PROTRUSION OF MUCOUS MEMBRANE THROUGH BULLET WOUND OF THE INTESTINE.

cleaning the skin surrounding the wound, and covering it with an aseptic dressing. Nowadays every soldier is provided with a first-aid dressing-case in time of war.

DELIBERATE TREATMENT.—*Removal of the bullet.* If the bullet is easily felt under the skin, it should be removed. Opinions differ as to the advisability of removing deep-seated bullets, which cause no symptoms. There is no doubt that bullets may remain in

Effect on the Nerves.—Nerves are only damaged if they lie in the track of the bullet. In such a case the patient presents all the usual symptoms of complete division of a nerve.

Effect on the Chest.—High-velocity bullets penetrating the chest may apparently cause little damage, and even if the lung is traversed, the amount of hæmoptysis may be very slight. If a main vessel is divided, the patient will soon die of suffocation owing to the filling of the bronchi with blood. The wound generally remains aseptic, and rapid healing occurs without pneumonia or pleurisy.

The most common complication of these bullet wounds of the lungs is hæmopneumothorax. The symptoms are pain, some dyspnœa, hæmoptysis, and slight cyanosis. The condition clears up, as a rule, without surgical interference.

Bullet wounds of the heart are generally fatal, although cases of recovery in which it is certain that the heart has been injured have been described.

High-velocity bullet wounds, on the whole, remain aseptic, but suppuration along the track of the bullet may occur in any of the tissues.

TREATMENT—FIRST AID.—

The first-aid treatment is that of any wound. It consists of

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the tissues for years without causing any inconvenience, but in the majority of cases it is better to remove the bullet unless it is embedded in some place difficult or impossible of access. The position of the bullet should always be carefully localized by means of radiography before removal is undertaken.

Wounds of the Abdomen.—It has been found that in warfare clean penetrating gunshot wounds of the abdomen are best left alone unless there is evidence of hemorrhage or escape into the peritoneal cavity of alimentary canal contents. The lack of perfect surgical surroundings makes abdominal operations in these circumstances exceedingly dangerous, and better results are obtained by expectant treatment. If, however, the wound occurs in civil practice, and the abdomen can be opened under aseptic conditions, exploration of the wound is the safer method of treatment.

Wounds of the Skull.—In all cases the skull should be trephined over the bullet wound in order that the extent of the damage to the inner table may be ascertained. A careful search should be made for the bullet, though it is better to leave the bullet behind than to damage the brain severely. When possible, the bullet should first be localized by a stereoscopic radiogram. The results after high-velocity wounds of the brain are surprisingly good if death does not occur immediately.

Wounds of the Chest.—No special treatment is necessary for gunshot wounds of the chest, and the bullet should only be removed if it is causing symptoms or if a radiogram shows that it can be easily reached.

The treatment of gunshot wounds of other parts, and the further treatment of these lesions, follow the usual lines for the treatment of wounds due to other causes.

B. Explosive Bullets.—Explosive bullets contain a small charge of some explosive which detonates when the object is struck, causing the bullet to fly into pieces. The wounds caused by these bullets are terribly ragged and dangerous. Expansile bullets are made by removing the front of the hard covering of an ordinary high-velocity bullet, as in the dum-dum bullet, or by cutting the hard covering of the ordinary bullet in several places. Both explosive bullets and expansile bullets are condemned in civilized warfare, and are only used in big-game hunting. The wounds caused are extremely lacerated, highly dangerous, and bleed severely.

TREATMENT.—In wounds of the limbs caused by these bullets, the question of amputation must first be decided, and the same rules followed as given in the section on Traumatic Gangrene (p. 163). If amputation is decided against, or if the part does not admit of amputation, the same treatment must be carried out as for wounds due to other causes. In all cases the track of the bullet should be explored to ascertain the extent of the damage.

C. Low-Velocity Bullets.—These bullets are usually made of lead, and are fired from small revolvers, toy-pistols, air-guns, small sporting guns, etc. On the whole, they produce larger wounds than the high-

velocity bullets, the wound of exit being particularly large. Fragments of clothing, and in some cases wads used to compress the powder, are often carried into the wound, and add to the danger of infection in addition to making a large lacerated wound. The charge of a sporting gun generally consists of a large number of small shot, and the penetrating power is small; but if fired close to the patient, a large lacerated wound is produced, or the pellets may penetrate the eye or the abdomen, and cause serious or fatal results.

TREATMENT.—The treatment is similar to that of other wounds. The bullets should be localized by radiography, and removed if they can be easily reached.

3. Wounds containing Foreign Bodies

Foreign bodies in wounds may be divided into three classes—(1) Those which are absorbable, (2) those into which the connective-tissue cells can penetrate, (3) those that are non-absorbable and impermeable. The first two varieties of foreign bodies are, for practical purposes, always introduced by the surgeon; the last may be introduced by accident.

1. Absorbable substances: The most commonly used are catgut and linen thread, which, when introduced into the tissues, after exciting a slight inflammatory reaction, are completely absorbed, the rate of absorption depending on the thickness of the material, the mode of its preparation, and the vascularity of the tissue in which it is placed. Minute foreign bodies, such as soot, coal-dust, and Indian ink, may be taken up by the phagocytes, and carried from the site of infection to the lymph glands. They may remain in the tissues for an indefinite time, for soot is discovered in the epithelial cells of the skin of the scrotum of a sweep many years after he has given up the trade.

2. Permeable substances: Such foreign bodies as tendons, silk, and paraffin wax, if aseptic, are gradually permeated with connective tissue, so that they apparently disappear; but they can be discovered on microscopic examination. In one case, ten years after the suture of a kidney by kangaroo tendon, the situation of the tendon was clearly seen on microscopic examination, although it was completely permeated by connective tissue.

3. The fate of such foreign bodies as silver wires, bone plates, bullets, needles, etc., depends on the asepticity of the wound by which they were introduced. If the wound remains aseptic, one of four results occur:

- (1) The foreign body, round which a capsule of fibrous tissue forms on account of the irritation of the tissues, remains stationary.
- (2) A cyst containing clear fluid, and lined by a capsule of fibrous tissue, forms round the foreign body.
- (3) If the foreign body lies in an evascular space, such as a bursa or a joint, it remains free and unencapsuled.

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- (4) The foreign body may wander through the tissues, and finally point under the skin a long distance from the place of entrance.

Foreign bodies may remain for years in the tissues without causing the least inconvenience, but at any time infection by micro-organisms may ensue, and an abscess form, with ultimate discharge of the foreign body. In some cases in which the presence of the foreign body has been unknown or unsuspected, the inflammatory swelling may be taken for a neoplasm or a lesion of tubercle or syphilis.

TREATMENT.—Foreign bodies introduced by surgical operations, such as plates for securing the fragments of a bone in position, are usually left, although some surgeons prefer to remove them after their work is done. Foreign bodies, as needles or bullets, introduced into a wound by accident, should as a rule be removed at once; but if the wound has healed, a radiogram should be taken, and the question of operation then carefully considered. In some cases (see Bullet Wounds) it is advisable not to attempt removal.

If the wound by which the foreign body is introduced does not remain aseptic, it does not heal, and suppuration and sinus formation result. The sinus will not heal until the foreign body has been removed, therefore this should be done as soon as the body is localized.

4. Stings of Insects

1. Stings of bees and wasps are exceedingly painful, and may be dangerous from one of three causes:

- (1) From their numbers. If a patient is stung by a large number of bees or wasps, death from heart failure may result.
- (2) From the situation of the sting. Stings in the mouth usually cause great swelling; suffocation may occur from oedema of the glottis.
- (3) By being a means of introducing such organisms as the streptococcus of erysipelas.

TREATMENT.—The sting and poison sac should be removed, and a dilute alkaline lotion, such as ammonia water, bicarbonate of soda, or sal volatile applied. If the sting is in the mouth, the usual treatment of acute oedema should be carried out.

2. Flies, midges, mosquitoes, spiders, etc., all produce a local inflammatory swelling by injection of an irritant poison. In the majority of cases, the condition is only an annoyance, although serious results may occasionally follow. Flies, for example, may be bearers of typhoid bacilli; the mosquito carries various tropical diseases, such as *Filaria sanguinis hominis* and malaria. The minute wounds of midges may be infected, and erysipelas or cellulitis result.

TREATMENT.—The part should be bathed with dilute alkaline lotions.

5. Snake-Bites

Poisonous snakes are much more common in the tropics and subtropics than in the United Kingdom, where the only poisonous snake of importance is the adder. The poison of this snake is not very powerful, and death is unlikely to follow unless the patient is a child, children being very susceptible to the venom of snakes.

SYMPTOMS.—Locally, there is a small double wound caused by the teeth, and into these wounds the poison is injected from the poison sacs at the base of the teeth. Rapid swelling round the wound ensues, followed by severe pain and possibly gangrene.

The general symptoms are those of shock—*e.g.*, rapid pulse, shallow respiration, cold clammy sweat, and frequently nausea and vomiting. These come on soon after the infliction of the bite, which, if it is going to prove fatal, generally does so within forty-eight hours.

TREATMENT—Local.—The limb should be firmly bandaged above the bite in order to stop, as far as possible, general infection and to encourage free bleeding. The bite should be excised, and the wound canterized or treated with a strong solution of potassium permanganate. The bandage should be removed after a few hours.

General.—The treatment of shock should be carried out; it is generally advised to give strychnine or alcohol freely. An antiserum called "antivenene" has been produced by Walnutto and Fraser by inoculating a horse with non-lethal doses of cobra venom. This, if injected within an hour of the bite, is valuable. It is given hypodermically in doses of 10 to 40 c.c.

6. Bites of Animals

Bites of animals are examples of lacerated wounds, and require the usual treatment of these wounds. They owe their special importance to the fact that they are the common means of conveying the virus of hydrophobia to man (see p. 103). In the case of human bites, the spirochæte of syphilis may be infected if the aggressor has syphilitic lesions in the mouth, and in one case, seen by the author, five chancres developed on the hand of a patient who was bitten by a syphilitic woman.

SCARS

A scar results from the healing of a wound, and consists of strands of fibrous tissue nourished by blood vessels and covered with epithelium. In the case of scars of the skin the epithelium is the squamous epithelium of the epidermis, and only contains sweat glands, sebaceous follicles, or hair follicles near the edges of the scar. When a wound involves a mucous membrane, the scar tissue is covered by epithelium derived from the surrounding epithelium.

A scar is at first soft and pink, owing to its vascularity, gradually, however, growing firm and white. This change is brought about by contraction of the newly formed fibrous tissue, which strangles the bloodvessels. In large wounds this contraction becomes pathological

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by causing deformity and hindering the movements of joints. A scar will increase in size with the growth of the patient; or, in some cases, it will steadily become broader although the wound healed by the first intention. The complications of scars are—

1. *Excessive Contraction*.—The contraction of scar tissue is a normal condition, and assists in the healing of wounds. If likely to be excessive, the following methods may be taken to prevent it:

- (1) Carefully splitting the wounded part in the position opposed to contraction. This splitting must be continued for a long time after the wound has healed.
- (2) Carrying out massage and passive movements in order that the scar tissue may be kept supple and stretched.
- (3) By covering the granulating surface with skin-grafts, any of the varieties of skin-grafting being useful.

If excessive contraction has already taken place, it may be remedied by the following methods:

- (1) Excision of the scar, and covering the raw surface with Thiersch's grafts or other forms of skin-grafts.
- (2) Plastic operations which are carefully planned to meet the particular case.
- (3) Injections of thiosinamino or fibrolysin into the part, combined with massage, passive movements, and baths.

Fibrolysin is used in a 15 per cent. solution, and 2 to 3 c.c. are injected into the part. This injection is repeated every three days until about thirty injections have been given. It is said to act by producing an active leucocytosis in the part, the leucocytes absorbing the fibrous tissue; but it is doubtful if it is of much value.

- (4) Application of X rays and Finzen light.

2. *Painful Scars*.—Scars may be painful owing to the following reasons: The ends of nerves in amputation stumps becoming bulbous; the involvement of nerve terminals in the scar; undue pressure on the scar tissue; in neurotic patients without obvious cause; from ascending neuritis.

- (1) Bulbous ends to nerves in amputation stumps are due to the growth of the axis cylinders of the nerves, which become rolled up in the fibrous tissue. It is only rarely that they are painful.

TREATMENT.—Excision of the nerve or reamputation if pain is present.

- (2) The inclusion of nerves in scars may cause extreme pain mostly of a shooting character and often paroxysmal, the paroxysms often coming on without apparent cause.

TREATMENT.—Excision of the scar and careful approximation of the skin surfaces.

- (3) In badly planned amputations, the scar may be directly pressed upon by the artificial limb, which will cause pain.

In some cases suppuration may be present under the scar, which will finally ulcerate.

TREATMENT.—The scar must be protected from pressure, or reamputation may be necessary.

- (4) The diagnosis of hysterical pain in a scar can often be made by the excessive nature of the pain. The patient may shrink from the merest touch on the scar, but when his attention is attracted elsewhere, pressure can be made



FIG. 13.—KELOID.

without causing complaint. The general condition of the patient's nervous system and his previous history may aid in making the diagnosis.

The **TREATMENT** is that of hysteria in general.

- (5) In some cases, especially if the wound has been infected, a scar may be excessively painful, and the pain extend along the nerve trunks which supply the part. The surrounding skin may be "glossy," hair fall out, and the movements of the nearest joints impaired. The pain is usually very severe, and may completely incapacitate the patient.

TREATMENT.—Treatment is unsatisfactory, as division of the nerve may fail to cure the affection. The condition is further described in the section on Injuries and Diseases of Nerves (p. 368).

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3. *Keloid*.—Keloid is an overgrowth of vascular fibrous tissue occurring in a scar, but its exact pathology is a matter of dispute. It may arise in such small scars as insect-bites, acne pustule scars, or after piercing the ears for earrings. It is most often seen, however, after burns and scalds or tubercular lesions. It is more common in young subjects than in the elderly, and in the black races than in the white.

The overgrowth is seen as a firm, pinkish-coloured mass, raised above the surrounding skin and sending out clawlike processes. The patient often complains of burning and itching of the part.

TREATMENT.—In a large number of cases, keloid will disappear spontaneously, and no treatment be necessary. The application of X rays, radium, or Finson light may bring about absorption in some instances, but the process is slow and uncertain. Injections of fibrolysin and the giving of thyroid extract improve some cases.

OPERATIVE TREATMENT.

—If the keloid occurs in a wound that has suppurated, or in a tubercular wound, excision of the keloid may be beneficial if the excision goes wide of the overgrowth, and union by the first intention is obtained.



FIG. 14.—ULCERATION OCCURRING IN AN EXTENSIVE SCAR.

4. *Weak Scar*.—Scars that have resulted from the healing of very large wounds, such as extensive burns, especially if contraction of the scar tissue has been prevented by adherence of the scar to underlying bone, are apt to break down in the centre from very slight causes, as the blood-supply to the central parts of such a scar is exceedingly scanty. Ulceration, following slight injuries, is very common in these scars, and is difficult to heal.

TREATMENT.—The treatment consists of excision of the weak part of the scar, and covering the raw area with skin-grafts.

5. *Pigmented Scars*.—These may be due to such foreign bodies as gunpowder, Indian ink, soot, etc., introduced when the wound was made, or to extravasated blood-pigment, which is most usually seen in chronic ulcer of the leg with venous congestion.

The only treatment is excision of the scar.

6. *Malignant Disease*.—Both sarcoma and carcinoma may originate in a scar, carcinoma of the squamous-celled type being the more common. It is generally seen in scars produced by chronic ulceration, and it is believed that the constant irritation of the chronic inflammation predisposes to the carcinomatous growth. The condition is found in chronic ulcers of the leg; it may also follow chronic ulcers on the tongue or on mucous membranes. It has been estimated that 10 to 50 per cent. of carcinomata of the stomach arise in the scars of non-malignant ulcers.

The treatment is the same as that of malignant disease due to other causes—i.e., free excision of the growth and the lymphatics draining the area in which it is growing.

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CHAPTER IV

INFECTED WOUNDS

Infected Wounds.—By this term is understood wounds in which bacteria are growing and producing local and general symptoms. It is customary to divide the bacteria infecting wounds into specific and non-specific, but with advances in bacteriology the distinction between these two terms is disappearing.

A *specific* disease is one caused by a particular species of bacterium—*e.g.*, tuberculosis—while a *non-specific* disease may be caused by any of several species. Cellulitis, for example, may be due to several species of organisms, but in modern surgery it is recognized that the term "cellulitis" is a clinical description, and not the name of a disease. To complete the diagnosis and to carry out modern surgical treatment it is essential to ascertain the exact variety of the infecting organism, which is specific for the particular case under observation. Vaccine treatment entirely depends upon the specific nature of all organisms.

It is still, however, convenient to use these terms in the classification of infected wounds.

NON-SPECIFIC INFECTION OF WOUNDS.

Infection of an Operation Wound by Pyogenic Organisms.—If an operation wound is infected by pyogenic organisms, instead of the patient's temperature becoming normal on the second day, it continues to rise, and the patient exhibits the general symptoms of an acute infective fever (see p. 20). If the wound is inspected on the third day in a case of acute infection, the whole area of the wound is found to be red, brawny, and oedematous, the redness being most marked at the line of the suture and in the stitch holes. The wound is tender, and the patient usually complains of throbbing pain in it. If a stitch be removed and the wound slightly opened, pus will escape, and later the whole wound will probably break down, and after a variable amount of suppuration will heal by granulation. The severity of the inflammation and the extent to which suppuration occurs varies considerably, and in some cases the general symptoms may be so slight that there is no reason to inspect the wound until the usual time for removing the stitches. Even then the wound may apparently have healed by the first intention, and it may be some

days or weeks longer before sufficient pus has collected to give unequivocal signs that suppuration has occurred. Examination of the pus removed from such an abscess may show no evidence of bacteria, and it is possible that the breaking down of the tissues is due to the irritation of chemical substances used at the operation. If chromicized catgut has been used as suture material, it is not uncommon to find the suture lying loose in the abscess cavity, and it is suggested that the condition is one of non-infective suppuration due to chromic acid.

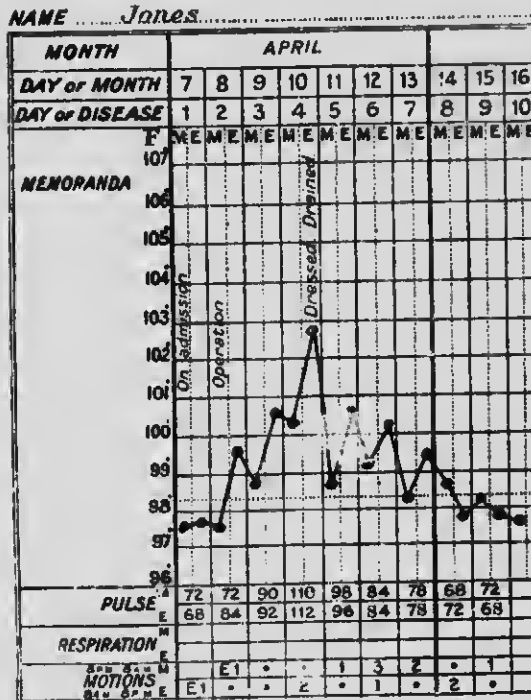


FIG. 15.—TEMPERATURE CHART OF A PATIENT OPERATED UPON FOR HERNIA, WITH INFECTION OF THE WOUND.

wound should be opened, and a search made for any suture that has not been absorbed. A drainage-tube is then introduced, and the wound dressed aseptically.

Septic Conditions.—Under the term septic there is grouped somewhat vaguely a large number of varying inflammatory conditions due to the invasion of the tissues by certain organisms which produce pus (pyogenic). The most common of these organisms are *Staphylococcus pyogenes aureus, albus, and citreus, Streptococcus pyocyanus, and Bacillus coli communis*. The organisms either grow locally, producing local inflammatory conditions, usually ending in suppuration and causing general symptoms by the absorption of their toxins (sepsis), or they invade the blood-stream, and are carried to all parts

TREATMENT.—Several of the stitches should be removed, so that the pus can escape from the wound, and an antiseptic dressing applied. The wound should be dressed daily until healing has occurred.

If the infection is very acute and the general symptoms severe, all the stitches should be removed, the wound thoroughly opened up, and fomentations applied until a healthy granulating surface is present. A dry aseptic dressing should then be applied, and renewed every two or three days.

In the case of mild suppuration the

of the body, where they may start secondary foci of suppuration (*general infective fever*). In these last cases the organisms can frequently be cultivated from the blood.

Septic conditions include abscess formation, diffuse cellulitis and suppuration, erysipelas, septico-pyæmia, and ulceration.

Acute Abscess.—An abscess is a localized collection of pus in the body. The pus may be localized amongst the coils of the intestine, or in the brain, or subcutaneous tissue, but it is always surrounded by a layer of granulation tissue more or less perfectly formed, which, again, is surrounded by a zone of inflammation. The pathology of the formation of pus has already been given under Inflammation.

CAUSE.—The cause of an acute abscess is infection of the tissue by one of the pyogenic organisms, usually the staphylococcus. The organism may reach the part in one of the following ways: (1) Direct infection through a wound; (2) by means of the blood-stream; (3) by the lymphatic stream; (4) by spreading along ducts, as in abscess of the breast; (5) by direct spread from another part, as in localized abscess in the peritoneum secondary to acute inflammation of the appendix.

SYMPTOMS.—The *general* symptoms are those of the absorption of toxins, and vary in degree with the virulence and nature of the organism and the pressure under which the pus is; they have already been described under Suppuration, and are—rise of temperature, sometimes with rigors; rapid pulse and respiration; sweating; anæmia and leucocytosis, constipation (sometimes diarrhoea), loss of appetite; delirium; and a scanty high-coloured urine containing albumin. There is also rapid loss of flesh and strength. The *local* symptoms are those of acute inflammation—viz., redness, swelling, heat, pain, loss of function, and, when the collection of pus is sufficient, fluctuation. As the pus comes to the surface, the skin becomes œdematous and dusky red in colour.

It is often exceedingly difficult to tell whether resolution of an inflamed area is still to be hoped for, or whether suppuration and abscess formation has occurred. The following points may help the decision:

GENERAL.—

1. If acute inflammation has lasted more than four or five days without retrogression of the symptoms, suppuration has probably occurred.
2. A markedly remittent temperature, especially if accompanied by rigors, usually means suppuration.
3. A marked leucocytosis indicates suppuration.

LOCAL.—

1. Marked œdema of the skin and subcutaneous tissue usually indicates deep-seated suppuration.
2. The burning continuous pain of inflammation frequently becomes throbbing when suppuration has occurred.
3. In deep-seated suppuration the swelling, at first brawny, becomes soft, and finally fluctuation is present.

TREATMENT.—The *General* treatment has already been given in the treatment of inflammation, but little improvement will occur until free exit is given to the pus.

Local.—An incision should be made directly into the abscess cavity, with full aseptic precautions, and so planned that it avoids damaging important structures, such as nerves, bloodvessels, and ducts, but at the same time is in a dependent position, so that drainage is facilitated. The abscess cavity should be freely opened, and any primary cause for the abscess should be removed. For example, after opening an abscess secondary to perforative appendicitis, the appendix should be removed if it can be done with safety; or in an abscess secondary to necrosis of bone the necrosed bone should be removed. If this is not done, the suppuration is likely to become chronic, and a sinus form, requiring further operation.

The abscess cavity should be gently wiped out to remove all pus, and the cavity may be swabbed with some strong antiseptic, such as pure carbolic acid. After opening the abscess, and especially if the pus is superficial, suction by means of bell-jars may be carried out, and the small wound left open; but in deep-seated abscesses drainage in a dependent position should be provided for by india-rubber drainage-tubes or gauze.

In cases of very acute suppuration, and where there is much tension of the surrounding tissue with severe pain, fomentations form a very useful dressing, but in other cases aseptic gauze and cotton-wool are better. Full aseptic precautions should always be taken in dressing an abscess, and will hasten considerably the period of healing.

HILTON'S METHOD OF OPENING AN ABSCESS.—When an abscess lies deeply, and is surrounded by important structures, as, for example, in the neck or axilla, Hilton's method of opening an abscess should be used. An incision is made over the swelling, and the subcutaneous tissue is incised until the deep fascia is seen; a small incision is made into this fascia, and the knife then laid aside. A steel director is pushed on into the swelling until the pus is seen to run down the groove. A pair of sinus forceps are then passed along the groove into the abscess cavity; they are then forcibly opened, tearing the tissue, but not doing any serious damage. The finger should be introduced and the cavity explored, and afterwards drained in the usual way.

Chronic Abscess.—Chronic abscesses have the same pathology as acute abscesses, and may be due to any of the pus-forming organisms. The general symptoms of infection are usually very mild, and the most constant local symptoms are swelling and, ultimately, fluctuation. The diagnosis from new growth is often extremely difficult, and in some cases is only settled by exploratory incision and microscopic examination.

TREATMENT.—The treatment of a chronic abscess due to the ordinary pyogenic organisms is similar to that of an acute abscess. Locally the abscess cavity should be freely opened and drained, and the cause of the abscess removed, if possible. In the general treatment, vaccine therapy is extremely valuable.

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Chronic abscesses due to the tubercle bacillus will be considered in the chapter on Tuberculosis.

Sinus Formation.—A sinus is a tract leading from a skin or mucous surface to a focus of deep-seated suppuration. It may result from an acute or chronic abscess, and may be associated with any of the organisms of suppuration; there is very frequently a mixed infection. A sinus is usually maintained by suppuration occurring round dead material at the bottom of the sinus. The dead material may be a foreign body, such as a silk stitch, a bullet, or a calculus, or tissue killed by the previous inflammation, such as dead bone, or the remains of a lymphatic gland. In some cases a sinus will not close because of constant movement of the part.

The walls of the sinus are made of fibrous tissue lined with granulation tissue, which constantly secretes pus. In old-standing cases there is a down-growth of epithelium from the skin or mucous membrane into the mouth of the sinus, and this again prevents healing.

TREATMENT.—The dead material at the bottom of a sinus always tends to be discharged along the tract of the sinus, and many sinuses close spontaneously if they are kept drained, the foreign body—necrosed bone, etc.—first coming away. If this does not occur, the dead material must be removed. The sinus should be carefully and deliberately opened up, and a careful search made for the cause of the sinus formation, and when this is found it should be thoroughly removed. The walls of the sinus are then scraped, and treated with pure carbolic acid or touched with the thermo-cautery, and the track drained with gauze, care being taken that it fills up with granulations from below. Vaccine therapy is often exceedingly useful.

If the sinus is due to constant movement of surrounding muscles, these must be kept at rest by suitable splinting. In some cases it is advisable to completely excise the sinus with the cause of its formation. Scraping a sinus without thorough exploration is usually useless, and often harmful.

Fistula.—A fistula is an abnormal canal leading from a mucous membrane to the skin or another mucous membrane; it usually results from acute or chronic suppuration. For example, an abscess in the ischio-rectal fossa may point into the rectum and on to the skin of the buttock, and the result will be a fistula from the rectum on to the skin. Fistula may also result from gangrene due to pressure, as in the case of a vagino-vesical fistula following sloughing of the vaginal wall, due to impaction of the foetal head in the vagina during parturition, or to ulceration, as in the case of a gall-stone ulcerating through the gall-bladder into the intestines.

A fistula when it is once established does not, as a rule, close spontaneously, owing to the down-growth of epithelium along the fistulous tract, so that it may become completely lined with epithelium.

TREATMENT.—The treatment of the various forms of fistulae will be given in the chapters dealing with the part of the body where the fistula occurs; but, speaking generally, it may be said that the treat-

ment of a fistula either consists of completely excising the fistulous tract and closing the opening by a plastic operation, or laying the fistulous tract open, scraping or cauterizing it thoroughly, and then allowing it to close by granulating from the bottom.

Results of Long-Continued Suppuration

A sinus or fistula may continue to discharge for months without the general health of the patient suffering, if there is no spread of the inflammation, and if the pus can escape freely to the exterior. If,

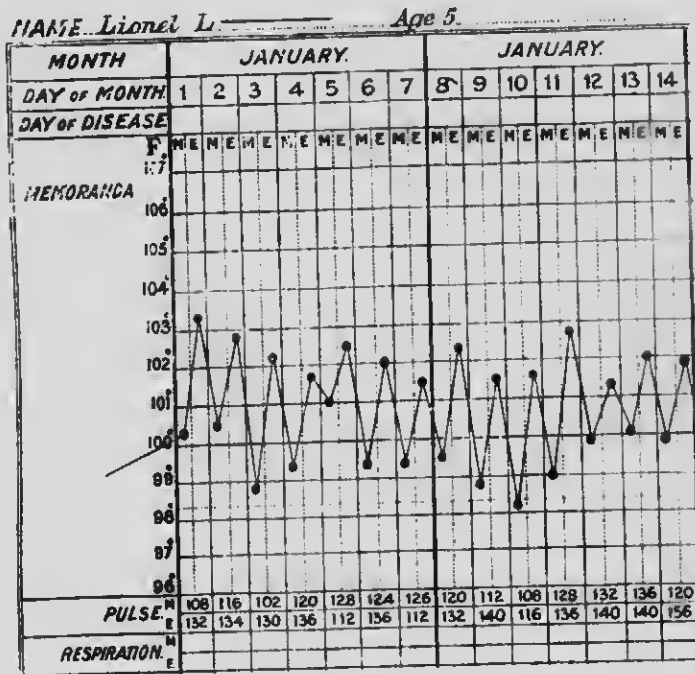


FIG. 16.—HECTIC TEMPERATURE ASSOCIATED WITH SUPPURATION OCCURRING IN BONE.

however, the suppurative inflammation continues to spread into the tissues, or if the pus cannot freely escape, toxins will be constantly absorbed, and will have a deleterious effect on the patient. The effects of this chronic toxæmia are—

1. **Hectic Fever.**—In this condition there is a regular rise of temperature each night and a fall in the morning. The evening rise is marked by a rapid pulse and quickened respiration, the face is flushed, the patient feels warm, and expresses himself as feeling better and stronger. The morning fall of temperature is usually rapid, and is accompanied by a profuse perspiration and some collapse, and the patient is left exhausted until the evening rise commences. The patient

loses flesh and strength, and there is a marked anemia, with sallowness of the skin. If the condition causing the hectic fever is not removed, death will take place from exhaustion.

TREATMENT.—The general treatment of inflammation, including serum therapy, should be carried out; but there will be no marked improvement until the local focus has been dealt with. The sinus should be freely opened up, all dead material removed, strong antiseptics applied, and free drainage established. If this is not sufficient, and the general health continues to deteriorate, amputation should be performed if the suppuration is occurring in a limb.

2. Amyloid or Lardaceous Disease.—This disease is usually associated with chronic suppuration, but it may occur in chronic infections, such as tubercle and syphilis, without suppuration, and in malaria and cancerous cachexia. It is either due to the effect of toxins on the tissue or to loss of substances, such as albumin or salts, in the discharge.

The disease consists of an infiltration of the subendothelial connective tissue of the capillaries and the tunica media of the smaller arterioles, with lardacin or amyloid substance. Lardacin (the term "amyloid" is a misnomer) is a nitrogenous substance allied to albumin and not to starch, and is a colourless, firm, waxy material, with definite colour reactions. With iodine the lardaceous portion of tissues are stained a mahogany brown, and if a 10 per cent. solution of sulphuric acid be added, the degenerated tissue becomes after a time bluish or blackish in colour. For microscopical purposes, the tissues should be stained with gentian violet (1 per cent. watery solution), and in a few hours the lardaceous material becomes stained a bright magenta, while the healthy tissues are blue.

The arterioles chiefly affected are those of the liver, spleen, kidneys, intestines, and lymphatic glands; but the change may occur in any organ, including the central nervous system. The lardaceous degeneration spreads from the arterioles into the connective tissue, and it is probable that the essential cells of the part are never affected, but undergo degeneration owing to obliteration of the arterioles and to pressure.

When an organ is affected with this disease, it becomes enlarged, but its general shape is retained. The weight is increased, the surface smooth, and the edges become more or less rounded. On section, the organ has a homogeneous, translucent appearance like wax, and, owing to the blocking of the bloodvessels, contains little blood. On microscopical examination, it is seen that the essential cells of the part are undergoing fatty degeneration.

SYMPTOMS.—The disease is most common in young subjects, and males are said to be affected more than females. The degenerative change may occur after a few months of suppuration, or its appearance may be long delayed, especially in children. The chief lesions are—

(1) *Liver.*—The liver is enlarged, firm, smooth, and the edges are rounded. There is no ascites, jaundice, or back-pressure on the portal system, in the early stages of the disease.

(2) *Spleen*.—The spleen is large and firm, being readily felt below the costal margin. On section, glistening, translucent areas (sago spleen) are present. There are no symptoms with the enlarged spleen except a secondary anaemia.

(3) *Kidneys*.—The kidneys are enlarged, but it may not be possible to palpate them. The urine is increased in quantity, pale, and of low specific gravity. It contains a large amount of albumin, and lardaceous casts may be seen under the microscope. The urea is diminished in amount. There is, as a rule, no cardiac hypertrophy or arteriosclerosis present.

(4) *Intestines*.—In the intestines it is the capillaries and arterioles of the villi that are chiefly affected, and owing to increased permeability of the vessels' walls, there is usually a watery diarrhoea. Secretion of digestive fluids and absorption of food is interfered with, and the patient wastes rapidly.

(5) *Lymphatic Glands*.—The glands undergo a firm, painless enlargement.

TREATMENT.—The only treatment is to remove the cause of the disease, and if lardaceous change occurs in a patient the subject of chronic suppuration, it is an indication for radical treatment. The local disease must be thoroughly eradicated if possible, and in the case of suppuration in a limb this probably means amputation. If radical local treatment is impossible, the disease is steadily progressive.

PROGNOSIS.—Lardaceous disease is only dangerous when it becomes advanced and destroys the essential cells of the important organs; a patient may live for many years with the condition. If the chronic suppuration is arrested before the change is marked, the lardaceous material may be absorbed; but later, although the cause may be removed, the change is permanent, but it may not seriously diminish the patient's length of life.

3. Slight Chronic Toxaemia and its Effects.—The absorption of very small quantities of toxins, especially from chronically inflamed mucous surfaces, such as the mouth (oral sepsis), the urethra (urethral sepsis), and vagina (vaginal sepsis), may result in anaemia with general malaise, headache, and neuralgia, which will be relieved by local treatment of the suppurating focus.

Besides this general toxæmia there is often a local toxæmia. Oral sepsis frequently results in a chronic gastritis, due to swallowing of pus, and this may be followed by gastric ulcer, duodenal ulcer, and, possibly, by appendicitis. Inhaling the pus may cause laryngitis, tracheitis, and chronic bronchitis, and if an anaesthetic be given, aspiration pneumonia. Chronic urethral sepsis may be followed by chronic cystitis and ascending pyelitis, and with chronic vaginal sepsis there may be chronic metritis and salpingitis.

It is believed that many of the chronic inflammations of bones and joints classed under the general term of "osteo-arthritis" or "osteo-arthropathy" are due to chronic toxæmia, and depend on some focus of suppuration in the body. In the treatment of these

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conditions it is important to cure any chronic discharge, and vaccine therapy, the vaccine being prepared from organisms collected from the discharge, may be of benefit to the joint condition.

Erysipelas

CAUSE.—Erysipelas is an acute spreading inflammation of the skin or mucous membrane, due to the *Streptococcus erysipelatus* of Fehleison. The variety of streptococcus, however, varies in different cases. The organism gains entrance into the body through a wound which may not be discovered. It most commonly occurs on the head and face, but no part of the body is exempt.

The disease occurs at all ages, and is most apt to attack people living under bad hygienic conditions, or those who are debilitated from

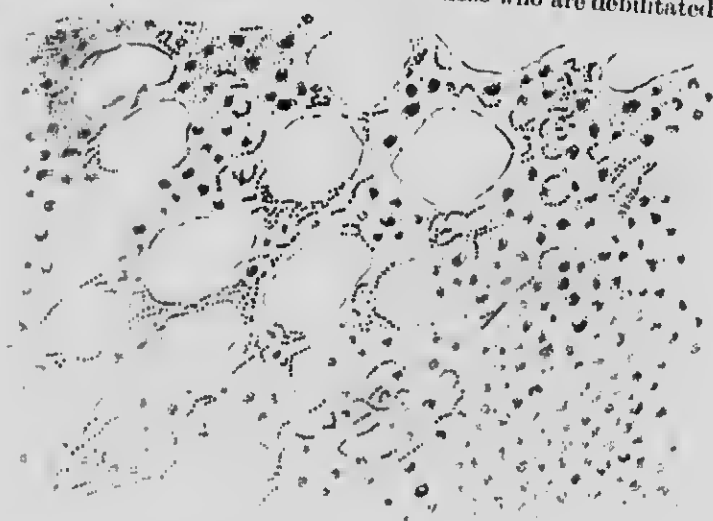


FIG. 17. STREPTOCOCCI FROM A CASE OF ERYSIPELAS.

diabetes, chronic nephritis, malignant disease, old age, or the specific infectious fevers, particularly scarlet fever. One attack also appears to predispose to other attacks.

PATHOLOGY.—The streptococcus is found in the lymph spaces of the skin, particularly at the spreading edge of the disease. It causes an acute inflammation, with a sero-fibrinous exudate. The endothelium of the lymph spaces is swollen and degenerated, and the subcutaneous lymphatics are filled with inflammatory exudate, the nearest lymphatic glands being acutely inflamed. The inflammation usually ends in resolution, with absorption of the exudate; but fibrosis, suppuration, or gangrene, may occur.

The incubation period is a few hours to two days.

SYMPTOMS.—The general symptoms are those of acute infection, and are frequently ushered in by a rigor, headache, and vomiting.

The local symptom is a bright red rash, spreading by a definite margin from the site of infection. The skin is oedematous, and there is intense swelling where the subcutaneous tissue is loose, as in the eyelids, penis, and scrotum. The skin over the swelling becomes tense and shiny, and is covered with small vesicles containing a yellow serum, which finally burst, dry up, and form slight crusts on the skin. The swelling

is not so marked where the skin is firmly attached to the deep fascia, as in the scalp, the palms of the hands and the soles of the feet. The lymphatics leading from the part are swollen, and may be traced as thin red lines on the skin, and the nearest lymphatic glands are acutely inflamed.

The inflamed part feels stiff, and is the seat of intense burning pain. As the inflammation advances at the edge, it subsides behind, but may leave behind it a bronzing of the skin.

In erysipelas of mucous membranes the involved membrane becomes red and swollen; and, later, small superficial ulceration occurs. The definite spreading edge is not so

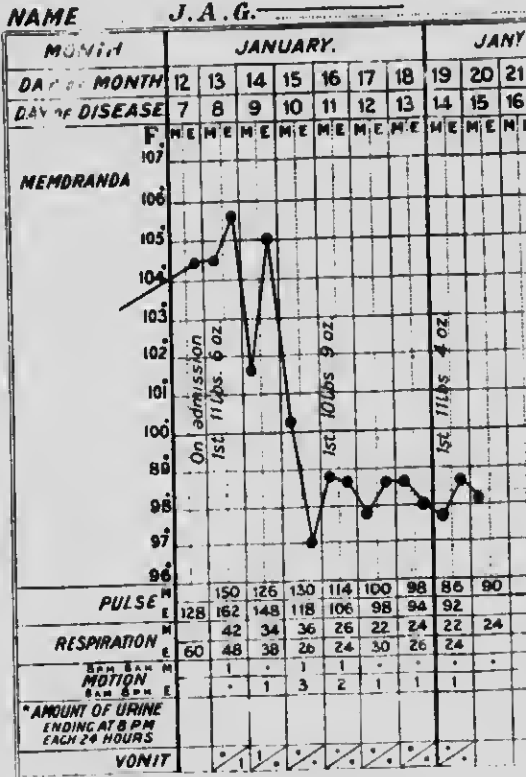


FIG. 18.—TEMPERATURE CHART OF A CASE OF ERYSIPELAS. FALL BY CRISIS.

marked as on the skin, and the vesicles are not seen. The swelling of the mucous membrane in the pharynx and larynx may lead to urgent dyspnoea.

Course of the Disease.—The disease usually lasts from seven to fourteen days, and the temperature falls by crisis unless suppuration occurs. In severe cases, and in debilitated subjects, the patient passes into the typhoid state, and the condition may end in death.

Erysipelas Migrans is a form of the disease in which the rash spreads from one part of the body to another, and this may continue for weeks. As each new area is attacked, there is a return of the general symptoms, but the same area is never affected twice. This condition may be complicated by a patchy broncho-pneumonia.

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TERMINATION.—The usual termination is *resolution*, with complete absorption of all the inflammatory exudates. If the inflammation has occurred on the scalp, the hair is usually lost, but it grows again.

In some cases a persistent œdema is left, and this is followed by the formation of *fibrous tissue* in the skin and subcutaneous tissue, which obstructs the lymphatics, and may lead to a permanent elephantiasis.

If the inflammation spreads into the subcutaneous tissue, *suppuration* may occur. Suppuration is also not uncommon in the lymphatic glands affected. In these last cases the suppuration may be subacute, and may become apparent some considerable time after the attack of erysipelas.

Gangrene following erysipelas usually occurs in the eyelids, scrotum, and penis—places where the swelling is greatest—and is probably brought about by the tension obstructing the blood-supply. The dead tissue is removed by suppuration.

COMPLICATIONS.—The complications of erysipelas are those of any septic condition—cellulitis, septic-pyemia, infection of serous and synovial membranes, lymphangitis, lymph-adenitis, phlebitis, and thrombosis, or an acute infection of bones. These all occur at times, and require appropriate treatment.

TREATMENT.—The *general* treatment is that of any septic condition, including the injection of antistreptococcic serum. Ferric chloride has been claimed as a specific drug in the treatment of this condition, but is probably of little value.

Local Treatment may follow one of two lines—(1) palliative; (2) curative.

1. Palliative treatment consists of relieving the burning pain of erysipelas by applying fomentations, evaporating lead lotion, calamine lotion, or dusting powder to the inflamed area, and waiting for resolution.

2. Curative. The wound, if evident, is thoroughly opened, treated with pure carbolic, and drained. The spreading edge of the inflammation is then treated with antiseptics—

- (1) By the inunction of ointments, such as ichthyol or mercurials.
- (2) Painting with strong ethereal solution of silver nitrate (gr. xxx. ad ʒi.) or linimentum iodi.
- (3) Scarification and application of mercurials.
- (4) Injections of antiseptics, such as carbolic acid, 1 in 20.

An attempt may be made to limit the spread by strapping the limb firmly beyond the edge of the inflammation.

Bier's Method of passive hyperæmia may also prove beneficial. If the eyelids, penis, or scrotum, are very œdematous, and gangrene is feared, they should be punctured in several places with a tenotomy knife to allow the serum to escape, or free incisions may be made into them for the same purpose.

Should suppuration or gangrene occur, the usual treatment for this condition must be carried out.

Chronic inflammation, with blockage of the lymphatics and subsequent lymphatic œdema, should be treated by elevation of the parts, massage, and bandaging; and, if persistent, lymphangioplastic operations may be tried. Although the first results of these operations are often excellent, the relief is not usually permanent.

Cellulitis

Cellulitis is an acute spreading inflammation of the cellular tissue, either subcutaneous or deep, due to infection by a micro-organism, usually the *Streptococcus pyogenes*. The organism always gains entrance to the tissues through a wound, which may be an insignificant scratch or a serious wound, such as a compound fracture.

The organism grows in the lymphatic spaces of the cellular tissues, and tends to spread along the lymphatic channels, so that the inflammation may be most severe some distance from the point of inoculation. There is always some inflammation of the lymphatic glands into which the inflamed area drains, and frequently suppuration occurs in them.

The *incubation* period is a few hours to two days.

SYMPTOMS.—The *general* symptoms, which frequently start with a rigor, are those of a severe infection. *Locally*, there is redness spreading from the wound and gradually fading into the healthy colour of the skin, and a brawny swelling of the part, which later becomes soft and boggy. The part is œdematous, hot, and painful, and the nearest set of lymphatic glands are acutely inflamed.

RESULTS.—Although there is always some suppuration at the point of infection, resolution may occur in most of the inflamed tissue under appropriate treatment. In other cases the inflammation becomes localized, and a circumscribed abscess forms; but in the majority of cases there is diffuse suppuration in the planes of the cellular tissue. Later the skin gives way over several points, and pus-discharging sinuses form. If the infection is very severe, and especially if the inflammation occurs in loose cellular tissue, as in the scrotum or eyelid, the condition ends in gangrene, and sloughs of cellular tissue have to separate by suppuration before healing can occur. In some very severe cases gas forms in the tissues, and on palpation a characteristic crackling is felt. Death may take place from septic absorption, or septicœmia may follow.

PROGNOSIS.—The prognosis is bad in olderly people and young infants, and in patients debilitated from any cause, especially chronic nephritis and diabetes.

TREATMENT.—The *general* treatment is that of acute inflammation. *Locally*, free drainage should be established at the site of infection and the local treatment of acute inflammation carried out. The part should be elevated; heat, in the form of fomentations or poultices applied, or Bier's method of passive congestion, should be used.

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it should be opened and drained in the usual way; but as soon as there is any suspicion that diffuse suppuration is occurring, free incision should be made into the inflamed tissue.

The incisions should be multiple, run parallel with the blood-vessels and nerves of the part, and be 2 or 3 inches in length. They should go freely down to the inflamed tissue and left widely gaping, so that the exudates can readily escape.

Fomentations should be applied, or Bier's treatment continued, or, if suitable, the part may be placed in a continuous hot bath of lysol ($\frac{1}{2}$ decalin to a pint of water), or some other diluted antiseptic, until all the sloughs have separated and the wounds are granulating.

If the cellulitis occurs on a limb, the part should be kept at rest in the early stages of inflammation by careful splinting in the most useful position should stiffness follow; but as healing proceeds, massage, passive and active movements should be carried out each time the part is dressed, to prevent adhesions from forming and matting the muscles and tendons to one another and to surrounding strictures. If these movements are not persistently carried out, stiffness and deformity will result.

In some cases of acute diffuse cellulitis amputation above the site of the inflammation is the best treatment.

CELLULITIS OF SPECIAL REGIONS

Cellulitis of the Subcutaneous Tissue of the Extremities (Cellulocutaneous Erysipelas). The infection usually starts from an infected wound of the fingers or toes, and rapidly spreads up the limb, especially on the inner side, as the veins and lymphatics chiefly run there. The organism present is usually a streptococcus.

The general symptoms are those of an acute infection; rigors usually occur. In alcoholics delirium tremens may supervene.

Locally the limb is enormously swollen, hot, and painful, and the patient cannot move the joints.

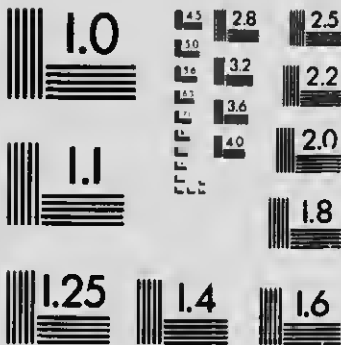
If an incision is made into the swollen tissue, the subcutaneous fat is found to be infiltrated with serum, which gives it a gelatinous appearance, but later pus is found. The swelling interferes with the blood supply of the limb, and thrombosis of the vessels may occur. This leads to sloughing of the skin and subcutaneous tissue, which may be very extensive. The lymphatics draining the part are acutely inflamed, and appear as tender red lines running up to the lymphatic glands, which are also acutely inflamed and frequently suppurate.

TREATMENT.—The limb should be put at rest in the elevated position, or Bier's method of passive hyperemia, which is particularly suitable for cellulitis of the limbs, may be used. As soon as it is suspected that the inflammation is going to end in suppuration, free incision should be made into the part. The incisions should be about 2 inches in length, and carried down to the deep fascia. They should be arranged in a diamond pattern, running parallel to the long axis of the limb, as this causes least interference with the blood supply. The incisions should be allowed to bleed freely, and no gauze or drainage-



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tubes are necessary. After the incisions are made, Bier's hyperæmic treatment may be continued, or fomentations applied, or the limb kept in a continuous hot antiseptic bath until granulations form over the wounds. Massage is necessary later to remove the inflammatory exudate and to get rid of stiffness.

Cellulitis of the Neck.—Acute inflammation of the cellular tissue of the neck under the deep cervical fascia is a very dangerous condition. The dense fascia prevents extension into the subcutaneous tissue, and the inflammation tends to pass along the planes of fascia into the mediastinum and pericardium, causing suppurative mediastinitis and pericarditis. The œdema of the skin is very intense, and there is a corresponding œdema of the pharynx and larynx, which may partially close the rima glottidis and cause difficulty in breathing. The *general* symptoms of toxæmia are usually very marked, on account of the inflammatory exudate being under tension.



FIG. 19.—INCISIONS FOR CELLULITIS OF THE ARM.

The causes of the condition are—Inflammation round the submaxillary gland; suppuration round a carious tooth; infection of the deep cervical glands; inflammation of the tonsils and pharynx, especially that associated with scarlet fever and diphtheria; acute osteomyelitis of the lower jaw; and direct infection of wounds of the neck.

The organisms are the usual pyogenic organisms, but two varieties need special mention—Vincent's and Ludwig's angina.

Vincent's Angina is most commonly seen after scarlet fever and diphtheria, and is said by Vincent to be caused by a mixed infection of a spirillum and a bacillus; the condition starts round the submaxillary gland. **Ludwig's Angina** is due to infection by the pneumococcus, and its chief characteristic is the intense brawny swelling of the neck, due to the amount of fibrin in the inflammatory exudate.

SYMPTOMS.—The *general* symptoms are those of an acute infection. The *local* symptoms are a deep-seated brawny swelling of the neck, fixing the head. The skin is red and œdematous, and the redness and œdema extend down on to the chest wall. The mouth can only be opened with difficulty, and inspection of the larynx will show the mucous membrane to be much swollen. The tongue is furred and the breath fœtid. The pain is usually intense, and there may be difficulty in breathing and swallowing. Thrombosis of the main vessels of the neck may be present, and if suppuration occurs, the large vessels of the neck may be opened and severe hæmorrhage result.

TREATMENT.—The first indication for treatment is to give free exit for any pus that may be present. An anæsthetic is usually necessary. There is, however, great danger in anæsthetizing these patients, and if there is much fixation of the jaw and difficulty of breathing, the

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exploration, in spite of the pain caused, must be done under local anaesthesia. If an anaesthetic is used, chloroform, or chloroform and ether mixture, should be administered. Nitrous oxide anaesthesia is especially dangerous and unsatisfactory.

A free incision should be made over the place of maximum swelling and tenderness, and cautiously deepened until the deep fascia is seen. This should be incised, and a steel director thrust in the direction in which the pus is suspected. If the pus is found, sinus forceps are introduced and opened, and drainage provided for by a tube. Fomentations are then applied to the neck. In some cases no local collection of pus can be found, or, if it is found, evacuation of it is not sufficient to bring about resolution of the inflamed cellular tissue. If these cases are left, and the patient survives the acute toxæmia, diffuse suppuration occurs in the cellular tissue of the neck and mediastinum.

This should be anticipated by free incision. An anaesthetic is given—if not considered too dangerous—and free incisions should be made into the cellular tissue. These incisions must divide the deep fascia, and as the inflammatory exudates make it hard to identify the various structures, they must be made very cautiously. The relationships of the nerves and vessels must be borne in mind, and care taken to avoid injury to them.

If there is much œdema of the larynx, the dyspnoea may become urgent, and demand tracheotomy, and whenever an anaesthetic is given to a patient with cellulitis of the neck, tracheotomy instruments should always be at hand and ready for instant use.

Cellulitis of the Axilla.—Cellulitis of the axilla most frequently follows infected wounds of the hand, either directly or secondarily to an acute septic lymphadenitis. There is a brawny swelling in the axilla, with redness and œdema extending over the chest, shoulder, and back. Suppuration may extend in the subcutaneous tissue, or under the pectoral muscles, and the shoulder-joint may be involved, an acute septic arthritis being present.

TREATMENT.—A free incision should be made in the base of the axilla until the deep fascia is reached, and this should then be incised for the whole length of the wound. The axilla is then opened with sinus forceps, and drainage established. A second opening, if necessary, should be made into the axilla from the front, the incision passing between the pectoralis major and the deltoid. Further incisions may be required over the chest and back.

Cellulitis of the Orbit.—Cellulitis of the orbit is due to—Infection of penetrating wounds; acute osteomyelitis of the bony wall; extension of suppuration from the accessory sinuses of the nose, the lachrymal apparatus, or from the eyeball; and infection of a compound fracture.

SYMPTOMS.—The *general* symptoms are those of an acute infection. *Locally* the eyelids are red, swollen, and œdematous, the conjunctiva is congested and œdematous, and there is exophthalmos. The eye is fixed and painful, and there is diplopia, or loss of sight. Optic neuritis is common, and later there is corneal ulceration and panophthalmitis. Suppuration is common, and the inflammation may extend to the

meninges through the foramina opening into the cranium, or septic thrombosis of the cavernous sinus may follow infection of the ophthalmic veins.

TREATMENT.—Incisions must be made into the cellular tissue of the orbit, and free drainage established. These incisions should be into the place of maximum swelling, and care must be taken to avoid damage of the eyeball. If possible, the incision should be made at the reflexions of the conjunctiva, but free drainage can be obtained if the incisions are made through the eyelids. Should suppurative panophthalmitis occur, the eyeball should be freely opened by a crucial incision, or it may be removed and the orbit drained.

Cellulitis of the Scalp.—Inflammation of the cellular tissue of the scalp may occur in the dense connective tissue between the skin and



FIG. 20.—INCISIONS FOR CELLULITIS OF THE SCALP.

the occipital frontalis muscle, or in the loose connective tissue under the muscle. In both cases the usual cause of the inflammation is direct infection of a wound of the scalp.

If the inflammation occurs in the dense subcutaneous tissue, the part becomes red, swollen, and tender, and when pus forms, it points over the site of infection. In suppuration beneath the aponeurosis the chief swelling and oedema is at the attachment of the fascia—*i.e.*, just above the eyebrow, the zygoma, and the superior curved line of the occipital bone. The whole scalp may be lifted up and float on the pus which forms in the loose connective tissue between the apo-

neurosis and the pericranium, and the abscess will usually point over the place where the swelling is greatest.

TREATMENT.—Cellulitis of the dense subcutaneous tissue should be treated by free incision and fomentations.

If the suppuration occurs under the aponeurosis, free incisions running parallel with the bloodvessels should be made over the eyebrows, zygoma, and the superior curved lines. If there is much pus, drainage-tubes should be inserted. Suppuration in these cases may result in necrosis of the skull bones and septic meningitis or thrombosis of the venous sinuses in the skull.

Paronychia, or Whitlow

Subepithelial Whitlow.—This variety is most commonly seen as a result of a prick with a needle. The epithelium is raised by a collection of thin pus underneath, and there is some pain

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and discomfort. As a rule, the condition is quickly relieved by an incision into the part and removal of the epidermis. This small operation is quite painless. If, however, the epidermis is thick, the pus may not be able to raise it, and it burrows into the pulp of the fingers, the condition merging into the variety described as "subcutaneous whitlow."

PERI-ONYCHIA is a special form of the subepithelial whitlow, in which the inflammation starts at the edge of the nail-bed, and tends to spread round it. It is often quite a chronic process, the finger round the nail being inflamed and tender, and a little pus escaping round the edge of the nail-bed. If left, it may completely detach the nail from its matrix, and cure will result; but the matrix will have been largely destroyed by the suppuration, and the subsequent growth of nail will be defective.

TREATMENT.—In chronic and subacute cases, the inflammatory process may sometimes be checked by the application of silver nitrate solution (5 grains to the ounce). This must be applied continuously by means of a piece of lint wrapped round the finger and covered by a piece of gutta-serena tissue. The nail and end of the finger will be blackened for a time, and the growth of the nail may be defective.

If the suppuration is not rapidly checked, the nail should be removed; it is best to do this under nitrous oxide anesthesia. The nail is split down the middle with a strong pair of sharp-pointed scissors, and the two halves pulled off with forceps. If the suppuration has been deep, the necrotic matrix is gently scraped with a sharp spoon, and pure carbolic acid applied with a brush. Hot fomentations are employed for twenty-four to forty-eight hours, according to the amount of pain of which the patient complains. At the end of this time a piece of lint soaked in silver nitrate solution (2 grains to the ounce) is applied, and covered with a piece of gutta-serena tissue. This is changed twice daily. As soon as the excessive granulations disappear, the lint dressing is discontinued, and the part kept well covered with powdered boracic acid.

If the nail is removed early, and the suppuration has not advanced far, no deformity of the nail will occur; but as a rule perfect growth is not to be expected.

The question of a peri-onychia being a primary syphilitic chancre must always be borne in mind, and will often only be decided by the indolent enlargement of the axillary lymphatic glands and the appearance of secondary symptoms.

Subcutaneous Whitlow.—This may be an extension of the subepithelial variety, or it may arise from direct infection of the subcutaneous tissue by a punctured wound, especially when made by infected safety-pins and surgical needles. The condition runs the ordinary course of cellulitis elsewhere. The whole finger becomes red and exceedingly tender, and the constitutional effects due to absorp-



FIG. 21.—DIAGRAM OF SUB-EPITHELIAL AND TREACHEROUS WHITLOW.

tion of the toxins may be severe. If untreated, especially in the case of working men with thick epidermis, the areolar tissue sloughs, and necrosis of the terminal phalanx may occur, owing to the intimate connection of the periosteum of the bone with the subcutaneous tissue. The pus may also pass under the extensor tendons and infect the joint, causing a septic arthritis; or it may extend into the synovial sheath of the flexor tendon, causing a thecal whitlow.

TREATMENT.—When the inflammation is limited to the pulp of the terminal phalanx, the finger should be soaked for an hour in hot water to soften the cuticle, which is then shaved away with a sharp knife until the small head of pus is found. This can be done under local anesthesia. Fomentations are applied frequently, and the hand kept elevated. In more severe and advanced cases nitrous oxide gas should be administered, and free incisions made into the part, a piece



FIG. 22.—SUBCUTANEOUS WHITLOW AND PERI-ONYCHIA.

of skin over the pus being cut away in order to allow of free exit. This incision should be made deliberately and carefully, or the flexor tendon synovial sheath may be opened and infected. Frequent hot fomentations should be applied, or, better, the hand should be kept in a continuous hot-water bath. Healing is as a rule rapid if a free exit for the pus and slough is made.

This septic infection may be met with on any part of the fingers besides the pulp of the terminal phalanx, but the treatment remains the same. On the back of the fingers, infection often takes place through a hair follicle.

If the treatment is neglected until a terminal phalanx has become necrosed, it should be removed by an incision through the pulp and the wound drained. The phalanx should never be amputated, for a useful extremity is left even after removal of the bone.

Thecal Whitlow, or Suppuration in the Sheaths of the Flexor Tendons.

—This condition ensues from direct infection of the sheath by a punctured wound, or by extension of the suppuration in one of the other varieties of whitlow. The whole finger is exquisitely painful, is kept semiflexed, all attempts to straighten it causing severe pain. The whole finger, and frequently the hand, is red and swollen. As the most marked redness and swelling is on the back of the finger and hand, a false idea as to the situation of the pus may be given. The synovial sheaths of the flexor tendons of the fingers are arranged in the following way: In the palm of the hand surrounding the tendons of the flexor sublimis and flexor profundus digitorum is the *great palmar bursa*. This sheath extends downwards to the middle of the palm, and passes under the anterior annular ligament up the forearm for $1\frac{1}{2}$ inches. The vaginal sheaths of the index, middle, and ring fingers are lined by synovial membranes, which end blindly over the heads of the metacarpal bones, and extend to the base of the terminal phalanx of each digit. The synovial membrane, lining the vaginal

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sheath of the little finger, is a direct prolongation downwards of the great palmar bursa. The synovial sheath of the flexor longus pollicis extends from the base of the terminal phalanx of the thumb to $1\frac{1}{2}$ inches up the forearm above the annular ligament, under which it lies. It may communicate with the great palmar bursa.

Suppuration in the synovial sheaths of the little finger and thumb readily extends into the palm of the hand and under the annular ligament to the forearm.

As a result of suppuration in the synovial sheaths, sloughing of the flexor tendons is common, leaving stiff and useless fingers. The interphalangeal and the metacarpophalangeal joints are frequently infected, and the condition may necessitate amputation of the finger, or, if the common palmar bursa is infected, of the whole hand.

TREATMENT.—This consists of free and early incision and drainage of the affected part. A general anæsthetic should always be given, and the incisions carefully and deliberately made into the infected tissue over a phalanx *not* opposite any of the interphalangeal articulations. The incision should be gradually deepened until pus is found, which may possibly be outside the tendon sheath, and the complication of opening the synovial membrane thus avoided. If the sheath is affected, however, it must be fully opened, and the pus evacuated.

Should infection of the common palmar bursa occur from extension from the little finger, it must be opened by an incision directly over the metacarpal bone in order to avoid the vessels and nerves, and a counter-opening made above the annular ligament on the ulnar side of the wrist. Tubes should be inserted for drainage.

If the suppuration is in the synovial sheath of the flexor longus pollicis, this must be opened in the median line by an incision over the head of the metacarpal bone, and a counter-opening made above the annular ligament on the ulnar side of the flexor carpi radialis tendon, care being taken to avoid the median nerve. If the incision be made on the outer side of this tendon, the radial artery is in danger. After

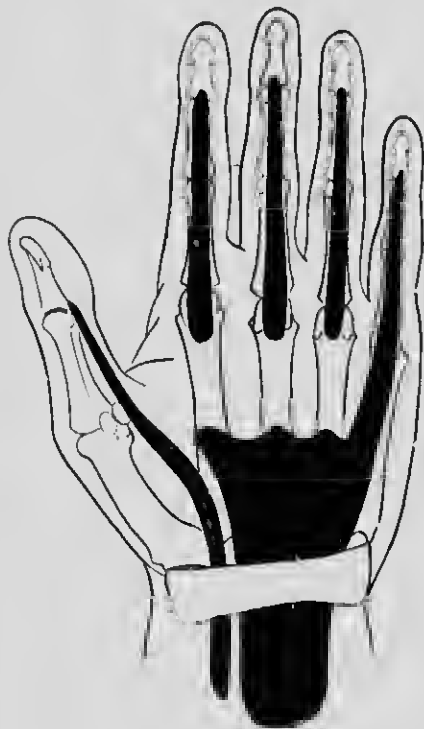


FIG. 23. DIAGRAM OF SYNOVIAL SHEATHS OF THE HAND AND FINGERS.

the sheaths have been thoroughly opened, they should be washed out with an antiseptic lotion, and drainage arranged for. Collections of pus in the subcutaneous tissue must also be opened and drained, and the incisions may have to be made well up the forearm. The dressings should be hot fomentations frequently renewed, and the hand and forearm should be kept on a splint covered with a mackintosh.

If possible, the whole hand and forearm should be kept for hours each day in a continuous hot weak lysol bath ($\frac{1}{2}$ drachm to a pint). As soon as healing begins, gentle passive movements must be carried out each time the hand is dressed to prevent adhesions of the tendons to their sheaths. Later, massage and forcible movements under anaesthesia may be necessary to secure mobility. Should the tendons slough, they must be removed, and a stiff finger will result. If this proves to be useless, and interferes with the free use of the hand, it may be amputated later.



FIG. 24.—SUB-PERIOSTEAL WHITLOW.

Periosteal Whitlow. This is a suppurative periostitis of a phalanx of a digit, and is the rarest form of whitlow. It is characterized by intense throbbing pain and severe constitutional symptoms.

TREATMENT. An anesthetic, preferably a general one, should be administered, and an incision made through the middle line of the pulp down to the bone. A small quantity of pus will be found under the periosteum, and the relief afforded by the operation is striking. If the pus is not promptly liberated, necrosis of the phalanx is sure to ensue, and infection of the flexor tendon sheath is common. If the phalanx becomes necrosed, it should be removed as soon as it is loose.

Bier's Method of Passive Congestion.—This method of treatment, which aims at increasing the hyperemia of an inflamed part by passive congestion, and so increasing the amount of antitoxins reaching the part, has been largely used in the acute inflammations of the hand and fingers.

Directly the inflammation occurs, Bier's elastic bandage, which is made of soft rubber about $2\frac{1}{2}$ inches wide, should be applied six or eight times round the upper arm. The bandage should be applied firmly enough to constrict the lumen of the veins mildly, but the arteries should be unaffected, and at all times the pulse should be felt below the place at which the bandage has been applied. The application of the bandage should cause no pain after the first few minutes. The skin on the distal side of the bandage should be bluish-red, never white.

In cases of acute suppuration in the hands and fingers, the bandage should be applied for twenty to twenty-two hours out of the twenty-four, and in the two-hour interval the arm should be elevated in order to remove the œdema. As the temperature falls and the condition improves, the daily time of the application of the bandage should be reduced by two hours at a time. It is of the utmost importance to

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understand that Bier's method is only an adjunct to other forms of treatment, and that incision into the inflamed parts directly has its present value just as important if Bier's method is used as with any other method of treatment.

GENERAL INFECTION BY NON-SPECIFIC PYOGENIC ORGANISMS

Septico-Pyæmia. Septico-pyæmia is a general infection of the blood by one of the pyogenic organisms, usually streptococcus or staphylococcus, with secondary foci of suppuration. A distinction is sometimes made between septicæmia and pyæmia, the first term, "septicæmia," being used when the organism infects the blood but there are no obvious secondary abscesses. The distinction is, however, unnecessary, as every case of pyæmia is a septicæmia, and it is impossible to say in any case that no secondary focus of suppuration exists.

CAUSE.—The cause is the invasion of the blood-stream by the organism, which gains entrance to the body through a wound. The wound may be slight, such as a scratch or a blister on the heel, or it may be severe, as after an operation, compound fracture, or infection of the placental site after parturition. The general health of the patient seems to have little influence on the liability to infection, but it is perhaps more apt to occur in patients with glycosuria or chronic kidney disease. The dosage of the organism, its virulence, and a predisposition on the part of the patient to pyogenic infection, are probably all factors in the production of the disease; but it is impossible at present to estimate the part played by each of these, and why the last one varies at different periods of a patient's life. The production of the secondary foci of suppuration is usually due to infective emboli being carried in the blood-stream from the source of the primary infection, the emboli being infective blood-clots formed by thrombosis occurring in the veins of the inflamed part. Emboli are, however, not necessary for the production of secondary abscesses, as the organisms may be arrested in the capillaries, especially if the part has been previously injured, causing a slight extravasation of blood, which forms a nidus in which the bacteria can localize themselves.

SYMPTOMS.—Septico-pyæmia may be either acute or chronic. The symptoms of acute septico-pyæmia are those of severe infection, with a remittent temperature. Rigors are common, and there is usually profuse sweating. The destruction of red blood-corpuscles (hæmolysis) is a marked feature, and the patient becomes sallow and anæmic. The loss of flesh and strength is usually very rapid, and the patient is generally delirious. On cytological examination of the blood a leucocytosis is found to be present, and on bacteriological examination the infecting organism may be found and identified.

In the very acute cases there are no other symptoms than those of general septic intoxication, and the patient dies in a few days, but usually there are other evidences of the infection of the blood-stream. They are—

1. *Rashes.*—These may be erythematous, closely resembling the rash of scarlet fever, urticarial, or pustular; but the most characteristic rashes are purpuric, either with minute hemorrhages (petechial)

or with large extravasation of blood under the skin (ecchymotic). They may occur on any part of the body, and on post mortem examination are also found in the mucous and serous membranes.

2. *Inflammation of Serous Membranes.*—Any of the serous membranes, pleura, peritoneum, pericardium, or meninges, may become acutely inflamed, and give characteristic symptoms and physical signs,

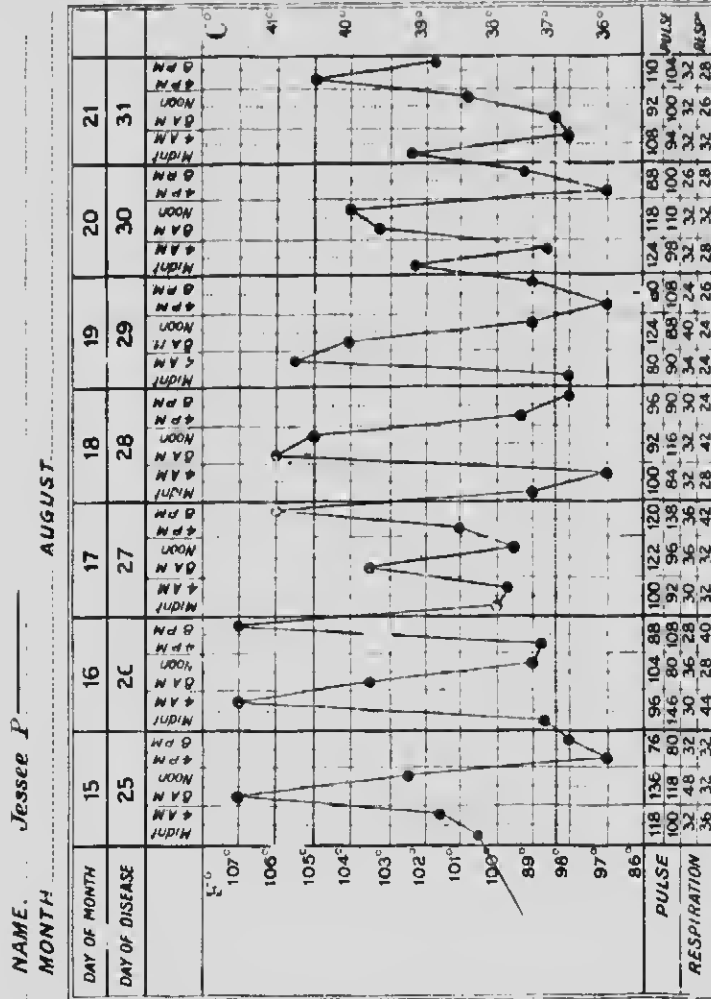


FIG. 25.—TEMPERATURE CHART OF A PATIENT WITH ACUTE SEPTICO-PYEMIA (STAPHYLOCOCCUS).

The inflammation is acute, and usually rapidly goes on to suppuration, but the exudate may be serous or serofibrinous, and if the patient recovers, resolution or fibrosis may occur.

3. *Inflammation of Synovial Membranes.*—Any of the joints, especially perhaps the knee-joints or the synovial membranes of the tendon sheaths, may become acutely inflamed, and show characteristic

symptoms as in suppurative mon. ankylosis. and if suppuration and joint ankylosis. 5. A scanty suppuration pressure the urine. 6. tion may liver, s presence founs of looked. **Port** occurs v serosal piles or in the n. **Post** sallow in mortis wound v acute in the sur in the v or extra fluid, da heart an purulent may be are found. The l or exten and ther on being. **Seco** are of tw which sh is most the absce in shape.

symptoms and physical signs. Suppuration may occur in the joints, as in the serous membranes, but in many cases the exudate is not purulent. Ankylosis or pathological dislocation of the joint is common. Patients with septico-pyæmia may recover with complete ankylosis of one or more joints, usually in a bad position.

4. *Septic Pneumonia*.—Acute inflammation of the lungs is common, and, if the patient survives long enough, abscess formation, diffuse suppuration and gangrene of the lungs may follow. The symptoms and physical signs are those of very acute broncho-pneumonia.

5. *Suppurative Nephritis*.—The urine in septico-pyæmia is usually scanty, high coloured, and contains albumin. In some cases diffuse suppuration occurs in the kidneys, and may result in complete suppression of urine, or albumin may be present in large amounts, and the urine contain pus.

6. *Abscesses*.—Secondary foci of inflammation ending in suppuration may occur in any part of the body, heart, lungs, kidneys, brain, liver, spleen, etc. In some cases it may be possible to diagnose the presence of an abscess, but in the majority of cases the general symptoms of toxæmia are so severe that the local manifestations are overlooked and only discovered on autopsy.

Portal Pyæmia.—Portal pyæmia, as opposed to systemic pyæmia, occurs when the primary focus of infection is the area drained by the portal system of veins—for example, suppuration after operation for piles or suppurative appendicitis. The secondary abscesses are formed in the liver.

POST-MORTEM APPEARANCES.—The body is usually emaciated, sallow in appearance, and post-mortem staining is well marked; rigor mortis usually slight, and decomposition commences early. The wound which is the primary focus of infection is usually in a state of acute inflammation, with pus formation. On making an incision into the surrounding tissue, there is found extensive clotting of the blood in the veins, and the clots are undergoing acute puriform softening, or extravasation of blood has occurred near the wound. The blood is fluid, dark in colour, and there is staining of the endothelium of the heart and great vessels. The serous cavities contain blood-stained or purulent fluid, and organs such as the heart and abdominal viscera may be covered with inflammatory lymph. Petechial hæmorrhages are found under the serous, synovial, and mucous membranes.

The lungs are congested or show evidence of broncho-pneumonia, or extensive suppuration. The liver and spleen are swollen and soft, and there is usually congestion of all the abdominal viscera. Bones, on being cut across, may show signs of acute diffuse osteomyelitis.

Secondary abscesses may be present in any part of the body, and are of two kinds—(1) Those which follow infarction of emboli; (2) those which show no evidence of this condition. The first variety of abscess is most common in the lungs, liver, spleen, kidney, and brain; and the abscesses form on the surface of the organ, are roughly triangular in shape, with the base just beneath the capsule. The second variety

is of the nature of a diffuse suppuration in the subcutaneous and intramuscular connective tissue, or a purulent effusion into the cavities of the serous and synovial membranes.

PROGNOSIS. The prognosis in acute septico-pyæmia is bad, and death usually occurs within fourteen days of the onset of the disease; but recovery may occur, especially if, after an acute onset, the condition becomes chronic. The period of recovery may at any time be interrupted by a recurrence of the disease, which may end fatally. A rigor usually indicates that a fresh focus of inflammation has occurred.

TREATMENT. The treatment of acute septico-pyæmia is mainly general, and follows the same lines as the treatment of other infective conditions. The patient's strength must be maintained with concentrated and peptonized food, and if alcohol in the form of port-wine, champagne, or brandy, enables him to take food, it is valuable. Vaccine therapy may be tried, and since the introduction of this treatment the prognosis has slightly improved. No drugs have any effect on the course of the disease. The blood itself may be treated in one of two ways—(1) The patient may be bled to remove some of the toxins and organisms from the body, and the blood replaced with normal saline fluid. (2) Antiseptics may be injected into the blood.

The *local* treatment consists of treatment of the primary focus of infection and treatment of the secondary foci.

1. If the primary focus be a wound, it should be opened freely, treated with strong antiseptics, and efficient drainage provided. In cases of suppuration in a vein—as, for example, in infective thrombosis of the lateral sinus or of varicose veins of the leg—a ligature should be placed round the vein above the clot, and either the vein excised or the infected clots completely removed. When the cause of the septico-pyæmia is acute suppurative osteomyelitis, with or without a compound fracture, either the bone must be very freely opened and drained, or the limb should be amputated. Evidence of inflammation of serous and synovial membranes does not contra-indicate the latter operation, but makes it more urgent.

2. *Secondary Foci.*—Abscesses should be opened and freely drained whenever they occur.

Arthritis.—Directly there is evidence of acute inflammation of a joint, it should be put at rest in the best possible position for ankylosis, and treated by splints or extension, as in other forms of arthritis. This is of the utmost importance, as it is common to see patients who have recovered from this very serious disease completely crippled and bedridden by pathological dislocations and ankylosis of joints in bad positions.

The joint should be aspirated early, and if the exudate is purulent, the joint cavity should be opened, washed out, and drained. As the infection is usually of the synovial membrane, early and free drainage may prevent subsequent ankylosis, and the joint may completely recover. If, however, the joint is completely disorganized, amputation may be advisable.

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Serous Membranes.—Inflammation of these membranes should be treated according to general principles. The fluid should be aspirated early, and if the exudate is purulent, the cavity must be freely drained.

All operations, even the most trivial, in a case of septicæmia should be performed under full aseptic precautions, as infection by other bacteria may occur. The acute inflammation of the lungs, kidneys, and other organs must be treated on general principles.

Chronic Septico-Pyæmia.—The symptoms of chronic septico-pyæmia only vary in degree of severity and duration from those of the acute disease. The continuation may last for months, and amyloid degeneration of the viscera may occur. It is perhaps most frequently seen in young subjects suffering from the effects of acute osteomyelitis, and there is a special tendency for other bones to become infected. The prognosis of the chronic form is much better than that of the acute, and becomes more favourable as time elapses.

TREATMENT.—The principles of treatment are exactly the same as in the acute form. Vaccine treatment is usually of more value than in acute cases, and, above all, fresh air, good feeding, and sunshine are most important. The patient should, if possible, be sent to the seaside or country, and the immediate improvement is often striking. If the condition does not improve with general treatment, and the primary focus is in one of the bones or joints of a limb, amputation should be performed in order to prevent the onset of amyloid disease or death from exhaustion.

SPECIFIC INFECTIONS OF WOUNDS

Tetanus

Tetanus is a local, specific, infective disease due to the *Bacillus tetanus*.

Bacillus Tetanus.—The *Bacillus tetanus* is found chiefly in soil, particularly if contaminated by horse manure, for horses are susceptible to the disease, and the bacillus is found in their faeces. It is also found in commercial gelatin made from the hoofs of horses, and occasionally in catgut. The organism is rod-shaped, and only characteristic in appearance when sporing. The spore forms at one end of the organism (drumstick bacillus), and does not stain so deeply as the organism. The bacillus stains readily, is Gram-positive, and, with suitable staining, is seen to possess flagella. Its cultivation and isolation is somewhat difficult, as it is a strict anaerobe, but it may be grown on glucose agar and blood-serum under anaerobic conditions. The culture has an unpleasant odour like burnt hair.

It is difficult to recover the organism from a wound infected by it, but inoculation experiments on mice prove the presence of the bacillus.

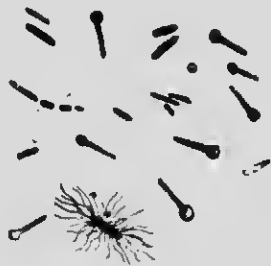


FIG. 26. — TETANUS WITH SPORES AND FLAGELLA.

The spores have very high powers of resistance to antiseptics, and may be kept in a dry condition for months without losing their virulence.

The poison produced by the tetanus bacillus is termed "tetanotoxin," and whilst the organism remains locally in the wound, it spreads to the central nervous system along the nerve-sheaths. It does not spread by the lymphatic or blood stream.

PREDISPOSING CAUSES.—The organism always gains entrance to the body by a wound, which is usually lacerated and contaminated with earth or horse manure. It is most common, therefore, in gardeners, stablemen, agricultural labourers, and soldiers on campaigns. It is more common and virulent in tropical and subtropical countries, and affects the negro races more readily than the white. Suppuration nearly always occurs in the wounds infected by tetanus, and it is believed that the suppuration, by irritating the tissues, and by the pyogenic bacteria absorbing the oxygen present, allows the tetanus bacillus to grow and produce its toxins.

POST-MORTEM APPEARANCES.—Usually the wound merely has the characteristic appearance of suppuration. The nerves leading from the wound may show an acute neuritis, but this is probably due to sepsis, and not to the tetanotoxin. The changes in the central nervous system are not characteristic. There is general congestion of the grey matter of the spinal cord and medulla, and irregular patches of more marked congestion, especially in the medulla and pons. There may be minute hæmorrhages in the congested areas. The motor ganglion cells may show degenerative changes.

Hæmorrhages, due to rupture of the bloodvessels during the violent spasms, may be found in the muscles.

INCUBATION PERIOD.—The incubation period of tetanus varies considerably, and may be a few hours or weeks. It is usually from four to fourteen days in this country, but cases with a shorter incubation period are not uncommon. The incubation period appears to be shorter in children than in adults, and in the tropics than in the temperate zones.

CLINICALLY, tetanus may be divided into acute tetanus, chronic tetanus, head tetanus or *Tetanus hydrophobicus*, and *Tetanus neonatorum*.

SYMPTOMS—Acute Tetanus.—The characteristic symptom is spasm of the voluntary muscles. The muscles first affected are those of the jaws and neck, then those of the trunk, and finally the limbs. The muscles of the hands and feet are affected late, and may be quite soft when the rest of the voluntary muscles are in violent spasm. The spasm of the muscles is *tonic* (continuous), and when once a muscle has passed into spasm it remains contracted until the disease is cured. There are, however, frequent exacerbations of the spasms, induced by reflex causes. A bright light, a noise, movement, touching the bed, attempts at swallowing, or even the patient's emotion, may all cause a sudden increase of the spasm, which partially passes off, but leaves the muscle more tonically contracted than it was before. The spasms of the muscles are exceedingly painful.

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EFFECTS OF THE MUSCULAR SPASM.—Feeding is difficult, as the teeth are tightly clenched, and the mouth cannot be opened (trismus or lockjaw), the jaw muscles being affected early. The spasm of the facial muscles pulls the corner of the mouth outwards, exposing the teeth in an unpleasant grin (risus sardonius).

When the erector spinae are affected, the exacerbations of the spasm arch the back violently, so that the patient may only rest on the back of the head and the heels (opisthotonos). Occasionally the body is bent forward by contraction of the abdominal muscles (emprosthotonos), or, more rarely still, curved to one side (pleurosthotonos).

The violent contractions may be sufficient to lacerate the muscles, and sometimes the rectus abdominalis has even been torn across. The chest being rigidly fixed, cyanosis, from interference with the movements of respiration, is a constant feature of the disease, and there is usually profuse sweating. The teeth are sometimes broken by contraction of the jaw muscles, and the tip of the tongue has been bitten off.

TEMPERATURE.—There is usually no rise of temperature in the early stages of the disease unless there is marked sepsis, but before death occurs the temperature generally rises, and may reach 107° F., or more; and it may continue to rise after death. Some cases are, however, apyrexial throughout.

OTHER SYMPTOMS.—As a rule the mind is clear, but there may be delirium. The pulse-rate is increased, the urine is scanty and may contain albumin. Constipation is usually a marked symptom, and the motions are dark in colour and have a foetid odour.

PROGNOSIS.—The prognosis in acute tetanus is bad, the majority of cases dying in from three to seven days. It varies with the length of the incubation period, and if this is less than four days the disease is always fatal. As the incubation period lengthens, the prognosis improves, but if it is under ten days, only about 4 per cent. of the patients recover. The convalescence is usually prolonged, and the stiffness of the muscles may last for months.

NAME Samuel E. — Age 33

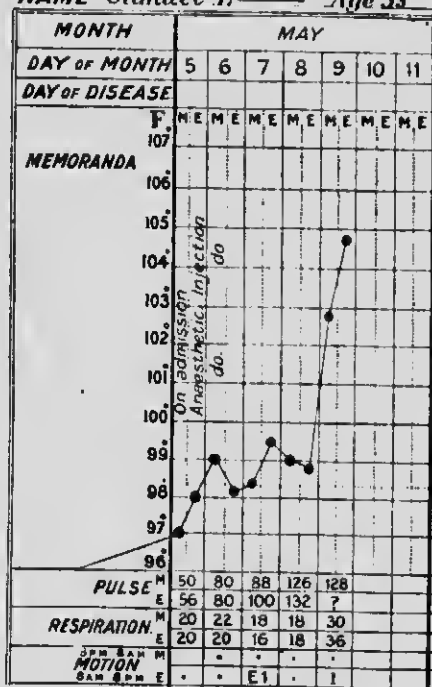


FIG. 27.—TEMPERATURE CHART OF A PATIENT WHO DIED OF ACUTE TETANUS.

Chronic Tetanus.—Chronic tetanus has a long incubation period, sometimes weeks. The spasm of the muscles is not so severe as in acute cases, and the spread of the spasm is slow. The spasms may be limited to the jaw and neck muscles, the exacerbations of the spasms being slight or absent. The prognosis is much better in the chronic cases, and if the incubation period is two or three weeks, about 50 per cent. of the patients recover.

Head Tetanus, or Tetanus Hydrophobicus.—In these cases the muscular spasms are largely limited to the laryngeal and pharyngeal muscles, making it difficult for the patient to swallow. Dyspnoea is present, and the symptoms therefore somewhat resemble those of hydrophobia. The infected wound lies in the distribution of the facial nerve, and there is usually facial paralysis on that side owing to the swelling of the nerve causing it to be pressed on in the aqueductus Fallopii. The condition is rare. The prognosis is a little better than that of acute tetanus.

Trismus Neonatorum.—Trismus neonatorum is tetanus occurring in the newly-born, due to infection of the umbilical cord by the tetanus bacillus.

In some countries, where dust is used as a dressing for the cut umbilical cord, the disease is exceedingly prevalent. The incubation period is about nine days (nine-day fits), and the symptoms are those of acute tetanus. The disease is very fatal, and death takes place in about three days.

TREATMENT—Prophylaxis.—The prophylactic treatment of tetanus consists of the careful aseptic treatment of all accidental wounds. If the wound is contaminated with garden soil, or if there is any special reason to fear it has been infected with tetanus, an injection of antitetanic serum should be given.

The treatment of tetanus consists of—

1. *Treatment of the Wound.*—The wound should be excised, or if a finger or toe, the part may be amputated. If neither of these is possible, it should be freely opened, and strong antiseptics applied. The further treatment is that of any wound.

2. *Securing Rest.*—To diminish the number of reflex exacerbations of the spasms the patient should be isolated in a semi-darkened room. All noise and bright light should be avoided, and absolute rest secured as far as possible. The nurse and doctor should be the only people allowed in the room, and the nurse should only touch the patient or the bed when absolutely necessary. Rest should also be secured by the use of sedative drugs. Morphine, chloral hydrate, and bromide of potassium are used for this purpose; or if the spasms are frequent and severe, chloroform may be administered for an hour or two.

Injections of curare to paralyze the nerve terminations in the muscles have been given, but there is danger of respiratory failure. If this drug is used, the surgeon must be prepared to perform artificial respiration at once and continue it. Results in acute cases are not encouraging.

3. *Drug Treatment.*—Carbolic acid given by hypodermic injection has been used with some success. An injection of 10 to 15 minims of a 2 per cent. solution is given three times a day into the subcutaneous tissues.

Magnesium sulphate has also been used with success by injection into the subarachnoid space of the spinal canal. Lumbar puncture is performed, and 40 minims of a 25 per cent. solution of magnesium sulphate is injected after some of the cerebro-spinal fluid has been removed. The injection is repeated daily until it is considered that the patient is well on the road to recovery. The injection markedly relieves the spasms, the improvement lasting for hours. The breathing must be watched, and the surgeon must be ready to perform artificial respiration.

4. *Serum Treatment.*—The serum treatment of tetanus consists of giving large doses of tetanus antiserum, with the hope of neutralizing the tetanotoxin. It has been shown that the antiserum has no effect on the toxin already absorbed by nerve tissue, and it is still doubtful whether serum treatment is of any value in the treatment of acute cases of tetanus. Cases that recover are cases of chronic tetanus, and these frequently recover without antitoxin treatment. The initial dose of antitoxin is 100 c.c. The injection may be given into—

- (1) Subcutaneous tissue. If given in this way, the antitoxin only neutralizes the toxins in the blood, and it has been shown that the toxin does not spread by the blood-stream, but along the nerves. The serum does little good if given by this method.
- (2) Intracranially. The injection is given into the posterior portion of the second frontal convolution on each side, through a trephine hole made midway between the external angular process of the frontal bone and the central point of the line between the root of the nose and the external occipital process. The good effect of the injection made in this way is so doubtful, and the increased danger so obvious, that this method of treatment has been almost entirely abandoned.
- (3) Into the main nerve trunks supplying the wounded area. The nerve trunks should be exposed, and the serum injected in the same way that cocaine is injected for "nerve blocking." This is a rational method of injection, and may be tried in all cases.
- (4) Into the spinal canal. Lumbar puncture is performed between the third and fourth lumbar vertebrae, a small quantity of cerebral fluid is withdrawn, and the antitoxin injected.

This method of treatment is the one most generally used at the present time, but, as stated above, the value of antitoxin treatment of acute tetanus is still *sub judice*.

Anthrax

Anthrax is a specific infective fever due to the *Bacillus anthracis*, and is a disease occurring epidemically amongst sheep and cattle. Man becomes infected by them either directly or indirectly. In animals the disease is known as "splenic fever," and is characterized by rise of temperature, enlargement of the spleen, and multiplication of the bacilli in the blood-stream.

The *B. anthracis* is 6 to 8 μ long, is aerobic, and may grow in chains. It stains with the aniline dyes, and is not decolorized by Gram's method. It grows readily on the usual culture media and on plates of gelatin. The colonies have a characteristic appearance like wavy locks of hair. The gelatin is liquefied.

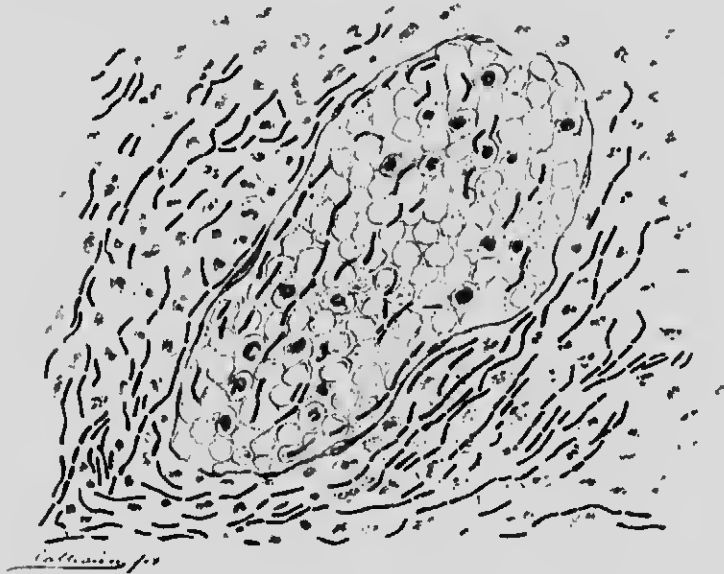


FIG. 28.—ANTHRAX PUSTULE: HIGH POWER, SHOWING THE BACILLI.

Sporulation occurs under certain conditions, but never in the body of an animal suffering from the disease. The spores are extremely resistant, and in the dry condition may continue to live for a year or more. They resist boiling for five minutes, and dry heat at 140° F. for hours, and are frequently used as a test for germicides.

ETIOLOGY.—Anthrax is a rare disease in man, and in England is chiefly found amongst people who handle imported hides. It is also found in woolsorters, graziers, butchers, and brush-makers. The incubation period is from a few hours to three or four days.

SYMPTOMS.—The bacillus gains entrance to the body in one of three ways—by the lungs, by the elementary canal, by direct infection through the skin.

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1. *Infection by Inhalation into the Lungs (Woolsorter's Disease).—*

The patient develops the symptoms of an acute pleuro-pneumonia, with high temperature and blood-stained sputum. There is frequently evidence of pericarditis, and the disease is as a rule rapidly fatal. On post-mortem examination, acute inflammation of the mucous membrane of the bronchi, blood-stained effusion into the air cells, and effusion into the pleural cavities and subendothelial hemorrhages are found. The lungs are collapsed, and there is acute inflammation of the bronchial and mediastinal glands.

2. *Infection by the Alimentary Canal.*—This is the rarest form of the disease, as the spores and bacilli are usually killed by the gastric



FIG. 29.—ANTHRAX PUSTULE: LOW POWER.

juice. The symptoms are those of an acute gastro-enteritis, with abdominal cramps, vomiting, and blood-stained diarrhoea. The mesenteric glands are acutely inflamed, and recovery is rare.

3. *Infection by the Skin—Malignant Pustule.*—This infection usually occurs on the face, hands, and forearms, or in the case of hide-porters, on the back. At the site of inoculation there appears a small red pimple, which soon becomes a vesicle containing a turbid fluid in which the bacilli may be found. The surrounding tissue is infiltrated with inflammatory exudates, and hemorrhages are common. The vesicle soon becomes gangrenous, and is surrounded by a ring of other vesicles, which in their turn may become gangrenous. The surrounding subcutaneous tissue is intensely oedematous, and the

nearest lymphatic glands are acutely inflamed, large, and swollen. The œdema may be intense, and if in the neck, may cause interference with respiration and deglutition.



FIG. 30.—ANTHRAX PUSTULE.

At first the *general* symptoms of fever are not marked, as the disease is local, but after the pustule has been present for three or four days, the organism gains entrance to the bloodstream, and a general anthracæmia results. The temperature rises to 104° to 105° F., and there are rigors, vomiting, hæmaturia, and coma. The pulse and respiration rate rise, and death usually takes place in three or four days. The spleen is not often markedly enlarged in man.

PROGNOSIS.—The prognosis in the respiratory and alimentary forms of the disease is bad. In the cutaneous form a large proportion of the cases end in recovery if the treatment is begun before general infection has occurred.

TREATMENT—Local.—The following methods of local treatment are used:

1. The use of fomentations as in the treatment of septic wounds.
2. Injections into the pustule of a drachm of 1 in 20 carbolic acid.
3. Excision of the pustule, and cauterizing the wound with the actual cautery or pure carbolic acid.

It is probable that the use of fomentations is as efficacious as the more drastic methods of treatment if sero-therapy is used.

General.—The usual treatment of any infective fever is carried out.

SERO-THERAPY.—The most extensively used serum is Sclavo's. It is prepared by immunizing animals with an attenuated culture of the bacillus, and then inoulating them with a large dose of a virulent anthrax. It probably acts by inducing a defensive phagocytosis, and is more antibacterial than antitoxic.

In an ordinary case 30 to 40 c.c. should be given subcutaneously, the dose being divided into three or four injections into different parts of the body. The improvement should be apparent in a few hours, but if there is none in twenty-four hours, a further injection of 20 to 30 c.c. should be given.

In grave cases 10 c.c. of the serum should be injected intravenously, preferably into one of the veins at the back of the hand, and a further 10 c.c. should be given in two hours if there is no improvement. Sobenheim's serum is given in this way, and the dosage is similar.

It is claimed that the use of these sera renders drastic local treat-

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ment unnecessary, that there is rapid improvement in the general symptoms, that the duration of the illness is shortened, and that the prognosis is considerably improved. If the sera are not available, 16 minims of a 5 per cent. solution of nucleinate of soda may be given subcutaneously to stimulate leucocytosis.

Glanders

Glanders is a specific infectious disease due to the *Bacillus mallei*.

This organism is rod-shaped, with rounded ends, about the same length as a tubercle bacillus, but thicker. It stains readily with the aniline dyes, but loses its colour on the addition of alcohol. It is negative to Gram's solution. The organism grows readily on all the usual culture media, but its growth on potato is characteristic. It must be grown at a high temperature (37° C.), and on the third day there is a growth of a golden-yellow colour. In a day or two longer it becomes chocolate brown, whilst the potato at the edge of the growth shows a greenish-yellow staining. The powers of resistance to heat and antiseptics are low, and it does not form spores.



FIG. 21.—*Bacillus mallei*.

ETIOLOGY.—The disease is always communicated to man from horses or donkeys, horned cattle being exempt. It is therefore commonly found in ostlers, grooms, coachmen, etc.; but a large number of cases have occurred amongst bacteriologists and their assistants. It is, perhaps, the most dangerous organism in the bacteriological laboratory.

The incubation period is one to fifteen days, most commonly five days.

Glanders is found in horses in two forms—acute glanders and chronic glanders, or farcy; but the chronic form may at any time become acute. In acute glanders there is an acute inflammation of the nasal mucous membrane, ending in ulceration, so that there is a discharge from the nostrils. The lymphatic glands of the neck are acutely inflamed, and secondary foci of suppuration occur in the lungs, liver, spleen, and other organs.

In chronic glanders, or farcy, the infection takes place through the skin, and there is a chronic ulcer at the seat of inoculation. The lymphatic vessels leading from the part are chronically inflamed, and form like knotted cords under the skin (farcy buds). Suppuration at various points is common, and secondary abscesses may form in any of the organs. The bacillus can be found in the pus.

SYMPTOMS IN MAN.—As in the horse, glanders may occur in two varieties in man—acute and chronic.

Acute Glanders.—The infection takes place through the skin, usually either of the hands or face, and the wound becomes inflamed and ulcerates. The disease is a general infection by the bacillus, and

is characterized by a pustular eruption somewhat resembling small-pox. These pustules occur in the skin and mucous membranes, including the nasal mucous membrane. They break down into ulcers, which may coalesce and cause extensive destruction of tissue. Inflammation of the serous and synovial membrane occurs, usually ending in suppuration. The bacillus is found in the pus. Secondary abscesses may occur in any part of the body. The temperature is raised to 102° to 104° F. The pulse is rapid, and the respiration-rate raised. Rigors may occur. The condition closely resembles an acute septicopyæmia due to staphylococci, and the diagnosis is only certainly made by discovering the organism. This is easy in acute cases.



FIG. 32.—GROWTH OF *Bacillus mallei* ON POTATO. (London Hospital Bacteriological Department.)

THE PROGNOSIS is bad. Death usually occurs in two or three weeks. Recovery is very rare.

TREATMENT.—The general treatment is that of any acute infective disease, and there are no specific drugs. All the lesions, both primary and secondary, should be treated antiseptically, and all abscesses opened and drained. Joints and serous cavities which become distended with pus should be drained.

Chronic Glanders — *Symptoms*. — The infection takes place through the skin, and a chronic ulcer develops at the site of inoculation (usually on the face), and spreads steadily, involving all the tissues. Necrosis of the cartilage and bones of the nose may occur. The edges of the ulcer are irregular, the floor sloughing, and the secretion foul and purulent. The lymphatic vessels leading from the ulcer are inflamed, and suppuration occurs at points along their course, leading to secondary ulcers. The lymphatic glands also become inflamed and suppurate. Secondary abscesses may occur in any part of the body, and the disease may at any time become generalized and acute. The diagnosis has to be made from tubercle, syphilis, and breaking-down carcinoma. It is only made certain by finding the bacillus. In the chronic cases the discovery of the bacillus is not easy, but it may be seen in sections made from the spreading edge of the lesion, or be identified by inoculation of guinea-pigs. An intraperitoneal injection is made into the male guinea-pig, and this is rapidly followed by a purulent inflammation of the tunica vaginalis due to acute orchitis.

PROGNOSIS.—According to Bollinger (1876), half the cases recover, but this estimate is much too high. In this country the great majority of cases end fatally from pulmonary glanders; and Robbins of Montreal states the number of definite cures at 6 per cent. in a series of 156 cases.

TREATMENT.—The treatment of chronic glanders is that of any infective ulceration, with secondary suppuration in the lymphatics.

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SERO-THERAPY.—A substance, **mallein**, has been obtained from cultures of *Bacillus mallei*, in the same way as Koch's tuberculin is obtained from tubercle bacillus. Mallein has been extensively used as a valuable method of diagnosis of glanders in horses. An injection of 1 c.c. of mallein is made into the suspected horse, and if the disease is present, there is a *marked* local reaction, and a rise of temperature of 1.5° to 2° F. A rise of temperature of 1° F. and a slight local reaction occurs in the healthy horse. Mallein is not used as a means of diagnosis in man, but it has been used as a curative vaccine.

Hydrophobia

The cause of hydrophobia is unknown, but from analogy it is believed to be due to a specific organism, and it is classed amongst the specific infective diseases.*

ETIOLOGY.—The infection is always communicated to man by the bites of dogs, wolves, or cats, suffering from the disease. The virus is believed to be contained in the saliva, and bites on the face, hands, and uncovered parts, are more dangerous than those inflicted through the clothes, as in the latter case the saliva tends to be wiped away from the teeth.

Hydrophobia (Rabies) in the Dog.—The dog becomes irritable, is listless, and changed in disposition, has a tendency to mope in corners, and to eat filth of all kinds, including its own excreta. Its bark is altered, and it wanders about without taking notice of surrounding objects. It is in this stage of the disease that the dog is most dangerous, for the condition is frequently unrecognized. A stage of frenzy follows, in which the dog runs blindly, snapping at anything in its way. Ropy saliva collects in its mouth, and the dog is easily recognized as being "mad." This is followed by a stage of paralysis, the lower jaw and the hind-limbs becoming first affected, and the dog dies five or six days from the onset of the disease. In dumb rabies the stage of frenzy is omitted, paralysis occurs early, and the dog dies in two or three days.

Hydrophobia in Man.—The *incubation period* is usually six weeks, but it may be as short as two weeks, and has been said to be as long as two years.

SYMPTOMS.—The wound, which has generally healed, becomes red and irritable. There is a rise of temperature and general malaise; the patient is depressed, and has an increasing fear of the disease. The characteristic symptoms are spasms of the pharyngeal and laryngeal muscles, interfering with respiration and deglutition. The spasms are induced by reflex causes, chiefly by attempts at swallowing; and finally they occur at the thought even of drinking. They are clonic in character, and may affect the diaphragm, causing a curious jerky inspiration, the sound of which has been likened by the laity to the barking of a dog. The mouth is filled with a thick, ropy saliva, which cannot be swallowed. The pulse is small, rapid, and intermittent,

* An organism has recently been described.

and frequently albuminuria is present. The mind is, as a rule, clear; but there may be hallucinations of sight and hearing. Restlessness, irritability, suspicion, and extreme depression, and fear of the disease, are always present; and sometimes also sexual excitement, priapism, and seminal emissions. In a few cases paralysis is a symptom from the first, resembling the dumb rabies of the dog.

PROGNOSIS.—When once the symptoms have appeared, the disease is invariably fatal, and death usually takes place in about four days. The only hope of curing the disease is by preventing its onset.

TREATMENT.—The bite of an animal believed to be suffering from rabies must be *at once* cauterized with the actual cautery, pure carbolic acid, or solid silver nitrate. Cauterization is useless if more than half an hour has elapsed since the bite. Excision of the wound is perhaps better than cauterization. The dog in a suspected case should *not* be killed until the diagnosis of rabies has been verified. If it is killed, the brain and cord should be removed, packed in ice, and sent, with the patient, to the nearest place where Pasteur's preventive treatment is carried out. An emulsion made from the brain and cord is injected into a rabbit, and if the animal dies of hydrophobia, the diagnosis is certain, and treatment must be at once begun. If possible, treatment should be started before the sixth day after the bite.

Pasteur's preventive treatment is a method of vaccine therapy. The virus is intensified and standardized by passing it through a series of rabbits until an animal of a certain weight is inevitably killed on the seventh day. A series of such animals is killed by the disease, and their spinal cords allowed to dry. As the drying proceeds, the virulence of the virus diminishes, until, on the fourteenth day, an emulsion made from the spinal cord is innocuous. An injection of an emulsion made from a spinal cord of low virulence is given, and then is repeated, using a more and more virulent cord with each injection, until an injection is given of a cord which has only dried for twenty-four hours. This would, if given as a first injection, have proved fatal, but no ill-effects follow its use, and the treatment is then stopped.

It is difficult to estimate the success of a preventive treatment, but there is no doubt that, since its introduction in 1885, Pasteur's treatment has enormously diminished the number of cases who would otherwise have succumbed to the disease, and the treatment should be used in all cases of bites from mad animals.

When once the disease has developed, the treatment is purely symptomatic, and consists chiefly of giving large doses of morphia and chloral to diminish the spasms. Inhalations of chloroform are also useful for the same purpose.

Actinomycosis

Actinomycosis is a local specific infectious disease due to the actinomyces, or ray fungus.

The *actinomyces* is a higher organism than those already considered, being a streptothrix. It grows in colonies, which are just visible to

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the naked eye, and these colonies on microscopical examination are found to consist of three elements—filaments, cocci, and clubs.

The *filaments* form a slender interlacing network in the centre of the colony, while at the periphery they are arranged in a radiating manner. In young cultures they stain uniformly, and are Gram-positive. In the older colonies the filaments may be broken up into small rounded bodies, so that they look like a chain of cocci, and they may become free by disappearance of the surrounding cells.

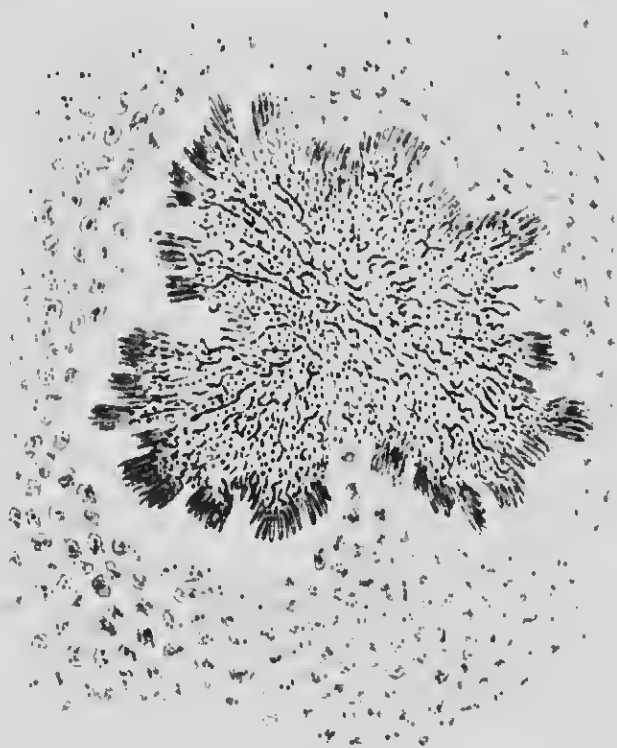


FIG. 33.—*Actinomyces hominis* IN Pus.

The *cocci* are developed from the filaments, but it is probable that they also multiply by division. They are sometimes termed "spores," but this is probably incorrect, and they should be looked upon as representing a stage in the growth of the bacterium under certain conditions. They stain readily, and are Gram-positive.

The *clubs* are elongated bodies found at the periphery of the older colonies, and probably represent aberrant culture forms. They are frequently absent in the colonies found in human beings, and, if present, are decolorized by Gram's method.

The actinomyces is grown with great difficulty, owing to contamina-

tion with other organisms. It is an anaerobe, and its rate of growth is slow.

ETIOLOGY.—The organism is found growing on cereals, especially barley, and commonly infects oxen. Man is infected in the same way, and the disease is generally met with in farmers, corn-dealers, graziers, etc., especially if the patient has the habit of chewing straw, the infection most commonly occurring in the tongue, gums, and tonsils. Infection of various parts of the alimentary canal, especially the appendix, is not uncommon, and the skin, the respiratory tract, and the female genitals, have been the primary seat of infection.

PATHOLOGY.—The local lesion is a chronic inflammation associated with the formation of a large amount of granulation tissue, which gradually breaks down into pus at various points.

SYMPTOMS.—The *general* symptoms are slight, and are those of a mild infection. The *local* symptom is the development of a painless chronic swelling, which enlarges steadily. As it reaches the surface, points of softening, the skin over which is reddish-blue in colour, occur on it, and these finally burst and discharge pus. This formation of several discharging sinuses, with puckering of the tissues due to fibrosis, gives a somewhat characteristic appearance to the lesion. If the pus be examined with the naked eye, small transparent jelly-like nodules are seen in it. They are usually greyish-green in tint, but exceptionally are yellow. If they are examined under the microscope, they are found to be colonies of the actinomyces. The lymphatic glands are not affected as a rule.

If the condition occurs in the appendix, or other deep-seated organ, the symptoms are simply those of a very chronic inflammation, ending in suppuration, and the diagnosis is only established when the organism is found.

Although the organism usually remains local, the inflammation spreading by continuity of tissue, invasion of the blood-stream sometimes occurs, and secondary foci of suppuration appear in distant parts of the body. When pus has formed in the granulation tissue, burrows in the part, and fistulæ form; or if the suppuration occurs in the mouth or nasal passages, pus containing the organism may be inhaled, and secondary abscesses develop in the lungs.

With the onset of septic infection, the general symptoms become more marked, and the disease may rapidly terminate in death.

DIAGNOSIS.—Before suppuration has occurred, the diagnosis has to be made from sarcomata and other forms of new growth, and when fistulæ form, from syphilis, tubercle, chronic glanders, etc. The only certain diagnosis is the discovery of the colonies of the organism.

PROGNOSIS.—The prognosis is not good, as it is difficult to get the local lesion to heal. When visceral infection occurs, or if the primary focus is deep-seated, the disease is usually fatal.

TREATMENT.—The local treatment consists of extirpation of the diseased tissue. If possible, it should be excised; but if this is not feasible, the fistulæ must be freely opened, scraped, and cauterized, all the diseased tissue as far as possible being removed.

X-ray treatment has also been of some value.

The general treatment consists of giving drugs and vaccine therapy. Of drugs, the most valuable is iodide of potassium, which should be given in large doses—20 to 30 grains three times a day. Organic preparations of iodine have also been used.

Intramuscular injections of 10 per cent. solution of cacodylate of soda has also been advocated.

Vaccine therapy has been tried, but its value has yet to be ascertained.

Infections by other Organisms of the Nature of Streptothrix and Cladothrix

The organism described above, the *Actinomyces bovis*, is a specific organism, but chronic inflammatory conditions ending in suppuration due to other varieties of streptothrix and cladothrix have been described under the term "actinomycosis," owing to the finding of filaments in the pus.

The difference in these conditions is the absence of the characteristic granules in the discharge. The organisms are frequently aerobic, and can readily be grown on culture media.

CHAPTER V

SPECIFIC INFECTIONS—TUBERCULOSIS AND SYPHILIS

TUBERCULOSIS

TUBERCULOSIS is a specific infectious disease due to invasion of the various organs of the body by the tubercle bacillus discovered by Koch in 1882.

CAUSE.—The tubercle bacillus is a slightly curved rod-shaped organism with rounded ends, measuring about 3μ in length and 0.3μ in breadth. It is non-motile, and has a beaded appearance when stained, but it is very doubtful whether this appearance indicates spore formation. In some cases it grows in branching chains, and it is therefore thought to be allied to the streptothrices. It stains readily with Ziehl's fluid (carbol-fuchsin), and retains the stain in the presence of 20 per cent. sulphuric acid (acid-fast), and it is also positive to Gram's stain. It is grown with some difficulty on blood-serum and other media, but it is readily cultivated on Dorset's medium (white and yolk of eggs), especially if 3 or 4 per cent. of glycerine is added. The bacillus is an aërobie, and requires a plentiful supply of oxygen as well as a high temperature (82° to 108° F.) for its growth. To the naked eye the colonies, which take two or three weeks to develop, have a dry, scaly appearance.

The organism is very resistant to adverse circumstances, such as drying, digestion in the stomach, and the presence of the products of putrefaction. In the dried state it has been found active after seven months, and in patient's sputum after six weeks. It is killed by boiling, and by 1 in 20 carbolic acid solution in a few minutes, and also by exposure to superheated steam.

It is at present undecided whether the forms of tubercle bacillus which are found in the lower animals, such as the udders of cows, are identical with the human tubercle bacillus, or separate varieties incapable of causing tuberculosis in man. It is most probable that the tubercle bacillus of cattle can infect humans, especially children and infants, in whom it is believed to be mainly responsible for alimentary and glandular tuberculosis, and all possible means should be taken to guard against infection with bovine tuberculosis. At the same time, there is no doubt that the chief mode of infection in man is from the inhalation or ingestion of tubercle bacilli derived from a patient suffering from tuberculosis.

PREDISPOSING CAUSES.—Although the presence of the tubercle bacillus is absolutely essential to cause tuberculosis, the presence of a suitable tissue soil is also important to allow the bacillus to grow and produce its characteristic toxin. The tubercle bacillus is very widely disseminated in the haunts of civilization, and, under existing conditions, all civilized human beings are constantly exposed to the infection, particularly those nursing or living with tuberculous patients, and yet only a proportion of the population (one-seventh in England) acquires the disease. Amongst nurses and doctors working in sanatoria, the number of cases is very few, although the tubercle bacillus is almost constantly found in the nostrils and upper respiratory passages whilst they are at work in the wards. What this predisposition to tuberculosis is cannot at present be stated, or even if it is the presence of a suitable tissue soil or a low resistance to the organism in the bactericidal substances in the blood, but the predisposing cause seems to be inherited in some cases and acquired in others.

INHERITED PREDISPOSITION.—In a few cases tuberculosis is congenital, and the child is born with tuberculous lesions. It is possible that infection has occurred either of the ovum or spermatozoon, but it is much more likely that the placenta has been infected. These cases are not to be confused with inherited predisposition. This predisposition is seen in the members of families in which many examples of the disease have occurred, and simply means that individuals, although apparently perfectly healthy, are more likely to develop tuberculosis than members of families free from the disposition. It is, however, extremely doubtful that there are any physical signs of this predisposition which will enable it to be diagnosed, or which will help in the diagnosis of an obscure case of disease.

Two types of individuals are commonly met with amongst the sufferers from tuberculosis, termed respectively the "sanguine" and the "phlegmatic" type.

The *sanguine* type have fine, regular features, delicate hands, clear white skins, in which the veins show. Their eyes are bright, and the lids have long lashes. The hair is long, fine, and silky, and grows down to meet the eyebrows as a fine down. Intellectually they are sprightly and emotional. The *phlegmatic* type are short and bulky, with large hands and feet. The features are coarse and irregular, the skin thick and harsh and the muscular outline of the body concealed by the subcutaneous tissue. There is little muscular power, and they are apathetic and without vivacity. It is this type that is common in the slums of large cities.

ACQUIRED PREDISPOSITION.—Acquired predisposition may be general or local.

General.—There is no doubt the predisposition to tubercle is acquired by living under bad hygienic conditions, and a patient without any inherited predisposition to the disease may readily contract it if he becomes debilitated in health from insufficient food, chronic alcoholism, confinement in ill-ventilated workshops, or other causes detrimental to the general health. This also applies particularly to

patients with inherited predisposition, who, so long as they live under good hygienic conditions, may be exposed to infection with impunity, but who rapidly become tuberculous if this favourable condition of life is lost.

In children a common cause of acquired predisposition is debility following the common diseases of childhood, such as broncho-pneumonia, the specific fevers, and rickets, which, by lowering the general state of health, appear to predispose the body to attacks of the tubercle bacillus.

Local.—Any tissue whose vitality has been depressed, especially by chronic inflammation or injury, appears to form a suitable soil for the tubercle bacillus. Tuberculosis of the lungs frequently follows a slight broncho-pneumonia, and lymphatic glands, the site of chronic inflammation due to carious teeth, are particularly apt to become infected with tubercle. In children injuries to the bones, resulting in damage to the soft spongy diaphysial bone, are a frequent predisposing cause of tuberculosis of the joints.

AGE OF THE PATIENT.—Patients with tuberculosis amenable to surgical treatment, such as those suffering from bone, joint, and glandular tuberculosis, are most frequently met with amongst the young, but no age is exempt, and bacteriological examination of chronic inflammatory lesions shows that tuberculosis is far from uncommon among the aged (senile tuberculosis). The age of the patient should therefore not be used as an argument against a lesion being tuberculous, but, on the other hand, a chronic inflammatory lesion in a child is most likely to be due to the tubercle bacillus.

MODES OF INFECTION—1. *By Inhalation.*—This is the most common mode of infection, and it nearly always occurs from inhaling the bacilli in the dried sputum of patients suffering from pulmonary tuberculosis. This mode of infection generally results in tuberculosis of the lungs, and then by direct extension to infection of the mediastinal lymphatic glands. This constitutes a constant source of danger, as infection can easily gain admission to the blood-stream.

2. *By Ingestion.*—This mode of infection is most commonly seen in children, and the infection takes place through the mucous membrane of the alimentary canal, especially that of the lower ileum and cæcum. In many cases this appears to be an infection by the bovine form of the bacillus, and the chief source of these organisms is from milk infected by cows with tuberculous udders. In cases where the patient already has pulmonary tuberculosis, the infection may occur from swallowing the sputum containing the bacillus.

3. *By Inoculation.*—This method of infection, contrary to the rule in the other infectious diseases of surgery, is the least common; but the danger of inoculation must always be borne in mind by those who attend on the tuberculous, or perform autopsies.

4. *By the Blood-Stream.*—After the organism has once gained entrance to the body by one of the above means, it may become disseminated by the blood-stream, and produce tuberculosis in such parts as bones, joints, glands, etc. In some cases the rupture of a tuberculous

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abscess into a vein will cause a generalized tuberculosis, or a localized tuberculosis may result, the organism usually lodging in a part predisposed to attack by injury or chronic inflammation.

5. *By the Lymphatics.*—The spread of tuberculosis by the lymphatic stream can often be readily traced. If the disease is acquired by inoculation, a tuberculous lymphangitis and lymphadenitis can often be traced from the wound, and in tuberculosis of the mesenteric glands a generalized tuberculosis may result from infection of the thoracic duct. Spread by lymphatics is also seen in genito-urinary tuberculosis and in glandular infection.

PATHOLOGICAL ANATOMY.—When the tubercle bacillus gains entry into the tissues, it produces a *local* inflammatory lesion, and a *general* toxæmia due to absorption of the products of growth of the bacillus.

The *local* inflammatory lesion is usually chronic (but cases of acute tuberculosis are by no means rare), and the characteristic reaction of the tissues is the production of the "tubercle." At the same time it must be fully understood that the "tubercle" is not pathognomonic of tuberculosis, but may occur in chronic inflammation due to other causes than the tubercle bacillus. It is found in connection with chronic syphilitic inflammation, in chronic ulcers of all kinds, and in chronic inflammation round foreign bodies. It is, however, most frequently seen in tuberculosis, and the presence of a large number of "tubercles" may be taken as evidence of that disease, although the only scientific proof is the finding of the specific bacillus.

Macroscopically, the tubercle is at first a small grey nodule, just visible to the naked eye, which subsequently becomes yellow and tends to fuse with surrounding tubercles, forming yellowish masses. Microscopically, the tubercle (if typical) is seen to consist of a central giant cell surrounded by a ring of endothelioid cells, which again are surrounded by small round cells.

The giant cell is irregularly oval in shape, and has many nuclei, which are arranged in a horseshoe shape round the periphery of the cell, or grouped in one part of it. It stains badly, as it is a degenerated cell, and the tubercle bacilli may be found in it.

The endothelioid cells are larger than the white cells of the blood, contain a single nucleus, and also take stains badly.

The small round cells resemble the leucocytes of the blood, and are of inflammatory origin. The tissue surrounding the tubercle is in a state of chronic inflammation, and there is a formation of granulation tissue, and *it is into this chronically inflamed tissue that the tubercular process spreads.*

The origin of the tubercle is doubtful, but the giant cells are probably endothelial cells in which the tubercle bacilli have settled. The nucleus of such a cell divides without cell division, and the process is continued until a giant cell containing many nuclei is produced.

The endothelioid cells are probably the endothelial cells surrounding the cell which ultimately becomes the giant cell; and the small round cells are probably the progeny of the endothelial cells of the bloodvessels of the part, as in other forms of inflammation.

No bloodvessels penetrate into the giant cell system, which is entirely avascular.

The giant cell system is by no means always found in tubercular lesions, and the more acute the inflammatory process is, the less typical is the appearance and the more it approximates to the histological characters of inflammation due to other causes.

The tuberculous process, when once it has started in a tissue, spreads along the lymphatic channels into the surrounding zone of chronically inflamed tissue, and as the giant cells degenerate, the bacilli are set free to form more giant cell systems at the periphery, and so the condition may be extended indefinitely.

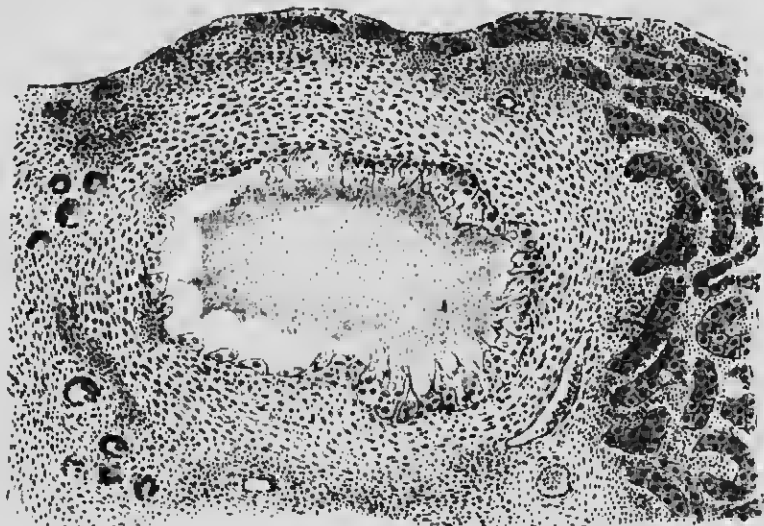


FIG. 34.—TUBERCLE OF THE LIVER, SHOWING ABSCESS FORMATION AND GIANT CELL SYSTEMS.

RESULTS.—The *local* results of tubercular inflammation are—fibrosis, suppuration, and gangrene.

Fibrosis.—This termination of tubercular inflammation is more common now than formerly, owing to the improved methods of treating tubercular affections, and it constitutes the cure of tubercle. It is more common in young subjects than in the elderly, and is more common in the surgical manifestations of tubercle than in the medical. The result is brought about by the granulation tissue surrounding the tubercle rather than by the cells of the tubercle itself. The tubercle bacilli having been killed by the bactericidal bodies present in the blood-serum, the cells of the tubercle undergo degeneration and absorption, while the surrounding granulation tissue changes into fibrous tissue in the manner already described under Inflammation, and, as a result, a little knot of fibrous tissue replaces the tubercle.

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This fibrosis sometimes extends *pari passu* with the spread of the tubercular process, and a joint may become the seat of dense fibrous ankylosis by gradual destruction of the tissues of the joint by tuberculosis, which is cured by the production of fibrous tissue. This fibrosis is often met with at the apices of the lungs during autopsy, and indicates the cure of an old tubercular lesion. The treatment of tuberculosis is designed to bring about the death of the bacilli and the obliteration of the evidence of their presence by fibrosis.

SUPPURATION.—This is the usual ending of the tubercle, the giant cell and the endothelioid cells dying and degenerating into an amorphous mass in the margins of which the tubercle bacilli are found. This suppuration differs from suppuration due to other pyogenic organisms in the small number of leucocytes in the degenerated tissue, and, at any rate in the early stages, in the absence of serum, so that the material is semi-solid and cheesy in appearance. From this appearance the older surgeons gave the process the name of *caseation*. If a gland which is the seat of tuberculosis is examined, it will be found that there are numerous points at which the suppuration is occurring, and that the tubercles have changed their colour from grey to yellow. These various points of suppuration coalesce until a definite small abscess has formed, and in the walls of the abscess the tubercular process is spreading by the formation of fresh tubercles. These in turn undergo suppuration, and add to the size of the abscess. In this way the whole of such a tissue as the psoas muscle may be destroyed, and an abscess formed, holding 2 or 3 pints of pus. As the process extends, more serum and leucocytes are added to the abscess contents, until it is impossible to tell from the macroscopic appearance of the pus the difference between these abscesses and those due to the other pyogenic bacteria. In these large abscesses it is often difficult to find the tubercle bacillus, and the bacteriological examination and cultivation may report the pus as sterile, but inoculation experiments on susceptible animals will usually prove the presence of the organism.

Suppuration having occurred in the tubercle, the following further events may follow:

1. Under appropriate treatment, the pus may be absorbed and be replaced by fibrous tissue formed from the surrounding granulation tissue. This will be cure of the condition, the tubercle bacilli being killed.
2. The abscess, when small, may be surrounded by a capsule of fibrous tissue, which will shut it off from the surrounding tissue. The tubercular inflammation then becomes quiescent, and the condition may be believed to be cured; but as the bacilli are not dead, at any time the inflammatory condition may light up again, and a so-called "residual abscess" result. This frequently follows an injury to the part.
3. The abscess being encapsuled by fibrous tissue, the fluid part of the pus may be absorbed, and calcareous salts become deposited in the degenerated cells, so that a small

nodule of calcareous matter is found lying in the middle of a mass of fibrous tissue. This calcareous nodule may remain for years without change; but, being a foreign body, if pyogenic organisms reach the tissue, suppuration and discharge of the mass may occur, and even when calcification has occurred, the tubercle bacilli may still survive, ready to start a fresh inflammatory process if the part be injured.

4. The abscess may extend as described above until it reaches a free surface, which will ultimately give way, and the pus be discharged. If this free surface is the skin, a cure may be brought about in this way, although more frequently a permanent fistula will be left; but if it be the lining membrane of a body cavity, such as a synovial membrane or the peritoneum, a generalized inflammation of that membrane will result.
5. The abscess may extend into a vein or artery and burst into it. In this way the infected material is carried all over the body, and a generalized tuberculosis will follow in exactly the same way that a generalized septico-pyæmia results from invasion of a vein by suppuration due to the staphylococcus or streptococcus.
6. At any time during the progress of a tuberculous inflammation an infection with other pyogenic organisms may occur, and a septico-tubercular inflammation will result. Pus formation will occur more rapidly, and the process become more acute and more closely resemble abscess formation due to such organisms as the streptococcus or the staphylococcus. The tubercle bacillus is difficult to discover in these abscesses, but can usually be demonstrated by inoculation.

Gangrene.—Tubercular inflammation being essentially chronic, the tissues rather undergo molecular disintegration than gross destruction, but occasionally large masses of bone may die as a result of tubercular inflammation. This is seen in such conditions as tuberculosis of the vertebrae or the head of the femur, in both of which affections large sequestra of dead bone are not infrequently found.

SYMPTOMS.—The local symptoms of tuberculosis are those of inflammation, but owing to the extreme chronicity of the process, heat and redness are usually absent until the inflammation actually reaches the skin. Pain also is frequently absent in the early stages of tuberculous inflammation, and a patient may have extensive disease of such an organ as the kidney, and complain of little or no pain in the loin. In joint disease, on the other hand, pain may be an early and prominent symptom. The two most important symptoms are loss of function and swelling, and these are often the only two signs present, and the diagnosis of tubercle has to be arrived at by other methods than the observance of clinical symptoms.

The clinical signs of tuberculosis in the various organs amenable

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to surgical treatment will be considered under their appropriate headings.

The general symptoms are due to the absorption of toxins from the inflamed area or to the bacilli entering the blood-stream and causing a generalized tuberculosis.

In the first case the general symptoms are slight. There is usually a slight nocturnal rise of temperature, and the patient suffers from a general malaise with loss of appetite and some anæmia. There is also some wasting, with loss of strength and energy. In generalized tuberculosis, when the organism is circulating in the blood and being deposited in all the organs of the body, the symptoms are much more severe, and frequently closely resemble those of typhoid fever. The onset may be abrupt, and the patient become seriously ill, with an irregular temperature, rapid pulse, and quickened respiration. The mental state is usually dull, and coma supervenes, but there may be an active delirium. The symptoms are, in fact, those of a profound infection, with few, if any, localizing signs; but in other cases the bacilli may especially affect the lungs or the brain, giving a pulmonary or a meningeal aspect to the disease.

Laboratory Methods of Diagnosis

1. USE OF TUBERCULIN.—(a) A small dose of Koch's old tuberculin (T.R.) may be injected into the patient. In a normal person no symptoms result, but if the suspected lesion is due to tubercle, there is a sharp rise of temperature, and increased inflammation in the diseased part. This test is not devoid of danger, and is chiefly used at present in the diagnosis of tuberculosis in cattle.

(b) Calmette's reaction: A drop of a 1 per cent. solution of freshly prepared tuberculin is inserted into the conjunctival sac of the patient, and if he has a tuberculous lesion, an acute conjunctivitis starts in a few hours, and lasts for twenty-four hours. This test is attended with some danger of severe conjunctivitis and corneal ulceration, especially if great care is not taken to avoid contamination with septic organisms. A positive reaction is of great value in diagnosis.

(c) Von Pirquet's reaction: A 25 per cent. solution of Koch's original tuberculin is inoculated into the arm of the patient by means of a slight scratch. In a tuberculous patient an inflammatory papule appears in twenty-four to forty-eight hours, and this should disappear again in about eight days, leaving some pigmentation behind. It is a test of great value if the reaction is positive.

2. EXAMINATION OF THE INFLAMMATORY EXUDATES.—(a) The exudate should be stained to exhibit the tubercle bacilli. The finding of the organism is, of course, pathognomonic.

(b) The cells present in a tuberculous exudate are chiefly lymphocytes, whilst in other inflammatory exudates they are chiefly polymuclear cells. A cytological examination of serous membrane exudates and cerebro-spinal fluid may help to establish a diagnosis.

(c) Inoculation of the exudate into susceptible animals, especially ininea-pigs, is a most valuable test, as tuberculosis will follow, even

if microscopical examination has failed to demonstrate the existence of the bacillus. In guinea-pigs well-marked tuberculous lesions will be found in three weeks.

3. EXAMINATION OF PIECES OF TISSUE REMOVED BY OPERATION.—This examination consists of—(a) Microscopical examination after suitable staining and the finding of a large number of giant cell systems, and infiltration with lymphocytes.

(b) Staining the section so as to exhibit the bacilli.

(c) Inoculation of a small piece of the tissue into a susceptible animal.

4. OPSONIC INDEX.—A low or raised opsonic index to tubercle found on three or four examinations may be taken to indicate the likelihood of tuberculosis.

5. A COMPLEMENT SERUM REACTION, on the same principle as Wassermann's serum reaction for syphilis, is being investigated, and so far has given promising results.

PROGNOSIS.—The prognosis of surgical tuberculosis in children is good, provided that the child can be put under good hygienic conditions and a suitable treatment efficiently carried out. Unfortunately, in hospital practice, after much time and care have been expended in the treatment of a case, the child returns to the same conditions of life which produced the disease, and relapses are common. There is always some loss of function after tubercle has healed, as fibrosis invariably occurs. The prognosis is better in infection of joints, bones, and glands, than in infection of the genito-urinary tract, the alimentary canal, or the lungs.

The prognosis in adults is not nearly so good, as the resisting power of the patient to the tubercle bacillus seems to diminish with age. This difference in prognosis is of importance, as earlier and more radical methods are advisable in dealing with tuberculosis in adults than in children.

TREATMENT.—The treatment of tuberculosis, which is both general and local, is precisely similar to the treatment of other inflammatory lesions, only the extreme chronicity of the condition and the frequency of relapses must always be borne in mind, and treatment must be continued long after the patient is apparently well.

The GENERAL treatment consists of—

1. *Good Hygienic Surroundings.*—The patient should live as much as possible in the fresh air and sunshine, and away from the centres of population, but even in cities much good will result from open-air treatment. The climate best suited for tuberculous patients is a dry one, with plenty of sunshine, and the question of seaside or country can be left to the individual patient. The patient should always be warmly clad, as cold lowers the vitality of the tissues.

2. *Diet.*—This should be generous and nutritive, and contain as much fat as possible without upsetting the digestion. Cocoa, milk, eggs, and butter, are particularly good.

3. *Rest* to the whole of the body is valuable in every case, especially in the early stages of the disease, as exercise is not beneficent to a patient

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with nocturnal elevation of temperature and general malaise. Exercise is good in moderation when the temperature remains normal.

4. *Drugs*.—There are no specific drugs in the treatment of tuberculosis, but cod-liver oil is a valuable and easily assimilated fat, whilst phosphates, iron, arsenic, and other tonics, may be useful in the treatment of the accompanying anæmia and as general tonics.

5. *Serum Therapy*.—Tuberculin B.E. (an emulsion of the bacilli mechanically killed by pulverizing them so that no bacillus is left whole) is given as a vaccine in doses of $\frac{1}{20000}$ milligramme, and repeated in slightly increasing doses at intervals for months. It is believed to raise the opsonic index of the patient by stimulating the tissues generally to produce more bodies inimical to the tubercle bacilli, and so bringing about their death. The value of vaccine treatment of tuberculosis is now considered to be firmly established, but it is merely an adjunct to other methods of treatment, and must not be considered to replace them.

LOCAL TREATMENT.—The advisability of **complete excision** of the focus of disease must be first considered. If this can be done completely, and healing of the wound by first intention obtained, it is often the best method of treatment. For example, in tuberculosis of the kidney or testis, early and complete excision of the organ will often completely relieve the patient, and is always to be advised. On the other hand, this method of treatment is often impossible, as in cases of spinal or intestinal tuberculosis, and in other cases it is most inadvisable, as in cases of tuberculosis of the urinary bladder or the hip-joint.

Rest.—By far the most important method of local treatment of tuberculosis is complete physiological rest to the inflamed part. In the case of joints and bones this is obtained by the use of splints and other apparatus, and in the case of visceral tuberculosis by diminishing as far as possible the work the inflamed organ has to do.

As there is no definite sign by which it can be demonstrated that the tubercular inflammation is cured and the disease is essentially chronic, rest must be continued until long after all sign of inflammation has subsided, otherwise recrudescence of the disease is almost certain. The function of the part must be cautiously resumed, and any return of symptoms is an indication for a further period of prolonged rest.

Prevention of Sepsis.—Septic infection is the most serious complication of tuberculosis, and any septic focus in the body must be carefully treated. This applies particularly to tuberculosis of the lymphatic glands, which are specially apt to become the site of a secondary infection.

Counter-Irritation.—The application of Scett's dressing (compound mercury ointment), tincture of iodine, blistering fluid, and the actual cautery, are all methods of counter-irritation used in the treatment of tuberculosis, and are probably of some small value.

Bier's Method of Passive Hyperæmia.—This method of treatment (see p. 25) is extensively used, and is of value, especially in tuberculosis of the bones and joints.

Injection of Iodoform Emulsion.—Iodoform is believed to have a germicidal action on the tubercle bacillus, and an emulsion in sterilized glycerine (10 per cent.) is injected into the joints and the tissues infected with the disease. It is not so extensively used now as formerly.

Massage and Passive Movements.—The use of these therapeutic methods is contra-indicated in all cases of active tuberculosis, and even after the disease is believed to be cured they must be used with extreme caution. In the case of joint disease, massage and passive movements may be of benefit after fibrosis has occurred, in obtaining some movement of the joint; but all forcible manipulations are forbidden, as they tend to cause recrudescence of the disease.

Tubercular Abscess.—A tubercular abscess usually arises in connection with some deep-seated tubercular lesion, such as tubercular disease of bone or tuberculous adenitis, and forms a soft, fluctuating swelling, generally without pain or redness. These abscesses sometimes contain a pint of pus, without causing any marked general symptoms, and without causing the patient much pain or inconvenience. They track along the lines of least resistance, and generally downwards, and finally form a large collection of pus under the skin, which may communicate with the pus under the deep fascia by quite a small opening. When the skin is invaded by the tubercular process, it becomes reddish-blue in colour, and finally gives way, so that the pus escapes. This may be followed by healing of the lesion by granulation tissue, but more commonly it leads to the formation of a sinus or a tubercular ulcer. The tract of the sinus is lined with tubercular granulation tissue down to the original focus of tuberculosis, and will not close until this heals or is removed by a surgical operation.

A *tubercular ulcer* has ragged, undermined, bluish edges, a floor covered with soft anæmic granulations, and a scanty secretion, in which tubercle bacilli may be found. Tubercular ulcers are found on mucous membranes as well as on the cutaneous surface, and may be difficult to diagnose from malignant and syphilitic ulcers, the most certain method of diagnosis being microscopic and bacteriological examinations of a piece of the excised edge of the ulcer.

Treatment of Tubercular Abscess.—The best method of treating a tubercular abscess cannot be stated concisely, as the treatment depends on (1) the situation of the abscess; (2) the site of the original focus of tubercular inflammation; (3) the age of the patient; (4) the after-treatment that can be carried out; (5) the social position of the patient as regards good hygiene; (6) whether a secondary infection has occurred.

The following procedures are suitable in different cases:

1. The abscess may be disregarded, and the general and local treatment of tubercular inflammation carried out with the hope that either the abscess may be absorbed or the original focus of disease may be cured, and the abscess then dealt with.

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2. The abscess may be aspirated. The aspirating needle should be passed through healthy tissue and the abscess cavity washed out with salt solution, and iodoform emulsion (10 per cent.) injected. A dressing and firm bandage are applied. Aspiration may be performed three or four times if necessary.
3. The abscess may be opened by a free incision, all the tubercular matter freely removed, especially the original focus of disease. The infected tissue is removed with scalpel scissors, flushing gonges, etc. The cavity is dried with sterile swabs, all bleeding stopped, and the wound then completely sutured, so that healing by the first intention results. If the abscess cavity fills again, the operation is repeated.
4. In those cases in which the patient is not seen until the skin is involved or septic infection has occurred, the abscess should be opened by a free incision, all the tubercular infected tissue removed, and the cavity either drained or packed with gauze, so that it granulates from the bottom. This method of treatment should be avoided, if possible, but it may be the only satisfactory method in neglected cases.
5. Complete excision of the abscess and the original focus of disease. This method of treatment is only possible in certain selected cases, such as localized tuberculosis of the skin, tubercular adenitis, and in some cases of tuberculosis of joints, but when it can be done it is the most efficient method of treatment.

Treatment of Tubercular Ulcers.—If the ulcer is of limited extent, the best method of treatment is complete excision, if the situation of the ulcer permits, and the wound may be (1) completely sown up, (2) allowed to granulate, or (3) covered by skin-grafts, according to circumstances. In other cases the ulcerating surface should be thoroughly scraped, so that all unhealthy granulations are removed, and the edges of the ulcer cut away with scissors and scalpel.

General treatment, including sero-therapy, is the only method of treatment in some cases in which anatomical considerations do not allow of more radical methods—*e.g.*, the bladder or alimentary canal.

Tubercular Fistula.—A tubercular fistula results from the opening or bursting of a tubercular abscess, the original focus of disease remaining unhealed, and maintaining a constant discharge. Fistulae are perhaps found most frequently in connection with tubercular bone disease, but may occur in connection with tubercular disease of any tissue. The diagnosis is obvious.

TREATMENT.—A thorough investigation should be made to ascertain the exact cause of the fistula. For example, in connection with disease of the bone a radiogram of the part should be taken to find out if a sequestrum is present.

The fistula should then be carefully opened up, and as much as possible of the diseased tissue removed, the walls of the fistula being carefully scraped to remove all the tubercular granulation tissue. The wound should then be drained with gauze so that it granulates from below. As these fistulae are always associated with other organisms besides tubercle, a bacteriological examination should be made of the discharge, and suitable sero-therapy carried out.

In some cases it is possible to excise the fistula completely with the original focus of disease, and this is the best method of treatment.

SYPHILIS

Syphilis is a specific infectious disease due to the *Spirochæta* or *Treponema pallida*.

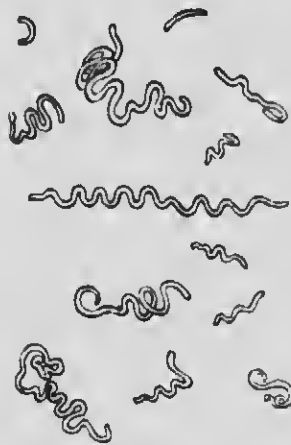
The *Spirochæta pallida* was first described by Schaudinn and Hoffmann in 1905, and is now admitted to be the specific organism of syphilis. It is one of the spirochæta, which are protozoa very commonly found in the mouth and on ulcerated surfaces. It is distinguished from other forms by its appearance and staining characteristics. It is a thin, threadlike organism about 10 μ in length, is arranged in a spiral form, and has a long flagellum at each end. It does not stain readily, and the best method of staining is Giemsa's. If a little of the secretum squeezed from a chancre is mixed with Indian ink and a slide preparation made, the organism appears unstained on a dark background. It can also be seen in the active state if secretion is examined under the ultramicroscope, and its characteristic slow movement distinguishes it from other spirochætes.

FIG. 35.—*Spirochæta pallida*.
(London Hospital Bacteriological Department.)

as heat and loss of moisture, and it soon loses its virulence after removal from the body.

It has been cultivated on artificial media. Inoculation of syphilitic material into the higher apes has been followed by the development of syphilis in these animals.

The organism has been found in all syphilitic lesions, both inherited and acquired, but it is mostly found in the primary and secondary lesions. It has also been found in the semen and in the blood, but it is absent from such physiological secretions as the saliva and milk if they are not contaminated from syphilitic lesions in the mouth or on the nipple. The organism has also been found in the cerebro-spinal fluid, and it has recently been demonstrated in that fluid, or in the



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central nervous system in the parasymphilitic lesions, such as tabes dorsalis and general paralysis.

Mode of Infection.—In the great majority of cases syphilis is acquired during sexual connection with a person suffering from the disease, and the primary lesion is found on the glans penis or prepuce in the male, or on the labia minora of the female. The body of the penis, the end of the urethra, the labia majora, and the os uteri are not infrequently the site of the chanere. Extragenital infection is less common than formerly, probably owing to increased knowledge of the danger of the disease. This mode of infection is more common in women than in men, and is seen on the lips. The infection is conveyed by kissing or by drinking from cups and glasses used by a syphilitic patient with a lesion in the mouth. Infections on the fingers of medical men, midwives, and nurses during their attendance on syphilitic patients is fairly frequent, and they in turn may infect other patients. The infection may be transmitted from a syphilitic child to its nurse, or a syphilitic wet-nurse may infect a child, and, through the child, the mother and other members of a family. Dentists may be infected from patients with syphilitic mouth lesions, and in turn, if they are not scrupulously aseptic, may infect other patients. There is no doubt that formerly when human lymph was used, vaccination was a source of infection.

Incubation Period.—The incubation period of syphilis is from two to six weeks—that is, this period of time elapses between exposure to infection and the appearance of a characteristic lesion. During this time the abrasion, which is possibly very minute, may completely heal, and the patient be unaware of any lesion. In other cases septic infection, or infection by the organism of soft sores, may take place at the same time; or a discharging wound, which only becomes characteristic of syphilis after the end of the incubation period, may be present directly after infection. It must, however, be understood that general infection takes place very rapidly. Experiments on apes show that destruction of the focus of inoculation is useless to prevent the onset of the disease if it is not undertaken within a few hours of infection.

For the sake of clinical and descriptive convenience, the disease is usually divided into three periods—the primary, the secondary, and the tertiary.

The **primary period** extends from the appearance of the first characteristic lesion until the appearance of general infection, and lasts from eight to twelve weeks. The disease appears to be limited to the site of inoculation and the lymphatic glands into which it drains.

The **secondary period**, which is characterized largely by skin affections and subacute symmetrical inflammations, lasts about two years, and is the period of greatest activity of the organism.

The **tertiary period** begins after two years' from infection, and has no limit, for the lesions may appear thirty or forty years after the primary infection, without the patient having apparently suffered in the interval.

This division of the disease into periods, although useful clinically, is entirely artificial and arbitrary.

Like other infectious diseases, syphilis shows two sets of symptoms, general and local. The *general* symptoms, which may be marked and which are mostly in evidence during the primary and secondary periods, are due to toxæmia, and resemble those of other infectious diseases—namely, rise of temperature, anæmia, and malaise. The *local* lesions are inflammatory, being subacute in the primary and secondary stages, and chronic in the tertiary stage.

Immunity.—It is probable that no human being is immune from syphilis, although it is stated that in certain countries where syphilis has been particularly rife for centuries and all the population are more or less syphilized, that syphilis is not so virulent a disease as in other communities. A patient who has suffered from syphilis is usually immune from further infection, but probably this is because the infection is still present, as is shown by the syphilitic reaction of the blood. Second attacks, occurring years after the first, however, are by no means uncommon, and it is probable that the more efficacious the treatment, the more likely is complete cure to result, and then a second infection may be acquired. There is some evidence to show that second infections are becoming more common now that the importance of thorough treatment is recognized.

Primary Syphilis.—The primary lesion in acquired syphilis is the Hunterian chancre. This appears first as a small raised papule, usually on some part of the genitals, which is quite painless, and may entirely escape the patient's notice. It increases in size and hardness till it is about the size of a split pea, and then some ulceration generally occurs in the centre, causing a slight serous discharge. The chancre is raised, has indurated edges, and if pinched between the fingers feels like a nodule of cartilage. The amount of ulceration is slight, and the sloughing floor is ultimately replaced by granulation tissue, and the ulcer heals, but the characteristic induration remains for some time. This hardness is due to infiltration of the infected part with inflammatory cells, and the formation of granulation and fibrous tissue. The formation of new bloodvessels is scanty, and they tend to undergo endarteritis obliterans, which accounts for the tendency of the papule to ulcerate. The Hunterian chancre causes little inconvenience to the patient, and heals with little or no scar, therefore evidence of syphilis on the penis may be entirely wanting, and the patient may deny with good faith the presence of a primary sore.

VARIETIES.—The appearance of the chancre varies according to its situation and the presence of other organisms.

On the glans penis there is often little induration, and the chancre is quite superficial, resembling a piece of parchment fixed to the glans; while when it is on the sulcus between the glans and the prepuce, it appears as a "collar" of indurated tissue, which is most characteristic when the prepuce is rolled back.

When the chancre is situated under a tight prepuce it may be

impossible to see it, but the characteristic induration may be felt through the prepuce and the diagnosis made.

Occasionally the chancre is situated inside the urinary meatus, and will only betray itself by a blood-stained discharge from the urethra.

In the female the characteristics of the chancre are often lost in a large amount of surrounding oedema, and it is generally necessary to wait for secondary symptoms before a diagnosis can be made. When situated on the os uteri or in the vagina, a chancre has been mistaken for a carcinoma.

If the chancre becomes infected with septic organisms, or if Ducrey's bacillus of soft sores is infected at the same time as the spirochæte, the appearance of the chancre may be completely changed, and an acute ulceration take its place. The sore will be painful, have a sloughing floor, and an abundant purulent secretion, and even if it should finally heal, will leave a very definite scar. If the secondary infection is very virulent, especially if the secretion is retained under a tight prepuce, the ulceration may be very severe, and rapidly destroy the glans and even the body of the penis. The condition is recognized by a foul secretion appearing from under the prepuce, which becomes red and inflamed. It ulcerates finally, exposing the remains of the glans penis. The inguinal glands may suppurate, and a similar gangrenous condition be produced in the groin. In all these cases it is not possible to make an absolute diagnosis of syphilis by clinical signs until the secondary rashes appear. The severe ulceration occurring on the genitals, following an impure connection, may be due to other organisms than the *Spirochæta pallida*, although this protozoon may be present, and ultimately cause the generalized symptoms of syphilis to appear.

Extragenital Chancres.—Extragenital chancres are usually atypical in appearance, and are often undiagnosed, even when they occur on the fingers of medical men who, presumably, are suspicious of any indolent ulceration. On the whole, extragenital chancres show more ulceration than genital sores, and as the sore is surrounded by a



FIG. 36.—MULTIPLE EXTRAGENITAL CHANCRES.

large area of inflammation, the induration is not so evident. The secretion is usually more abundant and foul, and the nearest lymphatic glands are acutely inflamed, resembling those of acute septic infection. Suppuration is, however, uncommon.

An extragenital chancre may resemble a carcinoma, and a correct diagnosis only be made on the appearance of the secondary phenomena.

Multiple Chancres.—It is not uncommon to see two or more chancres, but the inoculation must have occurred at the same time or during the incubation period of the disease. After the appearance of the chancre, fresh inoculation is not possible, and a primary chancre is seldom, if ever, auto-inoculable.

In one case a patient had five chancres on the back of the hand, due to the bite of a syphilitic woman, a chancre developing in each tooth-mark.

LYMPHATIC INFECTION.—The lymphatic glands in the groin become infected, and are felt as hard, discrete, painless nodules under the skin, the term "shotty" generally being applied to them.

If a secondary infection is present, the glands may be acutely inflamed and not characteristic. This abnormality is also frequently seen in association with extragenital chancres. Occasionally suppuration may occur and an inguinal abscess form. In some cases the dorsal lymphatics of the penis are indurated, and can be felt as definite cords running along the dorsum of the penis just under the skin. Edema of the prepuce may result from obstruction to the flow of lymph.

DIAGNOSIS.—The diagnosis of syphilis may be made absolute by the discovery of the *Spirochæta pallida* in the discharge from the chancre by one of the methods described above. This should always be done. At the same time, the length of the incubation period and the appearance of a typical Hunterian chancre with enlarged "shotty" glands gives a clinical feature which is unmistakable. The lesions that are most often mistaken for chancres are soft sores, gumma, carcinoma, and herpes. As regards all sores on the penis, it is of the utmost importance not to give a decided opinion that they are *not* syphilitic until five weeks have elapsed from the time of risk of infection; for a soft or septic sore may appear at once after exposure and at the same time be infected with the spirochæte, though it will not show the characteristic induration until the incubation period has passed. During this period mercury should *not* be given either by mouth or locally, as its administration may alter the appearance of the chancre and prevent the appearance of induration. As regards the appearance of soft sores, they are usually multiple, have a punched-out, sloughing appearance, a copious foul discharge, and no induration. The inguinal glands are acutely inflamed, and often suppurate.

When a mixed infection is present, especially in extragenital chancres, the diagnosis from the appearance of the chancre and glands may be impossible, the only certain method of diagnosis being the discovery of the spirochæte. If this is not found, it may be necessary to wait for the appearance of secondary symptoms before a definite opinion is given.

Wassermann's Serum Reaction in Primary Syphilis.—This method of diagnosis is not available in the very earliest stages of syphilis, as the characteristic reaction is not present in the blood-serum; but it will be found to be positive ten to fifteen days after the first appearance of the chancre. As it will rarely be possible to be sure of the diagnosis clinically before this time, the reaction is of great value in the early diagnosis of syphilis.

Treatment of Primary Syphilis.—The treatment of syphilis should be begun as soon as the diagnosis is established, and it is unnecessary to wait for secondary symptoms. The treatment is both local and general.

LOCAL TREATMENT—Prophylaxis.—The prophylactic treatment of syphilis is still in the experimental stage, but it has been shown by Metchnikoff, by experiments on apes, that inunction of mercurial ointment (25 per cent. calomel) within twenty hours of infection will prevent the onset of the disease. Some form of mercury should always be applied locally to the hands of surgeons who have been handling patients who are, or may be, suffering from this disease. The use of india-rubber gloves or india-rubber finger-stalls is also of value in preventing doctors and nurses contracting extragenital chancres.

Destruction of the Primary Chancre.—Destruction or excision of a sore on the penis that has been diagnosed as a chancre is useless to prevent the generalization of the disease, and should therefore not be done. In some cases of concealed chancre under a tight foreskin, the prepuce may be slit up, or circumcision may be advisable in order to prevent retention of secretion. If *phagedenic* ulceration occur, the ulcer, after being thoroughly exposed by slitting up the prepuce, should be dried and painted with some caustic, such as pure carbolic acid or acid nitrate of mercury, and the patient then placed in a hot bath, in which he should stay for several hours. In the intervals of bathing the ulcer should be dressed with mercurial ointment, calomel as a dusting powder, or iodoform ointment, until a healthy granulating surface is present.

In more severe cases it may be necessary to cut away the sloughing part with scissors or scalpel, and then cauterize the wound.

The local treatment of an uncomplicated chancre consists of keeping it clean with some form of mercurial preparation. Mercurial ointment, calomel powder, and *lotio nigra* are all equally efficacious, and the sore should be washed night and morning in some antiseptic lotion, as boracic or hydrogen peroxide.

As the discharge from the chancre is exceedingly infectious, all soiled dressings should be burnt, and the utmost care taken to prevent the spread of the disease.

The inflamed lymphatic glands do not, as a rule, need local treatment, but if the inflammation is severe, the part must be kept at rest. Secondary infection of the glands by septic organisms may lead to suppuration, in which case the usual treatment of this condition must be carried out.

GENERAL TREATMENT.—The drug which has been most extensively used, and which leads to the destruction of the *Spirochæta pallida*, is mercury, and it can be administered in several ways:

1. *By the Mouth.*—This is the method that is most convenient for the patient, and it is usually given in the form of pills or grey powders (Hyd. \bar{c} Cret.). Pills containing 2 grains of this powder should be given three times a day, and the dose increased until the gums become sore. It should then be decreased a little, and continued until the disease is considered to be cured. If diarrhœa is caused by the grey powder, it may be combined with a grain of pulv. ipeac. co. (Hutchinson's pill). Other forms of mercury, the green iodide, the perchloride, or mercury itself in the form of a pill, can be used if the grey powder does not prove efficacious.

It has been doubted that mercury given by the mouth ever cures syphilis, and there is no doubt that after a time the organisms become immune to mercurial treatment given in repeated small doses.

2. *By Inunction.*—This method is useful for rapidly getting the patient under the influence of the drug. A warm bath is given in the evening, and a small quantity of mercurial ointment is rubbed with a glass roller into the skin of the thigh. The part is washed next morning, and the process repeated in the evening, another part of the body being chosen. It is the method largely used at various English and foreign spas, where patients go yearly for treatment after the first full mercurial course is over.

3. *By Intramuscular Injection.*—This method has been largely used in naval and military practice, and consists of injecting the mercury into the substance of the gluteal muscles. Various preparations are used, but the best appear to be metallic mercury or calomel, made up with lanoline and liquid paraffin, the dose being 1 grain of metallic mercury once a week. The strictest aseptic precautions must be used, and the injection must be given deeply into the muscles. The treatment extends over four years, forty injections being given the first year, thirty the second and third years, and twenty the fourth year. This method is somewhat painful, and is not very suitable for general practice, but is much more efficacious than treatment by the mouth.

4. *By Fumigation.*—This method is useful when there are extensive cutaneous lesions, and is largely used in institutions. The preparation used is calomel, which is volatilized over a water-bath. The patient is stripped, placed in a cabinet or wrapped in a blanket, and $\frac{1}{2}$ drachm of mercury is vapourized under him, and so deposited on the skin. The patient should go to bed after the treatment, and the skin must not be washed.

Whatever method of treatment by mercury is adopted, the drug must be pushed to its full physiological effect, and the dose should be increased until slight salivation occurs. The amount of the mercury taken is then reduced slightly, but continued until the patient is believed to be cured. The idiosyncrasy of patients for mercury varies considerably, and it is important therefore that the patient's general condition should be carefully watched while he is taking this drug.

The general symptoms of malaise and anæmia should be relieved, and the body-weight should be maintained. If it is found that the general health is not improving under mercurial treatment, or the patient is losing weight, the administration of the drug must be stopped for a time, while the general treatment described below is being carried out. During a mercurial course the following precautions should be taken:

1. All articles of diet liable to cause diarrhœa must be avoided, or the drug will be passed by the bowels instead of being absorbed.
2. Smoking should be given up or indulged in with strict moderation.
3. The mouth and teeth should be kept scrupulously clean and as aseptic as possible, in order to prevent the onset of mercurial stomatitis, which will necessitate the discontinuance of the drug.

General Health.—It is of the utmost importance to maintain the general health of the patient during the continuance of the disease and during the mercurial course. He should have a generous diet, and be given directions for leading a healthy, hygienic life. Anæmia and any sources of ill-health should receive careful attention, and if the patient is at all debilitated, a holiday at the seaside or in the country is an important part of the cure. Alcohol is unnecessary, but may be taken with the meals if the patient's appetite is improved by it. The drugs that are of most use are iron, arsenic, and the hypophosphates.

Salvarsan ("606") (dioxy-diamido-arseno-benzol).—This synthetic drug, discovered by Ehrlich after a long series of chemical experiments, is giving brilliant results in the treatment of syphilis, the spirochaetes disappearing from the lesions, which heal rapidly, and the Wassermann reaction becoming negative.

A course of treatment by this drug consists of giving two or three intravenous injections of 0.4 to 0.6 gramme, according to the age and robustness of the patient. The second injection is given four days after the first, and the third a week later, and treatment is then suspended unless the Wassermann reaction becomes positive again.

TECHNIQUE.—The patient should be kept in bed for twenty-four hours after each injection under skilled observation if the treatment is to be free from danger; but the toxic effects are very few. The following description is taken from McIntosh and Fildes' book on "Syphilis":

"Materials required: (1) A glass-stoppered bottle with a wide neck, capacity about 300 c.c., sterilized preferably by dry heat, but also by boiling. (2) A few glass beads, thoroughly cleaned and sterilized in the bottle. (3) 0.9 per cent. saline solution (sterile). Pure crystallized NaCl and distilled water must be used. (4) 15 per cent. caustic soda solution, made with distilled water, and sterilized by boiling.

This may be kept in a drop-bottle. In the preparation of the solution ordinary surgical cleanliness only is required.

" Method: (1) Shake the contents of a capsule (0.6 gramme) into the bottle. (2) Fill up with 300 c.c. of saline solution, preferably warm, and shake thoroughly until the powder is completely dissolved. (3) Add 23 drops of the soda solution, or that quantity required for the quantity of '606' used (*vide* maker's formula), and again shake until the precipitate is dissolved. (4) If complete solution of the precipitate produced does not take place, add soda drop by drop, and shake. No more soda should be used than is necessary to just dissolve the precipitate. (5) Stand the bottle in hot water until the solution is warm. If the solution is not to be used immediately, it is better to dissolve the substance in the saline and to add the soda just before use.

" The solution is made up according to the maker's directions in a wide-mouthed sterile bottle of 300 c.c. capacity. The bottle contains some large beads (*a*), which have been previously thoroughly cleansed by boiling in an acid solution of bichromate of potash, washing in water, and sterilizing. These beads assist in the solution of the preparation. The bottle has either a rubber or ground-in glass stopper (*b*). When the solution has been prepared and warmed by standing the bottle in hot water, the stopper is fastened in, and the injection fluid can be transported to the bedside for use within about one and a half hours. If, however, it is necessary to delay the injection for this time after preparation, it is better, as stated before, to add the soda immediately before use. The actual apparatus consists of a rubber stopper (*c*), which is firmly 'screwed' into the bottle. This stopper is perforated in two places. One perforation carries a T-piece, the vertical arm of which is connected to a cotton-wool air-filter (*d*), and is controlled by a clip (*e*). The horizontal arm of the T-piece is connected with a rubber pump (*f*), and the air from this latter is sterilized by passage through a second glass tube containing cotton-wool (*g*). The second perforation through the cork carries a piece of tubing bent at the top (*h*), and leading to the needle. Below, this tube is carried to the bottom of the bottle by means of a rubber tube carrying on its lower end a sinker of lead. A piece of thin glass tube (*l*) is carried immediately behind the needle-holder (*m*), and is connected thereto by rubber. The needle-holder is merely a metal tube of small bore, carrying wings on each side, and ground to fit at the end a 'Record' needle. The wings are intended to lie flat on the patient's arm. The length of the needle is 1 inch to the point, and rather less than 1 millimetre in diameter. With the exception of the pump, the needle, and the two tubes (*d* and *g*), plugged with cotton-wool, the whole of this apparatus can be boiled, drained, and enclosed in a small sterile waterproof bag. The two filters (*d* and *g*) may be sterilized by passing through a flame before the wool is inserted, but they should not be put into position until the apparatus is assembled for use, as the wool must be kept dry. The needles are best kept in a small porcelain crucible containing olive oil. When required, the temperature of the oil is raised to about 130° C.; the needle is then removed and enclosed for transport in a piece of sterile lint.

" The injection is made as follows: 'Screw' the stopper (*c*) firmly into the bottle containing the solution of '606.' Insert the two filters



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(*d* and *g*), and attach the pump (*f*). Close the clip (*e*), and put a clip (*n*) on the tube leading to the needle. Give two or three pumps, and by momentarily releasing the clip (*n*), expel the air from the tubes. Attach the needle to the holder, and again expel the air, momentarily releasing the clip (*n*). All air is expelled when the fluid escapes freely from the needle-point, but in any case small bubbles are of no importance. Next, keeping the clip (*n*) in position, open the clip (*e*) for a few moments to relieve pressure in the bottle. A tourniquet having been placed on the patient's arm, so that the veins stand out, sterilize the skin, and then, having insured that the solution fills the needle to the point, push the needle into the vein with the bevel down. Remove

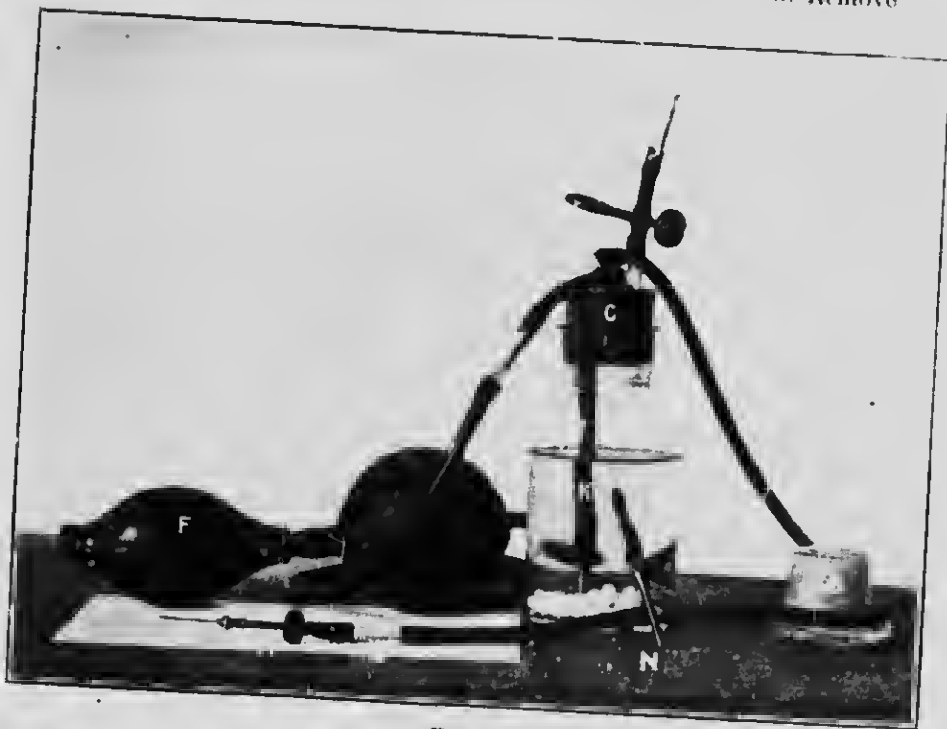


FIG. 37.

the clip (*n*) entirely. The pressure in the vein will cause the blood to appear at the window (*l*). The needle must then lie in the vein. Next fasten the needle in position by laying a strip of adhesive plaster across the wings of the holder (*m*), these wings having been arranged to lie flat on the arm when the bevel of the needle is down. The strapping may be conveniently applied to the skin on one side before the needle is inserted, and afterwards carried across to the other side. Release the tourniquet, and give three or four pumps, and the blood will soon be seen washed from the window (*l*), and the injection will proceed without any trouble other than four or five applications of the pump. Three hundred c.c. are introduced in from six to nine

minutes. At the end reapply clip (*n*). Release pressure by opening the clip (*e*), and remove the needle. Press upon the puncture, and hold the arm in a vertical position for a moment or two. No dressing is applied, but the arm is wrapped in a clean towel, and flexion of the forearm is not allowed for one hour.

"While removing the needle from the vein, it is almost impossible to avoid depositing a trace of the solution in the needle-track, and thus causing slight irritation or pain. This can be avoided by siphoning or sucking back into the apparatus before withdrawing the needle. To apply the siphon, the instrument devised by Dr. Dearden for our apparatus is convenient. It consists of a collar carrying a sharp spike. The collar is fastened round the neck of the bottle, which is then hung by the spike to the bedclothes at a lower level than the needle. When the injection is completed, the clip (*e*) is held open, and the blood will then appear at the window.

"The success of a vein puncture depends largely upon the condition of the vein and the position of the light by which the operation is performed. This must be at right angles to the line of the vein and low down to give greater relief. It is also necessary to obtain a maximum prominence and distension of the vein, to facilitate entry and to force the blood to appear readily at the window. If distension cannot be obtained sufficiently to secure this latter effect, the clip (*n*) can be put upon the tube leading from the pump, and slight suction can be applied at the filter (*d*) with the mouth; then if the needle is in the vein, the blood must appear at the window (*l*). Engorgement of the veins cannot be obtained readily by a circular application of a bandage. The best method is as follows: Pass a piece of 3-inch bandage behind the arm, and bring the two ends to the front; then, pulling very tightly, cross and reverse the ends, and carry them round again to meet on the outer side of the limb. Here tie a bow. In order to avoid pinching the skin under the point of reversal, place here a 'swab' between the knot and the skin. The veins can be made still more prominent by repeated clenching of the fist and by rubbing with ether during the process of sterilization.

"This method of giving intravenous injections is due, in principle, to Iversen, and is undoubtedly better and more convenient than others which have been described. In particular, no leakage of the solution occurs into the tissues surrounding the vein, giving rise to pain and infiltrations. These occurrences are not, however, of great importance. The pain disappears in a few minutes, and the infiltrations resolve in a few days without complications.

"This operation is nearly always entirely painless."

Salvarsan has been superseded to a great extent by **neo-salvarsan**, which is less toxic and more readily soluble than salvarsan. It is given in precisely the same way and with the same apparatus, but it is not necessary to use the beads in the bottle on account of the greater solubility of the drug. It is, however, believed by some observers that salvarsan is more powerful than neo-salvarsan, and they use it when a very rapid effect is desired.

AFTER-EFFECTS.—After the intravenous injection, the patient's temperature often rises. General malaise, increased pulse and respira-

tion rate, headache, and vomiting may follow. These effects are believed to be due partly to the liberation of the toxins of the spirochaeta, and partly to the saline fluid used in the injection.

RESULTS.—The results so far obtained from this method of treatment have been excellent, and there is no doubt that the primary, secondary, and tertiary lesions of syphilis rapidly disappear under general treatment with this drug, and the Wassermann reaction soon becomes negative. On the other hand, the question of relapses has to be considered, and it may be stated at once that relapses are common if the drug is given subcutaneously or intramuscularly. After intravenous injection, it is claimed that relapses are very rare if the maximum dose is given at each injection, but time has yet to elapse before the question of recurrence can be finally settled.

Fortunately, the use of salvarsan does not interfere with the use of mercury, and after the injections have been given, the patient may be given a mercurial course of two or three months in order to guard against a relapse.

In the parasyphilitic affections, salvarsan has not met with much success, but there have been indications that improvement may occur in the early stages of tabes dorsalis if the drug is given. On the other hand, some cases of parasyphilitic affection are made worse by the treatment.

Secondary Period.—The secondary period of syphilis begins from eight to twelve weeks after infection, and lasts about two years. During this period the patient is liable to suffer from subacute symmetrical inflammations of various parts of the body, and also from various cutaneous and mucous membrane lesions. The organisms are circulating in the blood, and as the period is one of general infection, the general symptoms of syphilis are most marked during this period.

GENERAL SYMPTOMS.—The patient feels ill, loses his energy, and suffers from headache. If the temperature be taken regularly, it will be found that there are frequent rises above normal, the pyrexia in some cases being pronounced. There is extreme hæmolysis, leading to anæmia and its symptoms, the appetite is poor, there is loss of flesh and strength, and the patient complains of wandering pains about the body.

LOCAL MANIFESTATIONS—1. Cutaneous Lesions.—The skin rashes of syphilis may imitate almost any known variety of rash, but on careful examination will be found to have the following characteristics: (1) They are polymorphic—*i.e.*, papules, macules, scaly patches, and pustules may all be found on the body at the same time; (2) they are roughly symmetrical; (3) the colour is suggestive, and has been likened to copper or raw ham; (4) they do not itch or cause pain; (5) they affect the flexor aspects more than the extensor; (6) they tend to disappear without treatment, but more rapidly under antisyphilitic treatment.

The earliest rash to appear is a roseola rash resembling measles, seen on the chest and flexor aspects of the arms. This rash is often only seen after the body has been exposed to the air for a short time,

and it usually fades early, leaving brownish stains. Other rashes are macular and papular, the latter frequently being covered by scales like psoriasis. These rashes are marked along the line of junction of the hair and forehead, forming the so-called corona veneris. Vesicular and pustular eruptions occur later, generally only if treatment is neglected and the general health fails. In bad cases the pustules are large and break down, giving rise to ulcers—a condition known as **ecthyma**. The discharge from these ulcers may dry on the surface of the ulcer, and the ulceration spread underneath, so that the body is covered with heaped-up crusts, which are dark in colour, somewhat resembling limpet-shells. On removal of the crust, a circular ulcer, which spreads superficially, is seen. After healing, a flexible circular scar remains, usually surrounded by pigmentation, which is characteristic of past syphilis. This condition is termed **rupia**, and is rarely seen except in neglected cases of syphilis, and it is symptomatic of general failure in health. Antisyphilitic treatment in these cases must be combined with good food, good hygiene, and often change of air and surroundings, before healing occurs.

Condylomata.—Condylomata are large papules found on those parts of the body which are habitually moist and warm, and where skin surfaces are opposed to each other, as in the axillæ or groins, under pendulous breasts, between the fingers and toes, round the anus, and on the external genitals, particularly in women. They are pathognomonic of syphilis. They are rounded, dull red in colour, and have a slight, but foul and highly infective, discharge. If they are neglected and irritated, superficial ulceration occurs, the edges of the ulcer being irregular and sloughing, and there is a copious purulent infective discharge. The scars left by the ulcers are characteristic, but not pathognomonic, of syphilis.

Condylomata round the vulva and anus are frequently the first manifestation of syphilis which cause women with this disease to seek medical advice. The complaint commonly made is that the patient is suffering from piles, but a careful examination will readily disclose the true nature of the disease.

2. **Hair.**—The hair in a syphilitic patient becomes dull, loses its gloss, and is difficult to keep in order. Later, it begins to fall out, and the most characteristic alopecia is a patchy one, the hair coming out in tufts. In other cases it is simply a rapid general thinning of the hair. Under antisyphilitic treatment, the hair grows again unless ulceration on the scalp occurs.

The nails may be thin, brittle, and lose their gloss, or there may be a superficial ulceration spreading round the junction of the skin and the nail, leading to destruction of the nail-bed and loss of the nail (syphilitic onychia).

3. **Mucous Membranes.**—The mucous membranes become inflamed, especially those of the mouth and throat. On examination of the mouth, the whole mucous membrane is reddened and congested. The epithelium in various places is heaped up and macerated, so that it forms grey plaques, to which the name of "mucous patches" is given.

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These mucous patches are found on the palate, tonsils, tongue, cheeks, and pharynx. They may also occur in the larynx, causing hoarseness and loss of the voice. If treatment is neglected, especially if the mouth is not cleansed, the mucous patches break down superficially, forming ragged ulcers, which may extend and cause extensive destruction of the palate and fauces.

Besides these ulcerated mucous patches, small superficial ulcers are frequently met with on the tongue, tonsil, and palate. These ulcers are small, with clean-cut edges, and are sometimes kidney-shaped, while others have a long sinuous outline resembling snail-tracks. They heal without scarring. Mucous patches, ulcers, and red patches, over which the papillae are lost, are common on some part of the tongue, and on other parts of it the papillae may hypertrophy to form a papilloma—a condition spoken of as "Hutchinson's wart." Subacute inflammation, with the formation of mucous patches, superficial ulcers, and papillomata, may also occur on the vulva or the vagina, and in the rectum.

4. *Lymphatic Glands.*—The lymphatic glands all over the body become inflamed, and are enlarged and tender. This general adenitis is most easily recognized in the epitrochlear glands or in the glands along the superior curved line of the occipital bone. The glands, which are only slightly enlarged, are discrete. Suppuration does not occur.

5. *Bones.*—During secondary syphilis, the patient frequently complains of wandering pains in the bones (ostalgia or osteocopic pains), which are worse at night. Subacute symmetrical periostitis of the tibia, ulnas, femora, and the long bones, is not uncommon, and leads to effusion under the periosteum and localized swellings (nodes) on the bone. The condition may entirely clear up, or ossification of the inflammatory exudate, leading to a permanent bony swelling suggestive of past syphilis, may occur.

6. *Joints.*—Subacute symmetrical arthritis, chiefly of the knees, is sometimes present. There is an effusion into the joint cavity, with little pain or disability. The condition clears up under treatment.

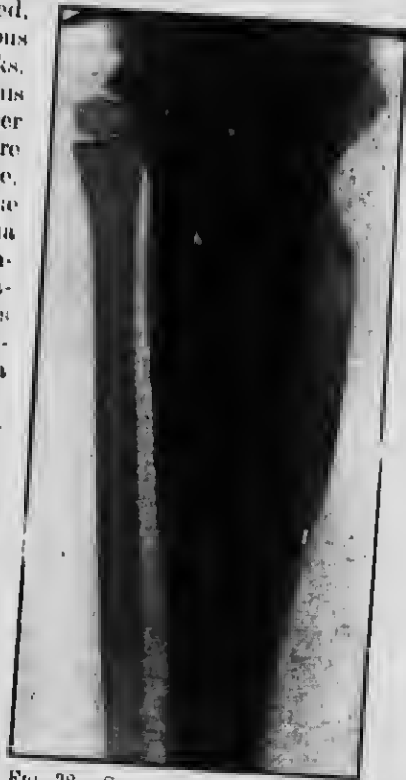


FIG. 38.—SYPHILITIC PERIOSTITIS OF THE TIBIA, WITH NEW BONE FORMATION.

7. *Lesions of the Eyes.*—The most common of these lesions is syphilitic *iritis*, which generally occurs in the second year of the disease. Both eyes are affected as a rule, but one before the other. The patient complains of pain, photophobia, and lachrymation. On examination, the conjunctiva is congested, and there is also subconjunctival congestion of the circum-corneal zone of vessels. The iris is muddy, its colour is changed, and nodules of lymph may be seen on it. The pupil is smaller than usual, and reacts sluggishly to light, and on atropine being applied it dilates irregularly. Later, it may become adherent to the anterior surface of the lens capsule by adhesions (posterior synechia). The media are hazy, and it is often impossible to see the optic disc.

Under antisyphilitic treatment, complete recovery may result, though permanent damage is often done.

Irido-cyclitis, choroiditis, and neuro-retinitis, may also occur. Fortunately, however, they are not so common as iritis. They all improve under antisyphilitic treatment, but may lead to more or less impairment of vision. If neuro-retinitis is neglected, optic atrophy and complete blindness may follow.

Diagnosis of Secondary Syphilis.—A careful attention to the history and the appearance of the primary sore, and a thorough examination of the patient, will rarely lead to an error of diagnosis of secondary syphilis, and at the present time the diagnosis may be made absolute by Wassermann's serum reaction. If this is strongly positive, the diagnosis is established, and it is even of more importance than the examination for the spirochete. Often, when the patient is seen, various antiseptic ointments will have been applied to the chancre, and under these circumstances the organism may not be found.

The duration and the severity of the secondary stage of syphilis depend on two factors—(1) the early and effective use of antisyphilitic drugs, (2) the general health of the patient.

If mercury or salvarsan has been given before the appearance of the secondary symptoms, and the treatment continued, their appearance may be entirely prevented and, at any rate, reduced to a minimum; but if the treatment be discontinued, relapse is almost certain. If treatment is not begun until the secondary symptoms are well advanced, it may be months before they completely disappear, and in some cases the lesions will persist until they gradually merge into those of the next period of the disease.

The general health of the patient is an important factor in determining the severity of the lesions and their duration. In some cases antisyphilitic treatment may be useless unless the patient is given a complete holiday, with abundance of good food and fresh air. Such severe cutaneous lesions as rupia and ecthyma, and severe ulcerating lesions in the mouth, are more an expression of failure of the general health than of syphilis, and in the case of the ulceration in the mouth it will be advisable to stop the giving of mercury completely for a time, for it may be difficult to decide if the stomatitis is syphilitic or mercurial. Some of the worst cases of secondary syphilis are seen in

patients who have started a mercurial course, and then, owing to lack of work, have discontinued treatment, being at the same time unable to obtain sufficient food, personal comforts, and cleanliness.

Treatment of the Secondary Stage.—The *general* treatment of the secondary stage of syphilis is a continuation of the treatment of the primary stage, and if mercury is being used it must be taken regularly, quite irrespective of the presence of syphilitic lesions. The general health should be attended to, and appropriate treatment carried out for anemia or loss of appetite.

The *local* treatment consists of keeping the mouth scrupulously clean, and if ulceration or mucous patches are present, mouth-washes should be ordered. If the rashes are ulcerating, *lotio nigra*, followed by the application of an ointment, such as iodoform or white precipitate ointment, should be used.

Condylomata are best treated by keeping them dry with a dusting-powder of calomel 1 part, and oxide of zinc 2 parts.

Iritis demands the usual treatment of iritis due to other causes, and inflammation of the bones and the joints require rest.

The hair will grow again under general antisyphilitic treatment. It cannot be too strongly impressed on the patient that all discharges from the secondary lesions are highly infectious, and if lesions are present in the mouth, there is great danger in kissing, or in allowing other people to use the same cups, glasses, spoons, etc.

Sexual intercourse remains the most *usual* method of spreading the infection, in spite of the fact that the primary chancre has healed, for a small mucous patch or little ulcer, or even a scaly papule on the penis or vulva, is quite sufficient to cause infection.

Sexual intercourse must be entirely forbidden during the secondary stage, for it is then that the offspring is most likely to be infected; abortions, miscarriages, and dead children often result.

Curability of Syphilis.—It is during the primary and secondary stages that the question of curability of syphilis will be asked by the patient. There is no doubt that syphilis can be cured, and if proof is needed, it is found in the second attacks of syphilis that may occur if the patient is exposed to infection. In considering the curability, the treatments by salvarsan and mercury must be considered separately. It is stated that if *salvarsan* is administered intravenously in proper doses in the primary or early secondary stage, the disease is rapidly cured, and there is no fear of causing infection at the end of a year. If the drug is not administered until the late secondary stage, cure takes longer, and may not occur at all; cure in the tertiary period is doubtful. With *mercury*, cure will result if the patient is brought early under the *full* influence of the drug, but if this drug is given in small doses, it is doubtful if it ever effects a cure. The older surgeons stated the cure could be obtained from a four years' full course of mercurial treatment, but this probably meant that the patient was no longer infectious owing to the lapse of time. Unfortunately, there is no criterion by which it can be judged that syphilis is cured. Wasser-

mann's reaction being negative is not sufficient to determine this point, as it is often negative after the administration of salvarsan, and in a few weeks becomes positive again. With a negative Wassermann the spirochæte may be lying quiescent in the tissues.

If mercurial treatment has been used, it is advisable to give the patient a short course of treatment each year, even if no symptoms are present, and certainly no harm follows this course of treatment.

Syphilis and Marriage.—The question of marriage will most frequently arise during the secondary period, and views on this subject have been considerably modified since the introduction of salvarsan treatment and the Wassermann serum reaction.

The rules laid down by Fournier still hold good as far as treatment by mercury is concerned. They are—

1. There must be no actual specific symptom (early or late) present.
2. At least four years should have elapsed since infection, and the longer marriage is postponed, the better.
3. At least two years should have elapsed since the last manifestation of syphilis.
4. The syphilis should have been of a mild type, and the patient placed under treatment early.
5. Mercurial treatment should have been properly and thoroughly carried out.

To these might be added that the Wassermann serum reaction should be negative.

These rules do not meet every case, and even if they are fulfilled, although there may be little or no danger of a husband *obviously* infecting his wife, yet freedom of the children from inherited syphilis cannot be guaranteed, although it is probable.

The advocates of salvarsan treatment state that if the treatment is given in the primary stage or the early secondary, and the patient has shown no symptoms of relapse within a year, marriage is then safe; but this statement has still to be proved by accumulated clinical experience.

In the case of women who have had syphilis and desire to marry, the matter is still further complicated by the fact that the liability of the mother to transmit the disease to her offspring is greater than in man, and, in the words of Fournier, "the responsibility of giving a syphilitic woman permission to marry should seldom be undertaken."

Late Secondary, Intermediate, or Reminder Stage.—This is not one of the classical stages of syphilis, but certain manifestations of the disease commonly occur towards the end of the second year, which are partly of a secondary and partly of a tertiary nature. They are benefited by iodide of potassium, which should be given in conjunction with mercury. These lesions are—

1. *Rashes.*—These reminder rashes are most commonly seen on the palms of the hands and soles of the feet, and consist of scaly, erythematous patches, which are very rebellious to treatment. They

also occur on other parts of the body, and may lead to ulceration, the ulcers usually having a serpiginous outline.

2. *Inflammations of the Deeper Structure of the Eye.*—These have already been described as manifestations of the secondary stage, but relapses of choroiditis and retinitis are always to be feared, and require energetic treatment in order to avoid blindness.

3. *Affections of Arteries.*—In some cases the arteries generally are the site of a chronic inflammatory condition chiefly affecting the intima, but also the media. The arteries all over the body are found to be thickened and tortuous, the condition resembling arteriosclerosis due to other causes. The diminution in the blood-supply and the occurrence of thrombosis may cause gangrene of the extremities. Antisyphilitic remedies may lead to some improvement.

More commonly the disease affects the arterioles of the central nervous system, and produces the condition of *endarteritis obliterans*. The interference of the blood-supply to the brain and spinal cord, especially if thrombosis is present, may lead to hemiplegia, monoplegia, or paraplegia, which, unlike the nervous symptoms due to sclerosis in the tertiary stage and the parasyphilitic lesions, yield to general antisyphilitic treatment. Perfect recovery, however, is not to be expected, and relapses are common.

Another rarer arterial lesion is lardaceous degeneration of the middle coats of the smaller arteries, which may occur without any suppuration being present.

4. *Affections of the Nervous System.*—These have been considered under the arterial affections, but in some cases sclerosis of the nerve tissue results, and recovery or improvement does not follow the administration of antisyphilitic remedies.

5. *Affections of Mucous Membranes.*—These lesions are most commonly seen in the mouth, and are continuations of the inflammatory condition seen in secondary syphilis. The most common is a superficial glossitis, with serpiginous ulceration. Smoking predisposes to this condition.

6. *Affections of the Testicles.*—Subacute orchitis, which is painless and symmetrical, sometimes occurs, while in some cases the epididymis is chiefly affected. The glohus major is thickened and tender, and the condition is usually bilateral. The inflammation subsides under antisyphilitic treatment.

7. *Rupia and Ecthyma*, which are described under the secondary stage, may occur during this period, especially if the general health fails.

TREATMENT.—The patient should be rapidly placed under the influence of mercury, which should be exhibited until slight salivation occurs, and at the same time iodide of potassium should be given. It is of the utmost importance that the lesions of the central nervous system should be treated energetically, or destruction of the nerve cells and permanent paralysis are inevitable. The general health should be treated at the same time, and change of air and good diet are particularly essential during this period of the disease.

Tertiary Stage.—The manifestation of tertiary syphilis is a chronic inflammation of the cellular tissue of any of the organs of the body, and this may occur from any time from six months after infection to an indefinite number of years.

The chronic inflammatory lesion is of two types, diffuse and localized; but both types may affect the same organ at the same time. For example, the liver may be the seat of diffuse syphilitic inflammation, but in one lobe a localized inflammation may also be present.

The diffuse inflammation results in *fibrosis*, so that the organ affected becomes firmer and harder than normal, and on microscopic examination it is seen that the essential cells are undergoing degeneration, owing to the pressure of the contracting fibrous tissue. This degeneration may proceed until the organ becomes a mass of fibrous tissue without any parenchyma; or, if the organ is a vital one, as the liver, until the patient dies from interference with its function. In the case of bone, this diffuse inflammation results in osteosclerosis, and the bone is harder and denser than normal, the cancellous tissue disappearing.

If the inflammation is localized, a large mass of granulation tissue, termed a **gumma**, forms. This granulation tissue consists of endothelial cells and leucocytes, and sometimes giant cells, among which newly formed bloodvessels run; but it differs from other forms of granulation tissue in the small number of bloodvessels, and the tendency these vessels have to undergo *endarteritis obliterans*, which curtails the blood-supply still further.

The *Spirochata pallida* is found in these gummata, which are therefore infective, although only mildly so, and the longer the period between the appearance of the gumma and the primary sore, the less infectious it is.

RESULTS—1. *Absorption.*—If antisyphilitic treatment is given, or sometimes without treatment, a large part of the granulation tissue may be absorbed. The remainder changes to fibrous tissue, and a scar which is much smaller than the original gumma results.

2. *Degeneration.*—In the absence of treatment, and sometimes in spite of it, the granulation tissue undergoes degeneration, which originates at the centre of the mass, and spreads gradually towards the periphery. This degeneration is due to several causes, in the main probably to the presence of the toxins of the spirochæte. It also depends largely on the interference with the scanty blood-supply both by the endarteritis obliterans, and strangulation by the formation of fibrous tissue at the periphery of the inflamed area. This degeneration results in the formation of a tough, homogeneous mass, which may subsequently become softer and semi-liquefied, and fluctuate. Even when degeneration and softening have occurred, the main bulk of the mass may be absorbed under antisyphilitic treatment, and a dense scar be the only evidence of the presence of a former gumma.

In rare cases the degenerated mass may be encapsuled by the formation of fibrous tissue round it, and remain quiescent, or calcareous salts may be deposited in it—as in the case of encapsuled tubercular

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deposits—and the gumma become obsolete. If antisyphilitic treatment is not carried out, the degeneration usually spreads until a free surface is reached, the soft semi-liquid material is discharged, and an ulcer results.

CLINICAL SYMPTOMS.—A gumma appears as a firm, painless swelling, which steadily increases in size. As it gets bigger, it softens in the centre, and fluctuation is obtained. The mass continues to enlarge, and the skin over it grows purple, and is slightly hot. It finally gives way, and the contents of the gumma are discharged. The ulcer that results is roughly circular, and has sharp punched-out edges, an infiltrated base, and a floor, on which the remains of the degenerated tissue is seen at first as a soft, yellow, tenacious slough (wash-leather slough). Later it is covered with unhealthy granulations. There is generally a foul, purulent discharge. As the ulcer is soon infected with septic organisms, the nearest lymphatic glands may be inflamed. These ulcers are rebellious to local treatment, but if this is combined with general antisyphilitic remedies, healing takes place rapidly as a rule. The scar is generally pigmented.

DIAGNOSIS.—The symptoms and physical signs of gummata in the various organs of the body will be described under their proper headings. It is proposed to consider here the general methods by which a diagnosis of gumma is arrived at. They are—

1. The causelessness of the swelling, the gradual softening, and steady growth.
2. The history of syphilis in the patient.
3. The presence of syphilitic stigmata or of other syphilitic lesions.
4. A positive Wassermann's serum reaction.
5. The effect of antisyphilitic medication.

If these points are carefully considered, mistakes in diagnosis are impossible.

Tertiary Rashes (Multiple Cutaneous Gummata—Syphilitic Lupus).

—The so-called rash of tertiary syphilis is caused by a gummatus infiltration of the skin breaking down to form ulcers. The gummata are multiple, and they gradually soften and ulcerate. These ulcers join one another, so that a large ulcer with crescentic outline, which gradually spreads over the surface of the skin, is formed. It tends to heal as it spreads. The unbroken gummata appear as small, rounded nodules at the margin of the ulcer, and the whole condition closely resembles lupus (tuberculosis of the skin).

The diagnosis is made on the conditions mentioned above and the more rapid rate of growth of the syphilitic lesion. It may be stated briefly that syphilis will spread in weeks as far as tubercle in months. The destruction of tissue is greater in syphilis than in tubercle, and if the condition occurs on the face, the cartilages and bones of the nose may be rapidly destroyed. The ulceration, as a rule, yields quickly to antisyphilitic remedies, and a thin, silvery, flexible scar is

left, the edges of which are often pigmented. These scars are not so likely to break down as lupus scars.

Gummata on Mucous Membranes.—Multiple submucous gummata leading to ulceration frequently occur in the pharynx, larynx, nose, tongue, and rectum. The ulcers are serpiginous in outline, and destroy the mucous membranes, and in the case of the nose the cartilages and bones. The ulceration extends deeply, and in the larynx the vocal cords may be destroyed. Healing leads to stenosis or stricture, especially in the larynx or rectum.

PROGNOSIS.—The tertiary syphilitic lesions generally yield rapidly to antisyphilitic treatment, but in some cases, as gummata of the



FIG. 39.—GUMMATOUS ULCERATION OF THE NECK.

glands and of the brain, the response to treatment is not prompt, and excision of the affected tissue may be necessary. The condition is only fatal to life on account of the situation of the gumma—for example, in the heart or brain.

Treatment of Tertiary Syphilis.—The drugs used in the treatment of tertiary syphilis are iodide of potassium and mercury, and they have separate rôles. The iodide of potassium, which should be given with plenty of water, promotes the absorption of the syphilitic granulation tissue, and will even be successful when this has broken down. It is doubtful whether it has any specific action on the spirochæte, therefore mercury should always be given at the same time, as this drug causes the death of the spirochæte, thus bringing about the cure of the disease. It is better to give the two drugs separately, and not to combine them in a mixture. The iodide should be stopped as soon as the swelling has gone or the ulcer has healed; but the mercury should be continued for at least six months, and it is better to give it for a year, especially if the initial treatment has not been thorough. The advent of a gumma means that the disease has not been cured, and a prolonged course of treatment is necessary.

Some patients have an idiosyncrasy for iodides, and their use is

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followed by conjunctivitis and rotinitis, with running from the eyes and nose. A pustular rash resembling acne appears on the face and back.

The initial dose of iodide should be small (5 grains three times a day), and if the rash appears, it may disappear if the dose is doubled. In some cases, however, toleration of the drug cannot be obtained, and the rash may continue to appear long after the drug has been stopped. Other patients can tolerate very large doses (60 grains three times a day), but if these large doses are being given, a diffusible stimulant such as ammonium carbonate should be administered in order to counteract the depressing influence of the drug. It is better to keep the patient in bed on account of its depressing act on the heart.

If potassium iodide is not tolerated, sodium or ammonium iodide may be tried, or *iodopin*, a combination of iodine with sesame oil, may be tried. This last drug may be given in ʒ-drachm doses of a 10 per cent. solution three times a day, or 30 minims of a 25 per cent. solution may be injected in the buttock daily until the swelling disappears.

Salvarsan and neo-salvarsan are also used in the treatment of tertiary syphilis, and give excellent results.

LOCAL TREATMENT.—No local treatment is necessary unless the gumma has broken down and ulceration is present, except in those cases in which local excision of the gumma is indicated, as in the lymphatic glands and brain.

When ulceration is present, the usual aseptic treatment of an ulcer should be carried out. For dressing, iodoform ointment, lint soaked in *lotio nigra*, dilute nitrate of mercury ointment, or the white precipitate ointment, are all good.

If the ulcer continues to spread in spite of the above general and local treatment, the edges and floor should be cauterized with the actual cautery, pure carbolic, or acid nitrate of mercury; and if necrosed bone or cartilage is present, this must be removed in the usual way.

In some cases, when an organ is destroyed by the disease, as in syphilitic testis, it may be advisable to remove it; but mercury must always continue to be given for the usual time, or the patient should be treated with salvarsan.

Diffuse Sclerosis in tertiary syphilis should be treated by salvarsan, iodides, and mercury, and if the treatment is started early, some of the young fibrous tissue may be absorbed, and considerable improvement result. The destroyed parenchymatous cells cannot be restored, however, and loss of function is inevitable.

Parasyphilitic Affections.—This term was given by Fournier to certain lesions in the central nervous system, which he believed occurred as a result of the saturation of the body with syphilitic toxins, but were not actually due to the presence of the infecting organism. The spirochæte, however, has recently been demonstrated in the central nervous system, and the lesions are now believed to be directly due to it. Wassermann's serum reaction is positive. The two chief

parasymphilitic affections are **General Paralysis of the Insane** and **Tabes Dorsalis**, and their diagnosis and treatment belong to the domain of general medicine.

CONGENITAL SYPHILIS

The inheritance of syphilis differs entirely from the inheritance of tuberculosis. In the former the actual organism of the disease is transmitted to the child, while in the latter it is vulnerability of tissue that is inherited.

Since the discovery of the *Spirochaeta pallida* and Wassermann's serum reaction, views regarding the inheritance of syphilis have been considerably modified, and it is now generally believed that *infection of the fetus is always transmitted from the mother*. Although the spirochaete has been demonstrated in the semen of syphilitic apes, it is unlikely that the virus could gain entrance to the ovum and lie latent without infecting the mother. On the other hand, infection of the placenta, both on the maternal and foetal sides, has been frequently demonstrated, and Wassermann's serum reaction is nearly always present in the mothers of syphilitic children. This view explains **Colles's law**. This law states that the mother of a syphilitic child, although showing no signs of the disease, cannot be infected by her own child, which, however, will infect another person. If the serum reaction of such a mother be taken, it will be positive, and the mother is protected because she has been already infected, and is suffering from the disease which she has transmitted to the child. Another point of importance is that a syphilitic father will not have a syphilitic offspring unless he is suffering from a lesion that will infect the mother, although his serum reaction may be strongly positive.

Profeta's law states that a syphilitic child is immune from syphilis till the time of puberty, although he may present no evidence of the disease. If the law is examined by the serum reaction, it will be found that about half the children born of syphilitic women give a negative Wassermann reaction. It must not be assumed, however, that all these patients are free from evidence of congenital syphilis. In some cases the disease is merely latent, and characteristic lesions will appear later; but in others it is possible that the child escapes infection on account of the relative non-infectivity of the mother. It is well known that the infectivity of syphilis becomes less as the date of infection grows more remote, therefore a child born many years after infection may easily escape.

Immunity is certainly not absolute after puberty, for patients who are the subjects of congenital syphilis may acquire the disease, although possibly more rarely than those who are not the subjects of the inherited taint.

The results of conception by a syphilitic woman will vary according to the time that has elapsed between the date of conception and the primary infection. A typical history of a syphilitic family may be stated thus: First conception results in abortion; second in miscarriage;

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third, child born dead and macerated; fourth, a child born with syphilis, death in a few days; fifth, child born healthy, syphilis in three weeks (the typical case); sixth, child healthy, with irregular manifestations of syphilis at any time; seventh, child healthy, and remains so. Of course, it must be understood that such a complete history is seldom obtained; a series of abortions may occur, or one child may be born healthy, and then a syphilitic child follow, and this, again, be followed by further miscarriages. The history is also considerably modified by treatment, and a mercurial course given to the mother may result in a healthy child being born, although the syphilis in the mother is of very recent date; on the other hand, if treatment is stopped, a syphilitic conception may follow.

The method of infection of the fœtus is still uncertain, but in those cases in which the fœtus is syphilitic before birth it is probable that the placenta is first infected, and then the spirochæte is carried to the fœtus. It has been suggested that when the disease does not develop until three weeks after birth, the infection takes place at the time of parturition, owing to the damage done to the placenta, which allows the maternal spirochætes to infect the fœtus by way of the umbilical vein. It is interesting to note that the organism has been demonstrated free in this vein.

The rules of inheritance may be stated thus:

1. That infection is always from the mother.
2. That a syphilitic father will not have a syphilitic offspring unless he is suffering from a lesion that infects the mother.
3. That the mother of syphilitic children has always been infected.
4. That the subjects of congenital syphilis are at first absolutely, and later relatively, immune from the disease.
5. That the nearer conception is to the date of infection of the mother, the more likely is the child to be syphilitic.
6. That the virulence of the infection gradually dies out.
7. That inheritance is subject to great variations, and treatment has important effects on inheritance.

Presence of the Spirochæta.—It may be stated briefly that the *Spirochæta pallida* has been found in all the lesions of inherited syphilis.

Wassermann's Reaction in Inherited Syphilis.—From figures given by McIntosh and Fildes, the Wassermann reaction was present in 234 out of 245 cases of inherited syphilis, and it is probable that the remaining eleven cases were examples of errors of observation. It may be considered that a negative reaction in a case of suspected inherited syphilis renders the diagnosis improbable.

CLINICAL SYMPTOMS.—The most common lesions present in a syphilitic child *at birth* are—Enlargement of the liver and spleen; inflammation of the diaphysial side of the epiphysial cartilages of the long bones; a bullous eruption round the wrists and ankles; periostitis of the skull bones; absence of subcutaneous fat.

These children are usually born dead, or they die of inanition in a few days.

In a typical case of congenital syphilis the child is born healthy and well nourished, and the symptoms appear about three weeks after birth.

1. **GENERAL SYMPTOMS.**—The child, although being properly fed, begins to waste, and becomes emaciated from no obvious cause; the skin is flabby and wrinkled; the complexion earthy in colour; and the child is constantly crying. The features are pinched, resembling those of an old man, and the hair loses its gloss and becomes "staring." The child is anæmic, and has short, irregular rises of temperature. Although all these symptoms generally disappear under treatment, the child may, nevertheless, waste and die.

2. **SKIN AFFECTIONS.**—Rashes resembling those of the acquired disease appear on the skin, the usual one being a dark roseola rash, which is most marked in the napkin area. Superficial ulceration of the skin is also apt to occur in this part, probably owing to irritation by the urine and fæces. The ulceration may extend deeply, and when healing takes place, scars are left. Condylomata round the anus on the genitals and thighs are common, and are pathognomonic of the disease. Ulceration at the angles of the mouth, between the fingers and toes, and round the anus, result, when healed, in scars which are one of the stigmata by which the presence of the disease may be recognized later in life.

Other rashes—pustular, vesicular, and squamous—may also occur; they have the same characteristics as in the acquired disease (see p. 131).

3. **AFFECTIONS OF MUCOUS MEMBRANES.**—The mucous membranes of the mouth and nose become inflamed; mucous patches and superficial ulcers are common. In the nose inflammation of the mucous membrane causes a discharge, which partially blocks the nasal passages and causes a peculiar noise as the child breathes (*snozzles*). The condition is a muco-periostitis, and if not quickly cured, may result in necrosis or maldevelopment of the nasal bones and cartilages, so that the bridge of the nose is not formed, and a characteristic saddle-shaped nose results. Superficial ulceration and mucous patches may also be seen on the mucous membrane of the anus and vagina.

4. **VISCERAL CHANGES.**—Enlargement of the liver and spleen are frequently present, owing to a subacute inflammation of the connective tissue of these organs. The condition may result in sclerosis, with permanent enlargement.

5. **AFFECTIONS OF THE BONES AND JOINTS (SYPHILITIC EPIPHYSITIS OR OSTEOCHONDRITIS).**—One of the most characteristic phenomena of inherited syphilis is an inflammatory condition of the bones occurring during the first few months of life. The inflammation starts on the diaphysial side of the epiphysial line, and spreads up the shaft under the periosteum. The inflammation is roughly symmetrical, and several bones may be affected. There is often effusion into the joints, and as the condition is painful and the child does not like to move the

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limb, it may be mistaken for a condition of paralysis. Spontaneous separation of the epiphysis may result, and if infection by septic organisms occurs, suppuration and discharge of the epiphysis may destroy the usefulness of the limb. Antisyphilitic treatment, if applied early, results in complete cure, but premature ossification of the epiphysial line, and consequent deficiency of growth, may take place.

Inflammation of the parietal and frontal bones round the anterior fontanelle leads to thickening and a characteristic shape of the head. These swellings are known as *Parrot's nodes*.

Craniotabes is a condition of wasting of the bones of the skull, leaving only the membranous part of the bone, which can be felt to crackle under pressure.

This condition is not pathognomonic of syphilis, but is seen in any wasting disease in infants. The absorption of the bone takes place chiefly at points of pressure.

6. AFFECTIONS OF THE EYES.—Inflammation of the cornea usually occurs later, but in infancy iritis, which may lead to permanent loss of sight, is not uncommon.

In the majority of cases, especially if antisyphilitic treatment is carried out, the child recovers from these early conditions; but they leave behind the following stigmata, by which the presence of the congenital disease may be recognized: (1) Scars at the corners of the mouth; (2) an earthy complexion; (3) depressed bridge of the nose; (4) square "natiform" shape of the skull; (5) adhesion of the iris to the lens; (6) enlargement of the liver and spleen.

Reminder Stage.—From the age of six years up to puberty certain other phenomena are likely to develop as reminders of the disease. They are—

1. EYE AFFECTIONS.—*Interstitial keratitis* is the most common of these. The inflammation of the cornea generally occurs in both eyes, and an exudate spreads from the periphery of the cornea to the centre, making it opaque and white (ground-glass cornea). There is some conjunctival congestion, lachrymation and photophobia. The condition clears up from the periphery to the centre; therefore, if any opacity is left, it is in the centre of the cornea. In some cases vascularization of the inflammatory exudate occurs, and pink patches (salmon patches) are seen in the cornea. The condition lasts from one to two years, and the prognosis is good.

Iritis and *choroiditis* are often present in conjunction with interstitial keratitis. They are difficult to diagnose, however, on account of the opacity of the cornea. Their presence should be suspected if there is much photophobia and congestion of the vessels of the circumcorneal zone. They make the prognosis much worse, for after the keratitis has cleared up, permanent defects in vision may result from the choroiditis.

Inflammations of the optic nerve, resulting in optic atrophy, may also occur.

2. PAINLESS SYMMETRICAL ARTHRITIS, with effusion into the joints, especially the knee-joints, may cause lameness.

3. INFLAMMATION OF THE INTERNAL EAR (OTITIS INTERNA) is not infrequent, and the patient becomes deaf. If treatment is not prompt and successful, permanent deafness may ensue.

4. THE TESTES OR THE OVARIES MAY BE CHRONICALLY INFLAMED, and if fibrosis occurs, atrophy, with impotence and infantilism, may be the result.

5. A SYMMETRICAL SUBACUTE PERIOSTITIS OF THE TIBIA may cause curving of these bones (sauro-shaped). The curve, which is more due to inflammatory thickening than to bending, is antero-posterior, and chiefly affects the middle of the bone.

6. TEETH.—The teeth characteristic of inherited syphilis are the upper central incisors and the first molars of the permanent set of teeth. The characteristic upper central incisors (Hutchinson's teeth) are small, and slope towards each other. The lower cutting edge is smaller than the upper part of the tooth (screwdriver shape), and is deeply notched, exposing the dentine.



FIG. 40.—HUTCHINSON'S TEETH.

The first molars may be dome-shaped, and smaller than usual, owing to the smallness of the central tubercle of each cusp.

OTHER LESIONS.—Besides these lesions, patients suffering from inherited syphilis may show similar lesions to those of the tertiary stage of the acquired disease. Gummata may occur in any part of the body and undergo their customary degeneration, with the formation of gummatous ulcers. Deep ulceration may be present in the mouth, pharynx, and larynx, causing destruction of the soft palate, perforation of the hard palate, and stenosis of the larynx. Fortunately, however, these serious lesions are not common. Tertiary syphilitic ulceration of the skin and sclerosis of bone or fibrosis of internal organs may be present, as in the acquired disease.

Parasyphilitic Affections of the nervous system may occur in inherited syphilis, general paralysis of the insane, and tabes dorsalis being present in patients as early as the age of sixteen years.

It is necessary to understand that the above description only applies to cases in which the inherited taint shows its full development, for few cases exhibit all these lesions. A patient may only show one or two of the lesions, and these may appear irregularly. For example, an otherwise apparently healthy child may develop condylomata ani at the age of three or four, and no other trace of the inherited taint be present. After puberty, interstitial keratitis may be manifest as the only trace of the inheritance. These cases are very puzzling, but the Wassermann's serum reaction and the result of antisyphilitic treatment make the diagnosis clear.

Transmission to the Third Generation.—It is possible that this sometimes occurs, but it is very difficult to prove. A wife suffering

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from inherited syphilis, or the wife of a man with the inherited taint, may bear a syphilitic infant; but before deduction can be drawn as to transmission to the third generation, absolute proof of the sexual purity of both parents must be obtained. This is a matter in which such proof can hardly exist.

Treatment of Congenital Syphilis—GENERAL.—A syphilitic infant should be nursed by its mother, and failing this, it should be artificially fed on milk. Under no circumstances must it be given to a wet-nurse. All discharges from the syphilitic lesions in early life are infectious. As soon as the diagnosis is made, mercury should be given, and continued for at least three years. The mercury is most conveniently given internally as grey powder, $\frac{1}{2}$ to 1 grain being given three times a day as long as it does not cause diarrhoea. If diarrhoea is present, or the digestion is upset, mercury may be given by inunction. A small quantity of the dilute oleate of mercury may be rubbed into the skin night and morning after the bath, or it may be smeared on to a flannel binder worn next to the skin. The usual attention should be paid to the general health, iron and cod-liver oil being given if necessary.



FIG. 41.—SYPHILITIC ULCERATION.

LOCAL.—The mouth should be kept clean by any simple mouth-wash, and ulcers on the skin treated locally by simple or mercurial ointments.

The later lesions require iodides as well as mercury, and surgical interference may be necessary in cases of necrosis of bone or perforation of the palate.

Iritis demands the use of atropin, and the subjects of interstitial keratitis should wear an eye-shade.

SALVARSAN IN CONGENITAL SYPHILIS.—The use of salvarsan in inherited syphilis is not without danger, and the number of cases treated by this method is still too few to generalize on. It has been discovered that salvarsan given to a syphilitic mother who is suckling her child will cause material improvement in the syphilitic lesion of the child, but that relapses are common. On the other hand, direct

inoculation of salvarsan into the child has been followed by death. It is suggested that the child should be treated first indirectly through the mother, and when improvement has taken place, direct inoculation should be carried out, 0.02 to 0.04 grain being given intravenously.

Soft Sores, Soft Chaneres, Ducrey's Infection.

Soft sores are due to a specific infection usually occurring on the prepuce in man and on the labi. minora in women, and conveyed from patient to patient during coitus. The specific organism, Ducrey's bacillus, is a small (1.5 μ) rod-shaped organism arranged in short chains, which stains readily, but is Gram negative. It is found in the base of the ulcers.

The incubation period is two to five days.

CLINICAL FEATURES.—The lesion first noticed is a small crop of pustules situated on the prepuce near the frænum, or on the labia minora, which rapidly break down into small ulcers with clean-cut edges surrounded by an area of acute inflammation. These ulcers have an abundant foetid discharge, and the prepuce or labia are usually swollen. Occasionally there is a single ulcer, but it has none of the induration characteristic of a syphilitic sore. As, however, Ducrey's bacillus and the *Spirochaeta pallida* may infect the same lesion, a primary syphilitic sore may supervene on a soft sore. Soft sores are auto-inoculable, and may appear in crops, or other parts of the body may be infected.

The glands of the groin are acutely inflamed, and suppuration is common. The pus is usually peri-glandular, and when the inflamed tissue is incised, the glands are found lying in an abscess cavity. The wound after incision or after the abscess has burst frequently ulcerates, and the ulcer has the same characteristics as the soft sores on the prepuce.

If soft sores occur under a tight prepuce, so that they cannot be kept clean and their secretion is retained, infective gangrene of the penis may occur, and the whole of the glans may slough.

TREATMENT.—The ulcers should be cauterized with pure carbolic acid or acid of nitrate of mercury, or touched with the actual cautery after applying cocaine. Afterwards they must be kept clean with peroxide of hydrogen lotion, and dressed with an ointment or a dusting-powder, iodoform being the best.

If the patient has a tight prepuce, it must be slit up or circumcision performed, but the patient should be warned that the ulceration may recur in the wound. Gangrenous ulceration must be treated by cauterization, the free use of antiseptics, and frequent baths. The inflamed glands in the groin should be treated by rest in bed and fomentations, but if suppuration appears inevitable or has occurred, the glands should be freely excised, the wound swabbed out with pure carbolic acid, and drained. Healing is slow.

The following differentiation between soft sores and primary syphilitic sores is useful:

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Soft Sores.

Usually multiple.
Incubation period, two to five days.
Acutely inflamed.
Edges clean cut.
Abundant foul secretion.
Auto-inoculable.
Glands, acutely inflamed, matted together; frequently suppurate.
No secondary symptoms.
Ducrey's bacillus found.

Syphilitic Sores.

Usually single.
Incubation period, two to five weeks.
Indolent.
Edges raised and indurated.
Secretion scanty.
Auto-inoculation very rare.
Glands, slight enlargement, discrete; suppuration does not occur.
Secondary symptoms appear.
Spirochæta pallida found.

CHAPTER VI ULCERATION AND GANGRENE

ULCERATION

AN ulcer is the result of an inflammatory condition occurring on a free surface (skin or mucous membrane), ending in destruction of the tissue in microscopic portions (molecular disintegration) from suppuration. The condition is always associated with the presence of microorganisms, which causes disintegration of the tissue by means of the peptonizing action of their toxins. These organisms may be specific or non-specific, and a secondary infection by non-specific organisms of a specific ulcer may occur.

A special variety of ulceration arises when a malignant new growth invades the skin or a mucous membrane. The cells forming the new growth undergo rapid degeneration, the breaking-down tissue is quickly infected by the non-specific bacteria, and a suppurating inflammatory condition is added to the new growth. These ulcers are termed "malignant ulcers."

Ulcers may therefore be divided, according to their primary cause, into—(1) Non-specific or septic ulcers; (2) specific ulcers; (3) malignant ulcers.

Non-Specific Ulcers.—Although the cause of these ulcers is infection by the organisms of suppuration, ulceration would soon cease and healing occur if certain local and general causes did not predispose to the maintenance of the ulceration. These causes are almost as important to the production of an ulcer as the organisms; and, clinically, an ulcer often receives its name from the most important of these predisposing causes, as, for example, the varicose ulcer associated with varicose veins, and the trophic ulcer due to loss of innervation of the part. The chief *local* causes are—

1. *Interference with the Blood-Supply of the Part.*—This is due to such conditions as atheroma, endarteritis obliterans, calcification of the arteries of the part, embolism or thrombosis occurring in one of the main arterial supplies.

2. *Interference of the Venous Return.*—The result of interference with the venous return is congestion and œdema of the part. This interferes seriously with its nutrition, and predisposes to ulceration.

The most common cause of this condition is varicose veins,

especially in those cases in which there is great dilatation of the small superficial veins.

3. *Want of Cleanliness.*—Ulceration may continue owing to constant reinfection of the wound, due to want of surgical cleanliness. This occurs if the secretion from the ulcer cannot escape freely. If the secretion from an ulcer is allowed to form a scab over the ulcer, the decomposing discharges which accumulate under the scab are exceedingly irritating, and lead to further extension of the ulceration.

4. *Interference with Contraction of a Wound.*—In the healing of wounds the formation of fibrous tissue from granulation tissue, and the subsequent contraction of the newly formed fibrous tissue, is an essential factor; and if from any cause this contracture is prevented, healing stops and ulceration may occur. This cause of ulceration is often seen in very large granulating surfaces, the centre of which will not heal, and in wounds situated over superficial bones to which they become adherent. If the wounds do heal finally, the scar is as a rule weak, readily ulcerating from slight causes.

5. Another factor preventing the healing of these wounds is the interference with the blood-supply to the centre of the wound by the formation of the fibrous tissue necessary to the process of healing. The contracting fibrous tissue constricts the bloodvessels running in the granulation tissue, healing ceases, and ulceration begins. This accounts for many of the more chronic forms of ulceration on the lower extremity.

6. *Deficient Innervation of the Part.*—Two factors combine to produce ulceration in a part that is deprived of its nerve-supply, the more obvious being the injury to which the part is exposed, owing to loss of sensibility. For example, a patient presses too long and heavily on a slightly inflamed part unconsciously, owing to this loss of sensibility, and ulceration follows. The second factor is the loss of the trophic nerves of the part, ulcers being apt to form rapidly and painlessly, and to take a long time to heal even when they are not exposed to injurious pressure.

The chief *general* causes predisposing to ulceration are—

1. General degeneration of the tissues due to old age.
2. Degeneration of the tissues associated with diabetes, chronic nephritis, lead-poisoning, syphilis, etc.
3. General malnutrition due to bad and insufficient food, imperfect hygienic conditions, cold and exposure.

Clinically ulceration may be divided into acute and chronic.

ACUTE ULCERATION

Acute ulceration is generally due to a mixed infection of various organisms, and in its most acute form is described under Gangrene, Phagedæna, Canerum Oris, and Noma. In less severe forms the ulcer presents the following characteristics: The floor is covered with tiny sloughs, between which yellowish granulations may be seen; the edges are irregular, deep cut, and sloughing; and the surrounding

tissue is acutely inflamed. The ulcer bleeds readily, is painful, and secretes a large quantity of foul pus; the base is not indurated. The nearest lymphatic glands are inflamed, and may suppurate. The patient's *general* symptoms are those of acute infection.

TREATMENT—Local.—The part in which the ulcer is situated is put at rest, and if this is the lower extremity, it should be elevated on an inclined plane. The surface of the ulcer should be cleaned, dried, and then cauterized, either with the actual cautery or with caustics, as pure carbolic acid, nitric acid, or acid nitrate of mercury. The part should be kept in a hot dilute antiseptic bath, or frequent fomentations should be applied until the ulceration ceases and the part is covered by healthy granulations. The cauterization may have to be repeated, and if the sloughing is very extensive, its removal with scissors or scalpel may be necessary.

The *general* treatment is that of any infective condition.

SERO-THERAPY.—A culture should be made from the surface of the ulcer, and a vaccine prepared from the dominant organism found.

CHRONIC ULCERATION

One of the most common causes of chronic non-specific ulceration is degeneration of the tissues due to varicose veins, and this so-called **varicose ulcer** will be taken as the type of chronic ulceration.

The condition is most frequently seen on the lower extremity, and is more common in women than in men. Degeneration occurs as a result of the dilatation of the small venules of the skin, and an eczematous condition is produced, which is usually aggravated by scratching. A small ulcer then develops, which, instead of healing, continues to extend. In some cases the initial ulcer is produced by rupture of one of the varicose veins, and in others infective phlebitis and the formation of an abscess which bursts through the skin is the cause of the primary ulceration.

A varicose ulcer is at first a small superficial ulcer with irregular edges, and has a floor covered by pale, unhealthy granulations, discharging a scanty secretion. It generally lies in the centre of a patch of eczema on the inner side of the leg. Not infrequently there are two or more of these superficial ulcers.

If the condition is neglected, the ulceration extends and the small ulcers coalesce, forming a large one. The tissue surrounding the ulcer is in a state of chronic inflammation, and gradually the ulcer lies in the centre of a mass of fibrous tissue, which fixes it firmly to surrounding structures, and a **callous ulcer** is formed. The floor of such an ulcer is depressed below the surface, is smooth or scantily covered with pale granulations; the edges are rounded, smooth, and thickened; the base is a mass of fibrous tissue, which constricts the bloodvessels running to the ulcer. The secretion is scanty, and the surrounding skin œdematous and congested.

When the ulcer is extensive, the blocking of the lymphatic and venous return from below the ulcer may be so severe as to cause a chronic œdema, resulting in elephantiasis.

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It must not be assumed that the callous ulcer of the leg is invariably due to varicose veins. Any chronic ulceration of the lower extremity, if neglected, will become callous and reproduce the above clinical picture. A common cause of this form of ulceration in women is chronic œdema of the leg, associated with phlegmasia alba dolens, occurring after parturition. The same condition is also seen in cases of chronic venous obstruction following typhoid fever and appendicitis.

TREATMENT—Local.—The first important principle in the treatment of chronic ulceration is **rest**, and if the ulcer be on the lower extremity, the patient should be in bed with the leg elevated, thus lessening the venous congestion and œdema. In the case of ulceration in the groin or in one of the flexures of the body, the part should be carefully splinted, in order that movement of the joint is impossible. It is best to keep the patient recumbent until the ulcer is completely healed; but if this is not possible, certain measures must be taken to support the veins of the part, in order to avoid congestion and to reduce the amount of surrounding œdema to a minimum. The following methods are used:

1. *Elastic Stockings.*—These are not very suitable if the ulceration is at all severe, for the stocking cannot be conveniently put on over the dressing. They are more suitable for use after the ulcer has healed.
2. *Elastic Bandages.*—There are many kinds of these bandages, from pure rubber, such as Martin's bandages, to a web bandage without rubber. One of the best forms is the stockinetto bandage, which is cheap, easily washed, and gives firm support. The bandages should be put on over the dressing and without reverses. They are best applied after the limb has been elevated for a few minutes.
3. *Strapping.*—The limb is elevated, and the foot carefully strapped with lead strapping from the toes up to the ulcer. The strapping is then started again above the ulcer and carried to the knee. The ulcer is dressed in any of the ways given below, and the strapping renewed as often as necessary.
4. *Unna's Bandage* is used in cases where an equitable pressure is desired, as in a case of varicose ulcer of the leg. The skin round the ulcer is thoroughly disinfected by washing it with soap and water, and subsequently with antiseptic lotions. The ulcer is cleaned and powdered with iodoform and boracic powder. A double-headed carbolic gauze bandage is taken and applied to the limb, commencing from the middle of the sore and going up and down. A mixture of gelatin and glycerine—10 parts of gelatin, 40 parts of water, 40 parts of glycerine—with some oxide of zinc, is rubbed into the bandage. This mixture is heated in a water-bath, being rubbed into the bandage while hot. Before it is set another bandage is dipped into hot water and applied. The dressing solidifies and forms a firm support for the leg; and while it does not have the weight of a plaster of Paris bandage, the pressure is more evenly distributed than with an elastic bandage.

Massage of the skin surrounding a callous ulcer is also useful in removing œdema.

It is of the utmost importance that a chronic ulcer should be rendered as **aseptic** as possible, and this may be accomplished by the following methods:

1. If the ulcer is very foul, fomentations should be frequently applied, or the part should be put in a continuous bath.
2. After the surrounding skin has been washed and bathed with antiseptic lotions, the ulcer is carefully cauterized with pure carbolic acid, nitrate of mercury, or zinc chloride.
3. An anæsthetic may be given, the limb cleansed, and the surface of the ulcer scraped with a sharp spoon.

After one of these methods has been used, the ulcer should be kept clean by bathing it twice a day with weak boracic lotion or very dilute carbolic acid lotion, and in the intervals dressed with some simple ointment, such as boracic; or if the granulations are exuberant, with an astringent lotion, such as *lotio rubra*, or silver nitrate solution, 2 grains to the ounce. Other useful astringents are—calomel, resin, eucalyptus, and dilute nitrate of mercury ointment.

Wright's Solution.—This method of treatment aims at causing a copious flow of serum containing antibodies through the ulcerated tissues, and so diminishing sepsis. The ulcer is bathed with Wright's solution twice daily, and in the intervals is dressed with boracic or some other simple ointment.

GENERAL TREATMENT.—The general treatment is that of any other septic condition. Iodides may be found of benefit in other cases besides those due to syphilis.

Sometimes, in spite of the most careful local and general treatment, the ulceration persists, and the question of *amputation* should then be considered, as it may be the only means of ridding a patient of an intolerable nuisance.

Healthy Granulating Surface.—The object of the above treatment is to stop ulceration and promote healing, and when this is accomplished, a healthy granulating surface is the result. A healthy granulating wound has the following characteristics: The floor is covered with small red granulations, uniform in size, not painful, and not bleeding readily. The edges of the wound are shelving, and present three zones—an inner zone of red, where the granulations are covered with a layer of transparent epithelial cells; a middle zone, bluish in colour, where the epithelium is thicker, and constriction of the blood-vessels is occurring owing to contraction of the fibrous tissue; and an outer zone of white, newly formed scar tissue, covered with sodden epithelium. The base is not indurated, and is freely movable. The surrounding skin or mucous membrane is healthy, and not congested nor œdematous. The secretion is scanty, and if the granulations are not irritated by strong antiseptics, is sero-purulent.

TREATMENT.—The treatment of rest and elevation, or the support of varicose veins if they are present, should be continued, and the wound and the surrounding skin kept clean and aseptic; but the use of strong antiseptics is unnecessary, and all undue interference is to be

depreciated. An absorbent dressing should be used, and a piece of sterilized oil-silk, the exact size of the wound, should be applied next the granulating surface, and covered with sterile gauze and cotton-wool. Holes should be cut in the oil-silk. This protects the growing epithelium, and renders the dressing much less painful.

If ointments are used, they should not contain strong antiseptics, and the prolonged use of ointments causes the granulations to become pale, large, and œdematous. This also applies if fomentations are too long continued. These exuberant granulations should be cauterized with solid silver nitrate, and a stimulating lotion, as lotion rubra or silver nitrate solution (2 grains to the ounce), used in the dressing.

Picric acid and Scarlet R., especially the latter, have the power of stimulating the growth of epithelium, and a granulating surface will often heal rapidly under their use. Scarlet R. is generally applied as an ointment, 5 to 8 parts of the drug being added to 100 parts of soft paraffin.

If the granulating surface is large, the contraction caused by its healing may produce considerable deformity, or seriously interfere with the movements of joints. To prevent this contraction, the part should be carefully *splinted*, and, later, *massage and passive movements* are useful in order to maintain the movements of the joints.

SKIN-GRAFTING

If a large area has to be covered with epithelium, the contraction of the scar tissue hinders healing in the centre, and a weak scar results, besides producing considerable deformity. To prevent this, and to obtain a much stronger scar, skin-grafting is used. This method of promoting healing, however, is only of value on a healthy granulating surface or on a fresh wound; it will fail if ulceration is still present.

METHODS—1. **Reverdin's**.—A cutaneous hair is seized with forceps, and pulled on till a piece of the epidermis is pinched up. This is cut off with a small portion of the cutis vera, and a little bleeding results. This small piece of skin is "planted" on the granulations, and other pieces of epithelium are "sown" all over the surface of the wound in the same manner. The wound is then covered with sterile silk protective and gauze, and left undisturbed for four or five days. On removal of the dressing the little islands will probably have disappeared, but in a few more days areas of epithelial growth will appear all over the wound.

2. **Thiersch's**.—In this method long strips of epithelium are used to cover the granulating surface completely. All exuberant granulations are scraped away, and the bleeding stopped by careful pressure. The grafts are cut from the inner surface of the thigh or arm by means of a razor lubricated with glycerine 1 part, alcohol 1 part, and water 2 parts. They should be as large as possible, and should include the superficial layers of the cutis vera. The grafts are spread all over

the granulating wound, and gently pressed down to remove all air-bubbles; they should overlap the edges of the wound. The wound is then carefully dressed with gauze, or the grafts may be covered with sterile silk protective. The dressing should not be disturbed for four or five days. When the dressing is removed, it will often appear that the grafts are removed too, as they can be seen adherent to the bandage, the wound appearing to be covered with granulations as before. The part of the graft which is separated, however, is the cuticle, and the deep layer of the grafts has usually become adherent to the wound, and in a few more days the wound will be seen to be covered with epithelium. The raw surface on the thigh is treated with a simple dressing.

3. Wolfe's.—In this method the whole thickness of the skin is used, but all the subcutaneous tissue must be carefully removed. The grafts may be cut from the patient or from some healthy person; it is often possible to utilize the prepuce removed by circumcision for these grafts. In applying them it must be remembered that the grafts will shrink to about two-thirds of their original size, owing to the elasticity of the skin. They may be simply placed over the raw surface, but it is better to stitch them into position with fine sutures. The method of dressing is the same as for Thiersch's grafting.

4. The Skin of the Lower Animals, such as rabbits, has been used for skin-grafting, and epithelium from other parts, such as the peritoneum, or the membrane of new-laid eggs has been used to cover raw surfaces, but the results are not so satisfactory as the above methods. Attempts have also been made to cover defects in mucous membranes, such as the urethra, by grafts from man or the lower animals, and in some cases with success.

After-Treatment of Chronic Ulcers.—The scars left by the healing of chronic ulcers, especially those of the leg, are generally weak, and ulceration is apt to occur unless care is given to the after-treatment. The patient should always wear some support to the leg, stockinette bandages being the best, and the leg, which must be kept clean, should be powdered with boracic powder under the bandage. The patient must be warned of the danger of scratching. If the slightest abrasion of the scar appears, it must be at once carefully treated, and the patient should rest the leg until it is healed.

OPERATIVE TREATMENT OF VARICOSE VEINS WITH A CHRONIC ULCER.—The presence of a varicose ulcer is an added reason for treatment of the varicose veins by operation, but this treatment should only be undertaken in those cases in which operation is likely to be successful (see Treatment of Varicose Veins). It is not usually advisable to operate on the veins near the ulcer, but portions of the vein may be removed at a higher level, or the main saphena vein may be tied at the saphena opening (Trendelenburg's operation).

Special Varieties of Non-Specific Chronic Ulcers—**1. IRRITABLE ULCER.**—This ulcer is generally found on the inner side of the leg just above the internal malleolus; it is more common in women than in men.

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It is characterized by its great pain, which is worse at night and in cold weather. On examination, several intensely tender spots are found on it. It is probable that these spots correspond with the terminals of sensory nerves.

TREATMENT.—The granulations should be cauterized or scraped away with a sharp spoon, and the usual treatment of chronic ulcer carried out.

2. ECZEMATOUS ULCER.—In this condition there is a large amount of eczema round the ulcer, and the methods of treatment used for the callous ulcer will often aggravate the condition. The ulcer and surrounding skin must be dressed with soothing applications, as *lotio calamina*, *liquor carbonis detergens*, *lotio glycerini plumbi subacetatis dil.*, or *iothyol ointment*.

3. PERFORATING ULCER.—These ulcers are met with on the feet of patients suffering from imperfect innervation due to peripheral neuritis, associated with alcoholism or diabetes, or in patients suffering from cord lesions, as locomotor ataxia or syringomyelia; but they may also occur in elderly people who do not show any evidence of these diseases, but whose feet are neglected and covered with corns. The condition is most frequently seen on the ball of the big toe. A corn forms under the head of the first metatarsal bone, and mild suppuration occurs beneath it. Owing to the loss of sensibility, the condition is neglected, and the line of least resistance for the suppuration to follow is upwards through the tissues of the foot, and not downwards through the dense callosity. The pus gradually burrows upwards, commonly through the metatarso-phalangeal joint, and appears at the dorsum of the foot. The pain and constitutional disturbances are very slight. Perforation of the corn generally occurs during the process of spread, and a small discharging sinus through the centre of a corn is present on the sole of the foot. These perforating ulcers are often multiple in patients suffering from locomotor ataxia.

TREATMENT.—The corn should be cut away freely, and the edges of the sinus thoroughly scraped, in order to remove all down-growth of epithelium lining the sinus. All the granulation tissue should be scraped away, leaving a healthy raw surface. The sinus should be drained with gauze and allowed to heal from the bottom. During the process of healing the patient should have the sole of the foot protected by a thick dressing, or should not walk at all.

In some cases amputation may be advisable. The usual treatment for peripheral neuritis, glycosuria, or the nervous lesion, should be carried out.

Ulceration due to Specific Bacteria.—

1. Ulceration in syphilis (see p. 139).
2. Ulceration due to the tubercle bacillus (see p. 118).
3. Soft sores (see p. 148).
4. Ulceration in glanders (see p. 102).

Malignant Ulcers.—These ulcers, including rodent ulcer, will be described in the chapter on Malignant Growths (p. 239).

GANGRENE

DEFINITION.—Gangrene is death of a part of the body. The term is applied to death of any tissue, but certain other terms also given to death of tissue need definition.

A *slough* is a dead piece of the soft tissues, and the process is called "sloughing." Death of the hard tissues (bone and cartilage) is termed *necrosis*, and the dead piece of bone is called a *sequestrum*.

CAUSES.—The causes of gangrene are—

1. Injury to the part, directly killing it. The injury may be *mechanical*, the part being crushed; *thermal*, as in burns, scalds, and some cases of frost-bite; *electrical*, *chemical*, etc.

2. Interference with the blood-supply, as in cases of embolism, thrombosis, arterio-sclerosis, torsion of the bloodvessels, surgical ligature of arteries, etc.

3. Inflammation due either to specific or non-specific organisms.

When a part dies it—

1. Loses its pulsation, owing to stoppage of the arterial supply.
2. Becomes cold, owing to loss of the warm circulating blood.
3. Loses its sensation, due to death of the nerves of the part.
4. Loses its function, owing to death of the cells.
5. Changes its colour.

These signs are present in all dead tissues, but the appearance of the part varies with the cause of the gangrene and the secondary changes which take place in the dead tissue.

Two types of gangrene may be differentiated, *dry* and *moist*, and which of the two is present depends on (1) the rapidity with which death takes place, (2) the amount of moisture in the part, (3) the presence or absence of the organisms of suppuration and putrefaction.

Dry Gangrene is usually due to gradual obstruction of the artery supplying the part, as in arterio-sclerosis, so that death takes place slowly. The condition is almost entirely limited to the extremities, and is most frequently seen in elderly people. Septic and putrefactive organisms are either absent or have little influence on the course of the condition, and if they do infect the tissue seriously, the condition changes to one of moist gangrene. The gangrene spreads slowly, and the separation of the dead tissue is often a matter of months.

SYMPTOMS OF DRY GANGRENE.—Local.—The part affected dries up and becomes hard and wrinkled, the fat is set free from the cells and soaks into the tissue, causing the skin to become semi-transparent like parchment. The part turns brown or black in colour from extravasation of the hæmoglobin of the blood. There is little or no smell. The condition is often very painful, as the nerves may take longer to die than the rest of the tissue.

General.—There are no constitutional symptoms due to the gangrene, as there is no absorption of toxins, and the patient only shows

symptoms of the condition (old age, embolism, etc.) that produced the gangrene.

Moist Gangrene.—Two varieties of moist gangrene must be considered: aseptic and septic.

ASEPTIC MOIST GANGRENE is rare, and is most commonly seen after surgical procedures, such as ligature of a main artery in continuity. The part has been rendered as aseptic as possible before the operation, and aseptic precautions are continued afterwards. The part has the usual signs of death given above, but alters little in size or consistency, although it becomes a greenish-purple in colour. The separation of the dead from the living tissue takes place without marked constitutional disturbance.

SEPTIC MOIST GANGRENE.—The great majority of cases of moist gangrene are infected with septic organisms and the organisms of putrefaction, and the death of the tissue and the spread of the process usually take place with great rapidity. The appearance of the part is mainly due to the changes of decomposition, and gas is found in the tissues. The living tissue lying next to the dead tissue becomes acutely inflamed, and the separation of the dead part is rapid and usually accompanied by marked constitutional symptoms.

SYMPTOMS OF SEPTIC MOIST GANGRENE—Local.—The part is blackish-green in colour from the formation of sulphide of iron from the hæmoglobin of the blood. Bullæ are present on the surface, due to the raising of the epidermis from the true skin, and contain a stinking turbid fluid. Gas is formed in the tissues, causing them to become swollen, and on pressing them a crackling sensation is felt. The tissues liquefy, become soft, easily lacerated, slimy and foul-smelling, and the gangrene spreads rapidly.

General.—The general symptoms are those of sepsis due to the absorption of toxins, and the symptoms of the condition which produced the gangrene.

RESULTS.—A part which is gangrenous must either be absorbed or become separated from the rest of the body.

Absorption only occurs when the dead part is small and remains aseptic. This absorption is best seen after surgical operations, when the parts beyond the ligatures, such as the remnant of the pedicle of an ovarian cyst, die from cutting-off of the blood-supply. The dead portion is invaded by leucocytes, which completely remove it.

Separation of the dead from the living tissue takes place by inflammation occurring in the living tissue lying next to the gangrenous portion.

If the gangrene is *aseptic*, the zone of inflammation is slight, granulation tissue forms slowly, and the growth of epithelium occurs step by step with the breaking down of the granulation tissue, so that when the dead part separates, the surface left is covered with epithelium. This is typically seen in intra-uterine amputations, but it also occurs in cases of dry gangrene in old people when the separation is very slow. This process is sometimes termed *anæmic ulceration*.

In those cases in which *septic* gangrene is present, the zone of in-

inflammation is well marked and extensive, and is termed the *line of demarcation*. Granulation tissue is quickly formed, and rapidly breaks down into pus, so that the dead tissue is quickly separated. This area of inflammation may lead to further gangrene by the inflamed tissue dying, and this accounts in some cases for the spread of the gangrene. The usual complications of sepsis may occur.

In cases of gangrene of a limb, the skin, subcutaneous tissue, and muscles usually die at a higher level than the bone, and contraction during healing is marked, so that the resulting stump is conical.

Treatment of Gangrene—General.—The general treatment consists of treating the cause of the gangrene—*e.g.*, diabetes, somnolence, embolism, and the general treatment of sepsis.

The patient should be put under favourable conditions as regards hygienic surroundings, and his general health maintained by a suitable diet. Stimulants are advisable in old people, and opium should be given to relieve the pain.

Local.—In the first place the local treatment consists of rendering the part as dry and aseptic as possible, as dry gangrene is a much less serious condition than moist. It should be carefully cleaned, dried, powdered with boracic or painted with iodine (2 per cent.), and wrapped in sterile gauze. If the gangrene remains dry, the part should be protected by wrapping it in gauze and cotton-wool, and the condition may be left to Nature to effect a slow separation.

In the case of moist septic gangrene the separation of the dead tissue may be aided by the application of moist heat in the form of fomentations or baths. This moist heat stimulates the activity of the tissues and of the organisms leading to a rapid formation of pus and separation of the dead tissue.

The separation can be aided by cutting away the dead tissue from time to time as it becomes loose. When all the dead tissue has been removed, a healing granulating surface is left which requires the usual treatment.

Amputation in Gangrene.—The question of amputation should always be considered in all cases of gangrene of the limbs, both dry and moist.

If the gangrene is moist and spreading rapidly, amputation should be performed well above the gangrenous portion, and this treatment should also be carried out for dry gangrene in elderly patients if a large part of the limb is dead.

In the first case the high amputation is performed so that there is little risk of the flaps becoming infected, and in the latter case to insure that the flaps have a good blood-supply.

In cases where the gangrene has ceased to spread, immediate operation is not usually called for, and the operation should be delayed until a well-marked line of demarcation shows the exact extent of the gangrene. If the tissues above this are healthy, the amputation should be performed as near as possible to the line of demarcation, proper flaps being secured.

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ULCERATION AND GANGRENE

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VARIETIES OF GANGRENE

Gangrene may be divided according to its cause into—

1. *Gangrene due to interference with the blood-supply.*

(a) **SUDDEN.**

Embolism.
Thrombosis.
Ligature of arteries.
Injury to arteries.

(b) **GRADUAL.**

Senile.
Diabetes.
Raynaud's disease.
Ergot.
Arteritis obliterans.
Bandages.
Pressure (bedsores).

2. *Gangrene from direct injury to the part.*

- (1) Trauma.
- (2) Heat and cold (thermal gangrene).
- (3) Chemical.

3. *Gangrene as a result of infective inflammation.*

- (1) Acute infective gangrene.
- (2) Malignant oedema.
- (3) Noma or cancerum oris.
- (4) Carbuncles and boils.
- (5) Acute necrosis of bone.

1. (a) *Sudden Interference with the Blood-Supply*

Gangrene resulting from **Embolism, Thrombosis, Ligature of Arteries, and Injury to an Artery** depends on a sudden stoppage of the blood-flow through a main artery.

An embolism usually becomes arrested at the place where an artery bifurcates or gives off a large branch, and the embolus stretches across the two openings, which become completely closed by the deposit of fibrin from the blood on the embolus.

Anemia and a bad state of health predispose to thrombosis, which generally follows injury. Gangrene following ligature or injury to an artery—severing it or causing rupture—is commonly termed "indirect traumatic gangrene," and is said to occur more frequently if the main vein is obstructed at the same time as the artery. This, however, is doubtful.

The sudden blocking of the main artery of a limb need not lead to gangrene in young healthy adults with sound arteries; but if the part beyond the block is diseased, especially if the arteries are the seat

of atheroma, gangrene of more or less extent will follow. In the case of young adults, the limb will become cold, lose its sensation, and be painful for a day or two after the interference with the blood-supply, but a collateral circulation will then be established, and all the symptoms pass off.

If the blood-supply of the part has been interfered with previously by an aneurysm or a tumour pressing on the main bloodvessel of the limb, so that a collateral circulation has already been established, ligation of the artery is much less likely to be followed by gangrene.

SYMPTOMS.—In the case of embolism there is a sudden severe pain at the place where the embolus is arrested, and also down the limb in the course of the vessel. The limb becomes cold and congested, and there is loss of power and sensation. The gangrene may be either dry or moist, depending on the rapidity of onset and the extent.

If the vessels of the part are atheromatous and death takes place slowly, dry gangrene will result; but if the gangrene is due entirely to the interference with the blood-supply (as when a tourniquet is left on for too long), the gangrene will be moist. The further symptoms depend entirely on whether the part remains aseptic or becomes infected.

TREATMENT.—The limb should be carefully cleaned, dried, powdered with boracic, and wrapped in aseptic gauze and cotton-wool, or painted with iodine (2 per cent. in spirit). It should be kept raised so as to favour the venous return. If gangrene supervenes, the same treatment should be continued, a line of demarcation waited for, and the limb then amputated just above this.

Should, however, the gangrene be moist, and septic inflammation of the limb occur, high amputation should be performed.

(b) *Gradual Interference with the Blood-Supply*

Senile Gangrene usually occurs in the lower extremity, and may be bilateral. It is more common in men than in women, as the great predisposing cause—degeneration of the arteries—is more frequently met with in the male sex.

The *predisposing causes* of this variety of gangrene are—(1) Atheroma, or calcareous degeneration of the muscular coats of the arteries, leading to a diminished blood-supply. (2) Varicose veins, hindering the venous return. (3) A weak heart-beat, still further diminishing the blood-supply. (4) Degeneration of the kidneys, with the accumulation of toxic bodies in the blood. (5) Degeneration of the tissues generally from the above causes.

When these conditions are present, and gangrene is likely to follow, the patient complains of numbness and loss of sensation in the part, inability to keep the part warm, and cramp in the muscles.

The *exciting causes* of the onset of gangrene are—

1. Thrombosis occurring in one of the main vessels, due to injury.
2. Embolism, usually following detachment of a calcareous plate.
3. Inflammation following a slight injury, such as cutting a corn.

In the last condition the inflammation of the degenerated tissue ends in death, and, as the inflammatory line of demarcation forms, death again results, and so the gangrene spreads by successive attempts to remove the gangrenous part ending in failure.

SYMPTOMS.—This type of gangrene usually starts in the big toe, and may spread to any distance up the limb. It generally becomes arrested at a joint, as the blood-supply is free near a joint, owing to the periarticular anastomosis. The part becomes dry and shrivelled, and there is, as a rule, great pain and cramp in the muscles, the pain persisting even when the gangrene is well advanced, owing to the late death of the nerves. The gangrene may at any time become moist owing to infection by septic organisms or the organisms of decomposition. The general health of the patient suffers from pain, want of sleep, and septic absorption.



FIG. 42.—SENILE GANGRENE OF THE TOE.

TREATMENT.—The preventive treatment of senile gangrene is the careful avoidance of all sources of injury, such as burns from hot-water bottles, cutting corns, blisters from ill-fitting boots, etc. The legs should be kept warm and the diet should be generous. When gangrene is actually present, the part must be kept clean, dry, and aseptic, and carefully covered with a thick layer of cotton-wool. The limb should be kept slightly elevated, so as to favour the venous return. The diet should be light and nutritious, and opium should be given for the relief of pain.

If only one or two toes die and the gangrene is limited, natural separation of the part may be waited for, especially if the patient is feeble and ill able to stand the shock of an amputation; but the process is long, tedious, and painful (weeks or months), and moist gangrene may supervene at any time from infection.

The question of amputation should always be considered early, and in most cases this treatment is the best. The amputation as a rule should be well above the gangrenous part, and in the majority of cases should take place at the knee-joint (Stokes-Gritti's, Stephen Smith's, or Carden's amputation), on account of the free anastomosis of arteries there. Amputation below the knee is likely to result in gangrene of the flaps, but in some cases of very limited gangrene amputation at the ankle may be undertaken if the anterior and posterior tibial vessels are felt to pulsate, and if the patient is very averse to losing more of the limb.

In cases of moist gangrene with septic infection, high amputation is the only means of saving the patient's life, and the amputation should be performed through the thigh.

Diabetic Gangrene.—Two types of diabetes are distinguished. The first occurs in young subjects, and the patients pass a large quantity of urine containing much sugar, waste rapidly, and frequently die in coma. The second occurs in elderly people who are usually fat, and who have only a slight increase in the amount of urine, which contains only a little sugar.

In the first type treatment is of little use. In the second careful dieting will often completely get rid of the sugar, and the disease lasts for years. It is the second of these two types that usually suffers from diabetic gangrene, the disease being associated with atheroma and peripheral neuritis. The condition is closely allied to senile gangrene, but usually occurs at an earlier age, and is more frequently of the moist variety.

SYMPTOMS.—The condition often originates from a slight injury, and the glycosuria may not be suspected until the urine is tested in the routine examination of the urine in cases of gangrene.

The gangrene mostly affects the toes, which are swollen, œdematous, and turn purplish-black in colour. Septic infection usually occurs, and the disease spreads rapidly, as in all infections in diabetic patients.

Even when the gangrenous process ceases, the septic inflammation may continue to spread, and the patient die of toxæmia. In a few cases the gangrene will be of the dry type.

The general symptoms are those of sepsis, and coma may supervene.

TREATMENT.—The condition of glycosuria should receive careful treatment. The carbohydrates in the diet should be strictly limited, and opium or codeine should be given freely.

The local treatment depends on the exact condition present.

1. If the gangrenous area is small and dry, the natural separation of the part may be waited for, the surgeon merely assisting the final stages of removal of the bone. The treatment will consist of keeping the part clean and dry.
2. If the vessels of the limb are not markedly diseased, the gangrene limited, and severe septic inflammation absent, amputation a short distance above the line of demarcation may be completely successful and all that is necessary.
3. If a large part of the limb is gangrenous, and the gangrene is moist, septic, and spreading, high amputation should be carried out as soon as possible. It is rarely of use to amputate below the middle of the thigh. The anæsthetic and shock of the operation may bring on coma, though this is not common in this type of the disease.

Gangrene due to Raynaud's Disease.—Raynaud's disease is a vasomotor disturbance, the cause of which is unknown. It is most common in young subjects between the ages of fifteen and twenty-five, but it

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may also occur in children, and is then often of a severe type. It chiefly affects the extremities, the ears, and the nose. The following conditions are described:

1. *Local Syncope*.—This is associated with arterial spasm, and is the mildest type of the disease. The fingers or toes become blanched, numb, and tingle with pain. After a variable period there is a stage of reaction, and the parts become flushed with blood, hot, and painful.

2. *Local Asphyxia*.—This condition may follow local syncope, or occur independently of it. The vessels are dilated, and the part becomes congested and of a deep blue colour. The asphyxia occurs in attacks which may recur at varying intervals for years, and lasts sometimes for days.

3. *Symmetrical Gangrene*.—The gangrene follows on the condition of local asphyxia, and is usually very slight in amount, the pad of the fingers and toes, the lobules of the ears, or the tip of the nose only being lost, and that only after repeated attacks. In some cases, especially in children, the gangrene is extensive, and may progress rapidly. In one case extensive gangrene of both arms and legs occurred. In other cases patches of gangrene may occur in the abdomen and chest. **Parexysmal hæmoglobinuria** may be associated with the condition, and depends on the spasm of the arterioles of the kidneys. The attacks of hæmoglobinuria usually occur in cold weather.

TREATMENT.—The treatment of local syncope is to keep the parts warm, and employ friction with stimulating lotions. Local asphyxia is treated by protection from cold, friction, and the use of electricity. A method that has met with some success is the electric bath, one terminal of a constant current being placed in the bath and the other on the patient's spine.

If gangrene occurs, the line of demarcation should always be waited for. The condition of local asphyxia generally gives a very false idea of the amount of gangrene that will result, as the deep blue congested area looks as if recovery was impossible. When the line of demarcation is present, amputation should be performed just above it.

Gangrene from Ergot.—This form of gangrene is almost entirely limited to people who eat rye-bread, but it has occurred from medicinal doses of ergot given for a long period.

When associated with the eating of rye-bread, it only occurs when the rye has been attacked by a fungus, the *Claviceps purpurea*, from which ergot is prepared.

The disease most frequently attacks middle-aged men, probably because they are predisposed to gangrene from the arterio-sclerosis due to alcoholism.

Symptoms.—The onset of the gangrene is usually preceded by pain in the extremities, cramps, and formication. The gangrene is dry, and may be of any extent from the loss of a nail to gangrene of a foot, or hand.

TREATMENT.—The use of the diseased rye-bread must be discontinued at once. As it is impossible to foretell the extent of the gangrene,

the part should be kept dry and aseptic until the line of demarcation forms. Amputation is then performed immediately above it.

Gangrene due to Endarteritis Obliterans.—Endarteritis obliterans is a disease due to a toxæmia attacking the intima of the smaller arteries and arterioles. The intima becomes thickened by increase of the number of endothelial cells, so that the lumen of the vessel is gradually obliterated. The outer coat of the arteries is abnormally vascular, and a small round-celled infiltration occurs, which also affects the tunica media. Thrombosis is apt to occur in the vessels.

The disease is most frequently seen in the vessels of the central nervous system, but it may occur in any of the arteries, including those of the extremities, and gangrene may result from insufficient blood-supply.

Syphilis is a frequent cause of this condition, but other toxæmias, such as typhoid fever and lead, may produce the disease.

The gangrene is usually of the dry variety.

TREATMENT.—If the gangrenous part is limited in extent, a line of demarcation should be waited for; but if the gangrene is extensive, the only treatment is high amputation.

Gangrene due to Tight Bandaging.—Gangrene of a limb or part of a limb from this cause is seldom seen, but sloughing of part of the soft tissues is not very uncommon, and will be considered in the next paragraph. If a limb becomes gangrenous, it is nearly always the forearm, and the fault lies in bandaging over the elbow with the joint extended, and then flexing it for the purpose of placing the arm in a sling. The bandage tightens, and first constricts the veins, causing the forearm to become blue and congested. If the bandage is not removed, the swelling continues until the arterial supply is interfered with, and the part becomes gangrenous. After some preliminary pain the part becomes anæsthetic, and the patient will let the bandage stay in position. The gangrene is moist, and is usually septic.

TREATMENT.—The prophylaxis is care in bandaging, and always bandaging the elbow with the joint flexed. If gangrene has supervened, the part should be kept as aseptic as possible, and amputation performed above the line of demarcation.

Gangrene from Pressure.—Gangrene from pressure occurs most commonly over bony prominences from the too tight application of splints, or under plaster of Paris bandages, especially if they are applied under anaesthesia. The pain is often slight, and the sloughing usually only involves the skin and subcutaneous tissue. The gangrene is usually of the moist type. If the part be examined before separation of the dead part has commenced, the skin is seen to be greyish-yellow in colour, is insensitve, and surrounded by a ring of dilated vessels. Careful aseptic treatment may result in dry gangrene.

TREATMENT.—The part should be kept dry and aseptic, and the slough allowed to separate spontaneously. If moist septic gangrene has already supervened when the case is seen, fomentations will hasten the separation of the slough. The granulating surface left after the

slough has separated may be allowed to heal naturally, or if the surface is large, it may be covered by Thiersch's skin-grafts.

Bedsore.—Bedsore is a special form of gangrene due to pressure. They are most commonly seen in old and debilitated thin people who are kept in bed in one position for a long time, such as in the treatment of fractured femur. Interference with the nerve-supply of the part, as occurs in fractured spine or peripheral neuritis, and delirium from any cause, the patient being constantly restless and incapable of appreciating pain, strongly predispose to the development of bedsore. Incontinence of urine and faeces, causing the skin to become sodden, also frequently determines the formation of a bedsore.

Two clinical types can be separated:

1. **Acute Bedsore:** This develops (sometimes in twenty-four hours) in patients suffering from a nerve lesion, usually paraplegia. The part has at first the symptoms of an acute inflammation, being red and oedematous; then blisters form on it, and it becomes gangrenous. Separation of the slough takes place in the usual way.
2. **Chronic Bedsore:** These occur over parts of pressure, chiefly the sacrum and the heels. The part first becomes oedematous, dusky red in colour, and the skin breaks. The gangrene is usually moist, and a slough separates by a line of demarcation.

The majority of bedsore are superficial, only involving the skin and subcutaneous tissues; but occasionally they extend down to the bone, and fatal meningitis has resulted from extension of the septic inflammation into the spinal canal. After the separation of the slough, a granulating surface is left, which heals in the usual way.

TREATMENT—1. *Prophylaxis.*—The bed of the patient must be kept dry, clean, and free from wrinkles, and, if possible, the patient's position should be constantly changed, so that various parts of the body receive the pressure in turn. A water-bed is valuable if bedsore are feared. The skin should be kept dry and clean, and at least once a day the following routine should be carried out: The part where pressure is feared should be washed with soap and water, and rubbed well with a brisk circular movement. After washing, the part is rubbed with methylated or other form of spirit for ten minutes, and it is then thickly dusted with a powder, such as zinc oxide and starch, in equal parts. If in spite of care the part begins to show signs of pressure, the part pressed upon may be relieved by a careful adjustment of air-pads, cushions, or rings, but they are a little difficult to keep in position.

2. *When the Skin is broken over the Part,* the rubbing with spirit is discontinued, but the part round the sore should be well washed with soap and water, dried carefully, and then rubbed with spirit as before. The sore and the surrounding skin should be smeared with zinc and benzoin ointment, care being taken not to leave on an excess of ointment.

3. *When a Slough has formed*, fomentations of boracic, weak lysol, or aseptic poultices should be applied until it separates, separation being hastened by the use of scissors. The granulating surface should then be dressed by a stimulating application, as castor oil and Friar's balsam (equal parts), lotio rubra, eucalyptus ointment, or scarlet R.

In some cases it may be necessary to skin-graft.

2. GANGRENE FROM DIRECT INJURY TO THE PART.

Traumatic Gangrene.—Traumatic gangrene may be divided into direct and indirect. Indirect traumatic gangrene has already been considered under Gangrene due to Sudden Interference with the Blood-Supply. It occurs when the main artery of a limb is ruptured or severed by accident. Direct traumatic gangrene is due to severe crushes or blows, which cause laceration of arteries, nerves, muscles, and, frequently, bones. The gangrene is partly due to interference with the blood-supply, partly to extensive swelling caused by extravasation of the blood, and partly to sepsis, which nearly always supervenes. The type of gangrene is septic moist gangrene.

TREATMENT.—The treatment of this condition is intimately associated with the question of primary amputation after accident, for primary amputation is frequently better treatment than amputation after gangrene has occurred. The guiding principle of the treatment of an injured limb is conservatism, and every effort should be made to save a limb or part of it. This applies especially to the upper extremity. In the lower extremity artificial limbs are exceedingly useful, and in many occupations hardly lessen the patient's wage-earning powers; but no artificial apparatus can (except in the smallest degree) replace the hand. Two fingers, or even one, are more useful than any artificial hand, and no effort should be spared to save the smallest part of the hand. The results of modern aseptic surgery are so good that limbs, which a few years ago would have been amputated, can now be saved by careful treatment of the primary accident. Under the following circumstances, however, amputation is necessary:

1. If the limb only remains attached to the body by a little muscle and skin.
2. If the limb is pulped, as often happens if it is caught in machinery.
3. If the main vessels are severed, so that gangrene is inevitable or has occurred.
4. If the tissues, and especially the nerves, are so injured that the limb will be useless if saved.
5. If severe infection occurs, and particularly if the wound is infected with the bacillus of malignant œdema, and spreading traumatic gangrene results.

In considering the question of amputation, the age and general condition of the patient must be taken into careful consideration. An amputation may be necessary in an aged or feeble patient which could be avoided in a young, healthy adult, with plenty of recuperative

power. It must also be remembered that the loss of a limb in an elderly patient is not so serious a social matter as a similar loss in a young wage-earning subject.

The question of amputation having been decided, the next question that arises is when it should be performed. It may be stated at once that *no operation should be performed while the patient is in a condition of shock*, unless it is considered that the pain of the lacerated nerves is maintaining shock.

All hemorrhage should be arrested by the application of forceps and ligatures, no search for the vessels being made, but the tissues ligatured in masses if necessary. An appropriate dose of morphia should be given for the relief of pain, the injured limb wrapped in sterile gauze, the patient made warm and comfortable in bed, and the treatment of shock carried out.

The solicitations of the patient's friends, and frequently the apparent need to do something, will often tempt the surgeon to operate early, and add the shock of the amputation to the shock of the accident, with fatal results. Amputation should be delayed until the patient's blood-pressure is again firmly established, and not performed whilst it is temporarily raised by the injection of a stimulant or saline infusion. The delay may be as long as twelve or more hours, but this is a matter of no consequence. For amputation of the lower extremity after accidents, stovaine, given by spinal injection, is a useful anæsthetic, and the main nerve trunks may be blocked with cocaine before the operation is performed (see p. 201).

The ideal to be aimed at in amputation after accidents is to save as much of the limb as possible, and classical amputations should be avoided in favour of an amputation designed to meet the particular case.

If it is decided not to perform primary amputation after an accident, the limb should be carefully cleaned, rendered as aseptic as possible, and covered with sterilized gauze, so that should gangrene supervene it may be aseptic. When gangrene is present, the treatment will depend on its nature. If the part is reasonably aseptic, a line of demarcation should be waited for, and amputation performed just above this; but if the gangrene is moist and septic, amputation well above the gangrenous part is necessary.

Thermal Gangrene—BURNS AND SCALDS.—A burn is destruction of part of the body due to the application of dry heat, and a scald is due to moist heat. The two conditions, however, are so similar that they may be described together.

Burns may be divided into four degrees:

First Degree.—The skin is scorched by the application of a flame; the part becomes reddened from hyperæmia, acutely painful, and slightly œdematous. No vesication occurs, but the epithelium becomes desquamated.

Second Degree.—The epidermis becomes raised from the true skin by the formation of blisters, containing a yellowish fluid in which pyogenic organisms are found. The skin surrounding the blister is

reddened. The burns are not very painful, and the epithelium which becomes separated is completely replaced by the true skin so that no scar results. There is, however, frequently discoloration, which may last for months.

Third Degree.—In this degree of burns the true skin is destroyed in patches, and the dead skin has to be separated as a slough. These burns are exceedingly painful, and after the slough has separated, the wounds heal by granulation tissue, so that scarring results. The resulting scar is, however, supple, and does not markedly contract, owing to the numerous islets of true skin that have not been destroyed forming centres from which the new epithelium grows. The sebaceous glands, sweat glands, and hair follicles are not all destroyed in this degree of burn.

Fourth Degree.—The whole of the true skin is destroyed, and the burn may then extend to any depth. The tissue which is destroyed becomes separated in the usual way, and the resulting wound heals by granulation tissue. The scars are dense, and may lead to great contraction and deformity.

These burns may involve large vessels, nerve trunks, and even bones.

It must be remembered that all these degrees of burns may be present in the same case, and the burn is classified from its most severe degree.

SYMPTOMS.—For the sake of convenience of clinical description, the phenomenon of burns may be divided into four stages—(1) Stage of shock, (2) stage of inflammation, (3) stage of separation of the slough, (4) stage of healing; and in each of the stages general and local symptoms must be considered.

1. *Stage of Shock.*—In this stage, which lasts for from twenty-four to forty-eight hours, the *general* symptoms of the patient are of much more importance than the local burn. Immediately after a severe burn, the patient is profoundly shocked, exhibiting all the symptoms of this condition. As a rule, he is apathetic, and does not complain of pain. Occasionally great restlessness and delirium are present. If the *general* symptoms are not marked, owing to the small extent of the burn, the pain is usually severe. It is a matter of dispute whether shock accounts for all the general phenomena present at this stage, and is the sole cause of death if it occurs. On post-mortem examination cloudy swelling of the liver and spleen, multiple minute emboli in various parts of the body, and hæmolytic, with deposits of hæmoglobin in the kidney cells, are found, as well as congestion of the abdominal and thoracic viscera and the membranes of the brain. It is suggested that a toxæmia is present, due to toxins produced by the burns or to non-elimination of normal waste, toxic products by the damaged skin and kidneys. The frequent occurrences of vomiting and diarrhoea during this stage of burns also suggests a toxæmia. In many cases of burns received during fires, poisoning by carbon dioxide and carbon monoxide contribute to a fatal result.

The *local* appearance at this stage depends upon the degree of

the burn. There may be redness, vesication, or a hard brawny condition of the skin, which is frequently charred.

2. *Stage of Inflammation.*—The general symptoms of this stage are those of acute infection, as the condition is a more or less severe septic inflammation of the tissue surrounding the burnt area. The part that has been killed by the burn has to be separated from the living tissue by the formation of granulation tissue, and as a burn is seldom or never aseptic, the inflammation ends in suppuration. The gangrene is usually moist and septic.

The local condition shows a slough surrounded by an area of acute inflammation, and a well-marked line of demarcation develops. The complications at this stage are those of sepsis; erysipelas, cellulitis, or septico-pyæmia may develop. The patient frequently suffers from lung complications such as bronchitis and broncho-pneumonia. The vomiting and diarrhoea frequently continue, and may contribute to a fatal result. This stage of a burn generally merges with the—



FIG. 43. —CONTRACTURES AFTER BURNS.

3. *Stage of the Separation of the Sloughs.*—

During this stage there is usually a constant discharge of pus from the burnt area, but if the treatment has been efficient, septic absorption ceases. The great danger of this stage is the occurrence of severe hæmorrhage, owing to a large vessel being opened by separation of the gangrenous tissue.

4. *The Stage of Healing and Contraction.*—After the separation of the sloughs, a healthy granulating surface is left, which heals in the usual manner by the formation of fibrous tissue and the ingrowth of epithelium. The formation of scar tissue in burns is often very extensive, owing to the large area affected. The amount of contraction may be serious, and lead to severe crippling of the movements of the joints and to considerable deformity.

Duodenal ulcer is a very rare complication of burns, and if it occurs, may lead to perforation. The ulcers which are found in the first and

second stages of the duodenum are believed to be due to toxæmia, and are usually formed in the second or third weeks after the burn.

Erythematous rashes are frequently seen in burn cases, especially in children, and the connection of these rashes with scarlet fever has been the cause of much controversy. It is impossible to distinguish many of these rashes from that of scarlet fever, but the inflamed condition of the tonsils characteristic of that disease is absent.

It has been suggested that the organism of scarlet fever, which is still unknown, gains entrance through the wound.

Whatever view is taken of these rashes, there is no doubt that in the children's wards of hospitals small epidemics of scarlet fever have followed the occurrence of these rashes in burn cases. Albuminuria and hæmaturia sometimes occur in cases of burns, and are due to acute nephritis. If suppuration is prolonged, albuminuria may be due to amyloid changes in the kidneys.

The Prognosis in burns depends on—

1. Age of the patient. Burns are more fatal in children than in adults.
2. Superficial extent of the burn. It has been stated that if one-half the superficial area of the body of an adult is burnt, no matter of what degree the burn is, or one-third of the body of a child, the burn will end fatally.
3. The situation of the burn. Burns on the trunk, especially on the abdomen and chest, are more fatal than burns on the extremities. Scalds in the mouth from drinking hot fluids are frequently fatal from œdema of the glottis or lung complications.
4. The depth of the burn.
5. The presence or absence of sepsis.

TREATMENT—General.—In the first stage of burns the most important treatment is the treatment of the shock. The patient should be put into bed, wrapped in blankets, and hot-water bottles applied to the extremities. Opium should be given freely to relieve the pain, and the further treatment of shock carried out (see p. 201). If the patient survives the stage of shock, the further general treatment is that of an infective condition (see p. 22).

Local Treatment.—The local treatment consists of rendering the skin round the burnt area as aseptic as possible, so that sepsis is reduced to a minimum. If the burn be very extensive, and the clothes burnt and sticking to the skin, the patient should be immersed in a warm boracic bath (temperature 96° F., and 10 drachms of boracic acid to a gallon of water), and the clothes soaked off. The warmth of the bath counteracts the shock, and the boracic is a weak antiseptic.

In less extreme cases the burns should be sponged with a lotion of warm boracic or dilute biniodide of mercury; or, in cases of small, deep burns, an anæsthetic may be given, and the part thoroughly cleaned as for an operation, tissue which is obviously destroyed being removed. Blisters should be dressed after cutting them with

sterilized scissors, as the serum present always contains septic organisms.

The further local treatment consists of the prevention of sepsis, and an aseptic absorbent dressing should be applied.

One of the best dressings is aseptic gauze soaked in a solution of picric acid (picric acid, $1\frac{1}{2}$ drachms; alcohol, 3 ounces; sterilized water, 2 pints), and covered with cotton-wool. This solution is antiseptic, and also promotes the growth of the epithelium. It is therefore useful for all burns, but especially the more superficial ones. The dressing is left in position for three or four days, and is changed as seldom as possible.

Other dressings are—Boracic acid ointment applied on strips of lint, eucalyptus oil, boracic acid powder, and a saturated solution of bicarbonate of soda; but they are all inferior to the picric acid dressing.

If the resulting gangrene is moist and septic inflammation is severe, fomentations of boracic acid will help to cause the more rapid separation of the sloughs, and promote the formation of healthy granulation tissue. Warm boracic baths may be used for the same purpose.

If hæmorrhage occurs during the separation of the sloughs, and fomentations are being used, these must be stopped. The part should be wrapped in aseptic gauze covered by absorbent wool, and the whole secured by firm bandaging.

When the surface is healing, too frequent dressing is to be deprecated, as it causes pain, and the removal of the dressing—however carefully it may be done—injures the growing edge of epithelium. Strong antiseptics are quite unnecessary, and are harmful, while fomentations tend to make the granulations anæmic and too abundant.

A useful dressing is sterilized oiled silk, in which numerous small holes are cut, placed over the wound, a layer of gauze, and then cotton-wool, all being secured with a bandage. Such a dressing only needs changing every two or three days.

During the healing of an extensive burn the great difficulty to overcome is the contraction that occurs owing to the formation of fibrous tissue. This contraction diminishes the size of the wound, and so hastens the healing process, the protecting epithelium not having to cover so large a space as the original wound; but it causes deformity, and may hinder the movements of joints.

If the wound be on a limb, and especially if it be near the flexure of a joint, a splint should be applied, in order to counteract the pull of the fibrous tissue, and the patient should not be allowed to assume a position which, although it will give great ease, will result in healing with deformity. For example, a patient with a burn on the front of the elbow-joint will keep the joint flexed, and when healing has occurred it will be found impossible to straighten the elbow. In such a case a splint should be applied so that the arm is kept extended, and every time the wound is dressed gentle passive movements should be performed, so that the fibrous tissue is kept supple and the joint movable. Every effort should be made to secure rapid healing.

When a scar has formed, it can be rendered more supple by massage and the inunction of ointments, and may be stretched by passive and active movements. Injections of thiosinamin or fibrolysin may be beneficial, and the X rays are useful in diminishing the amount of scar tissue. Contracture may also be prevented by skin-grafting.

X-Ray Burns.—This class of burn is seldom seen now, owing to a greater knowledge of the effect of X rays, the use of shields, and the shorter exposure necessary to obtain radiograms; but in the pioneer days of radiography the condition was frequently seen. Two classes



FIG. 44.—HAND OF A PIONEER X-RAY WORKER.

of cases are recognized— (1) Those due to repeated exposure to the rays, a condition of course most frequently met with in radiographers; and (2) those due to a prolonged exposure at one time, usually for therapeutic purposes.

1. In the first class of case, usually called "X-ray dermatitis," the early symptoms are itching and redness of the skin on the back of the hands. An erythematous rash then appears, the skin becomes dry and scaly, the nails brittle and cracked, and the hair is lost. Later, small superficial ulcers appear on the hands, and if a radiogram is taken of the phalanges, necrosis of the bone is seen. The condition is painful and very persistent, lasting for months and years, and if it does disappear, is apt to

return on re-exposure to the rays. Amputation of a phalanx may not arrest the disease, the necrosis spreading to the next.

Unfortunately, in several instances in the pioneer workers of radiography, all treatment proved unavailing to arrest the disease, and finally carcinoma developed in the affected parts, with fatal results.

2. Exposure to the X rays for a prolonged period at one sitting, although absolutely painless, is followed in about a week by redness of the skin and burning pain. A vesicle develops at the site of the exposure, and bursts in a day or two, leaving a painful, raw surface. A slough of varying depth gradually develops, and is separated by the usual line of demarcation. The process resembles a dry gangrene, and the condition is exceedingly painful, separation taking place very slowly.

TREATMENT.—The treatment is the same as that of an ordinary burn.

Exposure of the scalp to the action of the X rays in the treatment of *theca tonsurans* results in loss of the hair, and although, as a rule, the hair begins to grow in a few weeks, it may be permanently lost if the application has been too prolonged.

Sun-Burns.—Sun-burn, or erythema solare, is a burn of the first degree, caused by direct exposure to the sun's rays. The part becomes red, œdematous, and the seat of burning pain. In a few days the superficial epidermis peels off, and recovery occurs without scarring.

TREATMENT.—The prophylactic treatment consists of not exposing the skin to the direct rays of the sun, and if this cannot be avoided, covering the exposed part with some simple ointment, such as lanoline. The burnt surface should be treated with lanoline, ung. glyc. plumbi subacetat. dil., or vaseline.

Electrical Burns.—Two conditions arise from the passage of strong electrical currents through the body—electrical shock, and electrical burns. Electrical shock may kill the patient at once, as in electrocution, or may cause arrest of respiration and asphyxia. In the latter case, artificial respiration should be started immediately, and may lead to recovery even after some hours.

In electrical burns the paths of entrance and exit of the current are the parts most affected, and charring of the tissues may take place. The burns, like X-ray burns, are little painful at first, and the gangrene produced is aseptic moist gangrene, which very slowly separates from the rest of the tissue.

TREATMENT.—The treatment follows the line of treatment of ordinary burns.

Burns from Lightning.—Lightning has much the same effect on the body as a severe electrical shock, and death occurs immediately in many instances. In other cases, when the patient survives, paralysis may occur, due to hæmorrhages into the brain or cord, or to the effect of the lightning on the nerves and muscles. In the latter case the prognosis of the paralysis is good.

The local effects of the lightning vary from a slight local staining of the skin, often arborescent in appearance, to a severe burn. The arborescent appearance is probably due to breaking up of the red blood-corpuscles and setting free the hæmoglobin along the course of the vessels.

If a burn occurs, it follows the ordinary course of burns, but separation of the slough is usually very slow.

TREATMENT.—The treatment is that of burns due to other causes.

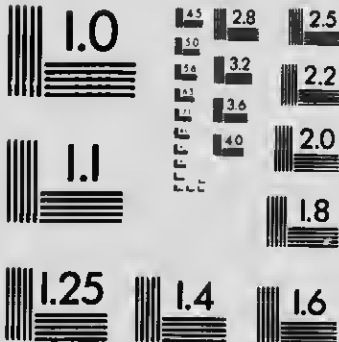
Burns due to Chemicals.—The caustic acids, such as nitric and sulphuric acids, and the caustic alkalis, such as caustic soda, cause burns which in no way differ from those due to heat except perhaps in the staining of the skin, nitric acid staining it yellow, and sulphuric acid causing charring.

TREATMENT.—The treatment of these cases is first to neutralize the chemical, and then to treat as burns due to heat.



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Carbolic Acid Gangrene.—This form of gangrene is usually seen in the fingers and toes when wounds of these parts have been treated by applying gauze dressings soaked in dilute carbolic acid. The condition may occur if the dressings are only left in position for a few hours. The effect of the carbolic is to cause embolism of the blood-vessels, and a dry gangrene occurs, involving the terminal phalanges. The condition gives rise to no pain, probably owing to the anæsthetic effect of the carbolic acid.

TREATMENT.—The line of demarcation should be waited for, and amputation performed just above this.

3. GANGRENE AS A RESULT OF INFECTIVE INFLAMMATION.

1. Acute Infective Gangrene is due to infection of the tissues by non-specific organisms, usually to a mixed infection of various forms of streptococci with other organisms. One of the most important of these is the *Bacillus aerogenes capsulatus*. This organism is a strict anaërobie, non-motile, and retains stains in the presence of Gram's solution. It possesses, as a rule, a well-defined capsule, may form spores, and by its growth produces a large amount of gas both during life and post mortem.

Infection mostly takes place through severe wounds, with extensive crushing and laceration of the tissues, such as bad compound fractures, especially if dirt is ground into the tissues. It may, however, take place through quite trivial wounds, such as bites, pin-pricks, or scratches, and is met with in post-mortem attendants, nurses, and medical students. The patients may have been previously in good health, but more often are debilitated, especially by alcoholism, syphilis, or by living under bad hygienic conditions. Another important predisposing cause is the retention of foul secretions in a wound. The disease sometimes attacks the penis, when the secretions from a soft sore or a chancre are retained under a tight foreskin (phagedæna).

SYMPTOMS—General.—The general symptoms are those of an acute infection, and as a rule the patient is delirious, with a high temperature. In debilitated or old people the temperature may not rise, and the patient passes into a state of low, muttering delirium, with a rapid, small, feeble pulse. Death usually occurs within a week from septic intoxication.

Local.—The local symptoms are those of a very severe cellulitis. The part becomes painful, swollen, and œdematous. There is a thin, acrid, evil-smelling discharge from the wound, the edges of which are brown in colour and slimy. The skin becomes dullish purple; bullæ form on the surface, containing dark blood-stained serum; and if an incision is made into the subcutaneous tissue, there is no bleeding, owing to thrombosis of the vessels. The disease spreads very rapidly, and if the organisms present are gas-forming, emphysematous crackling of the skin soon appears. The condition will spread from the ankle to the knee in the course of twelve hours. If the patient lives long enough, the whole limb becomes gangrenous and stinking.

TREATMENT.—The prophylactic treatment is the careful cleansing of all wounds, especially those that are contaminated with gross dirt. All torn and lacerated tissue should be freely cut away, and thorough drainage established.

The treatment of the condition itself is high amputation, if possible, as soon as the diagnosis is made, for it is the only chance of saving the patient's life. After amputation, the infection very frequently attacks the flaps, and therefore every care should be taken to disinfect the skin thoroughly, and the assistant who touches the limb should take no further part in the operation. If amputation cannot be performed, owing to the situation of the disease, free incision should be made into the infected tissue, and the part kept in a continuous warm antiseptic bath, or covered with hot fomentations.

2. Acute Traumatic Gangrene or Malignant Œdema.—This disease has the same predisposing causes as the previous infection, but the organism is specific, although it may be contaminated with other organisms.

The bacillus of malignant œdema is an anaerobic bacillus found in garden soil, dung-heaps, and cultivated earth generally. It is motile, with flagella, is negative to Gram's stain, and produces a large amount of evil-smelling gas in culture. The organism forms spores, usually situated in the centre, giving it a characteristic spindle shape; the spores are extremely resistant to adverse conditions.



FIG. 45.—BACILLUS OF MALIGNANT ŒDEMA.

SYMPTOMS.—The symptoms of this infection are similar to those of the preceding condition, but the spread is even more rapid and the disease more fatal. Death takes place in two or three days.

Bacteriological examination and discovery of the bacillus is the only certain method of diagnosis.

TREATMENT.—High amputation, undertaken as soon as the disease is diagnosed, is the only means of saving the patient's life, but the disease is generally fatal. The usual general treatment of an acute infection should be carried out.

3. Noma, or Cancrum Oris.—This variety of gangrene mostly affects the mouth, and, in some cases, the vulva. It is most commonly seen in children, especially in those debilitated in health by the acute infectious fevers, as scarlet fever, measles, etc.; or in those who are suffering from a chronic blood disease, such as splenic anæmia. The disease is occasionally met with in adults.

CAUSE.—Various specific organisms have been described as the cause of the disease, but there is no proof that any one of these is the specific agent. In some cases the diphtheria bacillus has been found, and the condition has improved after the injection of antidiphtheritic serum. The condition appears to be a non-specific inflammation, due to a streptococcus combined with various other forms of bacteria.

SYMPTOMS.—The disease starts as an ulcerative stomatitis on the inner aspect of the cheek, which becomes swollen. The first symptoms noticed are inability to open the mouth and the escape of a foul-smelling, blood-stained saliva. If the mouth is opened, a large ragged ulcer with irregular edges and a grey sloughing floor is seen extending over the inner aspect of the cheek. The tissue of the cheek becomes infiltrated and brawny, and two or three days after the onset of the

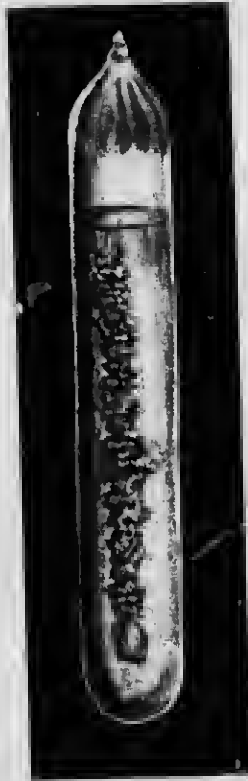


FIG. 46.—ANAEROBIC CULTURE OF THE BACILLUS OF MALIGNANT OEDEMA. FORTY-EIGHT HOURS OLD.

4. Carbuncles.—A carbuncle is a gangrene of the subcutaneous tissue as a result of acute inflammation due to infection by micro-organisms, usually the *Staphylococcus pyogenes aureus*, or *albus*.

ETIOLOGY.—The condition is most frequently met with in patients suffering from glycosuria, chronic alcoholism, or albuminuria, or in those debilitated in health from some other cause. It may, however,

disease a dull purple patch appears on the outer side of the cheek, spreading rapidly. The cheek then becomes perforated, and the gangrenous process may involve the floor of the mouth, the tongue, the orbit, and the jawbones. Secondary hæmorrhage, particularly from the facial artery, is to be feared. The discharge is very foul, and the general symptoms are those of an acute infection.

PROGNOSIS.—The disease generally ends fatally from toxæmia and septic bronchopneumonia. If recovery does occur, there is always considerable deformity from cicatricial contraction, and the upper and lower jaws are usually firmly fixed to one another (false ankylosis of the jaws).

TREATMENT.—As soon as the condition is discovered on the inner side of the cheek, the ulcerating surface should be freely cauterized, preferably by Paquelin's thermo-cautery. Acid nitrate of mercury, pure carbolic acid, chloride of zinc, may also be used, but are not so efficacious as the actual cautery. If gangrene has already occurred, the dead material must be freely removed with scissors and scalpel until the whole surface bleeds freely. This bleeding surface should then be cauterized and the wound dressed aseptically. The mouth and the wound should be frequently sprayed with peroxide of hydrogen, and no effort spared to keep the wound clean.

The general treatment is similar to that of other forms of acute infection.

If healing occur, skin-grafting and plastic operations will be necessary to remedy the resulting deformity.

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occur in previously healthy patients owing to infection taking place through the hair follicles or sebaceous glands.

Carbuncles may form on any part of the body, but are most frequently seen on the back of the neck or on the buttocks, and are most common in males over forty. The disease is rare in children.

SYMPTOMS.—The *general* symptoms are those of sepsis, but as a rule the temperature is not very high (101° to 102° F.) and the toxæmia not severe. In some cases, however, infective thrombosis of the vessels may be extensive, and septico-pyæmia result. *Locally* there is first a hard, brawny infiltration of the subcutaneous tissue, with redness and œdema of the skin. The swelling spreads in all directions, until it may be as large as the palm of the hand. It is exceedingly painful, preventing sleep. Vesicles appear on the surface, and these change to pustules, which burst and exude pus. The amount of discharge gradually increases, and the openings run together, exposing a large grey slough. The separation of the slough takes place slowly by suppuration extending into the surrounding tissue, and finally a large granulating surface is left.

PROGNOSIS.—The prognosis of carbuncle occurring in a previously healthy person is good, even if it be a very large one; but in debilitated people, especially in those suffering from glycosuria or albuminuria, the prognosis is very grave. Carbuncles on the face and anterior part of the neck are also dangerous, as the inflammation often extends to the cranial cavity, causing septic meningitis; or septic thrombosis of the large veins may occur and lead to septico-pyæmia.

TREATMENT.—The *general* treatment is that of acute sepsis, attention also being paid to the glycosuria or albuminuria if these are present. Opium should be given to relieve the pain. The administration of large doses of citrates may considerably hasten the softening of the carbuncle and increase the amount of exudate.

Local.—There are several different methods of treating carbuncles, depending upon the exact condition present, and no routine treatment would be satisfactory in every case.

In the case of small carbuncles seen early, the inflamed area may be excised; or if too large for this treatment, free incisions may be made into the edges of the carbuncle so as to relieve the pain, tension, and septic absorption. If the carbuncle is discharging freely, the softened and gangrenous part may be removed by cutting it away with scissors and scalpel; but an equally good result will be obtained by protecting the area, keeping the carbuncle clean, especially by bathing it with Wright's saline solution, and allowing the slough to separate spontaneously. Fomentations are of value in hastening the separation of the slough, but in some cases they cause a crop of pustules to appear round the carbuncle. This may be avoided by smearing the skin with dilute nitrate of mercury ointment before applying the fomentations.

Bier's Hyperæmic Treatment.—This method of treatment may be used at any stage of the disease. The treatment is carried out once a day, the suction cup being applied six times in three-quarters of an hour, with regular intermissions of two or three minutes.

This method of treatment does not do away with the need of incisions if pus has formed, but the incision should be small, and it is claimed that the duration of the disease is shortened and the resulting scar much smaller than after the older methods of treatment.

Vaccine Therapy.—This has been successful in treatment of carbuncle. The best vaccine is one prepared from the organism cultivated from the carbuncle; but if this is not possible, a stock vaccine of staphylococcus may be used.

Boils.—This condition is described in the chapters on Diseases of the Skin (p. 392).

5. **Acute Necrosis of Bone.**—Acute necrosis of bone in the majority of cases results from an acute inflammation caused by infection of the growing part of a bone by the *Staphylococcus pyogenes aureus*. The condition is one of gangrene of the bone, and is most conveniently described under Diseases of Bone (Chapter XV., p. 484).

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CHAPTER VII

HÆMORRHAGE—SHOCK—DELIRIUM—LEUCOCYTOSIS

HÆMORRHAGE

HÆMORRHAGE is the escape of blood from the bloodvessels, whether arteries, veins, or capillaries; but corresponding with these different vessels, three varieties of hæmorrhage, differing in local symptoms and treatment, are described. The *general* symptoms of hæmorrhage depend on loss of blood from the vascular system and consequent fall in blood-pressure, and are therefore similar in all the varieties of hæmorrhage.

Hæmorrhage is also classified as **external**—*i.e.*, when the blood escapes from the body and can be seen—and **internal or concealed**—*i.e.*, when it remains inside one of the body cavities—*i.e.*, the peritoneal cavity or the alimentary canal. Finally, hæmorrhage is classified into *primary, intermediary or reactionary, and secondary.*

Primary Hæmorrhage occurs *immediately* after division of a bloodvessel, whether artery, vein, or capillary, and is the common form of hæmorrhage met with in surgical operations and accidents.

Intermediary or Reactionary Hæmorrhage occurs some time after the bloodvessel has been wounded, generally within twenty-four hours, and is not associated with septic processes in the wound. It is seen after accidents and surgical operations accompanied by a severe degree of shock. In shock there is a fall in the blood-pressure, which rises again as shock passes off, and when the rise of pressure occurs, the temporary clot occluding the lumen may be driven from the end of the bloodvessel and hæmorrhage restarted. Intermediary hæmorrhage is nearly always arterial.

Secondary Hæmorrhage is caused by infective processes in a wound, which cause ulceration of the vessel wall before thrombosis has occurred in it. The term, strictly speaking, is limited to hæmorrhage from vessels that have been divided in an operation or an accident; but it is also used to include hæmorrhage in connection with ulceration, both simple and malignant. This form is not so frequently seen now as formerly, but it is still a very dangerous form of hæmorrhage, with peculiar difficulties in its treatment.

SYMPTOMS.—The symptoms of hæmorrhage naturally fall into two groups—*general and local.* The *general* symptoms, due to depletion

of the bloodvessels and fall of blood-pressure, vary only in degree with the amount of blood lost. The *local* symptoms vary according as the hæmorrhage is arterial, venous, or capillary; and with variation in symptoms, there is variation in treatment.

GENERAL.—A slight loss of blood is not accompanied by any general symptoms, but as the loss proceeds, the patient becomes increasingly paler, until he is blanched. This pallor is most readily perceived by looking at the conjunctivæ and the mucous membranes. The pulse is full, soft, and rapid, the respiration deep and sighing (air hunger), and attacks of faintness (syncope) occur. The patient's body is bathed in sweat, he is apprehensive and restless, throwing his arms about, sitting up in bed, and complaining of thirst. The temperature falls below normal, and the extremities are cold. The patient complains of dizziness of vision or complete loss of sight (amaurosis) and buzzing in the ears. Finally he becomes unconscious, with Cheyne-Stokes breathing, a failing pulse, and muscular relaxation, with incontinence of urine.

LOCAL—Primary Arterial Hæmorrhage.—When an artery is divided, the escaping blood is bright red in colour, and if the blood-tension is high, it is shot out with considerable force in a series of jerks corresponding to the beats of the heart. The loss of blood is rapid, and in the case of a large artery such as the common femoral, death will take place in less than three minutes if no treatment is adopted. If an artery is divided at the bottom of a deep valvular wound, the blood will apparently escape continuously, as in the case of venous hæmorrhage; but on opening the wound, the true character of the hæmorrhage will be seen. As the bleeding continues and the blood-pressure falls, the force and character of the hæmorrhage will be lost.

The principal loss of blood will occur from the cardiac end of the artery; but if there is a free anastomosis with other arteries, bleeding may be severe from the distal portion, and it is the establishment of a collateral circulation that leads to intermediary hæmorrhage in many cases. The distal end of a large artery should therefore always be secured as well as the proximal.

Primary Venous Hæmorrhage.—Owing to the low blood-pressure in the veins and the ease with which their walls collapse, blood escapes comparatively slowly from a vein unless it be one of the very large venous trunks, such as the internal jugular or the cerebral sinuses; or unless the vein be diseased, so that it cannot collapse, and the valves are incompetent (varicose veins). The blood escapes in a smooth, even stream uninfluenced by the heart-beat, and unless it comes from acutely inflamed tissue or from the pulmonary veins, is of a dark colour.

In hæmorrhage from the great veins of the neck or the axilla the flow of blood may be intermittent; but this intermittency depends on the movements of respiration, and not on the heart-beat, except in some cases of valvular disease of the heart, when there may be a venous pulse in the neck. The respiratory intermittency depends on the

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alteration in the pressure in the thorax during inspiration and expiration. During inspiration the negative pressure in the thorax is increased, the venous return to the heart is quickened, the veins become empty, and the flow from a wound is diminished. It is at this moment that entrance of air into a wounded vein is to be feared. During expiration the negative pressure in the thorax may change to a positive pressure, impeding the return of blood and causing congestion of the veins, with an increased flow from a wound. This increase of pressure in the thorax, with consequent dilatation of the veins, may, if the respiration is seriously embarrassed, as in obstruction of the larynx, cause venous hæmorrhage even from small veins to be serious.

Hæmorrhage from a vein occurs chiefly from the distal end, bleeding from the proximal end being checked by the valves. In those veins, where there are no valves such as the portal system, or if the valves are incompetent as in the case of varicose veins, bleeding from the proximal end may be severe, therefore both ends of a large vein should always be secured.

Primary Capillary Hæmorrhage.—Hæmorrhage from the capillary bed shows itself as a continuous oozing of red blood from many points of a raw surface. It generally ceases spontaneously, but under certain local or general conditions it may be dangerous.

The chief *local* condition that renders capillary hæmorrhage dangerous is the extent of the surface that is oozing. Serious loss of blood may take place after scraping the walls of a large tubercular abscess, or from the placental site after parturition.

The *genera* conditions causing capillary hæmorrhage to be dangerous, are more important, for when they are present, death may occur from hæmorrhage from quite a small surface. The most important of these conditions are certain general diseases, scurvy and leucocythæmia, blood diseases as Henoch's purpura, and certain chronic intoxications such as jaundice. A further cause is the curious family predisposition to hæmorrhage called "hæmophilia," which may cause hæmorrhage from small wounds to be fatal in spite of the most careful general and local treatment.

Intermediary or Reacti-vary Hæmorrhage is due to an interruption in the temporary closure of a wounded vessel, and, as a rule, comes on within twenty-four hours of the primary injury. It is a recurrence of the primary hæmorrhage, due to—(1) reaction after shock, the increasing blood-pressure displacing the newly formed clot in the mouth of the bloodvessel; (2) movement of the part; (3) slipping of a ligature tied round a vessel; (4) establishment of a collateral circulation, and bleeding occurring from the distal end of the vessel; (5) punctured wound of an artery, with displacement of the clot. This form of hæmorrhage is most commonly seen after surgical operations, and the symptoms are the same as those of primary hæmorrhage.

Internal or Concealed Hæmorrhage.—This variety of hæmorrhage is frequently also intermediary, and is especially liable to be dangerous after operations on the abdomen or thorax. It is often met with after

such severe abdominal injuries as rupture of the liver or spleen, and after operations on the rectum and bladder. Although there is usually an accident or an operation preceding this form of hæmorrhage, in some cases it apparently occurs spontaneously, as in the case of ruptured ectopic gestation or hæmorrhage from a latent duodenal ulcer.

The **DIAGNOSIS** of this condition is made by the history and the general symptoms and physical signs of hæmorrhage, although it is usually accompanied by local physical signs. In the case of a ruptured spleen free fluid in the abdominal cavity or dullness on one side is present, and in injuries to the thorax there may be signs of fluid in the pleural cavity. This variety of hæmorrhage is particularly dangerous, both on account of the difficulty of early diagnosis and the serious lesion that usually causes it. Intermediary hæmorrhage, occurring after an abdominal operation, is exceedingly likely to be mistaken for shock, and valuable time may be lost before the mistake is realized.

Secondary Hæmorrhage. Secondary hæmorrhage has been defined above as hæmorrhage due to ulceration of a bloodvessel before thrombosis has occurred. It may or may not be preceded by primary hæmorrhage. The most common cause of this condition is septic infection of a wound containing a large artery, the walls of which become infected, causing **INFECTIVE ARTERITIS**. In infective processes liquefaction of the tissues takes place owing to the peptonizing action of the pyogenic bacteria, and the bloodvessels share with the other tissues in this process. When the endothelium of a bloodvessel is inflamed, a thrombus forms in it; when, therefore, the wall of the vessel liquefies, no hæmorrhage occurs, the thrombus extending into the vessel and closing it. In cases of very virulent infection—especially when the blood-pressure is high, as in the large arteries—the thrombus in the vessel may disintegrate, and the wall of the vessel give way, causing severe hæmorrhage. Secondary hæmorrhage may also be due to ulceration of the vessel wall; it is met with in breaking-down malignant growths, or in simple ulceration associated with typhoid fever or gastric ulcer. Such chronic inflammatory processes ending in suppuration, as tubercular inflammation, may also lead to secondary hæmorrhage. The inflammatory process invades the vessel wall, and a small aneurysm arises as a result. Finally, the wall becomes so weak that it gives way under the blood-pressure, and hæmorrhage takes place. This is the usual cause of hæmorrhage from the lungs in phthisis.

The **SYMPTOMS** of secondary hæmorrhage are the same as those of primary hæmorrhage, and the hæmorrhage may be external or concealed. In many cases when a large vessel is opened, the hæmorrhage is rapidly fatal, although small hæmorrhages commonly give warning of the danger. These small hæmorrhages are recurrent and progressive, and their presence should always lead to thorough investigation of the wound.

In the modern treatment of septic wounds by continuous baths, secondary hæmorrhage must be watched for very carefully, for severe

hæmorrhage may occur into the bath without the patient being aware of the loss of blood, as the only symptom is a pleasant lassitude. A large amount of blood may be lost before the bleeding is discovered.

Natural Arrest of Hæmorrhage. The natural arrest of hæmorrhage is brought about by local and general conditions, and is best studied in the arteries, although the conditions are precisely similar in the veins and capillaries.

LOCAL CONDITIONS. When an artery, such as the radial, is cut across, the inner coat *retracts* and is curled up, owing to the recoil of Henle's membrane, which is chiefly composed of elastic tissue. At the same time the muscular middle coat *contracts* and *retracts* under the outer coat, and so considerably diminishes the lumen of the vessel. This contraction and retraction of the middle and inner coats of an artery may be so pronounced that if the radial artery is torn across, little or no blood may be lost, owing to the lumen of the vessel being closed, and in any case the amount is diminished and the flow partially arrested.

Directly the blood is shed, it tends to clot, and the wound rapidly becomes filled with coagulated blood, which still further hinders the escape of blood from the vessel. This clot is spoken of as **EXTERNAL CLOT**. When the flow of blood is partially arrested in this way, and escapes slowly from the vessel, a clot gradually forms in the mouth of the vessel, and extends some little distance up the lumen, forming an **INTERNAL CLOT**, which arrests the bleeding. The *temporary arrest* of hæmorrhage is brought about by the formation of a clot of blood within the mouth of the divided vessel.

GENERAL CONDITIONS.—The formation of the internal and external clots is aided by the following general conditions dependent on the loss of blood. As blood is lost from the body, the blood-pressure falls, owing to the emptying of the vascular system; but as this fall of blood-pressure is at first prevented by contraction of the arteries and increased force of the heart-beat, a considerable amount of blood may be lost without seriously affecting the blood-pressure. When the loss becomes excessive the blood-pressure falls, and the force with which the blood is expelled from the cut vessel is diminished, so favouring the formation of a clot in the mouth of the vessel.

In the same way the fall of blood-pressure associated with the *shock* of the injury allows the formation of an internal clot. It is important that stimulants should not be given, if shock is associated with loss of blood, until the bleeding vessel has been secured.

Another general condition favouring the arrest of hæmorrhage as bleeding proceeds is the alteration of the specific gravity of the blood and increase of its coagulability. During the loss of blood from the vascular system there is an absorption of lymph from the lymphatic spaces of the body and an increase in the number of white corpuscles in the blood, both factors leading to an increase of its coagulability, and so favouring the formation of both external and internal clot.

The *permanent arrest* of hæmorrhage does not take place until the end of the vessel is closed by the formation of granulation tissue, and

the temporary clot may be disturbed from various causes, leading to intermediary hæmorrhage. The internal clot takes no part in the permanent arrest of hæmorrhage beyond forming a pabulum for the formation of granulation tissue, which changes to fibrous tissue and seals the end of the vessel. The healing of a wound in an artery occurs in precisely the same way as the healing of a wound in any other tissue, by multiplication of the endothelial cells and the formation of new bloodvessels from the *vasa vasorum*.

AFTER-EFFECTS OF HÆMORRHAGE.—Immediately after a severe hæmorrhage the specific gravity of the blood is lowered, there is a leucocytosis, nucleated red blood-corpuscles appear in the vessels, the number of red cells is diminished, and the amount of hæmoglobin is less than normal. This condition of secondary anaemia is rapidly recovered from in the case of young patients, and in a fortnight all traces of a severe hæmorrhage may be obliterated; but in older subjects recovery is slow, and in the case of the aged a permanent anaemia may result from a large loss of blood.

TREATMENT—Preventive.—Hæmorrhago may be prevented in surgical operations by the application of a tourniquet sufficiently tightly to block the main artery supplying the part. In the case of a limb the part should be elevated for two or three minutes, in order to empty it partially of blood; and then, still keeping it elevated, the limb should be bandaged from the extremity upwards with an elastic bandage. A tourniquet should be firmly applied just above the elastic bandage, which is then removed. The limb will be found to be comparatively bloodless, and during the operation hæmorrhago will be reduced to a minimum. An objection to this method of preventing hæmorrhago is the amount of oozing that takes place from the severed vessels after the tourniquet is removed. The amount of this oozing may be diminished by applying the dressings and bandaging the limb firmly before the tourniquet is removed.

Other methods of diminishing hæmorrhage, especially during amputations of the limbs, are digital compression, temporary ligature or compression with forceps, or ligature of the main artery of the limb.

In those cases when an operation has to be performed on a patient suffering from some general condition which diminishes the coagulability of the blood, such as hæmophilia, jaundice, or leucocythæmia, calcium chloride may be administered before the operation. The drug should be given in 30-grain doses three times a day for two or three days before and after the operation. Many surgeons deny the use of this drug in preventing capillary oozing, but it is certainly harmless, and may be tried with other remedies to arrest hæmorrhage.

GENERAL.—The general treatment of hæmorrhage consists of promoting the rapid formation of an internal clot in the bleeding vessel, keeping the brain supplied with blood during the period of shock, supplying the amount of fluid in the vascular system necessary to maintain the blood-pressure, and, later, stimulating the blood-forming organs to replace the blood lost during the hæmorrhage.

1. *Rest*.—The patient should be kept completely at rest, with the foot of the bed elevated so that the head is the lowest part of the body, and if the hæmorrhage is severe, the limbs should be carefully bandaged from the extremities to the trunk in order to keep the thorax and brain well supplied with blood. This rest is valuable in quieting the heart's action, and so lessening arterial tension. Restlessness should be met with quiet restraint or the administration of sedatives. Of these, the most valuable is morphia, given in $\frac{1}{4}$ -grain doses, and it is especially useful when hæmorrhage is occurring from the intestine, lungs, or stomach, and surgical interference is contra-indicated.

2. *Shock* should be guarded against by warmth, but under no circumstances should stimulants be given unless the bleeding vessel has been securely ligatured.

In cases of severe "air hunger" oxygen should be given, provided the source of hæmorrhage is stopped.

3. *Drugs* are of little use in the general treatment of hæmorrhage, but the following have been recommended: Ergot, acetate of lead, tannic acid, gallic acid, adrenalin, and hamamelis. Of these, the most important is ergot.

Ergot or its alkaloids taken by the mouth or hypodermically, causes contraction of the muscular coat of the arteries, and so diminishes their lumen and the amount of blood lost. At the same time, however, it raises the general blood-pressure, and this more than counteracts its beneficial action on the vessels. Its use is almost entirely confined to gynæcological practice, where it is extremely valuable, for it has the same effect on the unstriated muscular tissue of the uterus as on the middle coat of the arteries, and, by causing forcible contraction of the organ, compresses the veins and blood sinuses in its walls. It is largely used in the treatment of post-partum hæmorrhage and menorrhagia.

4. *Infusion*.—The cause of death from hæmorrhage is the excessive fall of blood-pressure, due to the emptiness of the vascular system. This can be prevented by giving fluids to replace the blood lost. They should only be given after the hæmorrhage has been securely arrested, or, by raising the blood-pressure, they will increase the amount of blood lost, and, by displacing clots from the vessels, may cause intermediary hæmorrhage. Fluid may be given—(1) By the mouth; (2) by the rectum; (3) subcutaneously; (4) intravenously; the fluid most commonly used being normal saline fluid at a temperature of 110° F. This fluid is made by adding 1 drachm of sodium chloride to a pint of distilled water.

(1) *Mouth*.—The fluid lost during a severe hæmorrhage can often be supplied by drinking, and in cases of emergency abdominal operation, the patient should be encouraged to take fluid freely so long as it does not cause vomiting.

(2) *Rectum*.—Fluid may be given by the rectum, either as a single injection given slowly or as a continuous injection. For the first method the buttocks should be well raised on a pillow, and the saline fluid, at a temperature of 100° F., allowed to run in slowly from a funnel, to which an india-

rubber tube is attached. About 2 pints can be given in this manner; but the injection must be given slowly, or it will act as an enema. About half an hour should be occupied in running in 2 pints.

Continuous Injection.—A small Ferguson's vaginal speculum is introduced into the rectum, and through it is passed an india-rubber tube connected with a vessel containing the warm saline solution. The fluid is allowed to run in by siphonage at the rate of 1 pint an hour; it is readily absorbed. The fluid must be kept warm by heating with a spirit-lamp, or by surrounding the vessel containing it with a water-bath. After 2 to 6 pints have been given, the flow is disconnected for an hour or two, and a turpentine enema given to empty the bowel. The flow is then started again, and continued with intervals until it is decided that fluid is no longer required to maintain the blood-pressure.

- (3) *Subcutaneous Injection.*—Fluid can be given in this way by a large injection or continuously. As a large injection, the fluid is injected by means of a syringe, fitted with a large needle, into the loose cellular tissue under the breasts or in the flanks. About $\frac{1}{2}$ pint can be injected under each breast, but the injection is somewhat painful, and the fluid is only slowly absorbed.

Continuous Subcutaneous Injection.—The saline fluid is contained in a large glass bowl, which is kept in a hot-water bath, so that the temperature does not fall below 110° F. Hot water must be added to the bath from time to time. From the bowl a long india-rubber tube leads, and is connected by a Y-shaped junction with two tubes, into which hollow needles are fitted. A ball is fitted into the middle of the single tube, so that the whole apparatus can be easily filled with fluid.

The skin of the front of the patient's thigh should be cleaned as for an operation, and all the tubes and needles sterilized. The needles are filled with the fluid, and when it is running freely, they are thrust well into the subcutaneous tissue of the thigh, and secured by a piece of strapping. The fluid will then pass by siphonage into the patient's tissues. The tubes are fitted with clips in order that the rate of flow can be regulated or checked entirely.

Not more than a pint of fluid should be allowed to flow in one hour, and the amount injected depends upon the condition of the pulse. Infusion may be continued for days. If the fluid is run in too quickly, the tissues round the needles will become œdematous, and the infusion must be stopped, and the œdema removed by gentle massage, after which the flow may be again started. Occasionally, while the infusion is continuing, the patient becomes cyanosed, restless, and the pulse fails. The infusion should at once be stopped, stimulants given, or artificial respiration tried.

Adrenalin, in the proportion of 1 in 50,000 to 1 in 100,000, may be added to the saline fluid.

- (4) *Intravenous Injection.*—The vein usually selected for this operation is the median basilic of the left arm, but any vein which is large enough to receive the canula may be utilized.

The fluid used is saline solution, 1 drachm to a pint at a temperature of 105° F. In practice, the solution should be prepared at 110° F., for cooling occurs during the time taken to give the injection. The amount injected varies from 3 to 6 pints. The solution should be made with sterile water, and kept in a sterilized glass flask, the neck of which is closed with a plug of cotton-wool. When wanted for use, the flask may be placed in a hot-water bath; or if the solution is more concentrated than a drachm to a pint, hot sterilized water can be added until the dilution and temperature are correct.

The instruments required are—A two-way syringe holding about 5 ounces of fluid, canula, scalpel, dissecting forceps, aneurysm needle, scissors, ligatures, needles, and sutures. No anæsthetic is necessary, but an injection of eucaine may be given under the skin at the bend of the elbow.

A bandage is fastened round the upper arm tightly enough to constrict the veins, but not the artery, so that the veins at the bend of the elbow stand out clearly. The skin on the elbow is then cleaned, and the operation done under strict aseptic precautions.

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An incision is made over the selected vein, and about $\frac{1}{2}$ inch of it is laid bare. A double ligature is passed under the vein and divided, one end being placed at the upper end of the wound and the other at the lower. The lower ligature is loosely tied, in order to occlude the vein. A transverse slit is made in the vein, and the canula quickly inserted and secured by tying the upper ligature round the vein and needle. The bandage is then removed from the upper arm.

The syringe and the india-rubber tube leading to the canula are filled with the saline fluid, and the canula itself is allowed to fill with blood. These precautions are necessary to prevent air from being forced into the vein—a condition which may be dangerous. The tube and the canula are connected, and the fluid then slowly injected into the vein. The stream of fluid will produce a thrill that can be readily felt along the course of the vein, and which indicates that the fluid is running in easily. If a difficulty is experienced, the injection should be at once stopped, and the cause of the obstruction removed. (Edema round the elbow shows that the injection is being made too quickly, and that the fluid is not running along the vein, but passing into the subcutaneous tissue.)

The amount injected should be from 2 to 4 pints, according to the age of the patient and the amount of blood which has been lost; but the condition of the pulse should be carefully watched. Infusion should not, however, be discontinued directly on improvement in the pulse, for if this be done, it will soon be found to fail again. The infusion may be repeated, if necessary.

Should the ordinary apparatus for infusion not be at hand, an exploring needle may be plunged straight into a subcutaneous vein, and the fluid allowed to run in from a tube and funnel.

Adrenalin may be added to the fluid to be injected. If dyspnoea and cyanosis occur during the operation, the injection must be at once stopped, and artificial respiration started, if necessary.

After the required amount is injected, the canula and both ligatures are removed. The small skin incision is sutured, and all hæmorrhage arrested by a pad and bandage. If the vein is not ligatured, it may be used for a subsequent injection if this should be necessary. It must be remembered that the brachial artery lies immediately below the basilic vein, separated from it by the bicipital fascia. If a careless dissection of the vein be made, this vessel may be injured and an arterio-venous aneurysm result.

If the injection is likely to be repeated, the canula may be left *in situ*, with the india-rubber tube filled with saline fluid. A clip is placed on the tube and removed when the injection is to be repeated. Coagulation of the blood does not occur.

Rigors occasionally follow the intravenous injection of saline fluid. They usually occur about half an hour after the injection, and are of no importance. The patient should be kept warm, and no other treatment is necessary.

5. *Transfusion*.—The transfusion of the living blood of animals into the human subject has been abandoned on account of the danger of intravascular clotting and hæmolytic, and the infusion of defibrinated blood has been followed by dyspnoea, diarrhoea, and blood-stained effusions into serous cavities. In recent years the direct transfusion of blood from man to man has been advocated and practised in the treatment of hæmorrhage and shock. The method of procedure is to anastomose a peripheral artery, such as the radial of the donor, with a peripheral vein, such as the median basilic, of the recipient by suture or canula, and allow a direct flow of blood from one to the other. This method of treatment has been chiefly advocated by Professor Crile of America, and has been successfully carried out in many cases without ill-effects to the donor, and with great advantage to the recipient.

The general treatment of hæmorrhage after the acute stage is

passed consists of giving a generous diet, with red wines, and placing the patient under good hygienic conditions. Iron, arsenic, cod-liver oil, and nux vomica are useful.

LOCAL.—First-Aid Treatment—Primary Arterial Hæmorrhage.—The part should be elevated, and the wound quickly and thoroughly exposed, and the bleeding vessel pressed upon by the surgeon's thumb, or a piece of lint, linen, etc., as clean as possible, pressed into the wound. The circulation in the vessel should be controlled by pressure of the thumb of the other hand in the course of the artery, taking care to press the vessel against a bone, and not against the soft parts. All arterial hæmorrhage can be controlled in this way until further aid is at hand. The special places to compress the various arteries in the treatment of hæmorrhage are as follows:

Lower Extremity.—In all hæmorrhage from the lower extremity above the foot the common femoral artery should be compressed just below Poupart's ligament against the pubis, pressure being made backwards and a little inwards. The artery lies midway between the anterior superior spine of the ilium and symphysis pubis.

Foot.—If the bleeding be from the sole of the foot, pressure should be made on the posterior tibial artery midway between the prominence of the heel and the internal malleolus, pressure being made directly outwards. If the bleeding be in the front of the foot, the anterior tibial should be pressed directly backwards, midway between the two malleoli.

Upper Extremity.—If the bleeding be below the axilla, the brachial artery should be compressed against the humerus, as it runs along the inner border of the biceps muscle. Pressure should be made outwards and backwards. If the wound be in the axilla, pressure should be made on the subclavian artery above the clavicle downwards against the first rib. Pressure can be made with the thumb, with a door-key, or with a piece of wood wrapped in a handkerchief.

Bleeding from the Palmar Arch can be arrested by placing a piece of cork or a roller bandage, covered by a handkerchief, in the hand, and bandaging the fingers over it. The limb should be elevated.

Head and Neck.—If the hæmorrhage occur in the head or neck, the common carotid artery should be pressed backwards and slightly inwards against the tubercle on the transverse process of the sixth cervical vertebra, Chassaignac's tubercle. This tubercle is about 1 inch above the clavicle.

Hæmorrhage from the scalp can be arrested by direct pressure on the artery against the bony vault.

Tourniquets are instruments for compressing the artery above a wound, and the ideal tourniquet should imitate the action of the compressing thumb—that is, it should press upon the artery only, not on the accompanying vein or any other part of the limb. If no proper tourniquet be at hand, one can be improvised from a handkerchief and a piece of stick. A stone, a roller bandage, or a piece of wood, is placed on the selected part of the artery; the handkerchief is laid over this so as to encircle the limb, and its ends being tied, a few turns

of the stick through the loop of the handkerchief will make sufficient pressure to stop the flow of blood. Special forms of tourniquets are—

1. *Esmarch's Elastic Tourniquet*.—This consists of a piece of stout elastic tubing, into one end of which a hook is fixed, and at the other a short chain. The tourniquet is wound tightly round the limb, and the hook fixed to one of the links of the chain. It has the advantage that no anatomical knowledge is necessary for its application, therefore it can be used by anyone. Its disadvantages are that it compresses all the structures of the limb, nerves and veins as well as the artery, and that considerable strength is necessary in order to apply it tightly enough. It is mostly used as a means of controlling hæmorrhage during amputation and other operations, and can then be deliberately applied.

This plain elastic tube has been modified by passing it through a hole in a piece of boxwood, in which a groove has also been cut. The wood is placed in the line of the artery, the elastic tube stretched over the limb, and fastened by introducing it into the groove. The artery is the principal structure compressed if the wood is placed in the proper position, and the tourniquet is very easy to apply.

2. *Petit's Tourniquet* was invented in 1718. It consists of a webbing band passing round the limb and fastened with a buckle. A pad, which can be clamped down on to the artery by means of a thumb-screw, is attached to this band. The pad must be adjusted over the line of the artery, and in such a place that pressure can be made against a bone. It is not suitable for quick application to arrest hæmorrhage, and for amputations it has given place to the elastic tourniquet. It is, however, useful in deliberate treatment of hæmorrhage, as the screw can be relaxed in order to guide the surgeon to the wound when the vessel is exposed, and again tightened with little loss of time.

In cases of hæmorrhage from the lower extremity the tourniquet should be applied at or about the middle of the thigh, and in the upper extremity to the brachial in the middle of the arm.

A tourniquet must not be left on a limb for longer than two hours, or gangrene may occur. The actual time should be as short as possible, as the patient suffers intense pain in the limb, owing to the constriction of the nerves and bloodvessels. The special points to be noticed are—

1. That the tourniquet is applied tightly enough, or the veins, and not the artery, are compressed, and the bleeding increased.
2. That the tourniquet should never be used for venous hæmorrhage.
3. That it is only to be used when the bleeding is from a vessel in one of the limbs.
4. That it must not be left on longer than two hours.

Deliberate Treatment of Primary Arterial Hæmorrhage.—If the hæmorrhage has been naturally arrested, the surgeon should only interfere in the following circumstances:

1. When it is necessary to clean the wound in order to prevent sepsis. The hæmorrhage will usually recommence, and the vessel should be secured.
2. If the proximal end has been tied, but not the distal, and it is feared that when the anastomotic circulation has become established, bleeding may take place.
3. In punctured wounds of arteries recurrent hæmorrhage is common, and the artery should be tied above and below the puncture, and the vessel then divided between the two ligatures.

The great principles of treatment of wounded arteries are—(1) That the wounded vessel should be secured *in situ*; and (2) that both ends of the artery should be tied.

If the wound be at all large and deep, an anæsthetic should be given, so that it may be thoroughly cleaned and a deliberate search made for the bleeding-point. The wound should be enlarged if necessary, the bleeding vessel seized with artery forceps, and secured by a catgut or silk ligature. The exceptions to this rule are few, but in some cases pressure should be applied, for example—

1. In cases of hæmorrhage from a cavity, where pressure easily controls the hæmorrhage, as after removal of necrosed bone, or from the socket of a tooth.

2. In cases of hæmorrhage from the walls of cysts or hollow organs, which cannot be otherwise controlled, as in hæmorrhage from a cystic goitre, or from the uterus. The cavity must be carefully packed with gauze from the bottom.

3. In cases of deep hæmorrhage, where ligatures cannot be applied, and where pressure can be applied directly to the bleeding vessel and against structures firm enough to afford counter-pressure, as in bleeding from the deep palmar arch, or hæmorrhage after operations on the deep urethra. The pressure should be made directly on the artery, and not in the form of a graduated compress on the surface. In some cases, although the bleeding artery has been seized with forceps, it will be found difficult or impossible to secure it with a ligature. Under these circumstances two methods can be employed: (1) The artery may be sealed by **torsion** by gently drawing upon it, twisting it about eight turns, and then removing the forceps. This can be trusted to close even the largest arteries. When closing the artery by torsion, it is important to seize the artery as cleanly as possible, and in cases of large arteries care must be taken that one blade of the forceps is not introduced into the lumen. The artery should *not* be twisted until the forceps come away by breaking off the twisted part. (2) The forceps may be left on and a dressing applied round them. They should be removed in twelve to twenty-four hours, according to the size of the vessel.

Acupressure is seldom used, but a vessel may be closed by passing a suture under it, and tying it over the vessel. This method is useful when the suture serves to unite the edges of the wound at the same time, as in the scalp and in wounds of the liver and spleen. It is

also useful in stopping hæmorrhage from small bleeding-points in the gut.

Ligation of the Main Artery in Continuity.—In a few cases the principle of always tying the bleeding-point may be departed from, and the main artery of the part tied in continuity. These exceptions are—(1) Wounds of the deep branches of the external carotid; (2) the branches of the internal carotid; (3) the deep palmar arch; (4) the plantar arch. The method of treatment in these cases will be found under Wounds of Special Arteries (see p. 195).

First-Aid Treatment of Venous Hæmorrhage.—Venous hæmorrhage is rarely dangerous, unless from a varicose vein. In this condition the veins are held open by their adhesions to the surrounding tissues, therefore they cannot collapse, and the valves are also incompetent. Hæmorrhage may be fatal, especially as the loss of blood may not attract notice until a serious amount has been lost. The limb should be elevated, and all constricting bands between the bleeding vein and the heart loosened. This will often be adequate to stop the hæmorrhage. The wound should be covered with an aseptic pad secured by a bandage, and the limb should be bandaged from the extremity up to the wound, so that there is no congestion of veins below the seat of injury.

Deliberate Treatment of Venous Hæmorrhage.—The same methods are used as in the treatment of arterial hæmorrhage, but as a rule the distal end only of the vein needs to be secured, with the following exceptions: (1) Varicose veins; (2) all veins markedly influenced by the movements of the chest; (3) all veins devoid of valves *on the cardiac side of the injured spot*, such as the innominate and the vena cava.

A punctured or lateral wound of a large vein should be closed by suture or by a lateral ligature, as the vein will not then become occluded. In the case of the severance of the main vein of a limb the companion artery should *not* be tied.

Treatment of Capillary Hæmorrhage.—Capillary hæmorrhage is rarely dangerous. It can be arrested by the application of heat, cold, pressure, and hæmostatics.

Heat.—This is very useful in hæmorrhage from the face, the uterus, inflamed bone, etc. It should be applied in the form of hot water at a temperature of 115° F. Less than this will favour vascular engorgement, and a much greater temperature will scald the tissues. Heat may also be used in the form of the cauterium at a dull red heat, and in this form it is very useful in stopping parenchymatous oozing from such organs as the spleen and the liver. It has this drawback, that when the sloughs produced by the burn separate, hæmorrhage may start again.

Cold.—This can be applied in the form of cold water or ice, and is used in the treatment of hæmorrhage from the nose, mouth, and throat.

Pressure.—Care must be taken that the pressure is not sufficient to impair the vitality of the tissues and cause gangrene, and it should

be distributed over a large area, and not actually localized to the bleeding-point. In cases of deep wounds the hæmorrhage may be stopped by carefully plugging the wound from the bottom.

Hæmostatics.—The most commonly used are turpentine, perchloride of iron, thyroid extract, and adrenalin.

Wright's styptic is an extract of the thymus or testis made with saline solution, to which 5 per cent. of calcium chloride and a trace of sodium carbonate are added, with 1 per cent. carbolic acid as a preservative. The styptic is applied locally.

Before hæmostatics are employed, the wound should be carefully dried, and the hæmostatic applied directly to the bleeding vessels.

Treatment of Intermediary Hæmorrhage.—The treatment of intermediary hæmorrhage is the same as that of primary hæmorrhage. If the bleeding is slight, it may be arrested by pressure and elevation; but if this fails, the wound should be opened up, all the blood-clot removed, and the bleeding vessel secured by ligature.

Treatment of Secondary Hæmorrhage.—This is conducted under the following two rules:

1. That, even if the hæmorrhage has ceased spontaneously, operative interference is necessary to prevent its return.
2. That the bleeding artery should be secured *in situ*.

Exceptions to these rules are uncommon. If a wound becomes infected and secondary hæmorrhage is to be feared, every precaution should be taken to arrest the hæmorrhage, should it occur. If the wound be in a limb, a tourniquet should be placed in a convenient and exposed place, so that it can be seen at once and applied by anyone. The dressing should be as small as possible, in order that the hæmorrhage can be detected immediately, and should be applied by firm bandaging. The limb should be kept elevated. When a bath is being used, it must be frequently inspected; for unsuspected hæmorrhage may occur into the bath, and the patient become profoundly anæmic before attention is drawn to the bleeding. If hæmorrhage takes place, it should be arrested by pressure on the vessel or by the application of a tourniquet, and then an anæsthetic should be given if the patient's condition allows it. The wound should be thoroughly opened up, no matter how far healing has progressed, all blood-clot removed, and the bleeding-point seized with forceps and ligatured. Torsion should not be used. When the tissue is sloughing, so that the forceps will not hold, a stitch can be passed deeply through the tissues so as to include the artery, and then tied. The wound should be thoroughly cleaned, and rendered as nearly aseptic as possible, a light dressing applied, and the patient carefully watched for any recurrence of the hæmorrhage. Under the following conditions ligature is useless:

1. If the ligature will not hold on account of the sloughing condition of the part, or if the blood is oozing from a mass of septic granulation tissue. The hæmorrhage should be stopped by the application of the actual cautery at a dull red heat.

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2. When oozing occurs from the wound owing to some constitutional cause, such as jaundice, or hæmophilia, or leucocythæmia. The hæmorrhage should be treated by pressure and the application of such hæmostatics as adrenalin or turpentine.

3. When, on account of the position of the vessels, such as the naso-pharynx, the neck, and the abdomen, it is impossible to secure the vessel. The wound, after being opened up, should be plugged with aseptic gauze, which should be left in position for two or three days. In cases of arteries in the neck or naso-pharynx, ligature of the external carotid may arrest the hæmorrhage.

4. In cases of amputation near the trunk, if the bleeding recurs after an attempt has been made to arrest it by opening up the flaps, ligature of the main artery above the stump is the only mode of procedure.

5. In cases of amputation below the knee, when tying the artery on the face of the stump has failed, amputation at a higher level is the only resource, ligature of the femoral, as a rule, being useless. Ligature in continuity to arrest secondary hæmorrhage is likely to be followed by gangrene, and is also very apt to fail, for it is difficult to ascertain from which vessel the blood is coming.

HÆMORRHAGE FROM ARTERIES OPENED BY ULCERATION, either simple or malignant, must be treated on the same principles as other forms of secondary hæmorrhage. If the loss of blood has been severe, the bleeding-point should be sought for, even if the bleeding has ceased, and a ligature applied above and below the opening, if possible. Proximal ligature is only justifiable when ligature *in situ* is impossible, or an attempt to carry it out has failed.

WOUNDS OF SPECIAL ARTERIES

Internal Carotid.—If this artery be wounded deep in the neck, the best chance of recovery is given by ligature of the common carotid.

Internal Maxillary.—An attempt should be made to arrest the hæmorrhage by the application of heat, cold, styptics, and pressure. If these methods fail, the external carotid should be tied between its lingual and the superior thyroid branches.

Lingual Artery.—An attempt should be made to tie the bleeding vessel in the mouth, or a deep stitch may be passed through the tongue. If this fail, and the surgeon is sure the bleeding is from the lingual, that artery should be tied where it lies under cover of the hyoglossus. If the source of the bleeding is not certain, the external carotid should be tied.

Vertebral Artery.—Diagnosis is difficult, because pressure on the carotid below the transverse process of the sixth cervical vertebra will cause pressure on the vertebral, and the case may be mistaken for carotid bleeding. If an attempt to tie the bleeding-point fail, the wound should be carefully plugged; or if the vessel can be seized with forceps, these may be left on for twenty-four hours.

Internal Mammary.—The ends of the artery must always be tied, a costal cartilage being resected if necessary. The artery lies about $\frac{1}{2}$ inch from the sternum.

Intercostal Artery.—As a temporary measure, a piece of linen is pushed through the wound in order to form a pocket, and into this pocket pieces of linen are packed so as to make it too large to pass through the intercostal space. It is then pulled upon, and secured in position by a couple of pins. Permanent arrest is obtained by exposing and tying the artery as it lies in a groove on the under surface of the rib. A piece of rib is resected if necessary.

Axillary Artery.—The bleeding-point should always be well exposed, as it is often impossible to say whether the main artery or a branch has been divided. It may be necessary to divide both pectorals across the plane of their fibres in order to expose the severed vessel.

In cases of secondary hæmorrhage, the subclavian artery above the clavicle must only be tied as a last resource.

Superficial Palmar Arch.—This arch lies immediately under the deep palmar fascia in a line with the abducted thumb, and is superficial to the tendons and nerves in the palm of the hand. It should be exposed and the bleeding-point secured.

Deep Palmar Arch.—This arch lies on the bases of the metacarpal bones between the second and fifth, about $\frac{3}{4}$ inch higher in the palm than the superficial arch. An attempt should be made to secure the bleeding-point, and if forceps can be applied, these may be left *in situ*. If this fails, the wound should be carefully packed with gauze, a firm bandage applied, and the limb kept well elevated. When the patient has to get about, full flexion of the elbow will help to arrest the bleeding.

If these methods fail, the surgeon may deviate from the usual rule, and either tie *both* the radial and ulnar arteries at the wrist, or the brachial in the arm. Ligature of the two arteries is probably the better treatment.

Wounds of the Arteries of the Leg may be treated with elevation and pressure if the bleeding is not profuse; but it may be necessary to cut down and expose the vessel. In cases of secondary hæmorrhage it may be impossible to secure the bleeding vessel, and in these cases the superficial femoral should be ligatured in Hunter's anal.

Wounds of a Cranial Sinus must be met by careful plugging with aseptic gauze.

Hæmorrhage from the Socket of a Tooth may be continuous and serious in amount. It should be arrested by removing all clots, and passing a narrow strip of lint soaked in a hæmostatic down to the bottom of the socket, and then filling in all the gap lately occupied by the tooth, till the pad rises above the level of the other teeth. The pad is held in position by firmly closing the mouth. Hæmorrhage can also be stopped by the application of the cauterly at a dull red heat.

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Hæmorrhage from the Nose (Epistaxis).—If the application of iced compresses to the nose fail to arrest hæmorrhage, the anterior nares should be plugged with a strip of aseptic gauze steeped in a 1 in 1,000 solution of adrenalin chloride, or some other form of styptic (see Hæmostatics). As the hæmorrhage may still continue down the posterior nares, the pharynx should always be carefully inspected after the anterior nares have been plugged; and if a stream of blood is seen running down the throat, the posterior nares must be plugged. The gauze is removed from the anterior nares, and a soft india-rubber catheter, carrying a stout silk ligature, is passed along the floor of the inferior meatus till it appears at the back of the mouth. The ligature is grasped with forceps, one end pulled out of the mouth, and a roll of gauze or a piece of sponge about the size of a small walnut is firmly secured to it. The catheter is withdrawn, and the end of the ligature passing along the nose is firmly pulled upon. This thrusts the gauze pad firmly into the posterior nares, and the nose can then again be packed from the front. Hæmorrhage can always be arrested in this manner. The gauze pads may be left in position for twenty-four or forty-eight hours. Belloq's sound can also be used for carrying out the above manœuvre, but the catheter answers admirably, and is always easily procured.

Hæmophilia.

This term has been somewhat loosely used, and should be limited to a family disease characterized by a tendency to profuse hæmorrhage from slight causes.

THE PATHOLOGICAL ANATOMY AND CHEMISTRY of the disease are quite unknown, but the following theories have been advanced: (1) That the aorta and large arteries are abnormally small, and associated with this is a raised blood-pressure rendering it difficult to arrest the hæmorrhage; (2) abnormal thinness of the bloodvessels, especially a degeneration or congenital defect in the muscular coat, so that contraction is slight or absent; (3) absence of calcium salts, and so delay in the coagulation of the blood; (4) the presence of some unknown anti-coagulable substance in the blood. In many cases, however, the coagulation of the blood is normal and the clot firm.

The family character of the disease is well marked, and it is more common amongst Anglo-Saxons than the Latin races.

The females of a hæmophilic family rarely suffer from the disease; in fact, it has been denied that females are ever hæmophiliacæ, although some authors give the proportion of males to females as 13 to 1. The tendency to the disease is, however, transmitted through the females of the family, although the inheritance is by no means constant; for members of hæmophilic families are frequently quite exempt, or the disease may miss a generation completely, to reappear in the female line in the next generation. It is probable that the disease is never transmitted directly from father to son.

SYMPTOMS.—The symptoms of the disease are persistent hæmorrhage from small cuts or abrasions, a tendency to hæmorrhage into

the skin and from mucous membranes, and hæmorrhage into the joints producing chronic changes in them.

The tendency to hæmorrhage starts in early life, and often disappears as the patient gets older; cases of uncontrolled hæmorrhage occurring for the first time in adult life are not examples of the family disease. Fatal hæmorrhage may occur from a division of the umbilical cord, or, later, from such small operations as circumcision, removal of teeth or tonsils, or from slight injuries, such as a small cut or a prick from a needle: but, as a rule, the bleeding is spontaneously arrested before a fatal result occurs. The tendency to hæmorrhage is not constant, and a bleeder may be able to cut himself with impunity. Spontaneous hæmorrhages into the skin occur as small bruises or large hæmatomata, which may take weeks to absorb; they are determined by some slight accident, such as knocking the thigh against a table. Petechial rashes do not occur.

Hæmorrhage into the joints may lead to considerable crippling of the patient, owing to chronic changes set up by the presence of the extravasated blood. The hæmorrhage occurs from some slight injury, and the synovial cavity becomes distended with blood which may be entirely absorbed; but if the hæmorrhage recurs several times, changes in the joint resembling those associated with osteo-arthritis, or even tubercular arthritis, ensue. Attempts to improve the condition by breaking down adhesions or by operations have been followed by fatal hæmorrhage.

TREATMENT—Prophylaxis.—The prophylactic treatment of the disease is carefully guarding the male children in hæmophilic families from the ordinary little accidents of childhood, and in forbidding all operations, even the most trivial, unless they are absolutely imperative to save life. The females of bleeder families should not marry. When they do, they are said to be usually very fecund.

If hæmorrhage takes place, the treatment in no way differs from the treatment of hæmorrhage in non-bleeding patients, except that all operations such as ligature in continuity are contra-indicated. All the ordinary methods of arresting hæmorrhage should be tried successively, but arrest is generally spontaneous. Calcium chloride and calcium lactate given internally may be tried, but are generally useless. The injection of human serum, dog's and rabbit's serum, and anti-diphtheritic serum have all been advocated and successes claimed, and also the direct transfusion of blood. The hæmostatics most useful are adrenalin, ethyl chloride, picric acid, hydrogen peroxide, hot water, ice, pituitary extract. All may be tried successively, and all may be found to be equally useless. If there is a large wound, Thiersch recommends that it should not be sutured, but allowed to fill with blood-clot, and a compressive dressing applied. Finch advocates venesection or flooding the wound with hot water.

CONDITIONS SIMULATING HÆMOPHILIA.—Many cases of profuse hæmorrhage which are reported under the term "hæmophilia" occur in patients who are not suffering from this family disease. In the case of females, deaths from hæmorrhage from the uterus have been reported

as hemophilia. These deaths may have been due to submucous fibroids, carcinoma, or incomplete abortions; while petechial rashes, due to purpura hemorrhagica or associated with hysteria, have led to an erroneous diagnosis of hemophilia.

In some cases the cause of the inability of arrest of hemorrhage is merely local, as when the inferior dental artery running in its bony canal is injured during the removal of a tooth. In others, some general disease predisposes to hemorrhage, the most important of these being scurvy, jaundice, pancreatic disease, Henoch's purpura, purpura hemorrhagica, and Bright's disease. Hemophilia should never be diagnosed unless the family history is definite.

SHOCK

Shock is a condition of depression or inhibition of the cardiovascular centre in the medulla brought about by many causes. The degree of shock is estimated by the fall in blood-pressure. The exact means by which this depression or inhibition is produced is unknown, but the pathology of shock is now so far established that its treatment is placed on a rational basis, and is no longer empirical. This has largely followed the work of Crile on blood-pressure, and it is due to his investigations and to the investigations of others working on his lines, that the modern methods of regarding and treating shock are so different from the former empirical methods.

ETIOLOGY.—The causes of shock may be grouped as follows, although it frequently happens that two or more of these causes may be present in a given case. For example, a patient may suffer from severe pain from an accident and also from loss of blood, both of these conditions tending to produce shock:

1. A disturbance of the higher nerve centres, due to psychical causes, without bodily injury. Shock from this cause may be profound, and even fatal; or, if not fatal in itself, a slight injury when the patient is in this condition may bring about a fatal result. The most common example of this cause of shock is the anticipation of a surgical operation or of some other bodily injury.
2. Extensive lesions of the skin, producing severe pain, such as burns and scalds, or exposure to severe cold.
3. Injury to large nerve trunks. Shock in this case is probably due to overstimulation of the sensory nerve cells in the brain.
4. Hemorrhage.
5. Sudden severe irritation of extensive serous membranes. This occurs when a gastric or duodenal ulcer ruptures into the peritoneum or a hydatid cyst bursts into the pleura.
6. Manipulation of the abdominal viscera during an operation, especially if the parietal peritoneum or the mesentery is pulled upon.

7. Head injuries, the condition of concussion being one of shock due to an injury of the brain.
8. Injuries of the spinal cord, as in fracture dislocation of the spine.

PATROLOGICAL ANATOMY.—The pathological anatomy of shock, like the essential pathology, has been subject to much controversy, and it cannot be considered that the matter is settled. The majority of observers believe that the bloodvessels, both arteries and veins, are dilated, and that the blood tends to collect in the great veins of the abdomen, thorax, and brain. With this engorgement of the venous system there is a corresponding anemia on the arterial side, or as it has been expressed, "the patient bleeds into his abdominal veins." This causes the brain to be improperly supplied with blood. It must not be considered, however, that this is the *cause* of shock. The shock comes first, and its consequences are the engorgement of the abdominal viscera and the anemia of the brain.

Other observers believe that in the condition of shock there is arterial constriction, first at the periphery, and then, if the cause of shock continues, gradually ascending along the arteries. Thus the brain finally becomes anemic, and the blood is forced out of the contracted arteries into the veins.

No matter which view is taken of the pathological anatomy of shock, there can be no doubt that the blood tends to collect on the venous side of the heart, and that there is always a fall in the blood-pressure, becoming more and more marked as the shock increases, and that as shock is recovered from the blood-pressure steadily rises. That the fall in blood-pressure is not due to weakness or exhaustion of the cardiac muscle is proved by the fact that if the heart of an animal in which shock has been produced is stimulated directly, the contraction is powerful. It can also be proved in the same way that the muscles of the arterial wall are still capable of vigorous contraction.

CLINICAL SYMPTOMS.—The usual mental condition of a patient in a condition of shock is one of torpor, but unless he is anesthetized or suffering from a head injury, he is conscious, and will answer questions rationally.

In some cases, especially if a toxic condition is present, as well as in cases of extensive burns, the patient is restless and sometimes delirious. This condition is spoken of as "gouty shock."

The musculature is relaxed, the surface of the skin cold, cyanosed, and covered with a cold, clammy sweat.

The pulse is generally rapid, its chief characteristics being its low tension, smallness, and irregularity.

The heart-sounds are feeble, and the respiration is very shallow.

If taken in the axilla, the temperature is subnormal, but the rectal temperature may be raised. The pupils are dilated, but react to light and accommodation, and the conjunctival reflex is present; the sphincters are relaxed, and the patient passes his urine and feces under him. The amount of urine is diminished, and in profound shock complete suppression may be present.

TREATMENT.—In considering the treatment of shock it must be clearly understood that the condition of shock is temporary, no matter whether due to inhibition or to fatigue-paralysis of the cardio-vascular centre; and if the cause of the shock is removed, it is only necessary for the patient to live a short time in order that recovery may be complete. The condition is, as a rule, completely and permanently recovered from, and the problem of treatment is to keep the patient alive sufficiently long for the cardio-vascular centre to recover.

1. METHODS OF PREVENTING SHOCK IN SEVERE OPERATIONS.—The *mental condition* of the patient must be carefully considered. He should be reassured as to the result of the operation, and kept waiting as short a time as possible. *Warmth* before and during the operation is essential; he should be warmly clad, and the temperature of the operating-room should be maintained at 75° F. A hot-water pillow on the operating-table is advisable for young children and old people, and, if the operation is an abdominal one, the extremities should be wrapped in Gausee tissue. The preliminary starvation necessary for the proper administration of an anæsthetic should not be too prolonged, especially in children, and the patient should not be vigorously purged.

The choice of an anæsthetic is an important one, as the unconsciousness of pain under general anæsthesia does not abolish the liability to shock. It is of importance to prevent the sensory nerve impulses from the site of the operation reaching the brain. This can be accomplished by blocking the nerve path in the cord by stovaine anæsthesia, or by blocking the main nerve trunks by injection of cocaine into them. Spinal anæsthesia is of great value in preventing shock and many operations are done in safety under this form of anæsthesia which would be exceedingly dangerous under general anæsthesia. If there is no special contra-indication, ether by the open method is preferable to other forms of general anæsthesia.

Injection of saline fluid is valuable before an operation if the patient has lost a large amount of fluid from the body by hæmorrhage, diarrhœa, or vomiting. It can also be given with advantage during the performance of the operation under the same conditions.

Morphia is sometimes administered *before* the operation, and is useful to quiet the patient's mind, and to diminish the amount of anæsthetic necessary to induce unconsciousness.

2. METHODS OF TREATING SHOCK.—Absolute and complete *rest* is the first essential in the treatment of shock. The patient should be kept lying down in bed, with the foot of the bed raised, and everything, even changing his position, should be done for him. If there is much pain, *narcotics*, chiefly morphia, should be given, and this drug is especially useful in cases of shock with restlessness, or in cases of shock associated with burns and scalds and crushing accidents. The pain present in these cases materially helps to maintain the condition of shock.

Warmth.—The patient should be wrapped in hot blankets, and hot-water bottles should be placed in the bed in order that the body

temperature may be maintained. The temperature of the bed should not exceed 100° F., or marked arterial dilatation and sweating, with a fall in blood-pressure, will result. Care should be taken that the patient is not burned by the hot-water bottles, especially if he is under the influence of an anæsthetic.

STIMULANTS.—Cardio-vascular stimulants may be divided into two classes—(1) Those that stimulate the muscles of the heart and bloodvessels through nerves coming from the cardio-vascular centre in the medulla, and (2) those that directly stimulate the muscle itself.

Both kinds of stimulants have been, and are still, largely used in the treatment of shock; but the value of the first variety has been recently called in question, and many surgeons have completely given up their use. The most important of these stimulants are strychnine, alcohol, ether, digitalin, and caffeine.

Strychnine acts directly on the cardio-vascular centre, stimulating it and causing the heart to beat more forcibly and the blood-pressure to rise. The effect, however, is only temporary, and the already exhausted centre is still more depressed by the period of forced activity. If the injection is repeated, the rise of blood-pressure is less and the after-depression greater; and if the injections are persisted in and the blood-pressure is taken, it will be found that, instead of rising, it is falling steadily. Strychnine should therefore not be used in the treatment of shock, for in mild cases it is unnecessary, and in severe cases it is harmful by still further depressing the already exhausted cardio-vascular centre.

Alcohol.—Alcohol also stimulates the heart through the cardio-vascular centre, and at the same time causes peripheral vaso-dilatation. Its administration after a temporary rise is followed by a considerable fall in blood-pressure, and further administrations only increase the fall; therefore its use is contra-indicated in shock. The same is true of the other diffusible stimulants—viz., ether, ammonia, and sal volatile.

Digitalin acts partly centrally and partly peripherally, and, on account of its peripheral action, may be useful in the treatment of shock, but practically it is not found to be of much value.

Caffeine also acts directly on the heart muscle, and causes a rise of blood-pressure, though of very slight duration; it therefore probably has little value in the treatment of severe forms of shock.

The second variety of stimulants, which act directly on the muscular coat of the small arteries, and cause a rise of blood-pressure by increasing peripheral resistance, have been much used. The most important are *adrenalin* (extract of the medulla of the suprarenal gland) and extract of the posterior part of the *pituitary body*. These drugs are given by hypodermic injections, or adrenalin can be given in small doses, with continuous saline infusion (1 in 100,000). The great disadvantage of these drugs is their temporary action, for they are rapidly oxidized, and the increased blood-pressure is not maintained for more than a few minutes.

SALINE INFUSION.—The administration of saline fluid by use of the methods given under the Treatment of Hæmorrhage (p. 187) has been largely used in the treatment of shock, but the cases must be carefully selected, or harm will result. This method of treatment should only be used in these cases of shock which are associated with a loss of fluid from the body, either by hæmorrhage, diarrhoea, severe vomiting, or sweating. In these cases the blood-pressure falls on account of the absence of fluid from the vessels. This loss of fluid can be compensated to a certain extent by arterial constriction, but a limit is reached, and it becomes necessary, therefore, to supply more fluid to the vascular system. This is most readily done by intravenous infusion. In cases of shock unassociated with loss of fluid, saline infusion is contra-indicated. It is believed that the blood is banked up in the veins and the right side of the heart embarrassed. If this is true, it is irrational to distend the veins further with 2 or 3 pints of saline fluid. A temporary improvement is followed by a still further fall in the blood-pressure, and, as an American surgeon has put it, "the patient is drowned."

INFUSION OF BLOOD.—Direct infusion of blood (see Treatment of Hæmorrhage, p. 189) has also been used in the treatment of shock, and is valuable if the shock is associated with hæmorrhage. In other instances its use is harmful for the same reasons that saline infusion is harmful.

MECHANICAL PRESSURE.—This means of raising the blood-pressure has been long used in the form of firm bandaging to the limbs in order to drive the blood on to the heart and brain, but it has been elaborated by Crile. The patient is enclosed in a suit made of a double layer of india-rubber provided with a valve, so that air can be forced between the two layers, and it is claimed that the blood-pressure can be raised 25 to 60 millimetres of mercury by the use of this suit. The difficulties and disadvantages of this method of maintaining the blood-pressure are obvious, but in suitably selected cases it may be useful in the treatment of shock.

Operations during the Period of Shock after Accidents.—The question whether operation should be performed during the period of shock after an accident is an important one. It may be stated generally that no operation should be performed during this period. To add the shock of an operation to the shock of an accident is likely to prove fatal, and no operative interference should be undertaken until the blood-pressure has been firmly re-established. The entreaties of friends of the patient that something should be done must be resisted, and the patient ought not to be subjected to more interference than is absolutely necessary to stop hæmorrhage and prevent sepsis. All the bleeding-points should be quickly tied and the wound covered with a sterilized dressing, and then the attention is given to combating shock. If there is much pain, morphia should be given; and if much blood has been lost, the patient should be infused with hot saline fluid. It may be necessary to wait as long as twenty-four hours before setting a fracture or performing an amputation of the limb. If the

operation is amputation of one of the lower limbs, it should be performed under spinal anaesthesia. Of course, if a limb is merely hanging by a strip of soft tissue, it should be completely removed; but no extensive cutting or sawing of a bone should be done while the patient is in a condition of shock.

In cases of internal hæmorrhage, such as occurs when the spleen or liver is torn, or when a hollow viscus has been ruptured, the above rule does not hold. It is all-important that hæmorrhage should be stopped, and a laparotomy with the patient in a condition of shock may be necessary. In the case of rupture of a hollow viscus in the abdomen, waiting means the onset of general peritonitis; therefore, if this accident is diagnosed, preparations for an immediate operation must be made.

After head injuries such as depressed fractures, or injuries to the spine causing meningeal hæmorrhage, operations may have to be performed during the period of shock, for delay to arrest hæmorrhage may cause death or severe after-effects. As little as necessary should be done, and the operation must be performed very quickly, and the treatment of shock carried out afterwards.

DELIRIUM

Delirium after accidents and operations may be divided into four varieties: (1) Traumatic delirium; (2) toxic delirium; (3) delirium tremens; (4) delirium after head injuries.

1. **Traumatic Delirium** is a somewhat rare condition. It occurs in patients who suffer from instability of the nervous system, congenital or acquired. The patients may be hysterical or neurotic, and there is frequently a family history of insanity, epilepsy, or eccentricity.

The condition is most frequently seen after operations on the external genitals in both sexes, but may occur after any operation, especially those performed on elderly people. During the period when it was customary to treat the enlarged prostate by removal of both testes, about 10 per cent. of the patients suffered from post-operative insanity. The form of delirium is, as a rule, a low muttering delirium with delusions. It occurs most commonly within a day or two of the operation or accident, although occasionally it appears immediately the patient has recovered from the anaesthetic.

TREATMENT.—The treatment consists of careful nursing and feeding, hypnotics being given to secure sleep. The *prognosis* is good, although a few of the patients become permanently insane.

2. **Toxic Delirium.**—This form of delirium is due to the absorption of poisonous substances from the wound, the most common being the toxins of the pyogenic bacteria; but such drugs as iodoform or carbolic acid may produce the condition. It may also be due to the administration of morphia or chloroform. When caused by the absorption of the toxins of pyogenic bacteria, it is associated with rise of temperature, increased pulse and respiration rate, and usually suppuration

in the wound. The condition generally occurs on the second or third day after infection, and will continue until free drainage is secured and the temperature falls.

At first the delirium is of an active type, especially in young subjects; but if the absorption of toxins continues, and sometimes from the first if the patient is elderly or the toxic condition very severe, the patient passes into a state of low muttering delirium, with picking at the bedclothes—the so-called "typhoid state" (see p. 21).

In cases of iodoform-poisoning there is at first an active delirium with hallucinations, and if the case is a severe one, this is followed by cardiac depression, coma, and death.

TREATMENT.—The treatment of this delirium is the treatment of wound infection, and nothing is of use until free drainage has been established. The rest of the treatment is good nursing and feeding. The treatment of iodoform-poisoning is given on p. 39.

3. Delirium Tremens.—This form of delirium is only met with in chronic alcoholics, although the exciting cause may be a prolonged drinking-bout, an accident such as a fracture, or an acute illness, *e.g.*, pneumonia. In many cases there is no history of marked alcoholism, for the patients are often secret drinkers, and the habit is unknown to the friends.

The condition is an active melancholia with hallucinations, usually of sight or hearing, mental depression, delusions of persecution, and suicidal tendencies.

Delirium tremens in surgery generally arises two or three days after a severe accident, such as a fractured leg. The patient is restless, cannot sleep, and has tremors of the tongue and fingers. The appetite is lost, the tongue furred, the bowels constipated, and the temperature raised (101° F.). Hallucinations of sight soon appear, usually in the form of imaginary animals running about the patient, who tries to brush them away or to escape from them; in some cases there is the hallucination of sound, and the patient holds conversations with imaginary people.

The delusions are, as a rule, of persecution, and there is complete insensibility to pain; a patient with a fractured leg may endeavour to walk to escape from his persecutors. In some cases considerable cunning is displayed to effect an escape.

Later, the patient suffers from a low muttering delirium, with rapid pulse and respiration, dry tongue, sordes on the teeth, and muscular weakness; and if no improvement takes place, death ensues from heart failure.

PROGNOSIS.—The prognosis is good in a first attack in a comparatively young and healthy subject; but in the elderly, or if the attacks are often repeated, the prognosis is grave.

If the patient recovers physically, the mental condition usually clears, although some patients become chronically insane.

TREATMENT.—The preventive treatment of delirium tremens should be commenced, in all patients who are suspected to be chronic alcoholics, directly after an accident. The patient should be kept abso-

lutely quiet in a well-ventilated room, and fed frequently on a fluid, easily digested diet. Sleep should be induced by tepid sponging, and hypnotics given if necessary. When the surgical condition allows it, exercise in the open air is beneficial, and may induce natural sleep. The bowels should be opened with a brisk purge.

The question of giving alcohol in these cases is a vexed one, some surgeons always prescribing it, usually in the form of malt liquor (stout), while others interdict it entirely, and trust to paraldehyde, bromides, and morphia to procure sleep. There can be no doubt that the sudden cessation from alcohol by a patient accustomed to take it freely will cause restlessness and sleeplessness, but it is doubtful whether it is a potent factor in producing delirium tremens.

During the attacks the treatment consists of careful nursing, good hygiene, and the giving of hypnotics to procure sleep. Unfortunately, the majority of hypnotics are cardiac depressants, and the danger of the condition of delirium tremens is heart failure. Such hypnotics as paraldehyde and morphia should be chosen, as they do not markedly depress the heart. The diet should be fluid and light, and given at frequent intervals. The patient must be carefully watched, and never left alone for an instant, as he may seriously injure himself in attempts to escape from imaginary persecutors. If it is necessary to restrain him physically, it should be done by mechanical means so arranged that he cannot injure himself. Struggling with an attendant is likely to lead to further excitement, and may result in sudden heart failure. In the later stages of the disease stimulants are often necessary; they should be given in the form of digitalis and strychnine.

4. **Delirium after Head Injuries.**—An active delirium is not rare after severe injuries to the head, especially if the frontal lobes of the brain have been lacerated. After these injuries a state of great mental instability, and sometimes attacks of acute mania, are common. The condition may result in chronic insanity (see section on Head Injuries, p. 81C), though it is usually recovered from.

LEUCOCYTOSIS

The number of leucocytes in the blood varies considerably under perfectly normal conditions—*e.g.*, three or four hours after a meal there is a considerable increase, and also in different normal individuals. The number present varies from 5,000 to 10,000 per cubic millimetre. An increase above 12,000 is considered abnormal, and is termed a **leucocytosis**.

A leucocytosis is usually present in all acute infective diseases—*e.g.*, scarlet fever, diphtheria, smallpox—and in infections due to the pyogenic bacteria. In the last cases its presence is often considered as an indication that suppuration has taken place, but it is by no means pathognomonic. It occurs in other conditions besides suppuration, and in the very acute infections it is absent. Its presence in the infectious fevers is believed to be an attempt to arrest the invasion of the

bacteria and bring about their destruction; and its absence is looked upon as significant of a very acute infection in which the power of the bone-marrow to produce leucocytes is lost, owing to the severity of the disease. Absence of a leucocytosis in cases in which it should be present makes the prognosis very grave.

Beside the actual number of leucocytes present, the relative number of the various kinds must be considered. In normal blood the proportion of the various cells is—

Polynuclear neutrophiles	about 70 per cent.
Lymphocytes	.. 25 ..
Eosinophiles	.. 3 ..
Large mononuclear	.. 2 ..

In cases of acuto pyogenic infections with suppuration, the polynuclear neutrophiles are chiefly in excess.

Leucocytosis is also met with in some cases of malignant disease: in hydatid disease, in which the eosinophiles are chiefly in excess of the normal (eosinophilia); after severe hæmorrhage, especially if infusion has been used; after operations; in cases of lymphatic leucæmia, in which the lymphocytes are markedly increased (lymphocytosis); and in chronic inflammations due to syphilis and tubercle, in which, again, the lymphocytes are chiefly in excess.

The leucocytosis in the infective diseases appears with the general symptoms, and disappears with them. If suppuration occurs, the leucocytosis is increased.

TREATMENT.—As regards treatment, it is suggested that in acute infectious diseases melleinate of soda should be given by subcutaneous injection in order to cause an artificial leucocytosis.

LEUCOPENIA

A diminution in the number of leucocytes is met with in certain infectious diseases—for example, in tubercle, malaria, Malta fever, influenza, and the late stages of typhoid fever—and is termed **leucopenia**. The number of leucocytes may fall to 3,000 per cubic millimetre, and the condition may be used as a means of diagnosis. If, however, the infection is a mixed one, a leucocytosis may replace the leucopenia.

CHAPTER VIII TUMOURS AND CYSTS

TUMOURS

A TUMOUR, neoplasm, or new growth is an atypical new formation, not the result of inflammation. The new growth is atypical in structure, function, and termination.

1. STRUCTURE.—A new growth resembles the tissue from which it grows: for example, a tumour growing from the breast is composed of cells resembling the cells of the normal breast, but the similarity is not complete. The cells in appearance are atypical, and their arrangement, though resembling that in the normal breast, is somewhat different and the relative amount of gland cells and connective tissue also differs from that in the normal organ. A glandular tumour growing from the breast can be distinguished under the microscope from a normal or even an inflamed breast by its atypical structure.

2. FUNCTION.—Tumours fulfil no physiological function, and are in no way concerned with the general metabolism of the body. A tumour of the breast does not secrete milk, and a fatty tumour may continue to enlarge whilst the rest of the body is wasting.

3. TERMINATION.—Inflammatory processes always terminate in a definite manner, and normal metabolism progresses along certain definite lines, but tumours continue to grow indefinitely and often irregularly. Sudden increase of growth occurs without any apparent cause, and retrogression may occur equally without cause, thus upsetting a preconceived idea of the nature of the growth.

A tumour has to be differentiated from hypertrophy, gigantism, and inflammatory hyperplasia. Hypertrophy implies increased function as well as increase in size—as, for example, the increase in muscular power and size of the left ventricle in aortic stenosis. The enlargement is typical in every respect. In gigantism, either local or general, there is an increase in size of normal tissue, and, although there may not be increase in function, the tissues going to form the giant growth are typical in structure and function. Inflammatory hyperplasia is an increase in size of a tissue, largely due to increase of the fibrous element. To some extent, however, there is increase in the glandular elements such as occurs in chronic interstitial mastitis.

Clinically it may be difficult to distinguish between chronic inflammatory processes and new growth, and even with the tissue under the

microscope differentiation may not be easy. The above definition of tumours, however, excludes all increase of size due to inflammatory processes.

CAUSE.—The cause of tumour formation is unknown, and recent researches have tended to disprove all pre-existing theories rather than to establish a conclusive theory of the pathological nature of tumours. The following theories will be considered here, not because one of them is likely to prove the correct theory—for there is no proof to sustain any of them—but because of the important part these theories have played in the study of the pathogenesis of new growths and their treatment.

1. *The Theory of "Embryonic Rests."*—This theory was first put forward by Virchow to explain the appearance of cartilage in certain growths of the salivary glands and testes. It was subsequently expounded by Cohnheim to explain the origin of all tumours, and is usually associated with his name. This theory presupposes that certain groups of cells of the body remain dormant in their embryological state; and later in life, in response to some unknown stimulus, perhaps chronic irritation, begin to develop with their full embryonic force. This theory is quite inadequate to explain the origin of new growths, and need not be further discussed.

2. *Ribbert* carried Cohnheim's theory a little farther. He assumed that the tumours arise in misplaced cells, not from any exaltation of the activity of the cells themselves, but from lowered resistance of the surrounding tissues. This theory supposes that two different varieties of cells grow side by side, and do not encroach on one another owing to the tissue tension. If this tissue tension is lowered in one of the groups of cells, the other group promptly invades it, and a tumour results.

3. *Parasitic Theory.*—The analogy between the behaviour of inflammatory processes and new growths has led to many attempts to find a parasite as the cause of the tumour formation. It has been seen that both inflammation and new growth have a local focus. Both can infect lymphatic glands, both can invade the blood-stream and cause metastases, and both are associated with a toxæmia. The result of much research is that a large number of different parasites have been alleged to be the cause of malignant growths, such as bacilli (Schuller), micrococci (Doyen), blastomycetes (Russell), coccidia (Metchnikoff), protozoa (Maloney), etc. On the whole, the parasites discovered have been alleged to be intracellular bodies, and the theory is that their presence increases the metabolic activity of the cells. This parasitic theory has been practically limited to explain the cancers (epithelial growths) only, and any adequate theory of neoplasm must explain all forms of growth. The parasitic theory is not proven, and recent research tends still further to disprove it. It is of interest to note in connection with this theory that carcinoma and sarcomata of mice have been successfully transplanted from mouse to mouse through many generations, and in this animal the growth of malignant tumours has been very carefully investigated.

It is found that it is necessary to transplant actual pieces of the tumour tissue, and it is only the essential tumour cells that produce the new growth. The connective tissue of the tumour disappears and is replaced by connective tissue derived from the host. Many interesting facts on tumour growth and propagation have been discovered by research on mice, but no adequate theory of tumour formation has yet been advanced.

4. *Sex-Cell Theory*.—This theory supposes that all tumours arise from misplaced germ and trophoblastic cells, and is supported by the observation that both malignant tumour cells and sex cells divide with half the usual number of chromosomes (heterodox mitosis). Of this theory there is absolutely no proof; but it is important, as a method of treatment has been founded on it. It was noted that the trophoblast of the embryo disappeared at the same time that the pancreas developed, and Beard suggested that this disappearance was due to the development of pancreatic ferments. In consequence he suggested and advised the use of injections of trypsin and amylopsin in the treatment of malignant tumours, but this treatment has now been discarded.

ETIOLOGY.—In considering further the etiology of tumours, particularly of malignant tumours, the following factors must be considered:

1. *Heredity*.—There is no proof that the tendency to malignant tumour is inherited, and the fact that a mother died of malignant disease of the uterus is no evidence that a lump in the breast of her daughter is a malignant growth.

2. *Surroundings*.—In the case of cancer it is now fairly well established that this growth is most frequently met with amongst those dwelling in low-lying, damp, marshy districts. On the other hand, the idea that cancer has been associated with certain houses is given little credit.

3. *Chronic Inflammation*.—In many cases cancers develop at a site of chronic irritation—for example, cancer of the tongue developing at a spot where a hot pipe habitually rests, or cancer of the scrotum developing in chimney-sweeps in whom grains of soot can always be found in the epithelial cells of the skin of the scrotum. A still more striking example is the development of cancer in the hands of the older X-ray operators, who developed a chronic eczematous condition of the skin of the hands from working with unguarded X rays. The cancer in some cases developed years after X-ray work had been given up.

4. *Occupation*.—Apart from occupations leading to chronic inflammation, such as occurs on the arms of paraffin and tar workers, or the hands of X-ray workers, or the scrotum of chimney-sweeps, occupation appears to have no bearing on the development of tumours.

SEX.—Malignant growths are more common in women than in men, on account of the large number of cases of cancer of the breast and uterus in females. On the other hand, cancers of the tongue and alimentary canal are more common in men than in women.

AGE.—Tumours, both innocent and malignant, occur at all ages, but cancers become more common as age advances; over forty, therefore, may be termed the cancerous age. Sarcomas, on the other hand, are more frequently seen in young subjects.

INCREASE OF CANCER.—There seems to be no doubt that the number of patients who suffer from cancer is increasing, apart from the fact that diagnosis is more accurate than was formerly the case.

In regarding the increase, stress must be laid upon two factors: (1) That the length of life is steadily increasing, and a larger proportion of people now reach the cancerous age than was formerly the case; and (2) more children with inherited constitutional weakness survive to adult life. The increase in the number of cancer cases, however, seems to be progressing faster than can be explained by these considerations, and there is also some reason to believe that cancer is appearing at an earlier age than was formerly the case.

Varieties.—Tumours are divided into **innocent** and **malignant**. The essential difference between these two groups of tumours is given by Bland-Sutton: "The harmful effects of innocent tumours depend entirely on their environment, but malignant tumours destroy life whatever their situation."

Besides this essential difference, there are other points of difference which require mentioning.

An **innocent tumour** as a rule is enclosed in a capsule which separates it from the tissue in which it is growing. It grows slowly, pushes on one side and compresses the surrounding tissues, but does not infiltrate them nor infect the lymphatics or lymphatic glands. It does not cause metastases in other parts of the body, is generally easily removed, and does not recur. Innocent tumours are frequently multiple.

These tumours closely resemble the tissue in which they are growing, and the cells often become highly specialized. It may be taken as a rule that the more closely the cells of a tumour resemble the normal structure of adult tissue, the more innocent it is; whilst those tumours with undifferentiated structure, and having cells resembling the embryonic type of cell, are malignant, and the more undifferentiated the cells, the more malignant is the tumour.

An innocent growth very often causes death by its position—for example, a perfectly innocent growth in the thorax may press upon the œsophagus and cause death from starvation, or an innocent growth in the pelvis may cause death from intestinal obstruction.

A **malignant tumour** is usually single, and as a rule has no capsule, but infiltrates and destroys the surrounding tissues. It grows rapidly and infects the lymphatics and lymphatic glands, and causes metastases in other parts of the body. A malignant tumour is difficult to remove completely, owing to inability to define exactly its limits. It frequently recurs after apparent complete removal. It causes death by producing a condition spoken of as "cachexia."

CAPSULE.—The capsule of a tumour is due to inflammation caused in the surrounding tissue by the presence of the tumour, and is of a

ciatricial nature. Malignant tumours, when growing slowly and in their early stages, may have a capsule, whilst some innocent tumours, such as diffuse lipomata, are devoid of a capsule.

INFILTRATION.—The infiltration of the surrounding tissue leads to destruction of it, and also causes the tumour to become fixed to the surrounding parts. This destruction of the tissue may cause the death of the patient by destroying organs necessary to life.

LYMPHATIC INFECTION.—Malignant tumours vary in their tendency to infect lymphatics, and secondary growths in the lymphatic glands may occur in two ways. In some cases an embolus of the growth passes along the lymphatic channels, and is arrested in the gland, developing into a secondary growth; while in other forms of tumour direct spread along the lymphatics occurs, and nodules of growth arise between the primary tumour and the lymphatic gland.

ULCERATION.—When a malignant growth originates in the skin or in a mucous membrane, or when a deep-seated growth invades these structures, infection occurs and the growth ulcerates. If a large mass protrudes from the surface, it is said to fungate. The septic absorption resulting from such an ulcer considerably hastens the death of the patient.

METASTASES.—Metastases of the growth, which may occur in any part of the body, are due to the dissemination of minute portions of the growth by the blood-stream. Actual particles of the growth are carried by the bloodvessels to distant parts of the body until they become blocked in a capillary. Growth takes place, and a secondary growth appears which exactly resembles the parent growth, so that a tumour of epithelial nature may appear in bones, or a tumour of thyroid tissue may be present in the heart.

The **ENVIRONMENT** of malignant tumours is also of importance, for although they will cause death, no matter where they are situated, yet the mode and rapidity of death will depend largely upon the situation of the growth. A malignant tumour obstructing the œsophagus, while quite small, will cause death from starvation before any general dissemination has occurred, but a malignant tumour of the breast may be present for years before death results.

Cachexia.—The cachexia associated with malignant growths is due to several causes, of which the following are the most important: (1) *Pain and anxiety*; (2) *septic absorption*, if the tumour has ulcerated; (3) *hæmorrhage*, due to ulceration opening large bloodvessels; and (4) interference with the function of *vital* organs.

Whether the tumour itself produces toxins, which are absorbed and which produce anæmia and cachexia, has been a matter of dispute; but there seems little doubt that tumours do secrete a specific toxin.

Cachexia is usually more marked with tumours of a glandular nature than with connective-tissue growths, and enzymes have been obtained from malignant tumours. From the clinical point of view, however it must be remembered that absence of cachexia is no proof that a given tumour is not malignant.

A patient with malignant cachexia is anæmic, has a peculiar yellow

complexion that has been compared to a faded leaf, wastes, loses his appetite, and deteriorates bodily and mentally. Fever is usually absent unless the growth has ulcerated. In the case of some growths, however, especially of sarcomata of bone, pyrexia may be a feature of the disease, even although no ulceration has occurred.

RESULTS.—A malignant tumour, as has been stated above, destroys life, no matter where it may be situated, unless it is completely removed. Many cases of spontaneous disappearance of malignant tumours have been recorded, but this event is so rare that it can be given no weight when considering the treatment of a malignant growth.

Relationship between Innocent and Malignant Growths.—The histological characters of tumours are not always sufficiently marked to be absolute in determining whether a given tumour is malignant or innocent. For this reason it is impossible to say whether an innocent tumour ever changes its nature and becomes malignant, but the possibility of such a transformation must be admitted. On the other hand, there is no doubt that no hard-and-fast line can be drawn between innocency and malignancy, and that certainly in the connective-tissue group of tumours there is every gradation between a perfectly innocent fibrous tumour and a rapidly growing malignant sarcoma. It may be stated broadly that the more highly differentiated the cells of a tumour are, and the more it resembles normal tissue, the less malignant it is. The reverse also holds true, but the exceptions to this rule are numerous. Highly specialized tumours may show a high degree of malignancy, and the more tumour formation is studied, the less easy is it to define innocency and malignancy.

The importance of this uncertainty cannot be over-emphasized, and the diagnosis and prognosis of tumours as to innocency and malignancy is so doubtful that the treatment of all tumours is complete removal as soon as possible, if such removal will not destroy the life of the patient.

Classification.—The exact pathological nature of neoplasms being unknown, there is at present no satisfactory scientific classification of tumours, and the attempt at classification (see p. 214) is only tentative, but may be useful clinically.

A. TUMOURS ARISING IN CONNECTION WITH CONNECTIVE TISSUE (MESOBLAST)

I. INNOCENT TUMOURS

Lipoma

Lipomata are tumours composed of fat. They are found in every part of the body and at all ages, but are most common in adult life. They are frequently multiple.

PATHOLOGY.—On section these tumours have usually nothing to distinguish them from normal fat, but in some cases they contain a large amount of nevroid tissue—*naevo-lipoma*. The tumours are sur-

rounded by a cellular capsule, and when situated in the subcutaneous tissue are lobulated. Secondary changes in these tumours are rare, but calcification may occur.

A. Tumours of Connective Tissues (Mesoblastic)	<table border="0"> <tr> <td data-bbox="808 422 837 534" rowspan="2">INNOCENT.</td> <td data-bbox="837 377 1198 572"> <ul style="list-style-type: none"> Lipoma (fat). Fibroma (fibrous tissue). Neuroma (nerve). Chondroma (cartilage). Osteoma (bone). Angelioma (bloodvessels). Lymphangioma (lymph vessels). Myoma (muscle). Myxoma (mucous). </td> </tr> <tr> <td data-bbox="808 590 837 703" rowspan="2">MALIGNANT.</td> <td data-bbox="837 590 1198 703"> <ul style="list-style-type: none"> Sarcoma = <ul style="list-style-type: none"> Round-celled. Spindle-celled. Intermediate. Lympho. Endo- and peri-thelioma (psammoma). </td> </tr> </table>	INNOCENT.	<ul style="list-style-type: none"> Lipoma (fat). Fibroma (fibrous tissue). Neuroma (nerve). Chondroma (cartilage). Osteoma (bone). Angelioma (bloodvessels). Lymphangioma (lymph vessels). Myoma (muscle). Myxoma (mucous). 	MALIGNANT.	<ul style="list-style-type: none"> Sarcoma = <ul style="list-style-type: none"> Round-celled. Spindle-celled. Intermediate. Lympho. Endo- and peri-thelioma (psammoma). 			
INNOCENT.	<ul style="list-style-type: none"> Lipoma (fat). Fibroma (fibrous tissue). Neuroma (nerve). Chondroma (cartilage). Osteoma (bone). Angelioma (bloodvessels). Lymphangioma (lymph vessels). Myoma (muscle). Myxoma (mucous). 							
	MALIGNANT.	<ul style="list-style-type: none"> Sarcoma = <ul style="list-style-type: none"> Round-celled. Spindle-celled. Intermediate. Lympho. Endo- and peri-thelioma (psammoma). 						
B. Tumours containing Pigment		<ul style="list-style-type: none"> Melanoma. Chloroma. 						
C. Tumours in Connection with the Central Nervous System	Glioma.							
D. Tumours in Connection with the Bone Marrow	Myeloma.							
E. Tumours in Connection with the Teeth	<table border="0"> <tr> <td data-bbox="837 928 997 984" rowspan="5">Odontoma =</td> <td data-bbox="997 891 1198 928">Epithelial.</td> </tr> <tr> <td data-bbox="997 928 1198 966">Follicular.</td> </tr> <tr> <td data-bbox="997 966 1198 1003">Fibrous.</td> </tr> <tr> <td data-bbox="997 1003 1198 1041">Radicular.</td> </tr> <tr> <td data-bbox="997 1041 1198 1078">Composite.</td> </tr> <tr> <td data-bbox="997 1078 1198 1116">Malignant.</td> </tr> </table>	Odontoma =	Epithelial.	Follicular.	Fibrous.	Radicular.	Composite.	Malignant.
Odontoma =	Epithelial.							
	Follicular.							
	Fibrous.							
	Radicular.							
	Composite.							
Malignant.								
F. Tumours in Connection with Epi- thelia	<table border="0"> <tr> <td data-bbox="808 1059 837 1172" rowspan="2">INNOCENT.</td> <td data-bbox="837 1059 968 1134"> <ul style="list-style-type: none"> Papilloma. Adenoma. </td> </tr> <tr> <td data-bbox="808 1153 837 1285" rowspan="3">MALIGNANT.</td> <td data-bbox="837 1153 1198 1247"> <ul style="list-style-type: none"> Carcinoma = <ul style="list-style-type: none"> Squamous-celled. Columnar-celled. Spheroidal-celled. Rodent ulcer. </td> </tr> </table>	INNOCENT.	<ul style="list-style-type: none"> Papilloma. Adenoma. 	MALIGNANT.	<ul style="list-style-type: none"> Carcinoma = <ul style="list-style-type: none"> Squamous-celled. Columnar-celled. Spheroidal-celled. Rodent ulcer. 			
INNOCENT.	<ul style="list-style-type: none"> Papilloma. Adenoma. 							
	MALIGNANT.	<ul style="list-style-type: none"> Carcinoma = <ul style="list-style-type: none"> Squamous-celled. Columnar-celled. Spheroidal-celled. Rodent ulcer. 						
G. Tumours in Connection with Tro- phoblast		Chorion epithelioma.						
H. Teratoma		<ul style="list-style-type: none"> Twin. Filial. Terato-blastoma. 						

CLINICAL FEATURES.—*Subcutaneous Lipoma*.—Subcutaneous lipomata are most commonly found on the neck and shoulders, though they may be anywhere in the subcutaneous tissue. They form lobulated tumours, which are attached to the skin, causing it to dimple when the tumour is pinched up. They are freely movable, and have

a definite edge, which slips from under the finger and gives a sense of fluctuation. They are painless, and only cause inconvenience on account of their size. They give rise to frequent errors in diagnosis, especially when occurring in the palm of the hand or sole of the foot.

Subserous Lipoma.—Lipomata in this situation may grow to an enormous size, but small subserous lipomata which project through the abdominal wall into the hernial orifices or elsewhere are of more importance. These masses of fat are pedunculated, and, if found at a hernial orifice, are frequently mistaken for true hernie. Apart from the hernial orifices, they are most commonly found projecting through the rectus sheath in the middle line (*fatty hernia of the linea alba*).

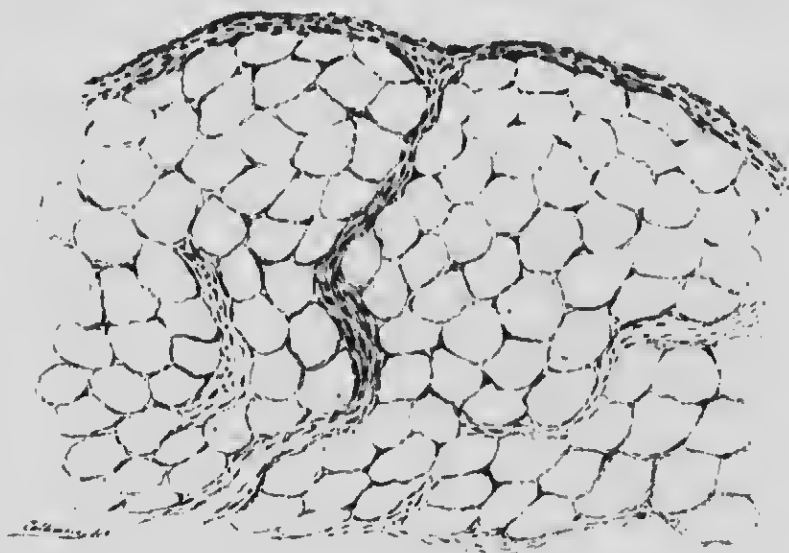


FIG. 47.—LIPOMA.

Not infrequently these fatty hernie drag with them a pouch of peritoneum, so that a true hernia is formed. This is most common at the femoral ring.

Subsynovial Lipoma.—Pads of fat are normally found under the synovial membrane of all joints, and lipomata projecting into the joint may arise from this fat. In some cases the lipoma appears as a number of finger-like processes, covered with synovial membrane, a condition to which the name *lipoma arborescens* has been given; or if associated with osteo-arthritis (as it frequently is), it has been termed "arthritis lipomatosa."

Intramuscular Lipoma.—Intramuscular lipomata have been found all over the body, and are chiefly important on account of the difficulty of diagnosis, which can often only be settled by exploratory incision.

Parosteal Lipoma.—These lipomata are generally congenital in origin, growing from the outer layer of the periosteum, and lie amongst

the muscles attached to the bone. They may also grow from the pericranium or from the dura mater. In all cases they are very difficult to diagnose.

Lipomatosis.—By this term is meant an overgrowth of fatty tissue in some part of the body which is not surrounded by any capsule, and which continues to increase in size indefinitely. The condition is sometimes called "diffuse lipoma," but it is not, strictly speaking, a tumour.

Lipomatosis is most often found in the neck. In this situation it is more common in men than in women, the patients being frequently chronic alcoholics. In women it is most commonly found on the abdomen and thighs.



FIG. 48.—LIPOMATA OF THE GROINS.
(London Hospital Medical College Museum.)

Treatment of Lipomata.—Subcutaneous lipomata should be removed by making an incision over them, and then shelling the tumour out, an operation which is one of the simplest in surgery. If the tumours are multiple, they rarely grow to a large size, and operative interference is unnecessary. Subserous lipomata projecting through the abdominal wall should also be removed; and if a peritoneal pouch is formed in connection with them, radical cure of the hernia should be carried out. Parosteal and intramuscular lipomata will usually be operated upon to establish a diagnosis, and should then be removed. The operative treatment of lipoma arborescens is unsatisfactory.

The **TREATMENT** is that of obesity in general; but if the condition is very unsightly, masses of the fat may be removed.

Adiposis Dolorosa (Dercum's Disease).—This condition is most commonly met with in women at the time of the menopause, and is often associated with asthenia and psychological changes.

The patient has diffuse symmetrical masses of fat in various parts of the body, which are painful. The skin over the masses is often hyperæsthetic. The pathology is obscure.

TREATMENT.—If possible, the fatty masses should be excised.

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Fibroma

Fibromata are tumours composed solely of fibrous tissue, and are one of the rarer varieties of innocent tumours. They consist of masses of fibrous tissue of varying density (hard and soft fibromata) contained in a capsule, and presenting on section a glistening appearance, due to the bands of fibres being cut across in different directions. These tumours are always more cellular in nature than normal adult connective tissue. It is of the utmost importance to realize that no definite line of demarcation can be drawn between them and the sarcomata. All that can be said is that the greater the number of cells (fibroblasts or spindle cells), the more likely is the tumour to be malignant. When the cellular element is prominent, the tumour is termed a "fibro-sarcoma." Degenerative changes are not uncommon in the fibromata, the tumour undergoing necrosis, with formation of cholesterol and fatty debris. Calcification may then occur.

I. HARD FIBROMA.—Hard fibromata are found in connection with tendon sheaths, fascia, the dura mater, and present themselves as hard,



FIG. 49.—DIFFUSE LIPOMATOSIS.



FIG. 50.—FIBRO-CELLULAR TUMOUR.
(The black area is due to gangrene of the mass.)

freely movable circumscribed tumours. On the jaw they grow from the periosteum, and form one of the rarer varieties of epulis. They are also found growing from the base of the skull into the nasopharynx. Both these varieties of tumours are more likely to be fibro-sarcomata than fibromata.

The TREATMENT is removal as soon as possible.

2. SOFT FIBROMATA OR FIBRO-CELLULAR TUMOURS.—These are soft growths, sometimes weighing several pounds, that are found in connection with the skin. The tumours are generally pedunculated, grow slowly, and may be present for many years without causing inconvenience. They are particularly common on the external genitals and thighs of women.

The TREATMENT is removal.

Neuroma

Tumours composed of nerve cells are amongst the rarest new growths known to pathologists, and are of no interest to the clinician.

AMPUTATION NEUROMATA.—The ends of the nerves in an amputation stump form not infrequently a firm, painful, bulbous mass, fixed to the surrounding structures by cicatricial tissue. On section this is found to consist of interlacing axis cylinders buried in endoneurium, representing an effort on the part of the nerve fibre to regenerate, and is not a tumour formation.

If the condition has once existed, and the bulbous ends have been excised on account of the pain they cause, they are very liable to return in the stump of the nerves.

TREATMENT.—Excision of the lower portion of the nerve, or reamputation.

Fibromatosis, Neuro-fibromatosis, Molluscum Fibrosum, False Neuromata, Plexiform Neuromata, Multiple-Plexiform Neuromata, Pachydermatocele.—Under these varying names a new formation occurring in connection with nerves not growing from nerve colls or axis cylinders, but from the endoneurium or perineurium, has been described. These various terms have been used in the description of more or less solitary specimens, and it is only recently that the connection between the various groups has been recognized. The simplest expression of the condition is a fibrous swelling occurring in the course of a nerve, which is freely movable and often painful. On dissection it is found to consist of fibrous tissue through which the axis cylinders run an uninterrupted course. The tumours may cause trouble from pressure, especially if situated on the nerve roots in the spinal canal or on the nerve of the cauda equina. These *false neuromata* are frequently multiplo.

A condition of multiple fibromata of the skin, sometimes amounting to many hundreds, had long been described until *Von Recklinghausen* in 1882 pointed out that these tumours were situated on the minute nerve twigs running to the skin, and were frequently associated with multiple fibromata on the nerve trunks, and that the condition was

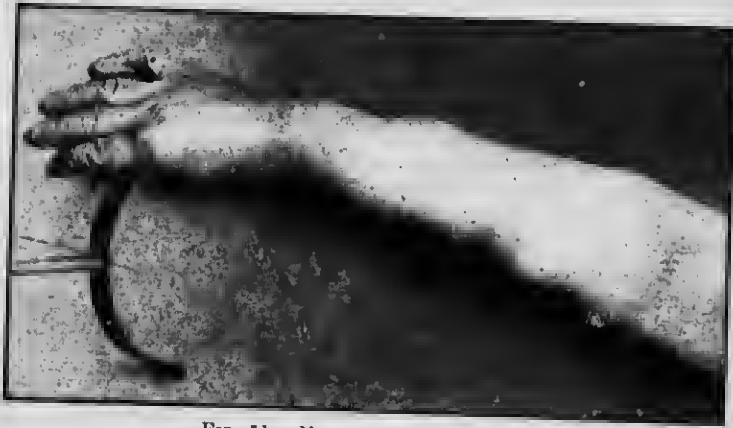


FIG. 51.—NEURO-FIBROMATOSIS.

a neuro-fibromatosis. This condition is sometimes associated with enormous pendulous folds in the skin, which are formed by great increase of the fibro-cellular subcutaneous tissue. The skin is usually coarsened and pigmented, and the mass may weigh several pounds. This condition is spoken of as *moluscum fibrosum*, and may exist without the multiple nodules on the nerves, appearing as a solitary pedunculated fibro-cellular tumour.

In other cases the condition of neuro-fibromatosis presents itself as an enormous overgrowth of the nerve sheath of a single nerve, all the branches being involved. The skin over the nerve is usually pigmented and coarse, and the tumour "feels like a bag containing a number of tortuous irregular vermiform bodies" (Bland-Sutton).

The condition may also occur in several nerves, or on parts of several nerves.

TREATMENT. — A single fibroma on a nerve should be removed, care being taken that the nerve is not injured; or if it is necessary to divide the nerve, the ends should be immediately joined, a nerve graft being used if necessary.

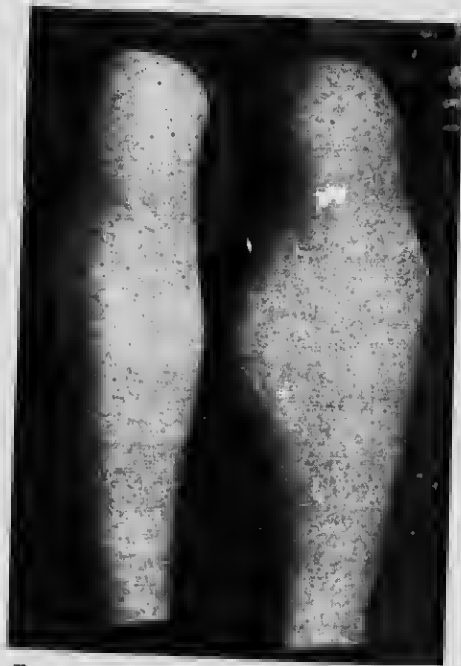


FIG. 52.—NEURO-FIBROMATOSIS OF THE LEG WHICH HAS BECOME SARCOMATOUS.

Neuro-fibromatosis, especially if associated with molluscum fibrosum, has no surgical treatment. It may be necessary to amputate a limb for plexiform-fibro-neuromatosis.

PROGNOSIS.—An undue proportion of patients suffering from fibromatosis die of sarcoma, and in some cases it is probable that the tumours growing from the nerve sheaths are examples of slowly growing sarcomata, and should be placed under this variety of tumour.

Painful Subcutaneous Nodules.—This is rather a clinical condition than a pathological entity. The condition shows itself as a small, hard, fibrous nodule in the subcutaneous tissue. It is freely movable, and is the site of attacks of severe pain. In some cases these nodules are multiple. They are most common in young adult life, and occur more frequently in women than in men.

TREATMENT.—Excision. Recurrence does not occur.

Chondroma

This term should be limited to innocent tumours composed of cartilage, and should not include the embryomata of the testis, or the mixed tumours of the salivary glands, both of which are essentially malignant.

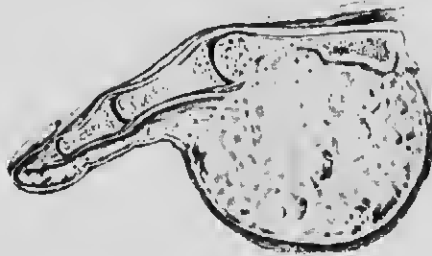


FIG. 53.—CHONDROMA OF A PHALANX.
(London Hospital Medical College Museum.)

Chondromata are composed of cartilage, closely resembling adult cartilage, but frequently containing a vascular cellular stroma, which also forms a capsule for the tumour.

They may calcify or undergo degeneration, the centre of the tumour breaking down into a jelly-like mass.

SYMPTOMS.—These tumours, often multiple, occur most frequently in the phalanges, on the ribs, and in the region of the ethmoid bone. They may cause great deformity, but, like other innocent tumours, give rise to no symptoms apart from their environment. They may press on nerves and cause pain, or grow into the skull, giving rise to the symptoms of cerebral tumour. On the fingers they grow from the interior of the bone near to the epiphysial line, and if not thoroughly removed, will recur. These tumours do not give a good shadow with the X rays.

TREATMENT.—A chondroma should be removed as soon as diagnosed by shelling it out from its capsule.

Ecchondroses.—These are masses of cartilage occurring at the edges of the articular cartilages in the condition known as "osteoarthritis," and are largely due to chondrification of the synovial fringes.

They frequently break off, and form one of the varieties of foreign bodies in joints.

Small cartilaginous nodules are also found in the nose and larynx, but their exact pathological nature is not yet clear.

Osteoma

Innocent tumours of bone may be divided into two classes—cancellous osteomata and compact or ivory osteomata.

The CANCELLOUS OSTEOMATA are most commonly met with at the ends of long bones, and are preceded by cartilage, so that the condition may be spoken of as an ossifying chondroma. They are often pedunculated, and remain capped with a thick layer of cartilage, and cease to grow when the epiphysis becomes fused with the diaphysis. They are frequently multiple. There appears to be a family tendency to the disease. Some authorities believe these osteomata to be directly associated with rickets, the tumours being said to arise in small islands of cartilage separated from the epiphysal cartilage during the irregular ossification that occurs in this disease.

SYMPTOMS. — The patient presents one or more hard, rounded tumours, growing from the ends of the long bones. They are painless, slowly growing, and only cause trouble by their unsightliness, by pressing on nerves, or by interfering with the movement of a joint. A bursa is frequently present over the osteoma.

TREATMENT.—If causing symptoms, or if the patient desires it, the tumour should be removed; but in the absence of symptoms, the tumour may be left, as it seldom causes real inconvenience, and malignant change does not occur.

COMPACT OSTEOMATA.—These tumours grow chiefly from the skull-bones, especially the frontal and the petrous portion of the temporal bone, and from the jawbones. They are sessile tumours, so hard as to be of ivory consistency, and may grow to a very large size. They



FIG. 54.—OSTEOMATA OF THE LOWER ENDS OF THE RADIUS AND ULNA.

frequently encroach upon the air sinuses of the skull, such as the frontal sinus or the antrum of Highmore; or they may invade the external auditory meatus, and are then sometimes symmetrical. After growing for some years, they may be separated from the bone by necrosis, due to cutting off their own blood-supply, and may then drop off, or remain as a loose body in a cranial sinus.

TREATMENT.—If causing symptoms, such as deafness—when growing in the external auditory meatus—or deformity, they should be removed, but, on account of their denseness, this is not an easy operation.



FIG. 55.—EXOSTOSIS OF THE FIBULA.

An excellent method of removal is to bore several holes in the base of the tumour with a dental engine, and then remove it with a mallet and chisel.

Exostosis.—Under this term is included several different pathological conditions, most of which are inflammatory in nature. They are—(1) Bony outgrowths from the articular ends of the bones in osteoarthritis; (2) ossification of ligaments; (3) ossification of tendons; (4) ossification of muscles; and (5) subungual exostosis. These conditions will be described under the sections on Diseases of Joints, Muscles, and Nails.

Angioma (Nævus).—Angiomata are innocent tumours arising in connection with the bloodvessels, and will be described under Diseases of the Bloodvessels.

Lymphangioma (Lymphatic Nævus).—These

tumours are innocent and correspond to the angiomata. They will be described under the section on Diseases of the Lymphatics.

Myoma

The myomata are tumours composed of muscular tissue, and are divided into two groups, striped and unstriped.

STRIPED MYOMATA (RUABDOMYOMATA).—These tumours are so exceedingly rare as to be pathological curiosities of little interest to

the clinician. They occur in the testis, kidney, and vagina, and are usually part of a malignant teratoma. In one case at least secondary deposits have been found containing striped muscular tissue.

UNSTRIPED MYOMATA (FIBROIDS).—Tumours composed of unstriped muscle are rarely pure, but usually contain a large amount of fibrous tissue (fibre-myomata), and the larger the tumour, the greater is the amount of the fibrous element. They occur in the stomach and intestines—where they are sometimes multiple—in the prostate, Fallopian tubes, round ligament, and other places where there is unstriped muscular tissue; but by far the commonest site is the uterus.

In this organ they are usually multiple, and each tumour is distinctly encapsuled. On section, they are pale and glistening, and the strands of fibres are seen to be arranged in whorls. Secondary degenerative changes are common, and the tumours may break down into cysts, or calcify, or become necrotic or infected. They give rise in the uterus to certain well-defined symptoms, and for their diagnosis and treatment a work on gynaecology should be consulted.

In other organs, such as the stomach, fibre-myomata can only be diagnosed by microscopical section after they have been removed from the body, and it is often exceedingly difficult to differentiate them from the sarcomata.

TREATMENT.—Excision.

Myxoma.

The myxomata are tumours composed of tissue similar to Wharton's jelly in the umbilical cord. Although it is exceedingly common for other tumours to undergo a myxomatoid degeneration, true myxomata are very rare tumours, so rare that some authorities consider that they ought not to be classed as a separate new growth. On the other hand, encapsuled tumours of pure myxomatous tissue have been described as growing from the endocardium, in the subcutaneous tissue, and in the nose and naso-pharynx. In regard to the last situations, the ordinary nasal polypus is *not* a myxoma. It consists of oedematous granulation tissue and mucous membrane, and is due to an inflammatory condition of the underlying bone (see p. 920).

Myxomatous tumours have been described as growing in the connective tissue between the muscles, and the buttocks appear to be the favourite site of these growths.

2. MALIGNANT TUMOURS ARISING IN THE CONNECTIVE TISSUES

Sarcoma.—The sarcomata are malignant tumours arising in connective tissue, and in the most typical varieties are composed of undifferentiated cells of an embryonic type.

MACROSCOPICAL APPEARANCE.—To the naked eye the sarcomata appear as soft, fleshy growths, pinkish-white in colour, but often with hæmorrhages present, altering their colour. They infiltrate and destroy

the surrounding tissue, growing along the planes of tissue and creeping in through interstices, such as foramina, or between the laminae of the vertebrae. They surround and press on the arteries and nerves, and frequently invade the veins and grow along their lumen. In the early stages, and more especially in some situations, they appear to have a capsule; but on examination this is shown to be either a simple condensation of the tissue around the growth or a natural barrier to extension, such as the periosteum. On microscopical examination this pseudo-capsule is found to be infiltrated with sarcoma cells.

Secondary changes are common, the most usual being hæmorrhage into the growth, which may be so extensive as to give the tumour the appearance of a blood-clot, a condition formerly spoken of as a malignant blood-cyst. Myxomatous and fatty degeneration of the tumour are also common, and fibrosis, ossification, and other changes may occur.

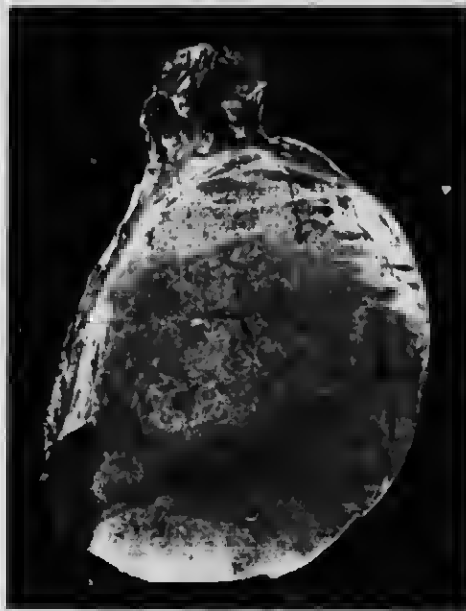


FIG. 56.—SARCOMA OF TESTIS.
(London Hospital Medical College Museum.)

thelial cells, which in some places may be deficient. This close connection between the tumour cells and the bloodvessels accounts for the frequency with which hæmorrhage occurs in these growths, and also for the dissemination of them by the blood-stream. The vascularity of some of the sarcomata may be so great that the tumour will pulsate, and a "hum" can be heard on listening over the tumour with a stethoscope.

CLINICAL FEATURES.—Sarcomata occur at all ages, but are more frequently found in young subjects than in the aged, who are more likely to suffer from carcinomata. In some cases they are congenital. They often definitely follow an injury, as the fracture of a bone, but it is doubtful how far this injury contributes to their occurrence.

MICROSCOPICALLY, a typical sarcoma is composed of a mass of embryonic, undifferentiated cells, each containing a single nucleus, lying in a homogeneous ground substance, each cell being quite distinct and surrounded by the ground substance. The bloodvessels, which are mainly capillary, are very numerous, and are in wide spaces in the growth, and are only separated from the cells of the growth by a single layer of endothelial cells.

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The typical sarcomata, composed of embryonic cells, grow rapidly, infiltrate the surrounding structures, and are disseminated by the veins, so that secondary growths are often found in the lungs. Secondary growths in the lymphatic glands do occur, but not so frequently or so early as in the case of carcinomata. They are particularly common in lympho-sarcoma and sarcoma of the testis, thymus, thyroid, and tonsil.

When the tumour, by its growth, reaches a free surface such as the skin, ulceration occurs, and the growth fungates. This condition gives rise to an irregular pyrexia owing to septic absorption; but, apart from ulceration, sarcomata—and especially those of bone—may be associated with a continuous pyrexia.

The degree of malignancy varies with the differentiation of the cells composing the growth. The typical sarcomata with an embryonic



FIG. 57.—LARGE ROUND-CELLED SARCOMA.

type of cell are very malignant, but the forms with highly differentiated cells, such as the fibro-sarcomata, are only locally malignant. Sarcomata may occur in any part of the body as a primary growth, but they are most common in the bones, subcutaneous tissue, intermuscular tissue, and fascia. As primary growths they are seldom met with in muscles, liver, lungs, spleen, or uterus. In the eye they occur in the retina in children, and in the nasal tract in adults.

VARIETIES.—The sarcomata may be divided into the following varieties:

1. *Round-Cellled Sarcoma.*—This variety of tumour is composed of round cells with a single nucleus, surrounded by a small amount of cytoplasm, and lying in a very vascular ground substance. Hemorrhages are common, and metastases occur through both the blood-stream and the lymphatics

The small, round-celled sarcomata are the most malignant of the sarcomata, and the cells are of the least differentiated type.

2. *Small Spindle-Celled Sarcoma*.—This variety of tumour is composed of spindle-shaped cells from 10 to 20 μ in length, and the cells are collected into bundles, which surround the capillaries. They are less malignant than the round-celled form, and metastases are uncommon.
3. *Large Spindle-Celled Sarcoma*.—The spindle cells in this variety are from 50 to 80 μ long, and the tumours are less malignant than the small spindle-celled variety. They often arise in connection with the periosteum.



FIG. 58.—LARGE SPINDLE-CELLED SARCOMA OF THE BREAST.

4. *Intermediate Types*.—The differentiation of the cells of a sarcoma may continue until connective tissue of an adult type is reached. This differentiation occurs in the centre of the tumour, while the spread of the undifferentiated cells occurs at the periphery. In this way the fibro-sarcoma, chondro-sarcoma, and osteo-sarcoma are formed. These are intermediate types between the pure embryonic cellular sarcomata and the fibromata, chondromata and osteomata, and are all much less malignant than the pure sarcomata. Metastases are rare.
5. *Lympho-Sarcoma*.—The cells of the lympho-sarcoma resemble those of the small round-celled sarcoma, but this variety is distinguished by a well-marked reticulum in the ground substance similar to that found in the lymphatic glands.

These tumours arise in lymphatic glands and lymphoid nodules, are of high malignancy, and are disseminated by the lymphatics as well as by the bloodvessels.

TREATMENT. The treatment of sarcoma is thorough removal with a wide surrounding area of apparently healthy tissue, and it is usually advisable to remove the nearest set of lymphatic glands as well. The treatment of inoperable tumours in general is discussed on p. 243, but a special method of treating sarcomata will be mentioned here:

Coley's Fluid.—This fluid consists of a mixture of sterilized cultures of the *Streptococcus erysipelatis* and the *Micrococcus prodigiosus* grown in bouillon. The fluid is standardized, so that the strength

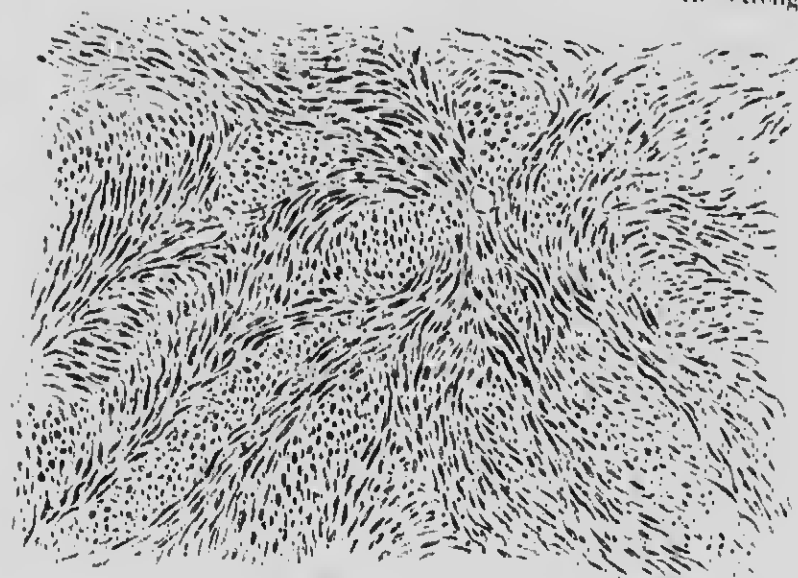


FIG. 50.—SECTION OF FIBRO-SARCOMA.

and dosage can be estimated, and injections are made into the patient, either into the tumour itself or into some distant part. The initial dose is $\frac{1}{4}$ minim, and this is steadily increased according to the amount of reaction. The reaction to these mixed toxins must be quite definite, a temperature from 101° to 105° F. being produced, with headache, rigors, sweating, and vomiting. The frequency and amount of the injections must be estimated for each patient according to his ability to withstand the reactions.

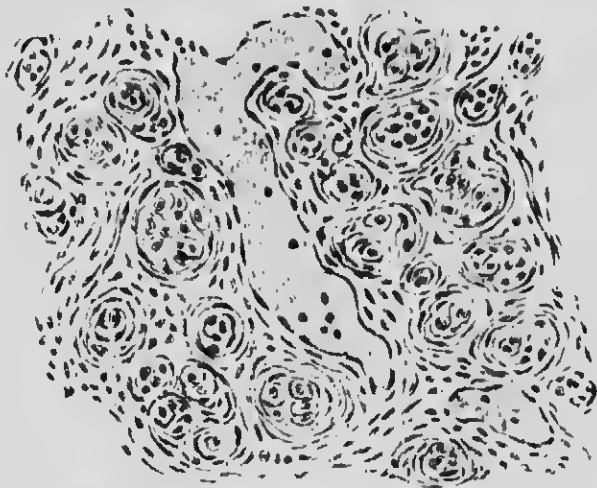
In the great majority of cases the treatment is useless, and the patient is put to great discomfort without any beneficial results; but in a few cases (10 to 20 per cent.) the tumour becomes smaller and less vascular. If this occurs, a tumour which was previously inoperable may become operable, and in a few cases the tumour has permanently

disappeared. It does not appear possible at the present time to distinguish the cases that will improve from the large majority in which the treatment is useless, and treatment in each case must be looked upon in the nature of an experiment.

Coley also advises the use of the fluid as a prophylaxis against recurrence after the removal of a sarcoma. If this is done, the doses should be small and the reaction kept well within bounds. The treatment of sarcomata of bones by this method is considered under *New Growths of Bones* (p. 507).

Endothelioma and Perithelioma

The endotheliomata are tumours arising from the endothelium of the bloodvessels (*hæmo-endothelioma*), or the lymphatics and



Collier's

FIG. 50.—ENDOTHELIOMA OF THE DURA MATER.

lymphatic spaces, such as the pericardium, peritoneum, and pleura (*lymph-endothelioma*). The peritheliomata arise from the lymphatic endothelium of the perivascular spaces.

Considerable discussion has taken place about these tumours, some pathologists considering they are common, and others putting them amongst the rare varieties of neoplasms. A typical endothelioma is a slowly growing tumour of low malignancy, but metastases do occur.

Diagnosis of this form of tumour is only possible by the aid of the microscope. Clinically, they resemble the slowly growing sarcomata. On microscopic examination, a typical endothelioma is seen to be composed of a collection of whorls of concentrically disposed, flattened cells lying in a cellular stroma, and in some instances blood-corpuscles are seen in the lumen of the whorl. The central cells of the whorl

tend to undergo hyaline degeneration. In the case of endotheliomata growing from the pia mater or the choroid plexus, calcareous salts are deposited in the degenerated cells, and the tumour is called a **psammoma**.

If a perithelioma is examined microscopically, it is seen to consist of capillaries lined by an endothelium, and round each capillary is a collection of radially disposed cells at right angles to the axis of the capillary. The cells farther from the bloodvessels are the oldest, and undergo hyaline change. When this is extensive, the tumour is spoken of as a **cylindroma**.

B. TUMOURS CONTAINING PIGMENT

1. **Melanoma**.—The melanomata are new growths, usually of a highly malignant nature, which are characterized by the presence in

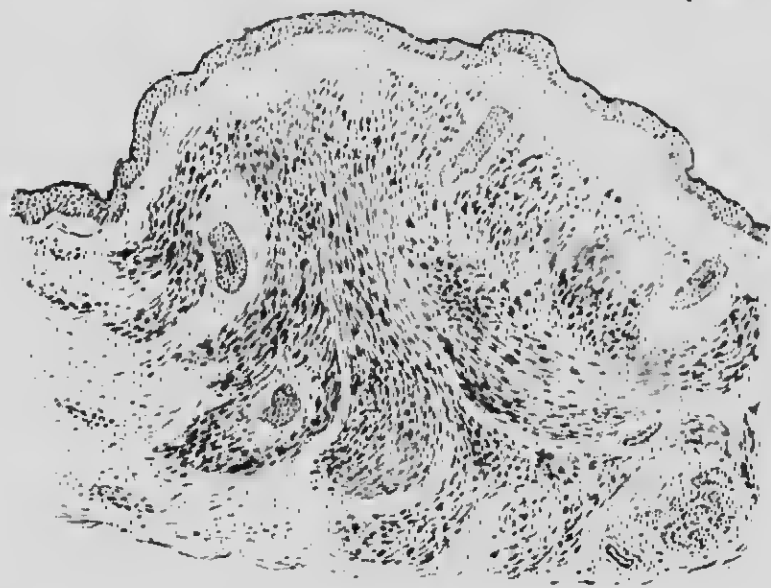


FIG. 61.—MELANOMA (LOW POWER).

the cells and in the stroma of a black pigment called "melanin." The exact nature of these tumours is indefinite; they are generally—and perhaps properly—classified with the sarcomata; but some authorities believe the cells of the tumour to be of epithelial origin, and classify them with the carcinomata. It is possible that both views are correct, and that, although the great majority of these tumours arise in connection with connective tissue, those arising in the ciliary body of the eye are examples of melano-carcinoma.

On microscopical examination, two classes can be distinguished—(1) Tumours composed of small spindle cells, which are more common in the eye; and (2) tumours composed of large epithelioid cells, tending

to be arranged in an alveolar structure, which are more common in connection with the skin. The melanin is found both in the cells and in the stroma, but in both the primary and secondary growths it is very unequally distributed, so that the nodules of the growth vary in colour from coal black to pink. For example, in secondary melanomata of the liver a black nodule may be next to one that, on macroscopic examination, cannot be distinguished from a nodule of secondary round-celled sarcoma. Degeneration of the cells containing the pigment occurs, and the pigment may be set free to enter the blood-stream. When this occurs, it may be deposited generally in the tissues (melanosis), or may be passed in the urine (melanuria).

The urine when passed may at first be clear, but it becomes black on exposure to the air. The addition of bromine water causes a yellow precipitate, becoming black on exposure to the air.

CLINICAL FEATURES.—These tumours occur at all ages, but are most common about middle life. They arise in connection with the skin, especially in pigmented moles or in places where the skin is deeply pigmented, such as the anus and nipple, or in the neighbourhood of the nails; in the uveal tract of the eye; in the mouth, and in the vagina. The primary tumour is usually quite small, and may very exceptionally show little signs of malignancy; but as a rule there is rapid infection of the nearest lymphatics and glands as well as general dissemination of the growth. This general dissemination is more extensive than in any other form of neoplasm, in some cases every part of the body being the seat of secondary growths, although they are usually most abundant in the liver. Sometimes the secondary growths appear long after the primary growth has been removed. In one case known to the author general dissemination,



FIG. 62.—MELANOMA OF THE FOOT.
(London Hospital Medical College Museum.)

with melanosis and melanuria, occurred twenty years after the primary growth in the eye had been removed.

TREATMENT.—The treatment of these growths is early and free excision with the nearest set of lymphatic glands, and, if possible, the intervening lymphatics. The prognosis is bad.

2. Chloroma.—This variety of tumour is distinguished by the green colour present on section immediately after removal. It is probably allied to leukaemia. The growths are multiple, and most frequently arise in connection with the bones of the orbit and skull. Secondary deposits may occur. There is usually no treatment.

PLATE I.



Melanoma of the Anus.

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C. TUMOURS IN CONNECTION WITH THE CENTRAL NERVOUS SYSTEM

Glioma.—The gliomata are tumours derived from the neuroglia—that is, the supporting tissue of the brain and spinal cord which is supposed to be epiblastic in origin. They are found in connection with the brain, spinal cord, and retina, and vary somewhat according to the situation in which they are found.

BRAIN.—Two varieties of glioma are described in the brain—the *hard* and *soft*. The *hard* gliomata are found in connection with the ventricular walls, and project into the ventricles. They are encapsuled, and can readily be enucleated.

The *soft* variety have no capsule, and infiltrate the surrounding brain, so that it is difficult to distinguish their limits. They are very vascular, somewhat translucent, and of pulpy consistence. Hæmorrhage into them is very common.

These tumours are most frequently found in children under twelve years of age, and grow very slowly. They never cause secondary growths, nor do they invade the membranes of the brain, so they must be considered as benign growths. Although they are eventually fatal on account of their environment, the patient may live for years.

SPINAL CORD.—In the spinal cord an overgrowth of neuroglia element is the pathological basis of the disease termed “syringomyelia”; but at the present time this is described rather as a hyperplasia than as a neoplasm. The condition is a gliomatosis, and no surgical treatment is possible.

RETINA.—Gliomata of the retina differ from the gliomata of the brain in infiltrating surrounding structures and causing metastases; they are therefore malignant. They form soft grey tumours, projecting from the retina into the vitreous chamber, and are rarely met with after the age of twelve.

On microscopic examination, these tumours are seldom formed of typical glial tissue, and their exact nature is in dispute. It is probable that many of them are round-celled sarcomata, but some authorities, who term “sarcomata” all tumours composed of undifferentiated cells, believe these tumours consist of undifferentiated glial cells, and use the term “glio-sarcoma.”

D. TUMOURS IN CONNECTION WITH THE BONE MARROW

Myeloma.—Large giant cells are normally found in the bone marrow, and are associated with the development of the bone. Tumours arise from these cells, both from the interior of the bone and from under the periosteum. It was formerly customary to include these tumours with the sarcomata (giant-celled sarcoma, or myeloid sarcoma), but clinically they are more of the nature of innocent than of malignant growths, and it is better to class them by themselves.

These tumours originate most often in the centre of long bones near the ends, but occasionally they grow from the periosteum of the jawbones, forming one of the varieties of epulis. The growth of the

tumour leads to the absorption of the bone in the centre, and at the same time new bone is laid down by the periosteum, the bone becoming expanded.

The tumours are very vascular, and of a deep brown colour. They do not *as a rule* form metastases, and local removal, if thorough, is not followed by recurrence.

On *microscopical* examination, the tumour is found to consist of short spindle cells of the fibroblastic type and numerous giant cells. These giant cells stain well throughout, and contain many well-formed nuclei of uniform size scattered evenly through the cell. Spicules of new bone are sometimes formed in these tumours, the bone

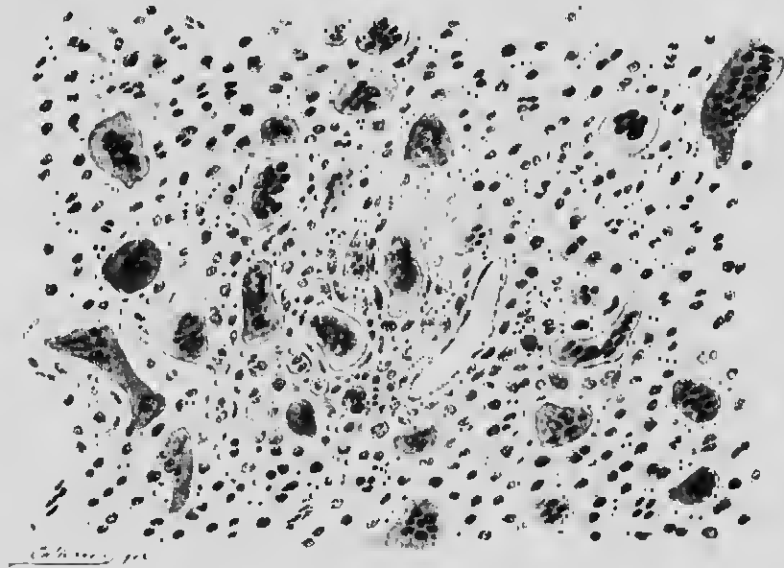


FIG. 63.—SECTION OF A MYELOMA.

destruction is the more prominent feature. In a few instances when these tumours form metastases, it will be seen on microscopical examination that the matrix contains a large number of small round cells, or, in other words, has become sarcomatous.

The clinical features and treatment of these tumours will be considered under Diseases of the Bones.

Myelomatosis.—This condition is a primary multiple process affecting several bones simultaneously. The growth occurs in the medulla, especially of the vertebrae, ribs, and cranium, converting it into a reddish tumour mass, and causing absorption of the bone. This absorption of bone leads to deformity, owing to bending of the bones and spontaneous fractures. There is pain in the bones, intermittent fever, and a progressive anaemia. During some period of the disease, albumose is found in the urine (myelopathic albumosuria, or Bence-Jones's disease).

It is believed that this condition is an overgrowth of the *blood-forming elements* of the bone marrow, and the condition is allied to myelogenous leukaemia; but the disease is usually limited to the skeleton, and there is no enlargement of the lymphatic glands or spleen. The condition may become sarcomatous, and secondary growths occur in various parts of the body. There is no treatment.

E. TUMOURS IN CONNECTION WITH THE TEETH

Odontomata.—These tumours are described in the section on Diseases of the Jaw, p. 963.

F. INNOCENT TUMOURS OF EPITHELIAL ORIGIN

Papilloma.—The papillomata arise from a surface epithelium, such as the skin, lining membrane of the uterus, or bladder, or in connection with ducts or cysts.

Three varieties may be recognized—hard papillomata, or warts; soft papillomata, or villous growths; and intra-cystic growths.

1. **HARD PAPILOMATA, OR WARTS.**—These growths arise from surfaces covered with a squamous epithelium, such as the skin, vagina, anal canal, and glans penis. They consist of a centre core of vascular connective tissue covered with a squamous epithelium, and appear as hypertrophy of the normal papillae of the part. The epithelium grows outwards, and, no matter how abundant it may become, it never penetrates the basement membrane to invade the connective tissue. There is some doubt as to whether these hard papillomata should be classified amongst the tumours, for there is considerable evidence to show that they are of an infective nature. They are frequently multiple, spreading round an initial growth, and are often associated with irritating discharges, such as gonorrhœa, or in connection with syphilis (Hutchinson's wart and condylomata). It is also believed by some pathologists that they can be infected from patient to patient, or from one part of a patient to another.

CLINICAL FEATURES.—Warts are more general in children than in adults, and occur most commonly on the hands, where they are usually multiple. They may persist for years, appearing in crops; but they frequently disappear spontaneously with the removal of an irritating discharge. In elderly people, and especially if a wart is irritated, a carcinoma may develop at its site.

2. **SOFT PAPILOMA, OR VILLOUS TUMOURS.**—These tumours occur in the bladder, pelvis of the kidney, alimentary canal, particularly the rectum, and in the ducts of glands. They are branching tumours, either sessile or pedunculated, consisting of a core of very delicate vascular connective tissue, covered by a transitional or a columnar epithelium.

CLINICAL FEATURES.—These tumours are most common between the ages of thirty and forty, and bleed readily, so that the one constant clinical symptom is hæmorrhage. The hæmorrhage is generally profuse and intermittent, and there are often no other symptoms. The tumour may grow to a very large size, in some cases filling the whole of the urinary bladder. A villous papilloma is frequently the forerunner of a carcinoma.

3. **INTRACYSTIC GROWTHS.**—These papillomata are often found in connection with the cysto-adenoma. They form villous tumours projecting into the cyst. Like the other papillomata, they have a central core of connective tissue, and are covered by transitional, columnar, or squamous epithelium, according to that which lines the cyst wall. In the case of a papillomatous cyst of the ovary bursting into the peritoneal cavity, secondary papillomata may grow all over



FIG. 64.—PAPILLOMA.

the peritoneum, and it may be hastily assumed that the condition is malignant; but these secondary warts may entirely disappear in the same way that warts will disappear from the skin. On the other hand, carcinoma may develop at the site of an intracystic papilloma.

Adenoma

The adenomata are tumours arising from the epithelial cells of a gland, and their structure resembles the acini of the gland or the ducts. Although in some cases the structure of an adenoma closely resembles that of the gland from which it arises, the acini are usually irregular, and the cells are arranged irregularly in layers instead of the acini being lined by a single layer of spheroidal cells. The cells are situated upon a definite basement membrane, which they do not penetrate. The amount of stroma present in the tumour varies considerably. In some cases it is scanty, and the growth is almost entirely glandular—**pure adenoma**; and in others the stroma predominates—**fibro-adenoma**. These glandular tumours as a rule have no secretion except in the case of adenomata of the intestine, which have goblet cells, and discharge mucus, and adenomata of the thyroid, which often contain colloid

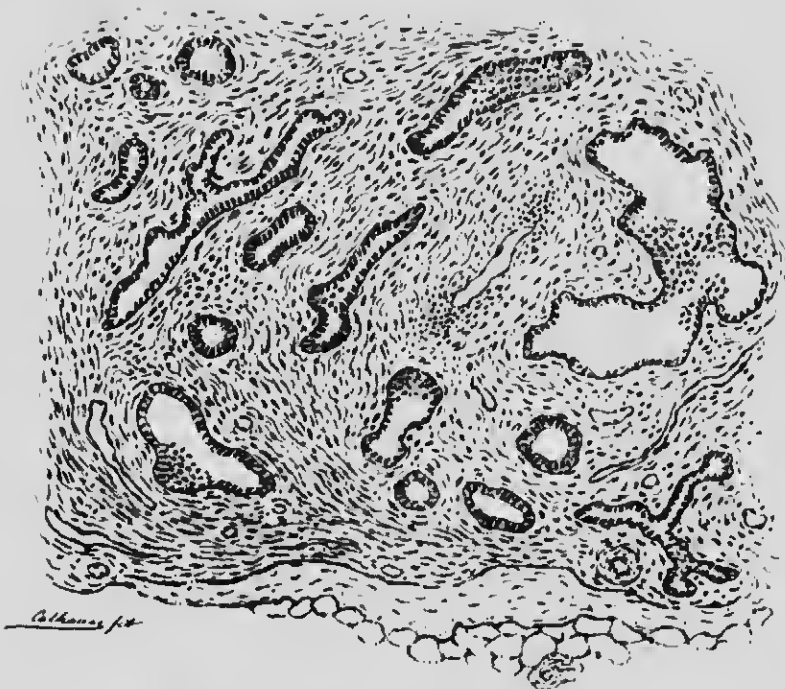


FIG. 65.—FIBRO-ADENOMA OF THE BREAST.

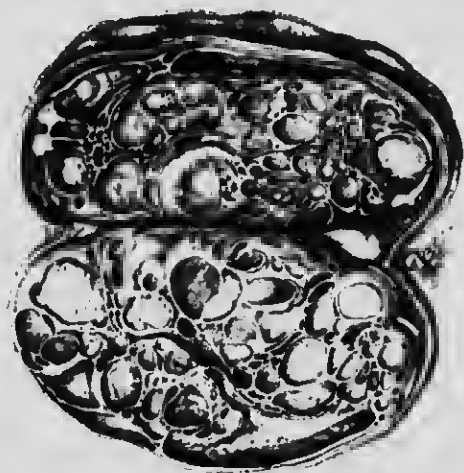
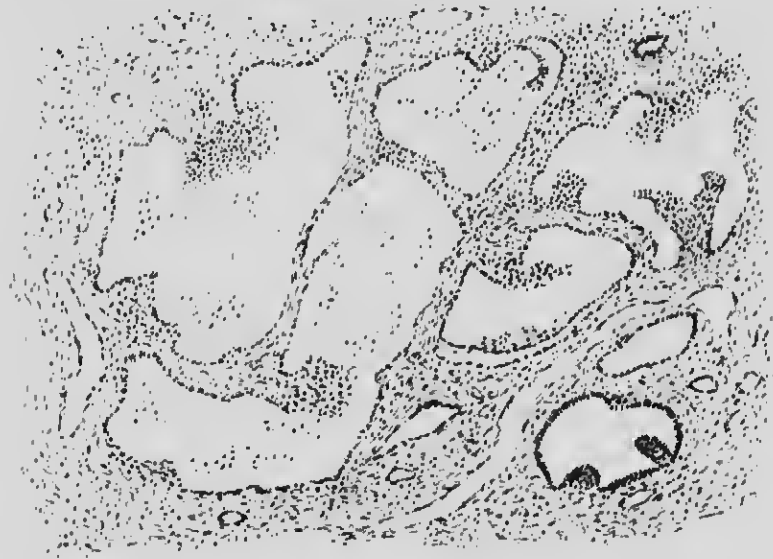


FIG. 66.—CYSTO-ADENOMA OF THE OVARY

material. The cells of an adenoma may break down, and the acini become distended with fluid, and in this way some of the largest cysts in the body are formed—**cysto-adenoma**. These cysts may contain intra-



Rehmann, 1900

FIG. 67.—SECTION OF CYSTO-ADENOMA OF THE OVARY.

cystic growths formed from a proliferation of the lining membrane of the cyst, and the growth may be so large as to entirely fill the cyst, giving the appearance of a papilloma rather than an adenoma.

CLINICAL FEATURES.—These tumours occur chiefly in young subjects, and are frequently multiple. They form rounded, encapsuled tumours, moving freely in the gland from which they arise. They rarely grow to a large size unless they become cystic, when they may form very large tumours. There is no infiltration of surrounding structures and no infection of lymphatic glands, and it is doubtful whether the cells ever become malignant. In some cases a malignant growth may appear to arise in an intracystic papilloma, and it is also possible for a sarcoma to arise in the stroma of an adenoma.

An adenoma arising in connection with the mucous membrane of the alimentary canal often becomes pedunculated, forming the common variety of polypus of the intestine.

TREATMENT.—Excision. The tumour as a rule easily shells out of its capsule.

MALIGNANT TUMOURS OF EPITHELIAL ORIGIN

Carcinoma.—These tumours are malignant new growths arising in epithelial structures in the skin, in the mucous membranes, and in the glands, the essential feature being the overgrowth of the epithelial elements.

On microscopical examination, it is seen that they resemble in structure the glands, or epithelia, from which they arise, but that the

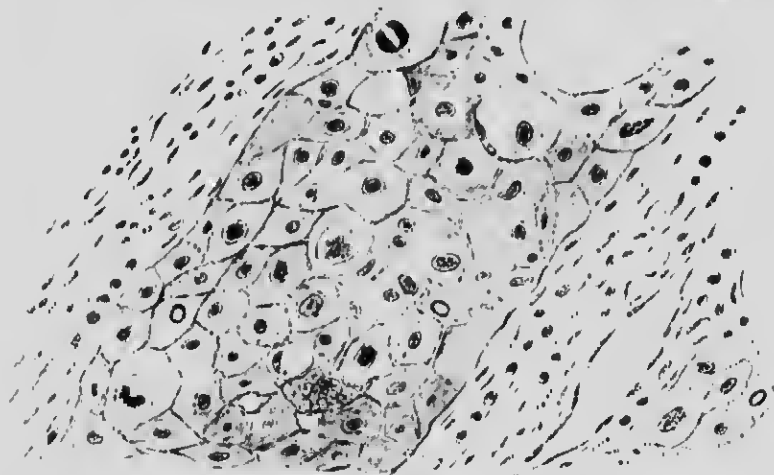


FIG. 68.—RAPIDLY GROWING SPHEROIDAL-CELLED CARCINOMA (ENCEPHALOID).

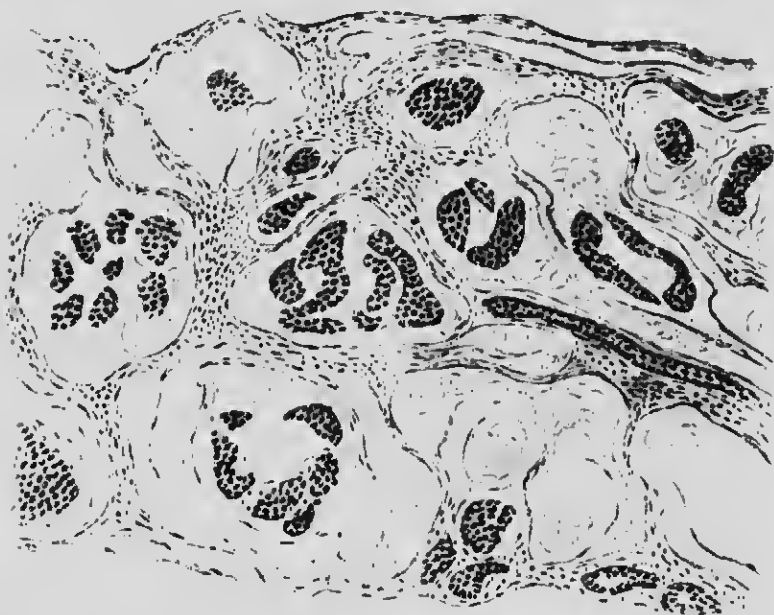


FIG. 69.—SPHEROIDAL-CELLED CARCINOMA OF THE BREAST UNDERGOING COLLOID DEGENERATION.

divergence in structure from the normal tissue is more marked than in the case of the adenomata and papillomata. This divergence in structure (anaplasia) is seen in both the cells and their arrangement,

and as a rule the more marked the anaplasia, the more malignant the tumour. In the more slowly growing of the glandular carcinomata, the imitation of a gland may be very exact; the cells are arranged in alveoli, and the intracellular substance may be normal in arrangement. On careful examination, it will be seen that two or more layers of cells are present in the alveolus, that the basement membrane is absent, and the epithelial cells are invading the surrounding structures, and also becoming much less like typical glandular cells. In more malignant cases the alveolar arrangement is lost, and there are solid masses of cells without any lumen, and a diffuse infiltration of the interstitial substance by atypical epithelial cells, many of which show heterodox mitosis. In the most rapidly growing of all the carcinomata the alveolar arrangement and the specialized epithelial structure of the cells may be so far lost that the growth is difficult to distinguish from a sarcoma or endothelioma.

The rule that the greater the anaplasia, the more malignant the growth has many exceptions among the carcinomata. It is not unusual to find a growth that has a very close resemblance to the normal gland, infiltrating the surrounding tissue, and causing secondary deposits in other organs. In some of these cases the growth—for example, thyroid and prostatic carcinoma—has a very high degree of malignancy, and yet, on microscopical examination, has the appearance of an adenoma. These growths are sometimes called **malignant adenomata**, but this is a term that leads to confusion.

If the growing edge of a carcinoma where it is invading the surrounding tissue be examined, it will be seen that as the carcinoma advances it gives rise to a well-marked inflammatory reaction of the

tissues with a small round-celled infiltration. This small round-celled infiltration goes on to the formation of cicatricial tissue, the carcinoma cells becoming surrounded with fibrous tissue. It is believed by some pathologists that this represents an attempt—possibly sometimes successful—at cure of the carcinoma.

DEGENERATION.—Degeneration of the cells of a carcinoma is of common occurrence, the most frequent being a fatty degeneration of the older cells, due to the formation of fibrous tissue round them, and consequent strangulation of the bloodvessels. In a scirrhus growth this may be so

excessive as to give the centre part of the tumour the appearance of a fibroma. The degeneration of the tumour cells may lead to the formation of cysts in the tumours, with alteration in the characteristic physical signs. Colloid change is a special form of degeneration mostly seen in



FIG. 70.—FUNGATING CARCINOMA.

the carcinomata of the alimentary canal and the omentum. The cells are distended with a modified mucin (colloid), and the growth is massive and translucent. The condition is sometimes classed as a special variety (colloid cancer).

ULCERATION.—When a carcinoma originates in or invades a free surface, the growth quickly breaks down, and is invaded by septic organisms, causing ulceration. The tumour as a rule grows more rapidly, and infection of the lymphatic glands may occur. The glands may break down in their turn and form large ulcerating masses.

CLINICAL FEATURES.—The carcinomata usually occur in the middle-aged, and the frequency with which the various organs are invaded depends to some extent on the sex of the patient. Carcinoma of the breast is much more common in women than in men, while carcinoma of the tongue and alimentary canal more often occur in males. In a few instances the growth is preceded by a condition of chronic inflammation of the part, but in the majority of cases no cause can be found. The primary growth has no capsule; it invades surrounding tissue, and quickly causes secondary deposits in the nearest lymphatic glands, which become enlarged, hard, and matted together. This enlargement of the lymphatic glands is not necessarily at first carcinomatous, but may be due to inflammatory changes in the gland, and it is not unusual to find no trace of new growth in enlarged glands removed by operation. The condition is at first painless, but later the patient complains of neuralgic pains, due to inclusion and pressure on nerve filaments. The general health is not affected at first, but, later, *cachexia* occurs, owing to pain, anxiety, hæmorrhage, sepsis, and the destruction of vital organs, and perhaps also to the absorption of a specific secretion. General dissemination by the blood-stream also occurs, but not so early as in cases of sarcoma.

VARIETIES OF CARCINOMA.—These new growths are classified according to the epithelium from which they arise, and three varieties are recognized—(1) Squamous-celled carcinoma, or epithelioma; (2) spheroidal-celled carcinoma, or glandular carcinoma; and (3) columnar-celled carcinoma, which may arise from glands or from the ducts (duct carcinoma).

Squamous-Celled Carcinoma.—This variety of growth arises from surfaces covered with a squamous or transitional epithelium, as the skin, œsophagus, vagina, and urinary bladder. When examined under the microscope, it presents solid branching columns of cells growing down into the connective tissue beneath, and invading the muscles and other structures. The stroma between the columns of cells is vascular, and the seat of inflammatory changes with small round-celled infiltration. The growth arises typically from the cells of the Malpighian layer of the skin, and these cells are large with deeply staining nuclei, though in the more rapidly growing forms the characteristic appearance of the prickle cells is lost.

In the more slowly growing variety a characteristic feature is the formation of cell nests. The cells in the centre of one of the down-growing columns are concentrically arranged, lose their definite

outlines, and eventually become keratinized. When the column is seen under the microscope cut across, the cell nests appear as rounded bodies, the centre cells being indefinite and staining well with eosin, while as the edges of the cell nests are approached, the cells become more definite and stain with hæmatoxylin.

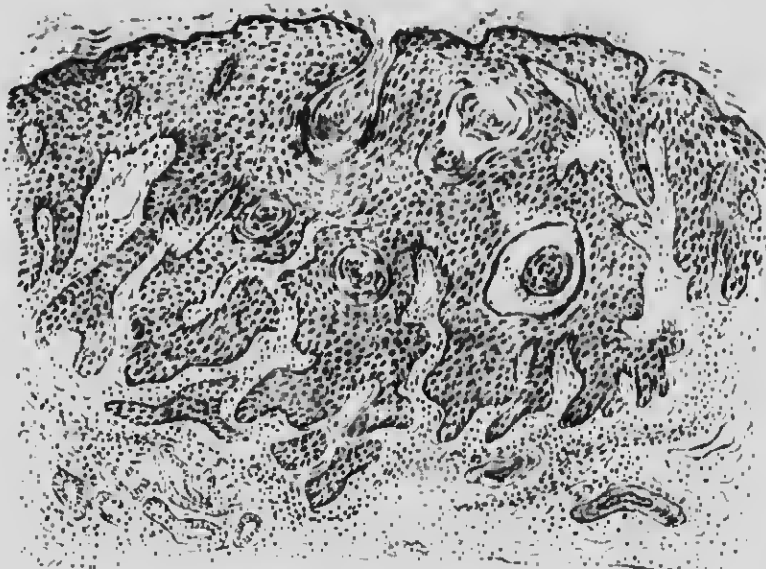


FIG. 71.—SECTION OF A SQUAMOUS-CELLED CARCINOMA.

CLINICALLY a squamous-celled carcinoma begins as (1) a wart or papilloma with an indurated base, (2) a subcuticular hard nodule, or (3) a tiny fissure or ulcer with indurated edges. Whatever appearance the growth has at first, however, it shows itself finally as a **malignant ulcer** having the following characteristics wherever it is found: The floor is sloughing, devoid of granulations, and has little hard nodules over it; the edges are hard, everted, and irregular; the base is indurated and fixed to surrounding structures, the secretion is profuse and foul; bleeding readily occurs on examination. In the papillomatous growths the ulcer is usually surrounded by a hard, warty growth, and the ulceration proceeds slowly. Invasion of the lymphatic glands by small emboli of the growth occurs early, and the glands become enlarged, hard, matted together, and fixed to the surrounding structures. Septic infection is apt to occur from the primary ulcer, and the glands may soften and break down, causing secondary ulcers very similar to the primary. As the growth proceeds, further lymphatic infiltration occurs, but general dissemination by the blood-stream is not common in the squamous-celled carcinomata. Death occurs from septic absorption, pressure on important structures such as the trachea or œsophagus, and hemorrhage from ulceration, into the larger bloodvessels.

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Spheroidal-Celled Carcinoma.—These tumours arise in glandular organs, and on microscopical examination are seen to resemble more or less completely the glands from which they arise. The growths are not encapsuled, and they invade the surrounding structures, so that it is very difficult to determine their exact limits. They travel along the lymphatics to infect the lymphatic glands. Degeneration with cyst formation frequently occurs, and dissemination by the blood-stream is more frequent than in the squamous-celled carcinomata.

According to the amount of fibrous tissue formed by the inflammatory reaction in front of the advancing growth, five varieties of growth are described: (1) *Carcinoma simplex*; the amounts of epithelial tissue and interstitial tissue is about the same as in a normal gland. (2) *Medullary or encephaloid*; the epithelial elements are markedly

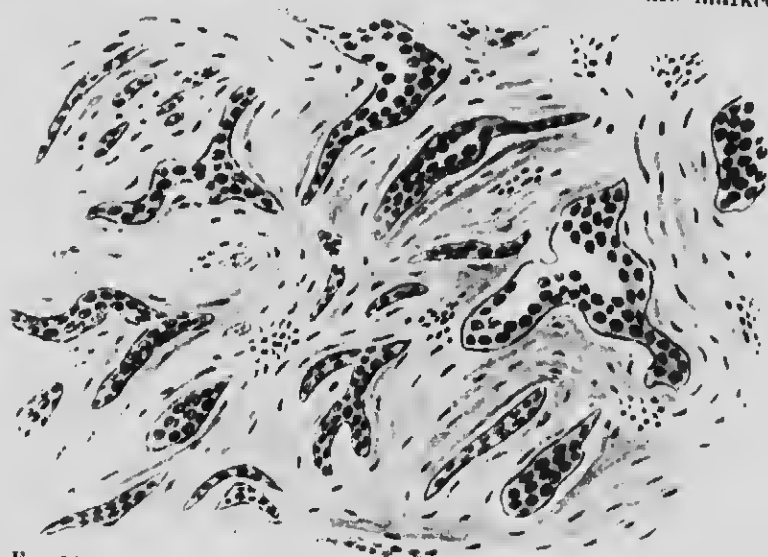


FIG. 72.—A SLOWLY GROWING SPHEROIDAL-CELLED CARCINOMA (SCIRRHUS).

in excess, and growth is rapid. (3) *Scirrhous*; the fibrous tissue is in excess, the tumour is hard and growth slow. (4) *Atrophic* is a more advanced degree of the scirrhous, and is chiefly seen in elderly people. (5) *Carcinoma sarcomatodes*; a rare condition in which the new interstitial tissue becomes sarcomatous.

CLINICALLY these tumours appear as hard masses in a gland, without definite edges, which become fixed to the skin over the gland and to surrounding tissues. The centre of the tumour is usually harder than the periphery, although this may be altered by cyst formation occurring in the growth. If the growth is of the scirrhous type, it creaks when it is cut into, and has the appearance of an unripe pear. On scraping it, a "cancer juice" containing many epithelial cells is obtained. If the growth is encapsuled, it is soft and pinkish-white in colour, and is usually very vascular, so that hæmorrhages

into its substance are common. The encephaloid growths quickly invade the overlying skin, which becomes infiltrated with the tumour cells, and finally breaks down so that the tumour fungates. The scirrhous growths invade the skin more slowly. Septic infection then occurs, and there is an abundant foul-smelling discharge, which still further adds to the misery of the patient.

The lymphatic glands are infected early by the growth of the cancer cells along the lymphatics, and secondary nodules of growth in the course of the lymphatic channels are common.

Columnar-Celled Carcinoma.—The columnar-celled carcinomata arise in connection with the columnar-celled glands of the alimentary canal or the ducts of the other secretory glands of the body. In the

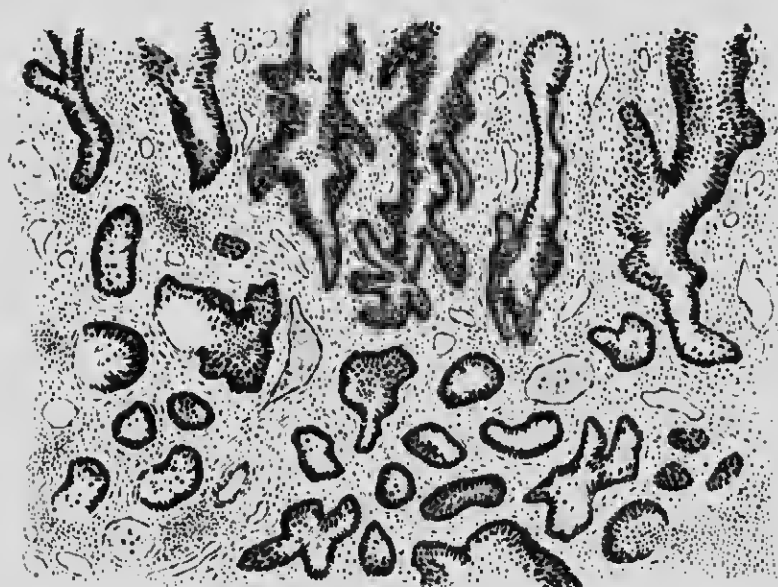


FIG. 73.—COLUMNAR-CELLED CARCINOMA.

alimentary canal the tumour shows branching columns of epithelial cells growing down into the submucous tissue, and eventually invading the muscular and peritoneal coats. These branching columns of cells resemble the Lieberkühn's follicles of the intestine, and, as in the other carcinomata, are surrounded by an inflammatory reaction. In some cases the infiltration is so rapid that a large fungating ulcer forms, which has the usual characters of a malignant ulcer (see p. 239); but in other instances the fibrous tissue formed is in excess, and by its contraction steadily narrows the lumen of the bowel (annular carcinomatous stricture).

A columnar-celled carcinoma arising in a duct (duct cancer) may show itself as a rapid growth of columnar cells infiltrating the surrounding tissues, or as a papillematous growth with an indurated base, which breaks down and bleeds readily.

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The columnar-celled carcinomata invade lymphatic glands early by growth along the lymphatics in the same way as the spheroidal-celled carcinomata. Dissemination also takes place by the blood-stream. It can be very generally stated, however, that the columnar-celled carcinomata are not of such a malignant type as the spheroidal-celled growths.

Treatment of Carcinoma.—The treatment of carcinoma is early and complete excision of the growth. This involves removal of the tumour with a large area of the surrounding, apparently healthy, tissue, together with the nearest set of lymphatic glands, and all the intervening fascia containing the lymphatic vessels draining the part. All the diseased tissue should be removed in one piece, starting at the limit of the field of operation, and, if possible, no cancerous tissue should be cut across during the operation. It is not absolutely known if carcinoma in the human subject is infectious; but numerous instances are on record of carcinoma occurring in the line of an incision and in the scars of the stitches, so that every care should be taken to prevent infection of the wound by the cancer cells. If it is necessary to explore a tumour before removal, the same instruments should not be used for completion of the operation until they have been re-sterilized.

Treatment of Inoperable Malignant Growths.—All malignant growths should be treated, if possible, by complete excision. If this cannot be done, cure may occasionally be obtained in other ways, or, if cure is impossible, the patient's life may be prolonged or made more comfortable. The following methods of treating malignant growths other than by operation demand attention:

1. *X Rays.*—These have been largely tried, and with some success, especially in the treatment of rodent ulcer. On the deep-seated growths they have little influence, and in some cases the condition may be made distinctly worse by the rays. They appear to be of most value in preventing recurrence after operation, and many surgeons use them as a routine after removal of carcinomatous growths. In some instances, also, they have caused the disappearance of recurrent growths. The treatment should be left in the hands of an expert, for extensive X-ray burns may be caused by the treatment. It must not be forgotten that X rays have been responsible for the onset of carcinoma in the hands of X-ray workers.

2. *Radium.*—It is too early to speak of the results of radium treatment, but cures are being reported.

3. *Ligature of the Arteries supplying the Growth.*—This method of treatment may lead to a diminution of the rate of the growth, and so prolong life.

4. *Injection of Boiling Water into the Arteries supplying the Growth.*—This method has recently been used for growths of the pharynx, etc., the boiling water being injected into the external carotid and its branches. Disappearance of the growth has resulted.

5. *Division of Nerves.*—This method is used solely for the relief of pain, and does not retard the rate of growth.

6. *Injections of Trypsin, Amylopsin, etc.*—The idea of this method of treatment was based on a wrong conception of the cause of malignant growth, and has been given up.

7. *Application of Caustics, Zinc Chloride, etc.*—This method may be used in destroying pieces of growth that cannot be removed by operation, and may retard the rate of growth, but is little likely to be curative.

8. *Scraping with Sharp Spoons, Use of the Cautery, Antiseptics, etc.*—These methods are used when the growth is ulcerating, and are beneficial in reducing the amount of sepsis and discharge. The patient's life may be made much more comfortable, and the rate of growth diminished.

9. *Injection of Vaccines.*—Doyen's serum obtained from the *Micrococcus neoformans* is the most known. This micrococcus has been found to be the *Staphylococcus albus*, and injection of the serum may be beneficial in reducing the amount of sepsis in ulcerating growths.

10. *Double Ovariectomy* in the case of carcinoma of the breast has been followed in a few instances by disappearance of the tumour.

11. *Injections of Coley's Fluid.*—This has been discussed under the treatment of inoperable sarcomata. It is useless for the carcinomata.

Rodent Ulcer

Rodent Ulcer is considered under Diseases of the Skin (p. 401).

G. TUMOURS IN CONNECTION WITH THE TROPHOBLAST

Chorion - Epithelioma, Deciduoma - Malignum.—A chorion-epithelioma is a malignant tumour occurring in the uterus and arising from the chorionic villi of a foetus. It may occur after a normal pregnancy, but is much more frequent after an abortion, especially if the chorionic villi have undergone hydatidiform change. The tumour is a rapidly growing mass of tissue which, on microscopical examination, is seen to consist of multinucleated masses of protoplasm without definite cell outlines, resembling Langhan's layer of the chorion. The growth is extraordinarily vascular, and persistent bleeding from the uterus is the most important symptom of the growth.

The growth is highly malignant, and secondary deposits occur in all the organs of the body. As might be expected, the teratomata which are derived from all the layers of the embryo frequently exhibit chorion-epitheliomatous tissue (see Testicular Teratomata).

H. TERATOMATA

The importance of this group of tumours is being more and more recognized, and many tumours that up to the present have defied classification, or have given rise to considerable dispute as to their place in a classification of tumours, are now being included under the term "teratoma." The term formerly was used to describe a foetus *in foetu*—i.e., a tumour derived from an included embryo, but has recently been expanded to include other types of tumour, and the following varieties of teratomata are now recognized:

1. **Twin Teratoma.**—This is the foetus *in foetu*, and the tumours arise from the inclusion in the body of the host of an imperfectly developed twin, which has ceased to grow at an early stage of development.

2. **Filial Teratomata.**—These are tumours derived from groups of cells capable of developing into a fresh individual, either cut off from the parent by dichotomy—*e.g.*, sacral teratomata—or derived from an aberrant growth of the germinal cells, so-called “ovarian dermoids” or “mixed tumours” (fibro-cystic disease) of the testis.

3. **Terato-Blastoma.**—These are the mixed tumours of the kidney, parotid gland, submaxillary gland, etc., which are derived from germinal cells capable of producing both epithelium and connective tissue. The tumours therefore contain both epithelial and connective-tissue elements—*i.e.*, glands, cartilage, bone, and connective tissue.

Teratomata present an extraordinary variety of contents, some of them, as the ovarian teratomata, exhibiting specialized adult structures as bones, teeth, mammae, hair, etc., whilst others are simply masses of epithelial cells and connective tissue.

CLINICALLY the teratoma may appear as innocent tumours persisting for years and growing slowly, but sooner or later taking on a malignant growth; while in other cases they are amongst the most rapidly fatal of the tumours. In one case of a testicular teratoma known to the author, death from general dissemination of the tumour occurred seven weeks after the tumour was first noticed.

The secondary growths that occur in connection with these tumours are often of a mixed nature, and may contain cartilage and other adult structures as well as sarcomatous, carcinomatous, or chorion-epitheliomatous tissue.

TREATMENT.—The treatment of a teratoma is early and complete removal.

CYSTS

Cysts are hollow, rounded swellings, formed of fibrous tissue lined by an epithelium, with fluid or semi-fluid contents. The term is very loosely applied, and no classification is at present satisfactory. The following varieties will be described:

1. **Retention Cysts.**—These cysts arise in connection with glands, and are produced by a duct becoming blocked, preventing the secretion of the gland from reaching the exterior. The duct and the gland become converted into a cyst. They are most common in the



FIG. 74.—TERATOMA OF THE TESTIS, WITH MARKED CHONDIFICATION. (Sir James Paget's case. London Hospital Medical College Museum.)

pancreas, breast, and salivary glands, and the ordinary sebaceous cyst is probably produced in this way.

2. Distension Cysts.—These cysts arise from the distension of pre-existing spaces which have no opening on the exterior of the body, and are usually inflammatory in origin. In some cases they are due to extravasation of blood, as in cysts in the membranes of the brain, while in other cases the exact cause cannot be ascertained. The last variety includes many of the hydroceles, and the only explanation given, other than inflammation, is that there is a loss of balance between secretion and absorption.

3. Implantation Cysts.—These cysts arise in connection with wounds, and are due to small pieces of epithelium being driven into the subcutaneous tissue by the injury. They resemble the dermoids in structure, but are traumatic in origin.

4. Cysts in Connection with New Growths.—Cysts may arise in connection with new growths in three ways:

(1) The alveoli of the glandular epithelial tumours, both innocent and malignant, but particularly the innocent (adenoma), frequently become distended with fluid, so that the tumour presents the appearance of a multicellular cyst. In this way some of the largest tumours in the body have been formed, and cysts have developed containing quarts of fluid (cysto-adenoma and cysto-carcinoma).

(2) By degeneration of the tumour tissue. This degeneration may occur in either innocent or malignant tumours, so that cysts without any lining membrane form in the substance of the tumour, and contain a mucoid fluid with numerous degenerated cells.

(3) By hæmorrhage occurring into the tumours. Cysts are most frequently formed in this way in the sarcomata, endotheliomata, and chorion-epitheliomata.

5. Parasitic Cysts.—Various parasites may give rise to cysts within the body, the most important being the hydatid cyst.

HYDATID CYST

A hydatid cyst is the cysticercus stage of the life-history of the *Tænia echinococcus*. The *Tænia echinococcus* in the adult form is a tapeworm usually found living in the duodenum of the dog. It is about $\frac{1}{4}$ inch long, and consists of four segments; the first, or head, has four suckers and a double row of hooks, and the last segment



FIG. 75.—*TÆNIA* ECHINOCOCCUS.

contains the fertilized ova. This segment is passed in the excretion of the dog, and is conveyed to the human stomach on uncooked vegetables, such as lettuces and watercress. In the stomach the chitinous envelope of the ovum is dissolved, and a small free-swimming embryo with hooklets is set free; this burrows through the mucous membrane of the stomach, and enters the blood-stream, and is carried to any part of the body, but usually to the liver along the portal vein. Here it becomes blocked in a capillary, loses its hooklets, and passes into the cysticercus stage (hydatid cyst).



FIG. 76.—HYDATID CYST OF THE LIVER, SHOWING DAUGHTER CYSTS.

A hydatid cyst consists of three layers, two belonging to the cyst proper, and the third formed of fibrous tissue, the result of the irritation of the tissues in which the cyst is lying. Of the two layers of the cyst proper, the outer is a laminated homogeneous hyaline layer loosely attached to the adventitious fibrous layer, while the inner is a cellular and granular layer, from which the heads of the adult tapeworms develop. As the cyst grows, daughter cysts are frequently developed in the inner layer (endocyst), and become free in the parent cyst (endogenous cyst formation); but in some cases, and especially if the parent cyst is growing in bone, the daughter cysts bud out through the ectocyst, and remain free of the parent (ectogenous cyst formation). The heads of the adult worm (scolices) are either

developed singly from the endocyst of the parent or daughter cysts, or several are developed together in a brood capsule.

The fluid from a hydatid cyst is opalescent, contains a faint trace of albumin, and has a specific gravity of about 1006. On microscopic examination, scolices or hooklets may be found, but some cysts are sterile.

CLINICAL SYMPTOMS.—A hydatid cyst forms a slowly growing, painless, symptomless, cystic swelling, and only causes trouble from pressure effects. Percussion over the cyst may give a "hydatid thrill," but this is neither common nor pathognomonic.

LABORATORY DIAGNOSIS—(1) *Eosinophilia*.—Increase of the number of eosinophiles of the blood is a very constant feature in hydatid disease (57 per cent. in some cases), especially if the cyst is situated in the liver, but it also occurs when other vermiform parasites are present in the body, and is only useful if the clinical symptoms of hydatid disease are present. It may be used to differentiate hydatid cyst from other cystic conditions, but it disappears when the cyst dies.

(2) *Precipitin Reaction*.—This consists of observing the precipitate formed when the serum of a patient suffering from hydatid disease is added to hydatid fluid. It is only of value in about one-third of the cases.

(3) *Fixation of the Complement*.—This reaction is analogous to the Wassermann reaction of syphilis, and is said to give very accurate results. It can be used where there is no clinical evidence of hydatid disease. For the details of applying this test, works on serum diagnosis should be consulted.

RESULTS.—(1) The hydatid cyst may continue to grow until it reaches a free surface and ruptures—*i.e.*, on the skin—into the stomach and intestines, or into the urinary tract. The diagnosis is then evident from the appearance of the daughter cysts.

(2) The cyst may rupture into one of the body cavities, such as the peritoneal cavity, where it sets up a low form of inflammation with formation of a large amount of serous exudate. The rupture often causes severe shock, and the absorption of the hydatid fluid may give rise to a diffuse urticarial rash.

(3) The hydatid may die, the fluid part become absorbed, and the cyst shrink up. Calcareous salts are frequently deposited in the walls of the dead cyst.

(4) The tissues round the cyst may become infected with pyogenic organisms and suppuration result, so that the cyst becomes converted into an abscess, with the usual local and general symptoms of suppuration.

TREATMENT.—A hydatid cyst should be excised completely if this is possible. If this method of treatment is not practicable, the cyst should be incised, the contents and lining membrane removed, and the cavity drained. If suppuration has occurred, the case must be treated like any other abscess.

6. Dermoids.—A dermoid is a cystic tumour lined by skin or mucous membrane, and containing the elements derived from these structures

—i.e., hair follicles, sebaceous glands, sweat glands, and nails. They may be divided into two groups—skin or sequestration dermoids, and tubulo-dermoids.

(a) SKIN OR SEQUESTRATION DERMIDS.—These cysts occur in the line where the two halves of the body coalesce during development, in the lines of coalescence of the various processes by which the face is formed, or in the fissures and clefts present in the neck of the embryo, and are due to sequestration of a small piece of epithelium during the process of development. These pieces of epithelium become detached, and lie in the connective tissue, and later develop into cysts lined by skin, from which hairs grow, and containing a sebaceous matter produced by the sebaceous glands on the skin. These cysts are most common at the external angular process of the frontal bone, and although they seldom grow to a large size, they may be connected with the dura mater by a stalk passing through the bone. They also commonly occur in the middle line of the neck lying just beneath the skin, and also in the sacral region. It is, however, more common to find a post-anal dimple in this region than a dermoid cyst, but the two are closely related, for the post-anal dimple is only a dermoid in which sequestration of the epithelium has not been complete.

These cysts should be removed, as they are unsightly, and also as suppuration may occur in connection with them.

(b) TUBULO-DERMIDS.—A tubulo-dermoid is a cyst arising in connection with a canal present in the embryo which should have disappeared before birth. The most common of the canals which give rise to tubulo-dermids are the thyroglossal duct, the post-anal gut, and the branchial clefts. These cysts differ from the skin dermoids in being lined by mucous membrane instead of skin, and containing mucus in place of hair and sebaceous matter. Suppuration may occur in connection with these cysts, and usually results in the formation of a fistula, and to cure this condition the whole of the cyst wall must be removed. These cysts will be further described under their appropriate headings.

The so-called "ovarian" and "testicular" dermoids are now considered to be teratomata, and the use of the word "dermoid" in connection with these tumours should be discontinued.

CHAPTER IX

DEFORMITIES

GENERAL CONSIDERATIONS.—The method of production and cause of deformity has been clearly laid down by Professor Julius Wolf,



FIG. 77.—JUDSON'S MODEL FOR DEMONSTRATING THE RELATIONSHIP BETWEEN SCOLIOSIS AND LATERAL CURVATURE OF THE SPINE.

who has formulated a law, the simplest expression of which is "that structure is adapted to function." Applied to bones, this means that the shape of any bone, both as regards its internal and external architecture, is directly dependent upon its function; and if its function is altered, its shape alters in order to adapt itself to the new conditions. For example, if a bone is fractured and the fracture is not accurately set, the strains thrown upon the bone by the weight of the body and the pull of the muscles will differ from those present in the normal bone. As a consequence, the lines of force in the cancellous tissue of the bone will be altered, and the external shape of the bone will also change, to adapt itself to the new conditions. Again, a vertebra has its characteristic shape, because that is the best possible shape to carry out its functions of supporting the weight of the body and giving origin and attachment to the muscles. If, from the assumption of a habitual posture, abnormal strains are thrown on the bone, its architecture will gradually alter in order to meet those strains in the best possible way and with the least possible amount of material. The shape of a scoliotic vertebra, therefore, does not depend on pressure on the bone, but is the best shape to carry out the work it has to do with the habitual posture and altered conditions of its functions.

Many deformities are only pathological, in the same way that hypertrophy of the heart is pathological when it occurs in order to compensate for a valvular lesion.

The prevention of deformity, therefore, is the prevention of abnormal function and posture, and the cure of deformity is the inducing of new static conditions which will bring about a second alteration in shape. For example, the cure of talipes equino-varus consists of placing the foot in the correct or over-corrected position, and using it in this position until an alteration in the shape is brought about. An operation on a bone does not cure a deformity, but it allows the deformed limb to be placed in such a position that Nature can in time reconstruct the entire bone, both internally and externally.

DEFORMITIES OF THE SPINE

Scoliosis.—Scoliosis is a habitual or fixed lateral curve of the spine, accompanied by rotation of the bodies of the vertebrae. The cause of the rotation is physiological, for the shape of the vertebrae and their

articulation to one another is such that rotation must accompany lateral curve. This is shown by Judson's model, which consists of an articulated spine so arranged that a lateral curve can be produced by pressure from above. The lateral curve is accompanied by rotation, the larger bodies of the vertebrae always

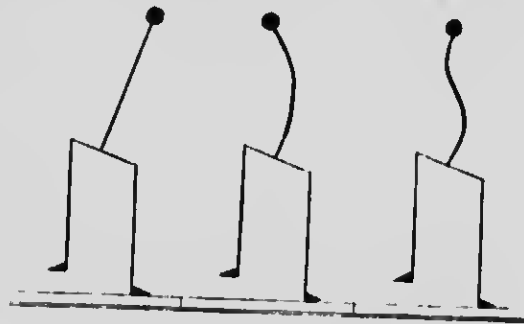


FIG. 78.—DIAGRAM SHOWING PRODUCTION OF SCOLIOSIS FROM OBLIQUITY OF THE PELVIS.

rotating into the convexity, and the smaller spinous processes into the concavity of the curve. Clinically the scoliosis tends to hide the amount of lateral curve as judged by the position of the spinous processes, as the rotation of the vertebrae turns them back towards the middle line.

CAUSES.—The cause of scoliosis is the assumption of a habitual posture, generally associated with weakness of the spinal muscles and ligaments. The cause of this habitual posture is evident in about 20 per cent. of the cases, and these will first be considered:

1. Compensatory scoliosis, owing to obliquity of the pelvis.

The obliquity of the pelvis may be either temporary or fixed, and is due to such causes as congenital shortness of one leg, congenital dislocation of one hip, unilateral coxa vara, acquired shortness of a limb—*e.g.*, after excision of the knee—spasm of muscle associated with sciatica or sacro-iliac disease, etc.

As a consequence of the oblique position of the pelvis, the spine is thrown out of the upright into a position of unstable equilibrium (Fig. 78). To remedy this and to bring the centre of gravity back between the feet, the spine is curved (primary curvature) (Fig. 78), and in order to support the head in the upright position, a



FIG. 79.—SCOLIOSIS DUE TO SINKING IN OF THE CHEST AFTER AN EMPYEMA.

secondary curve develops (Fig. 78). As explained above, rotation of the vertebrae always accompanies lateral curve, and scoliosis develops. In the great majority of cases, the lateral curve is purely compensatory and non-progressive, the curvature being arrested as soon as it has compensated for the obliquity of the pelvis.

No treatment except remedying the oblique position of the pelvis is necessary; and if this cannot be brought about, no attempt to

prevent or remedy the scoliosis should be made *unless it is progressive*. It would be as rational to try to prevent the deformity in these cases as it would be to prevent hypertrophy of the heart in a case of valvular disease.

2. Curvature, secondary to diseases in the thorax, as empyema or fibroid phthisis, with contraction of one side of the chest. The curve is toward the sound side.
3. Secondary to other curvatures of the spine, as congenital torticollis or some cases of Pott's disease with lateral deviation.
4. Diseases of the nervous system affecting the spinal muscles. The most common of these is anterior poliomyelitis, chiefly affecting the spinal muscles on one side. It may also occur with progressive muscular atrophy, Friedreich's ataxia, etc. Scoliosis also develops with the muscular dystrophies.

5. Occupation scoliosis: Scoliosis is seen in people whose occupations involve an habitual deviation of the spine; but as this most often develops after the growth of the body is complete, the deformity is usually slight.
6. Congenital scoliosis is rare, and is probably due to a malposition *in utero*. A slight congenital deviation may be progressive, and this progression may account for a small number of cases in which the cause of the deformity is obscure.
7. Rickets: In rickets there is weakness of the muscles and ligaments and softness of the bones, therefore a lateral curve is easily produced. In many cases the habitual position has arisen through the custom of carrying the child sitting on one arm with its head resting on the nurse's shoulder and the body curving over the breast. Rickets may also result in scoliosis by causing obliquity of the pelvis, as in cases of unilateral coxa vara, or genu valgum. A slight rachitic scoliosis may become progressive later in life.

The remaining 80 per cent. of the cases occur during puberty and adolescence, and are usually termed "adolescent scoliosis."

Adolescent Scoliosis.—Although severe cases sometimes occur in boys, this condition is more common in girls, and the patient generally comes for treatment between the ages of twelve and twenty years. The patients are, as a rule, ill-nourished and overworked, living under bad hygienic conditions. The deformity, however, does sometimes develop in carefully managed children. In some instances there appears to be an inherited tendency, several members of a family developing the deformity.

The cause of the condition is believed to be the habitual assumption of a faulty position, due to a habit or occupation or, more commonly, to an attempt to give relief to overtired muscles. The assumption of this attitude is at first voluntary, but later becomes so habitual that the patient is unaware that she has the spine curved, and if made to straighten it, feels uncomfortable and awkward. Gradually the deformity becomes fixed, the shape of the bones and articular surfaces being altered according to Wolff's law.



FIG. 80. SCOLIOTIC SPINE.

The muscles and ligaments on the convexity of the curve are stretched, and those on the concavity adaptively shortened, rendering the patient unable to straighten the spine and assume the erect position.

Two curves are usually present, a dorsal and a lumbar. Opinions differ as to which of these two is the primary curve, but probably it is the lumbar. In the majority of cases the lumbar curve is convex to the left and the dorsal curve convex to the right.

Anatomical Changes in Fixed Scoliosis.—Not only is the spine distorted as a whole, but each individual vertebra shows the effect of the rotation. The bodies grow wedge-shaped, the broadest part of the wedge being on the side of the convexity, and the pedicles, laminae, transverse and spinous process, are all twisted, as shown in Fig. 80. The intervertebral discs and the articular surfaces are altered in shape to accommodate themselves to the altered curves of the spine and to the shape of the vertebrae. The ligaments on the concave side are shortened and are lengthened on the convex; later, if osteo-arthritic changes occur, they may become ossified. The muscles are also adaptively lengthened on one side and shortened on the other. The ribs, which are attached to the transverse processes, accompany them in their rotation and are altered in shape, so changing the contour of the thorax, the capacity on the convex side being increased and that on the concave side diminished. In consequence the viscera are distorted and serious interference with the movements of the heart and lungs may ensue. The shape of the abdominal cavity is also altered, leading to changes in the viscera, and the pelvis may be characteristically deformed (scoliotic pelvis). The body is shortened by the curves, and appears out of proportion to the length of the legs and the arms.

SYMPTOMS.—The patient, in the great majority of instances, is brought for treatment on account of the deformity, the parents stating that the hip or shoulder is "growing out," or that the deformity has been accidentally discovered. Pain is sometimes present. The patients are often neurasthenic, muscularly weak, and anemic.

EXAMINATION.—The patient is stripped so as to expose the whole of the spine and the crests of the ilia, and is then allowed to assume her natural habit of standing. If the spinous processes are traced out, two lateral curves will as a rule be found, the lumbar curve being to the left and the dorsal to the right. Exceptions to this rule are common, and occasionally as many as four curves may be found. The scapula on the side of the convexity is raised (shoulder growing out), and the waist on the side of the concavity is more marked, making the hip appear more prominent (hip growing out). If the patient is made to bend forward with the arms hanging, it will be seen that the ribs on the convexity are more prominent than those on the concavity; while in the lumbar region the erector spinae muscles on the side of the convexity are very prominent. This prominence is due to the rotation of the vertebrae thrusting the transverse processes and the muscles attached to them backwards.

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Examination of the front of the body shows corresponding changes, though in a less marked degree. The shoulder girdle on the convexity

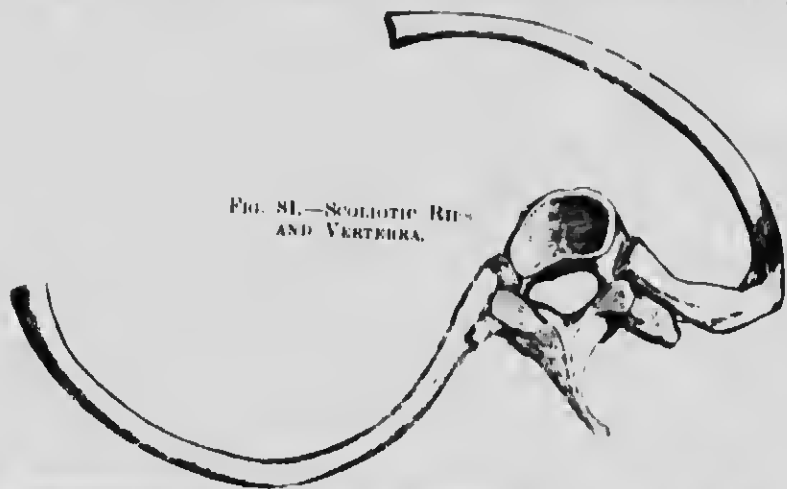


FIG. 81.—SCOLIOTIC RIBS
AND VERTEBRA.



FIG. 82.—SCOLIOTIC PELVIS.
(London Hospital Medical College Museum.)

of the curve is held higher than that in the concavity, the chest is more prominent on the side of the concavity, and the sternum is pulled over to the side of the convexity.

A careful examination should always be made for any obliquity of the pelvis, and, if this is present, its cause should be ascertained.



FIG. 83.—SCOLIOSIS: POSTERIOR VIEW.



FIG. 84.—SCOLIOSIS, WITH PATIENT BENDING FORWARD.

rest in bed is necessary. The meals should be regular, not hurried over, and the food plain. If the patient is at school, she must have

The patient should then be examined as to the fixity of the curve and the mobility of the spine, as the prognosis of the cure of deformity depends upon these features. If the patient is able to get rid of the deformity by holding herself erect, or if the deformity disappears when the patient is hanging from a trapeze, the posture is only habitual, and treatment may result in complete cure. On the other hand, if bony changes have occurred, and the patient is no longer able to assume the upright position, complete removal of the deformity is unlikely to result, although the condition may be much improved.

TREATMENT.—Any obliquity of the pelvis should be corrected, if possible, and in mild non-progressive cases secondary to this deformity, no further treatment will be required. In adolescent scoliosis without deformity of the lower limbs, a careful inquiry should be made into the patient's habits and occupations, and her general condition fully examined. Anæmia, if present, should receive appropriate treatment; errors of refraction should be corrected by suitable glasses, and nasal obstruction, due to adenoids, etc., should be remedied. Attention should be given to the daily life of the patient, small details being of importance. She should sleep by herself on a firm horse-hair mattress with one pillow. At least eight hours'

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a seat with a back which supports the spine. Any tendency to "loll" while sitting should be repressed. When standing, the feet must be flat on the ground, and the knees kept braced up, so that the pelvis is held horizontally. In the case of boys, the habit of standing and walking with one hand in the trousers' pocket must be corrected.

DRILLING AND EXERCISES.—Drilling is advisable in order to teach the patient to stand erect, and exercises are given for the purpose of strengthening the muscles and ligaments, but neither should cause fatigue, and the patient should rest flat on the back after each course of exercise. Drilling must be carried out under the personal supervision of the teacher, who, having placed the patient in the correct position, must see that this position is maintained.

Exercises may be considered under two headings, general and special.

GENERAL EXERCISES are designed to strengthen all the muscles of the body, and the simpler they are the better. If constant supervision by a teacher is not possible, the patient should perform the exercises before a looking-glass in order that she may see that she is standing in the correct position.

SPECIAL EXERCISES are designed to strengthen special groups of muscles and so remedy the deformity. It is doubtful if they are of greater value than general exercises. They may do harm if not performed under the direct supervision of a teacher specially trained for this work.

Baths and general massage are useful adjuncts to exercises.

EFFECTS OF EXERCISES.—In cases of habitual scoliosis, drilling and exercises, if properly carried out and combined with general treatment and good hygienic conditions, will bring about a complete cure of the deformity. In more advanced cases with fixed deformity, exercises, by strengthening the patient's muscles and rendering her movements more graceful, will tend to hide the deformity, although they will not bring about cure.

POSTURAL AND FORCIBLE CORRECTION.—Many forms of apparatus have been devised for correcting scoliosis by pressure and forcing the patient to assume the over-corrected position. This method of

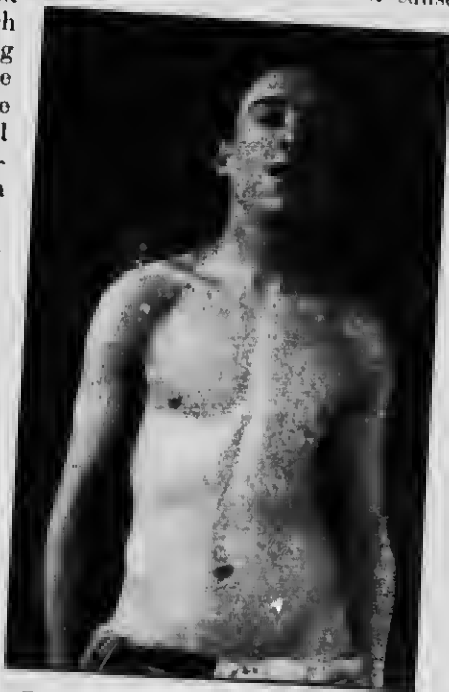


FIG. 85.—SCOLIOSIS: ANTERIOR VIEW.

treatment can only be carried out in special institutions and under the personal supervision of the surgeon, while the patient must give the whole of her time to correction of her deformity. It is of use only when the treatment is undertaken during the period of growth. Exercises must be given at the same time.

JACKETS.—It may be stated as a general rule that jackets are to be avoided in the treatment of scoliosis, as they hinder free mobility

of the spine, interfere with exercise, and weaken the muscles of the back; they should *never* be used during the early stages of habitual scoliosis. They are only useful in certain conditions, and are then applied for three reasons:

1. *To correct the deformity.*

For this purpose jackets are made fitted with springs and laces, which press on projecting parts of the ribs and spine, while an attempt is made to support the shoulder girdle by arm-rests. Jackets used for this purpose have very little value even when made by a competent instrument-maker under the personal supervision of the surgeon, who should himself make the necessary alterations if the condition improves.

2. *To prevent increase of the deformity.* Well-fitting poroplastic, leather, or plaster of Paris jackets are of value in preventing increase of the deformity, and may be ordered if the patient is unable to devote the necessary time to rest and exercises.
3. *To hide the deformity.* This is the great use of spinal jackets and is especially indicated in bad cases of fixed scoliosis, when an attempt to remove the deformity is useless. A skilled instrument-maker and a clever dressmaker can hide almost any degree of lateral curvature.



FIG. 86. SKELETON OF KYPHOSIS, SHOWING STRAIGHTENING OF LUMBAR SPINE. (London Hospital Medical College Museum.)

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The use of jackets should always be supplemented by massage and exercises.

Prognosis.—Early, habitual scoliosis may be completely cured; but if the deformity has become fixed by bony change, complete restoration of the shape of the spinal column is not to be expected. Careful treatment, however, will enable the patient to hold herself more erect and give grace to her movements.

Kyphosis.—Kyphosis is an increase in the normal dorsal curve of the spine. It may be associated with a compensatory curve in the lumbar spine, or the lumbar curve may be straighter than normal. Kyphosis may be due to—

A. General diseases, which weaken the spine or interfere with its function. The most important of these are—

- (1) Rickets. The curve is most marked in the lower dorsal region, and may be so sharp as to be difficult to diagnose from the angular curve of tuberculous of the spine.
- (2) Spondylitis deformans. The whole of the spine is usually involved.
- (3) Osteitis deformans: The curve is limited to the dorsal region.
- (4) Acromegaly.
- (5) Osteomalacia.



FIG. 87.—KYPHOSIS.

The patient was a fish porter, and carried heavy weights on the head.

TREATMENT.—Rickety kyphosis is treated by keeping the child flat on the back until the rickets is cured, and then teaching the child to stand erect, and giving suitable exercises. The other cases do not admit of treatment.

B. Localized disease or injury of the spine, as Pott's disease, fracture dislocation, tertiary syphilis, and malignant new growth. The kyphosis is usually angular.

The Treatment is considered under Diseases of the Spine.

C. Faulty posture. This may be due to various occupations, as those followed by tailors and bootmakers; to the lifting of excessively heavy weights during the growing period of life; or to the habitual assumption of a faulty posture when sitting and standing, owing to general weakness of the muscular system. This last condition is the most important, and is usually spoken of as round shoulders.

Round Shoulders are more common in girls than in boys, being chiefly met with in children or young adults who are muscularly weak and anemic. These patients often suffer from nasal obstruction or errors of refraction.

On examination, an increase in the dorsal curve is seen, the head is carried forward, the chest flattened, and the abdomen protuberant. The lumbar curve in some cases is diminished and in others increased. A slight scoliosis, which may increase, frequently accompanies this deformity.

TREATMENT.—Nasal obstruction, if present, should be removed, and errors of refraction treated. The general health of the child should be improved in every way. The treatment of the deformity consists of teaching the child to stand erect and strengthening the muscles by giving suitable exercises. These exercises should never be pushed to

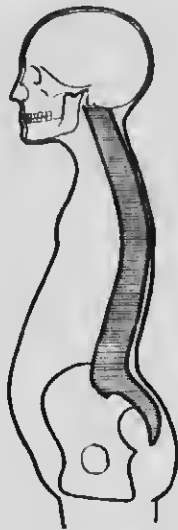


FIG. 88.—WEAK BACK WITH ROUND SHOULDERS.

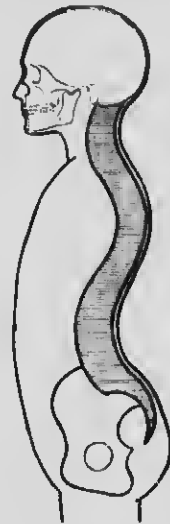


FIG. 89.—LORDOSIS AND KYPHOSIS.

fatigue, and must be carried out under proper supervision. The child should have adequate rest after the exercise. Massage is a useful adjunct. As in scoliosis, careful attention should be given to the details of daily life, and the child must have a proper seat and desk at school. So-called shoulder braces are useless, and artificial supports should be avoided.

Lordosis.—Lordosis is an increase in the normal lumbar curve, and is generally a secondary deformity. It is compensatory to—

1. Kyphosis.
2. Fixed flexion of the hip, owing to ankylosis following such conditions as tuberculous of the hip. In order to bring the foot to the ground the patient has to flex the lumbar spine.
3. Displacement of the head of the femur backwards, owing to acquired or congenital dislocation of the hip.
4. Increase in the weight of the abdominal contents, as in pregnancy, excessive obesity, or large fibroid or ovarian tumours.

It may be *primary* in cases of spondylolisthesis, or occur in certain nervous and muscular lesions, especially the muscular dystrophies. In the latter cases the head and shoulders are thrown backwards in order to balance the body without muscular aid.

TREATMENT.—The treatment of lordosis is the treatment of the primary cause.

DEFORMITIES OF THE UPPER EXTREMITY

Congenital Elevation of the Scapula (Sprengel's Deformity).—The scapula on one side is elevated and rotated, thus bringing the lower angle nearer the vertebral column. The bone is usually smaller than the normal scapula, and may be joined to the spine by a ridge of bone. The cervical muscles attached to the scapula are shortened and the movements of the shoulder limited. A slight scoliosis is frequently present.

ETIOLOGY.—The etiology is doubtful, but the deformity is believed to be due to malposition of the arm *in utero*.

TREATMENT.—If the muscles are much shortened, they may be divided by an open tenotomy; and if the scapula is connected with the spine by a ridge of bone, this may be divided. In the majority of instances no treatment is advisable.



FIG. 90.—SPRENGEL'S SHOULDER.

Congenital Dislocation of the Shoulder.—This is a very rare deformity, the cases described being probably due to traumatism during the delivery of the child. The displacement is forwards.

Congenital Dislocation of the Elbow is rare. The radius is more often displaced than the ulna, and the resulting disability is slight. Removal of the head of the bone may increase the range of move-

ment. As a rare deformity, the upper ends of the radius and ulna may be fused together.

Congenital Dislocation of the Wrist is extremely rare.

Club-Hand.—Two distinct varieties of club-hand occur:

1. There is simple distortion of the hand analogous to congenital talipes, and probably due to the same cause.
2. The deformity is associated with defective development or absence of the radius or ulna. The radius is the more commonly defective, and of thirty-nine cases the deformity was bilateral in nineteen (Hoffa).

In cases of absence of the radius, the ulna is usually short and bent inwards, and the hand runs at right angles to this bone towards the radial side. The hand is generally normal, but the thumb may be rudimentary or absent.

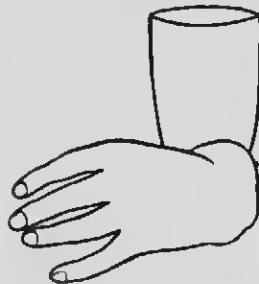


FIG. 91.—CLUB HAND.

TREATMENT.—Club-hand of the first variety should be treated in the same way as congenital talipes, by manipulation and retentive apparatus. The prognosis is good. The second variety of club-hand must be treated by operation, and various methods are used. After-treatment must be prolonged. The arm is always short and the hand weak.

Congenital Contraction of the Fingers.—

The digit most often congenitally contracted is the little finger. The condition may be unilateral or bilateral. The defect appears to be in the skin, and may be remedied by a plastic operation, but there is a great tendency to recurrence.

Syndactyly (Webbed Fingers).—The fingers may be joined together to any extent, the union varying from a web of skin joining two fingers as far as the first interphalangeal joint to complete fusion of all the fingers of the hand with bony union. The thumb is the digit most frequently separated from the others. The deformity may affect all the digits on the hands and feet, or be limited to two digits of one extremity. Like other deformities, it frequently runs in families.

TREATMENT.—The fingers are separated by means of a plastic operation, the one most commonly performed being Didot's (see diagram). There is a great tendency to recurrence of the deformity, or dexion of the fingers may follow, owing to contraction of the scar tissue; to avoid this the after-treatment must be very prolonged.

In cases of marked fusion of the fingers, an X-ray photograph should be taken before any operation is performed, to show if there is any fusion of bone. Even in complete syndactyly, the patient may be able to use the hand with extraordinary dexterity.

Polydactylism.—Supernumerary fingers and toes are frequently seen, and this deformity may occur in several members of the same family.

The accessory fingers vary from a knob of skin and subcutaneous tissue to a fully formed finger. They are most common on the radial side of the hand. The *treatment* in the majority of cases is removal. The number of fingers may also be diminished, the most usual deficiency being that of the thumb in cases of absence of the radius. Some of

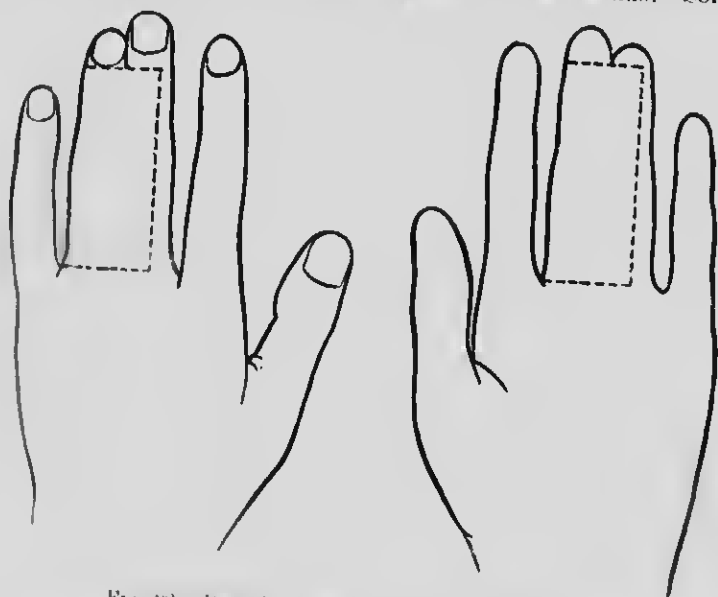


FIG. 32.—DIPLO'S OPERATION FOR SYNDACTYLY.

the fingers may be represented by short stumps, the condition being ascribed to intra-uterine amputation by amniotic bands; but as the end of the stump may carry a nail, it is difficult to understand how the deformity can be due to such an amputation.

Hypertrophy of the Digits.—One or more of the digits, or the whole hand or foot, may be enormously enlarged, the condition being a local **gigantism**. All the structures of the finger may be involved, or the condition may mainly affect the subcutaneous tissue. This local gigantism may be associated with absence of one or more of the digits, or with syndactyly.

Trigger Finger.—On extending the closed fingers, one finger—usually the middle or ring finger—remains flexed. If a greater muscular effort is made, or the finger passively extended, it flies into complete extension with a jerk. The same difficulty may be experienced on flexing the fingers.

CAUSE.—The cause is a disproportion in size between the tendon sheath and the tendon; either the tendon is too large at one place, or the sheath too small. The cause of increase or diminution in size is probably inflammation following injury.

TREATMENT.—Passive movement and massage combined with rest should be given a prolonged trial, but if this treatment is not found successful, the tendon sheath should be opened and the condition found treated.



FIG. 93.—DUPUYTREN'S CONTRACTION

generally originates in the ring-finger, but the other fingers are ultimately involved. Both hands, as a rule, are affected, although the deformity is usually more advanced on one side.

CAUSE.—The cause is unknown, the following theories being held:

1. It is due to fibrosis following gout, rheumatism, or rheumatoid arthritis.
2. It follows repeated slight injuries, such as occur in many trades.
3. It is infective in origin.

The condition is seldom seen before middle life, is much more common in men than in women, and the majority of cases are found among the well-to-do.

SYMPTOMS.—The patient complains of the deformity. The grip of the hand is weakened, and he is unable to extend the fingers. On examination, the ring and sometimes the little and middle fingers are flexed; and on attempting to straighten them, a hard cord is felt running from the palm of the hand to the fingers. This cord is firmly attached to the skin, which it causes to wrinkle, the subcutaneous tissue over it having disappeared. The condition is slowly progressive over years.

The tendons and joints are secondarily affected, according to Wolff's law (see p. 250).

Mallet Finger is due to a complete or partial rupture of the extensor tendon of one of the fingers, so that the terminal phalanx is kept flexed. The treatment is suture of the divided tendon.

Dupuytren's Contraction.—Dupuytren's contraction is a deformity of the hand due to contraction of the median portion of the deep palmar fascia, and its prolongations to the fingers. The contraction of this fascia causes the fingers to be flexed, and they may be so closely drawn into the palm of the hand that the nails may cut the skin. The contraction

TREATMENT.—The contracted hands should be divided subcutaneously or dissected away by an open operation. The fingers are then held extended on a splint. After the stitches are removed, massage and passive movements must be continued until the fingers are supple. If treatment is carried out in the early stages, the prognosis is good.

DEFORMITIES OF THE LOWER EXTREMITY

Congenital Dislocation of the Hip.—Congenital dislocation of the hip may be unilateral or bilateral, the former being the more common. It is about five times more frequent in girls than in boys, and slightly more common on the left side than on the right.

CAUSE.—The cause of the condition is unknown. Two theories are advanced: (1) That it is a defective development analogous to cleft palate; (2) it is due to pressure of the uterus in cases of deficiency of liquor amnii, the contracting muscular tissue forcing the head of the femur away from the acetabulum.

PATHOLOGICAL ANATOMY.—The following description applies to a child of about three years of age who has walked:

ACETABULUM is somewhat triangular in shape, small, and shallow, and partly filled with cartilage and fibro-fatty tissue.

HEAD OF THE FEMUR is smaller than normal, and somewhat flattened on its inner and under surface. Later, it may become atrophied and almost non-existent.

NECK OF THE FEMUR is shorter than usual, and the angle it makes with the shaft of the femur may be increased (coxa valga) or diminished (coxa vara).

ILIUM.—Attempts at formation of a new acetabulum may be present on the dorsum ilii.

CAPSULE is thickened and elongated, the anterior wall being tightly drawn across the acetabulum. It is somewhat hour-glass in shape, a condition that may seriously hinder reposition of the head.

LIGAMENTUM TERES is drawn out and ribbon-like, or it may be absent.

MUSCLES.—The long muscles of the thigh, the adductors, and the ilio-psoas are adaptively shortened, and those attached to the great trochanter are altered in direction.

PELVIS.—In unilateral dislocations there is some obliquity of the pelvis; and in bilateral there is lessening of the antero-posterior diameter. From an obstetrical point of view these changes are not very important.

SPINE.—Lordosis and secondary kyphosis are usually present, and in unilateral cases there is some degree of scoliosis.

Displacement.—Three displacements occur:

1. The usual displacement is for the head of the bone to pass upwards and backwards on the dorsum ilii, and as the patient grows older and heavier, the head of the femur may travel upward until it comes to lie above the crest of the ilium. The backward displacement of the femur

causes the pelvis to tilt forward. This displacement is compensated for by lordosis of the lumbar spine.

2. Anterior displacement: the head of the bone lies under the anterior superior spine, and the projection of the spine prevents further upward displacement. No lordosis is present.
3. Very rarely the head of the bone lies immediately above the acetabulum. No lordosis is present.

CLINICAL FEATURES.—The condition is seldom diagnosed until the patient begins to walk. She is then noticed to limp and to stand in an awkward attitude. These children

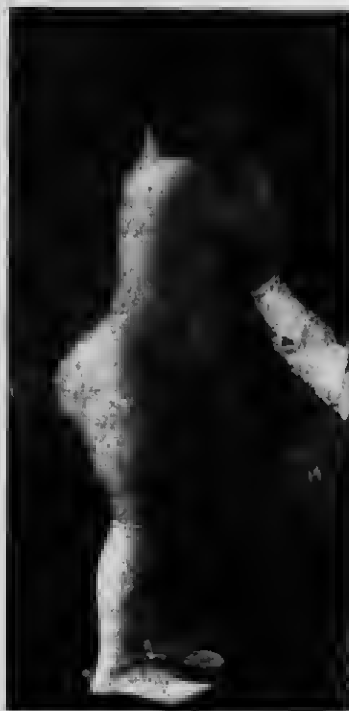


FIG. 94.—CONGENITAL DISLOCATION OF THE HIP, SHOWING LORDOSIS.

generally walk later than usual. Occasionally something abnormal in the shape or movement of the hip is noticed by the mother before the child walks.

UNILATERAL DISLOCATION—Gait.—The child walks with the limb everted, and each time the weight is thrown on the affected side, the body dips downwards on that side. As the shortening increases, the child compensates for it by walking on the heads of the metatarsal bones (compensatory equinus), or by flexing the sound knee.

Inspection.—The leg on the affected side is shortened, and the shortening is shown to be in the upper part of the femur by finding that the great trochanter lies above Nélaton's line, and the vertical limb of Bryant's triangle is shortened. The leg is everted, and the thigh on the affected side does not lie so close to the vulva or scrotum as on the sound side. The buttock is broadened and flattened, and the gluteal fold shorter and deeper.

Movements.—Movements of the hip are quite painless, and all the movements, with the exception of abduction, are freer than in normal children. Adduction is especially free, and the femur may be made to cross the upper part of the thigh of the opposite side. When this is done, the head of the femur can be felt, and sometimes seen, lying above and behind the acetabulum.

Telescopic movement of the hip is present. This is obtained by laying the patient flat on the back, fixing the pelvis, and then alternately pulling on and relaxing the dislocated leg. The head of the bone will be felt to slide up and down on the dorsum ilii to the extent of one or two inches.

BILATERAL CASES.—The child walks with both legs everted, the gait is "waddling," the body dipping from side to side with each step. Marked shortening of the adductors may cause the legs to cross when walking. The buttocks are broadened and flattened, and a well-marked lordosis is generally present. The external genitals are prominent, and the thighs do not lie close together as they do in a normal child. The other signs are similar to those in unilateral cases. Radiography will at once demonstrate either condition, and will also differentiate between congenital dislocation, coxa vara, or tuberculous of the hip. The situation of the head of the femur and any torsion of the neck will also be shown if a series of radiograms are taken.

TREATMENT.—The modern method of treatment is replacement of the head of the bone in the acetabulum, and maintaining it there by the application of a series of plaster cases until it forms a cavity for itself. This treatment is carried out by two methods: (1) Manipulation, or Lorenz's method; (2) the open operation, or Hoffa's method.

A. LORENZ'S METHOD.—This is most suitable in cases below the age of seven, and the earlier this method of treatment is carried out, the greater the chances of success. With increased skill, the age limit may be extended. The child is placed under an anesthetic, and the shortened muscles stretched and massaged. The limb is manipulated until the head of the femur is felt to be in the acetabulum. It is then in a position of marked abduction and eversion, flexed at a right angle to the body and slightly hyperextended, and it is fixed in this position by plaster bandages. Two or more attempts may be necessary in older children before the bone can be placed in position. If the condition is bilateral, both hips should be replaced at the same time.

The further treatment, which usually extends over one or two years, consists of gradually bringing the femur downwards and inwards until it is in its normal position, being fixed in each new position by



FIG. 95.—CONGENITAL DISLOCATION OF THE HIP, SHOWING SEPARATION OF THE FEMORA.



MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

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a plaster case. The child is allowed to walk in the plaster as soon as the leg can be brought to the ground.

RESULTS.—(1) Reposition may be a complete failure, or the deformity may recur as soon as the plaster is removed.

(2) A posterior dislocation may be changed into an anterior, the head of the femur lying under the tendon of the rectus femoris or



FIG. 96.—CONGENITAL DISLOCATION OF THE HIP (X RAY).

under the anterior superior spine. This is an advantage, as it removes the lordosis and the shortening does not increase.

(3) Reposition may be so successful that it is almost impossible to detect the past deformity. These cases are at present the exception.

(4) Death may result from shock.

(5) Ankylosis of the hip in a bad position has occurred.

B. HOFFA'S METHOD.—This is reserved for older patients and for cases in which Lorenz's method has failed. The acetabulum is exposed and gouged out, and the head of the femur placed in it. Tenotomy of any shortened muscles is performed. This operation has only proved successful in the hands of very experienced orthopaedic operators.

C. OTHER METHODS.—The condition may be relieved by the use of a high boot, the height of which will have to be increased from time to time. A padded leather jacket with prolongation over the thighs may prevent the head of the femur slipping up on the dorsum ilii and increasing the deformity.

In some cases which are left unreduced, secondary osteo-arthritis changes occur in the false joint which is formed, leading to pain, contraction, and loss of mobility.

Coxa Vara.—The normal angle of inclination of the neck of the femur to the shaft is 125 degrees. A diminution of this angle constitutes the deformity known as "coxa vara." It is accompanied by forward and outward curving of the neck, the trochanter being displaced backwards, and the limb everted. The neck of the femur is often shorter than normal.

CAUSES.—The cause of coxa vara is a disproportion between the weight to be borne and the strength of the neck of the femur, the fault in the majority of cases lying in the femur.

1. Rickets. Bilateral coxa vara is common in rickets, but the deformity is often overlooked, as it is bilateral, and the functional disability is not great. The limbs are everted, the child standing and walking with the toes turned out. Inversion is limited. The deformity, which is often associated with other rickety deformities, is treated by keeping the child lying down during the acute stage of rickets, and splinting the lower limbs to correct the eversion. These patients seldom require operative treatment for the deformity.



FIG. 97.—RACHITIC FEMUR, SHOWING ANTERO-POSTERIOR CURVE AND COXA VARA.

(London Hospital Medical College Museum.)

2. Late rickets. It is probable that some cases, to be described as adolescent coxa vara, are associated with softness of the neck of the femur, due to late rickets.
3. Osteo-arthritis. In osteo-arthritis of the hip, absorption of the head and neck of the femur with coxa vara is common. It is more convenient, however, to consider this as part of a disease, and not as a deformity. The same applies to alteration of the inclination of the neck, associated with osteomyelitis and Charcot's disease.
4. Traumatic coxa vara (adolescent coxa vara). This variety of the deformity has specialized clinical features, and most frequently requires treatment.

Adolescent coxa vara is more common in boys than in girls, and the patients usually come for treatment between the ages of twelve and eighteen. In its most typical form it is unilateral.



FIG. 98.—COXA VARA.

CLINICAL FEATURES.—The patient complains of pain and weakness in the hip-joint, limping, and loss of mobility. Careful questioning will usually elicit the history of an accident occurring some weeks or months before the onset of the symptoms. The accident was probably not a very severe one, and the patient may have continued to get about with difficulty; or he may have had to lie up for a few days with pain and bruising about the hip. Radiography has shown that this accident has resulted in a partial or complete fracture of the neck of the femur, or in some cases in a partial separation of the upper epiphysis of the femur. In a child such an accident may be associated with little functional disability at first, but if he gets about soon after the accident, a gradual shifting of the femur upwards at the site of the fracture will occur, and coxa vara develop.

EXAMINATION.—The patient walks with a limp, and when standing, the pelvis on the affected side is raised, owing to the adduction at the hip, so that apparent as well as real shortening is present. There is often a compensatory scoliosis. The limb is usually everted, and the great trochanter is prominent. All the movements of the hip are somewhat limited, but the power of abduction may be almost entirely lost. Measurements show that real shortening ($\frac{1}{2}$ to 1 inch) is present, and examination

of Bryant's triangle and Nélaton's line proves that this shortening is due to elevation of the trochanter. The muscles round the hip-joint are somewhat wasted.

In bilateral cases the deformity may not be so obvious, as the pelvis is not tilted; but the adduction may be so marked that the patient crosses the legs at each step (scissor gait).



FIG. 99.—TRAUMATIC COXA VARA.

Radiography is almost essential to correct diagnosis. The diminished inclination of the neck of the femur to the shaft can be seen. The head of the femur is generally somewhat flattened, the neck shortened, and there may be evidence of the fracture and callus formation.

DIAGNOSIS.—The chief difficulty lies in diagnosing this deformity from tubercular arthritis of the hip, in which all the movements of the joint are markedly limited. The diagnosis must be made by means of radiography, which will show the deformity in one case, and erosion of the head of the femur or the acetabulum in the other. Cases of congenital dislocation of the hip which have escaped diagnosis till adolescence may also cause difficulty in diagnosis, but radiography will at once decide which deformity is present.

TREATMENT.—If the diagnosis is made early, especially if radiography shows a fracture through the neck of the femur, or a separated epiphysis following a recent accident, the patient should be kept recumbent, and extension applied to the limb in the abducted position. This treatment should be carried out for at least six weeks. The patient is then allowed up in a plaster case, or in a Thomas's hip-splint, with a patten on the sound limb. Walking without apparatus and crutches may be resumed at the end of three months.

In old-standing cases with well-marked deformity, operation is the only method of treatment that is useful. Two operations are advocated—

1. An osteotomy, linear or cuneiform, of the neck of the femur. This is excellent in recent cases of fracture, but as the hip-joint must be opened, a certain amount of loss of movement is certain to result.

2. Subtrochanteric osteotomy, linear or cuneiform.

After either operation the limb should be put up in a position of abduction, and extension maintained for six weeks. The weight should not be borne on the limb for three months. The shortening that is always present in unilateral cases should be compensated for by wearing a high boot.

Coxa Valga.—In this deformity the angle of inclination of the neck of the femur to the shaft is increased.

CAUSES.—The deformity is secondary to other conditions, especially congenital dislocation of the hip and infantile paralysis, and has little clinical importance.

CLINICAL FEATURES.—The limb is lengthened, abducted, and rotated outwards, and the great trochanter is flattened and depressed below Nélaton's line. The diagnosis is made by radiography.

TREATMENT is usually unnecessary.

Rudimentary or Absent Patella.—In genu recurvatum, or in the rare cases of congenital dislocation of the knee, the patella may be rudimentary or absent. No treatment is possible. The functional disability may be slight if there is no other marked deformity of the joint.

Congenital Displacement of the Patella.—The displacement is outwards, and may be persistent or intermittent.

In *permanent* displacement the patella rests on the external condyle of the femur, and the displacement is increased on flexing the knee:

No **TREATMENT** is likely to be of use.

Intermittent displacement may occur every time the knee is flexed, or only when there is a sudden flexion of the knee, the latter cases being accompanied by pain and disability. The patella returns to its normal position when the knee is extended.

The deformity is more common in girls than boys.

TREATMENT.—The displacement may be prevented by the use of a knee-cap, but in the majority of cases operation is necessary. The usual operation consists of removing an elliptical portion of the capsule on the inner side of the joint, and bringing the cut edges together. An alternative operation is to transplant the tubercle of the tibia, with the attached ligamentum patellæ, into the inner aspect of the tibia. If the condition is associated with genu valgum, this deformity should be cured.

Genu Recurvatum.—This deformity consists of a hyperextension of the knee. It may be congenital or acquired.

CONGENITAL.—The congenital variety is believed to be due to malposition *in utero*. In the majority of cases it is a condition of hyperextension with limitation of flexion, but exceptionally the tibia may be dislocated forwards on the femur. The diagnosis is obvious.

TREATMENT.—Anæsthesia should be induced if necessary, and the knee flexed and maintained in this position until the tendency to hyperextension disappears.

ACQUIRED.—The causes of acquired genu recurvatum are—Infantile paralysis, with a flail joint; Charcot's disease of the knee; talipes equinus, the knee being hyperextended so that the heel can be placed on the ground; traumatism, with rupture of the posterior ligaments of the knee, or separation of the lower epiphysis of the femur; rickets; osteomalacia, or other causes of softening of the bones.

The **DIAGNOSIS** is obvious, and the amount of disability depends on the cause. The condition is often associated with some degree of genu valgum.

The **TREATMENT** depends on the cause.

Genu Valgum.—In the erect posture the normal angle of inclination of the femur to the tibia in the male is about 172 degrees. In the female it is somewhat less, owing to the relatively increased width of the pelvis. If the angle of inclination is lessened, the patient is suffering from genu valgum, and when he stands erect with the internal condyles of the femur touching one another and the patellæ looking directly forwards, the internal malleoli are separated by a gap. The width of the gap measures the degree of genu valgum.

CAUSES.—Excluding the rarer causes of genu valgum associated with osteo-arthritis of the knee, Charcot's knee, or fracture near the knee-joint, patients with genu valgum come for treatment in early childhood or in adolescence.

Genu valgum in early childhood is invariably associated with rickets, but it is often difficult to state what is the actual exciting cause of the deformity, and why some patients develop genu valgum and others genu varum, or bow-legs. The habit of standing with the leg

abducted and the knee slightly bent inwards (position of rest) is probably the cause of some cases of deformity; others may be due to the method of carrying the child with the mother's arms round the lower ends of the femora, pressing them together.

The genu valgum of adolescence is in many cases an exaggeration of a slight genu valgum of childhood, the deformity becoming more pronounced owing to the overstrain from prolonged standing or the carrying of heavy weights. In other cases it may be due to a recrudescence of rickets or to the development of late rickets.



FIG. 100.—SECTION OF A FEMUR FROM A CASE OF GENU VALGUM, SHOWING OBLIQUITY OF THE EPIPHYSEAL LINE (SEMI-DIAGRAM-MATIC).

PATHOLOGICAL ANATOMY.—Examination of the femur shows that the lower extremity of the shaft of the femur is curved outwards, and there is increased growth of the *diaphysis* on the inner side, so that the epiphysal line becomes oblique. A corresponding change occurs at the upper end of the tibia, but as a rule it is not so marked in this bone. The greater deformity is rarely in the tibia. The femur is somewhat rotated inwards, and the tibia outwards; therefore, when the patient stands erect, the knee-joint is rotated outwards, and the patella looks outwards. The position of the feet varies in different cases. Some patients invert and adduct the feet in order to compensate for the abduction of the knee, the result being a "pigeon-toed" walk. In other cases, genu valgum is associated with flat-foot and eversion, both deformities being due to the same cause. The ligaments and muscles on the inner side are lengthened, and on the outer side shortened, and there may be some laxity of ligaments and slight

hyperextension of the knee. In very bad cases of deformity the patella may be dislocated outwards when the knee is flexed.

CLINICAL FEATURES.—The deformity may be unilateral or bilateral, or genu valgum in one leg may be associated with genu varum in the other. The patient walks with an awkward gait, and may knock one knee against the other (knock-knee). He is easily fatigued, and may complain of pain, especially on the inner side of the knee, where the greatest strain is thrown on the ligaments.

EXAMINATION.—The patient should be seated with the legs fully extended. The limbs should be rotated inwards until the patellæ look directly upwards and the internal condyles are made to touch each other. The amount of separation of the internal malleoli gives the extent of the deformity. The patient is then made to flex the knees to a right angle. If the malleoli now come together (and they

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usually do), the deformity is in the femur, but if they are still separated, the tibia is partly at fault. Laxity of the ligaments should be examined for by testing the lateral mobility of the knees with the joints extended.

If the patient is examined in the erect position, he will, to some extent, conceal the deformity by standing with the legs rotated outwards, one slightly in advance of the other, the internal condyles overlapping.

TREATMENT.—Careful investigation has shown that if rickets is cured and the general health of the patient improved, slight rickety deformities, including genu valgum, in children below the age of six, disappear or become less marked during growth. This spontaneous disappearance, however, should not alone be relied on, for it does not happen in all cases, and is rarely complete. A slight deformity left from early rickets may become exaggerated in adolescence. The genu valgum of adolescence shows no tendency to disappearance.

The treatment of rickety genu valgum consists of the treatment of rickets, rest, and the prevention of the abnormal attitude.

SPLINTS.—(1) In severe cases the child should wear external splints, reaching from the great trochanter to below the feet, to prevent walking. The splints should be worn night and day until the rickets is cured and the deformity considerably diminished. The splints should be removed morning and evening, and the legs bathed and massaged. In less severe cases the splints used need only be worn during the day.

(2) In milder cases the splints should extend from the great trochanter to the external malleolus, and the patient may be allowed to walk.

Wooden splints or metal splints and braces, as Thomas's knock-knee brace, may be used. These braces should *not* be jointed at the knee.

The treatment by splints and braces must be continued for at least six months.

In adolescence, genu valgum, or in the rachitic variety when the patient does not come for treatment before the age of six years, splints are of little use, but in mild cases rest and manipulation may be tried. During manipulation the patient should be seated, and manual pressure used to force the knee into the proper position. This manipulation should last for about ten minutes, and be repeated several times a day. If the deformity is marked, operative treatment is necessary.

MACEWEN'S OPERATION.—The femur is divided about $1\frac{1}{2}$ inches above the external condyle by means of an osteotome, the bone being



FIG. 101.—GENU VALGUM.

partly cut across and partly fractured. A saw may be used instead of the osteotome. The limb is then placed in the slightly over-corrected position, and secured in a plaster of Paris case or on a splint. The patient should not be allowed to bear the full weight on the limb for at least three months.

CUNEIFORM OSTEOTOMY.—In extreme cases a wedge-shaped piece of bone is removed from the inner side of the femur.

OPERATIONS ON THE TIBIA.—If the deformity is largely in the tibia, osteotomy of this bone must be performed below the epiphysial line. The osteotomy is either linear or cuneiform, varying according to the amount of the deformity. In



FIG. 102.—Bow LEGS DUE TO RICKETS.

a few cases both the femur and the tibia must be divided.

OSTEOCLASIS.—The bone may be divided with an osteoclast, but this entails considerable risk of damaging the epiphysial line.

Genu Varum and Rickety Curves of the Tibia and Fibula ("Bow-Legs").—A pure genu varum—*i.e.*, an outward curve at the knee-joint—may occur in rickety children or in those who follow certain occupations, as horse-riding, if the patient is short-legged. In the majority of cases, however, genu varum is associated with curves in the tibia and fibula, usually near the lower end.

DEFORMITY.—The curve may be a gradual and uniform bowing of the femur and the tibia. With the outward bowing of the femur there is generally an inward bowing of the

tibia, most marked at its lower third, and almost angular in character. The last curve is frequently combined with or replaced by an antero-posterior curve. The ligaments of the knee are often relaxed, and the deformity is generally associated with flat feet. In some cases genu varum in one limb may be associated with genu valgum in the other. Genu valgum is rarely associated with curved tibiae.

CAUSES.—The condition is almost invariably due to rickets, and the curves in the tibiae themselves may be taken as evidence of the presence of that disease. The direction of the curves is determined by the habitual posture of the patient, and Fig. 103 shows the sitting attitude which produces the usual curves. In infants the wearing of a thick diaper between the legs may account for the curve in the

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femur. Once the curve has developed it tends to increase, as long as the softening of the bones, due to rickets, lasts, on account of the pressure from the weight of the body when the child stands or walks.

The diagnosis is evident on inspection, and a radiogram will show whether the deformity is chiefly in the femora or tibiae.

Prognosis.—The tendency for the deformity to disappear is greater than in genu valgum, and in young children careful treatment can invariably be relied upon to decrease the deformity. The most difficult part of the deformity to relieve is the anterior bowing in the lower third of the tibia.

TREATMENT.—In early cases the treatment consists of the general treatment of the rickets, rest, mechanical treatment of the deformity, and the prevention of the habitual posture that brought about the deformity. Splints should be used in the same way as in the treatment of genu valgum. In severe cases they should reach below the feet so that the child cannot walk, and should be worn at night; but in milder cases the splint should reach the internal malleolus only, and walking may be allowed. Excellent braces, fitting into the boot and secured to a pelvic girdle, are also made. Massage of the muscles should be



FIG. 103.—RICKETS, SHOWING THE METHOD OF PRODUCTION OF THE CURVES IN THE TIBIAE.

carried out daily. Treatment must be continued for at least six months.

OPERATIVE TREATMENT.—This should be reserved for very severe cases or for those patients who only seek treatment after the bones are completely ossified. Such bones are usually denser and harder than normal bones.

OSTEOCLASIS.—This can be performed with the hands (manual osteoclasia) or by means of an osteoclast. Manual osteoclasia is only possible in young children with soft bones, and there is some danger of separating the epiphyses. The bones broken are the tibia and fibula. The limb is placed in splints in the corrected position, and full weight is not borne on it for three months.

OSTEOTOMY.—Osteotomy is necessary in patients with hardened bones, and may be linear or canalicular; the former is to be preferred. It may be necessary to divide the femur as well as the tibia and fibula, but it is better to operate on the bone with the greater deformity first, and see the effect before the second bone is divided. Non-union is very rare.

The antero-posterior curve of the lower end of the tibia and fibula should always be treated by osteotomy if it is marked as splint treatment is of little use in this deformity.

TALIPES

Various deformities occurring in the foot in the region of the ankle-joint and tarsus are comprised in the term "talipes." The following varieties are recognized:

Talipes Equinus.—The heel is drawn up and the patient walks on the heads of the metatarsal bones.

Talipes Calcaneus.—The heel is dropped, and the patient walks on it with the rest of the foot raised.

Talipes Varus.—The patient walks on the outer border of the feet, and the toes point inwards.

Talipes Valgus.—The patient walks on the inner border of the feet, and the toes point outwards.

It is more common to get combinations of these deformities than for one to occur alone, the most frequent combination being talipes equino-varus, and the next talipes calcaneo-valgus.

TALIPES EQUINO-VARUS.—This condition may be congenital or acquired.

Congenital Talipes Equino-Varus

CAUSE.—The cause of the condition is unknown, the following theories being held:

1. It is due to malposition or pressure *in utero* associated with too little liquor amnii, hydramnios, contracted pelvis, etc. This is the most generally accepted theory.
2. It is due to a neuro-muscular defect of congenital nature.
3. It follows intra-uterine infantile paralysis.

Occasionally the condition runs in a family, and it may be associated with other congenital deformities, such as hare-lip, cleft palate, or syndactyly.

The deformity is more common in boys than in girls, and if unilateral, is slightly more common on the right than on the left; but in about one-half of the cases the condition is bilateral. Talipes equino-varus may be present in one foot and calcaneo-valgus in the other.

ANATOMY.—Careful examination in the majority of cases will show that there is a rotation inwards of the leg and foot below the knee.

this rotation being, however, most marked at the ankle and mid-tarsal joint. The plantar aspect of the foot is more concave than normal, and the sole of the foot looks inwards, backwards, and downwards. The heel, which is drawn up, is smaller, and the whole foot somewhat shorter than the normal. The external malleolus is more prominent than usual, and the tarsus is flattened in front of it—a physical sign which is diagnostic of congenital or, *no-varus*. Examination of the *bones* and their *articular surfaces* will show that they are more marked in the astragalus and the os calcis than in the other bones. The neck of the *astragalus* is longer than normal, and turned inwards and downwards.

The *ligaments* are altered to correspond with the altered shape of the bones and joints, being shortened on the concavity and lengthened on the convexity, and all the other structures of the foot, the *fasciæ*, *muscles*, and *skin*, are adapted to the deformity in the same way.



FIG. 104.—CONGENITAL TALIPES EQUINO-VARUS.

The ligaments which chiefly resist reduction of the deformity are the internal calcaneo-scapoid, the internal lateral ligament of the ankle-joint, and the plantar fascia. The muscles most active in maintaining and increasing the deformity, and which will most often require tenotomy, are the tendo Achillis, the tibialis anticus, and tibialis posticus.

The deformity, which may be slight at birth, will, if untreated, increase steadily, the structures of the foot adapting themselves more and more to the unusual method of progression, according to the law of Julius Wolff (p. 250), so that finally the patient may walk on the dorsum of the foot. At the same time, those muscles which have not been used atrophy and contract, and the foot becomes rigid in its deformed position. Bursæ and corns develop over the sites of abnormal pressure, and increase the difficulty in walking.

DIAGNOSIS.—The diagnosis is usually obvious, but the table on the next page gives the distinction between congenital and acquired (from infantile paralysis) cases:

	CONGENITAL.	ACQUIRED (INFANTILE PARALYSIS.)
<i>Onset</i>	Present at birth	Follows some months after an acute disease causing paralysis.
<i>Distribution</i>	May be unilateral or bilateral. If bilateral, both feet usually affected to the same degree.	May be unilateral or bilateral, but in bilateral cases the amount of deformity and often the variety, varies on the two sides. Arms and other parts of the body may be affected.
<i>Condition of muscles</i> ..	Muscles ill-developed, but no great wasting, and all muscles act.	Muscles wasted in groups, and some muscles completely paralyzed.
<i>Electrical changes</i> ..	No R.D.*	R.D.* present.
<i>Reflexes</i>	Normal.	Usually lost.
<i>Vasomotor changes</i> ..	Not present.	Present. Patient usually suffers from chilblains.
<i>Growth of bones</i> ..	Normal.	Defective growth.
<i>Creases in sole</i> ..	Exaggerated.	Creases smoothed out.
<i>Flattening in front of external malleolus</i> ..	Present.	Absent.

TREATMENT.—Treatment should be begun as soon as the child is born, and should never be delayed for any reason. The stages in the treatment are—

1. Rectification of the external deformity.
2. Maintenance of the rectified position, while the bones and joints alter their structure according to Woolf's law.
3. Supervision and careful teaching of the proper method of walking.

1. The methods of **Rectifying the External Deformity** are numerous, and the treatment of any particular case depends on (1) the amount of the deformity; (2) the age at which the patient is brought for treatment; and (3) the care and attention that can be given to after-treatment. In every case it is necessary to combine two or more methods of treatment. It is not enough to correct the deformity, but at the end of this stage of treatment, the deformity should be over-corrected—*i.e.*, equino-varus changed to calcaneo-valgus.

(a) **MANIPULATION AND MASSAGE.**—This is essential in every case. The whole leg should be massaged, and then the nurse, grasping the leg with the left hand, should gently draw the foot into the corrected

* R.D.=Reaction of degeneration.

position, and hold it there for a few minutes. This method of treatment should be continued in the intervals of other treatment; it should never be forcible enough to cause pain. At the same time the whole leg should be rotated outwards to correct the internal rotation.

(b) SPLINTS.—In the intervals of manipulation the foot should be held in the over-corrected position as regards the *varus* by the use of a malleable external splint. The nurse or mother should understand how this is to be applied, for it must be removed several times a day for manipulation. If the removal and reapplication of the splint cannot be trusted to the mother, the foot may be placed in a plaster of Paris case, which is renewed every two weeks, the over-corrected position being gradually attained.

An excellent splint for correction of the *varus* deformity is Judson's brace, the application of which is explained by the diagrams (Fig. 106).

(c) TENOTOMY.—The *equinus* deformity may be removed by gradual over-correction or by manipulation and splinting; but it is more satisfactorily treated by a tenotomy of the tendo Achillis, which should be done before the child is three



FIG. 105.—OLD-STANDING CONGENITAL TALIPES EQUINO-VARUS.

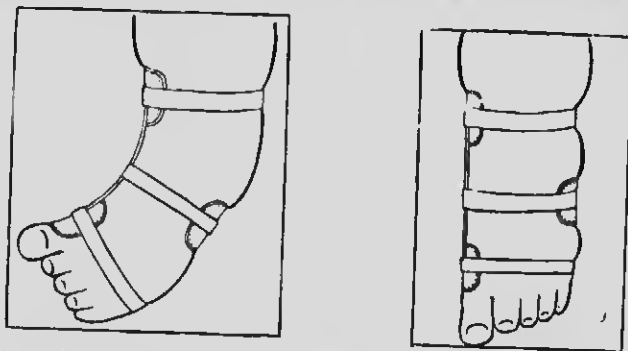


FIG. 106.—JUDSON'S SPLINT FOR STRAIGHTENING TALIPES VARUS.

months old. After the tenotomy the foot is placed in the over-corrected position, and there is no fear of non-union of the tendon.

Tenotomies of other muscles are seldom necessary; but those that

may have to be tenotomized in neglected cases are the tibialis anticus and the tibialis posticus. It may also be necessary to divide the posterior and internal lateral ligaments of the ankle-joint. This stage of the treatment—*i.e.*, over-correction of the external deformity—should be complete in three months, and the foot be in the position of calcaneo-valgus.

2. **Maintenance of the Corrected Position.**—If this is not carried out until the child can walk, the deformity is sure to recur. Many splints and braces have been designed to prevent recurrence of the deformity,



FIG. 107.—ERNST'S VARUS SHOE.



FIG. 108.—NIGHT SHOE.

and the simplest are usually the best. An excellent brace is Ernst's varus splint, an illustration of which is given. The brace should be worn day and night, but should be removed several times a day, the foot thoroughly massaged and manipulated, and the leg rotated outwards on the femur. As the tendency to recurrence disappears and the child begins to walk, the brace can be removed during the day and replaced by a light splint at night; but the daily massage and manipulation should be continued, and any tendency to recurrence should be treated by the reapplication of the splint.

3. **Supervision.**—If the correction has been thoroughly carried out, all that is necessary is to teach the child to walk with the sole of the foot flat on the ground, and the toes turned slightly outwards. The tendency to inversion may be corrected by slightly thickening the sole of the boot on the *outer* side. In many cases, however—especially with hospital outpatients—it will be necessary to give the child an instrument to hold the foot in the corrected position when walking. This instrument will consist of a strongly made boot with a straight inner edge (surgical boot), into the heel of which are inserted two lateral irons jointed at the ankle. The irons extend to just below the knee, where they are connected by a padded strap (lateral irons). A broad leather strap is fastened to the sole of the boot on the outer side, and is carried round the ankle to fasten *outside* the iron on the inner side opposite the external malleolus. This strap causes eversion of the foot, and from its shape is termed a "T-strap." A spring is fixed to the outer lateral iron in such a manner as to dorsiflex the foot—uplifting toe-spring (see Fig. 112).

The child will still walk with the toes turned in while wearing this apparatus unless taught to turn them out, and the only way to correct this tendency mechanically is to carry the instrument to the pelvis.

NEGLECTED CASES.—The following methods of treatment are used for neglected cases:

1. **Operations on Soft Structures.**—Tenotomy of the tibialis anticus, tibialis posticus, division of the plantar fascia, and the internal and posterior ligaments of the ankle-joint, and the internal calcaneoscapoid ligament followed by manipulation and splinting.

2. **Forcible Correction of the Deformity.**—An anæsthetic is given, and the foot forcibly manipulated with the hands or with a Thomas's foot-wrench into the over-corrected position. The foot is then placed in a plaster of Paris case, which is removed every month, further forcible correction being carried out if necessary.

3. **Phelps's Operation.**—After division of the tendo Achillis and the posterior ligament of the ankle-joint, an incision is made on the inner side of the foot, dividing everything until the astragalo-scapoid joint is opened. The foot is then wrenched into the over-corrected position and the wound allowed to granulate. Healing may be promoted by covering the large gap left after the correction with skin by means of



FIG. 109.—RESULT OF PHELPS'S OPERATION

a plastic operation. The foot must be kept in a splint or a plaster of Paris case for several months.

4. *Ogston's Operation*.—In this operation the ossifying centres of the astragalus, os calcis, cuboid, and scaphoid are scraped out, and the position of the foot forcibly corrected, the corrected position being maintained by a plaster of Paris case. It is most suitable for neglected cases in patients five or six years old.

5. *Astragalectomy*.—The most usual operation is removal of the head of the astragalus, but the whole bone may be removed and a very useful foot result. After-treatment must be carried out for months.

6. *Cuneiform Osteotomy*.—This should always be secondary to other forms of treatment, but when it is undertaken, a wedge should be removed from the outer part of the foot in order to correct the deformity completely. Retention of the foot in a plaster of Paris case is necessary.

No operation can be considered as a cure of the deformity, and relapses will occur after every method of treatment unless careful after-treatment is carried out for years.

7. *Amputation*.—In old-standing aggravated cases, amputation of the foot may give a better result than any form of orthopædic treatment.



FIG. 110.—TALIPES CALCANEO-VALGUS.

Congenital Talipes Calcaneo-Valgus.—The chief deformity is the eversion of the foot (valgus). This form of congenital talipes is much more easily corrected than equino-varus, manipulation and massage being generally all the treatment necessary. If, however, the deformity is marked, a splint holding the foot in the position of varus should be worn in the intervals of massage.

In some cases the condition passes unnoticed until the child begins to walk, when he is brought for "weak ankles." Massage and manipulation should be carried out, and the child should wear a special boot, with the sole slightly raised on the *inner* side, and fitted with lateral irons and a valgus T-strap.

Acquired Talipes

Every variety and combination of deformity may be present in acquired talipes, but the equino-varus variety is more common than any other variety, although the predominance is not so great as in congenital cases.

CAUSE.—The causes of acquired talipes are—

1. Congenital defects of the nervous system: spina bifida, hydrocephalus, cephaloceles.
2. Paralysis of cerebral origin: hemiplegia, Friedreich's ataxia, spastic diplegia, etc.
3. Paralysis of cord origin: anterior poliomyelitis (infantile paralysis), injuries to the spinal cord, syringomyelia, progressive muscular atrophy.
4. Injury and disease of peripheral nerves: injury to the external popliteal, peripheral neuritis.
5. Muscular dystrophy.
6. Cicatricial contraction following burns, ulcers of the leg, and abscesses.
7. Fracture of the bones, with or without myositis—*e.g.*, talipes valgus after Pott's fracture.
8. Compensatory talipes, from shortening of the leg, due to congenital dislocation of the hip or excision of the knee.
9. Maintenance of the foot in a bad position, as may occur when a child is kept for a long time in a box-splint, with the weight of the bedclothes resting on the toes. This variety is termed "talipes decubitus."

ANTERIOR POLIOMYELITIS (infantile paralysis) is by far the most common cause of acquired talipes, and this condition will be described first. It is an acute inflammation round the motor nerve cells of the spinal cord, almost certainly due to a micro-organism which has not yet been discovered.* It occurs epidemically, being most common in children under three years of age, although it may appear any time before adolescence. It affects both sexes in equal numbers.

CLINICAL FEATURES—1. *Stage of Onset.*—The onset is generally sudden, associated with rise of temperature and the usual symptoms of any febrile attack. Vomiting and intestinal disturbance are common, and there may be so much pain that a diagnosis of rheumatic fever is made. In some cases the febrile disturbance is slight or absent, and a child may one morning be found to be paralyzed without any apparent cause. The paralysis in these cases is often put down to a fall. If the child has not walked before the onset of the disease, the paralysis may only be discovered when he attempts to walk. The paralysis reaches its fullest extent within one week of the onset of the disease.

The lower extremities are far more often paralyzed than the upper, but the disease may cause paralysis of any of the muscle groups of the body. In a series of 416 cases affecting the lower extremities, the right and left legs were each affected alone in 123 cases, and both legs in 170 cases.

2. *Stage of Recovery.*—All the general symptoms disappear, and the paralyzed muscles begin to recover, the recovery being very slow at first. This stage of recovery lasts about two years, but at the end

* A specific organism has recently been described.

of six months after the onset of the illness the final amount of paralysis is fairly accurately established. It is impossible to say directly after an attack how much paralysis will remain. In some cases very little improvement occurs, while in others the amount of recovery is surprising. The muscles that remain paralyzed waste, the reflexes are lost, and the reaction of degeneration is present.



FIG. 111.—INFANTILE PARALYSIS OF THE LOWER EXTREMITY.

The vasomotor nerves are affected, as well as the nerves to the skeletal muscles, and there is paralysis of the muscular coats of the vessels of the limb. As a consequence, it is cold and blue, and has a sluggish circulation. The patient is apt to develop pressure sores and chilblains. Growth of the bone is also retarded, and the limb becomes shorter than its fellow, unless both are equally affected.

Deformity.—It cannot be too clearly stated that, except for the defective growth of the leg, deformity should not occur in a case of infantile paralysis, and the presence of talipes means neglect of the condition or inefficient treatment. The development of deformity is due to the patient being allowed to hold the foot constantly in an abnormal position. For example, if the anterior tibial group of muscles is paralyzed, the foot hangs downwards, owing to the force of gravity, and the patient is unable to raise it. If this attitude is allowed to persist, the muscles will adapt themselves to the altered position. The anterior group of muscles will stretch, and the muscles of the calf will become structurally shortened, and talipes equinus will result.

If the quadriceps extensor is paralyzed, the knee cannot be extended, and if the patient is allowed to sit in the usual way, with the leg hanging down, the knee will become permanently flexed, owing to stretching of the extensor muscles and structural shortening of the ham-strings.

The weight of the body will usually be responsible for inversion (varus) or eversion (valgus) of the foot. A child with paralysis of the peroneal muscles (evertors) will tend to walk on the outer side of the foot, and if this is allowed to continue, the foot will turn in more and more, until the patient may walk on the dorsum. If the tibialis anticus and posticus (invertors) are paralyzed, the child will walk on

the inner border of the foot, and the weight of the body will evert the foot still further.

The deformity does not only involve the muscles and fascia, but if an abnormal attitude is persisted in, the bones and joint surfaces gradually alter their structure in order to adapt themselves to the altered attitude (Woolf's law).

TREATMENT.—During an attack of acute anterior poliomyelitis the patient is under the care of a physician, but as soon as the febrile attack is over, surgical treatment must be begun in order to aid the recovery of the muscles, and to prevent the onset of deformity.

1. Massage of the paralyzed muscles is important to maintain their nutrition, and stimulation by the constant current may also help. Electrical treatment by itself, however, has little value, and is much too often persisted in, to the neglect of other and more essential treatment.

2. The joints controlled by the paralyzed muscles should be moved through their full range of movement at least once a day.

3. The limb should be carefully splinted, so that no group of muscles is stretched or allowed to remain shortened. In the case of the foot, this is easily accomplished by placing the leg on a posterior splint with a footpiece. This splint should be worn day and night, and only removed for massage, passive movement, and electrical treatment.

4. As soon as the paralyzed muscles begin to regain their power, careful active movements should be carried out against graduated resistance, but the child must not be allowed to hold the foot in an abnormal position while these exercises are being employed.

5. About six months after the onset of the paralysis the patient should be fitted with a walking instrument, so that the foot is held in the proper position when he is taught to walk. If the paralysis only affects the leg below the knee, the instrument consists of a boot with lateral irons, a valgus or varus T-strap, and an uplifting or depressing toe-spring, according to the paralysis present. In those cases in which the quadriceps or ham-strings are paralyzed, the instrument must be carried up to the hip and secured to a pelvic girdle. A joint is placed at the knee with a ring-catch, so that when the child walks the joint is locked and the knee is held stiff. If both limbs are paralyzed, a double instrument is used.

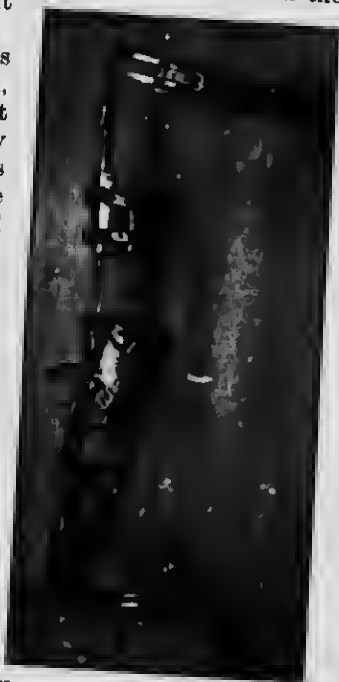


FIG. 112.—WALKING INSTRUMENT FOR TREATMENT OF INFANTILE PARALYSIS.

The child should not be allowed to walk or stand until the instrument, which should always be worn during the day, has been fitted. At night a light shoe (Fig. 108) should be worn, in order to maintain the correct position. As the paralysis improves, the instrument may be made less complicated.

There is this essential difference between congenital and acquired talipes: in congenital cases the correction of the deformity is the most difficult part of the treatment, and when this is accomplished the patient is cured; in the acquired form the paralyzed muscles remain, and cure cannot be expected. An instrument of some kind is usually necessary as long as the patient lives.

OTHER METHODS OF TREATMENT.—As the final extent of the paralysis cannot be ascertained until after one or two years of careful treatment, other methods of treatment should be postponed till then. They are—

Arthrodesis.—If all the muscles that move a joint are paralyzed (ball joint), it may be fixed in a favourable position by removing the articular surfaces of the bones and obtaining bony ankylosis. The joints most usually subjected to this treatment are the knee, the ankle, and the mid-tarsal joints.

Muscle Transplantation.—The attachments of muscles that are overacting may be transplanted so that they reinforce paralyzed muscles. For example, if the peroneus longus is pulling the foot into the position of talipes valgus, its tendon may be transplanted into the tendo Achillis if the gastrocnemius and soleus are paralyzed, and the muscle made to act as a plantar flexor of the foot.

Muscle transplantation requires elaborate technique and after-treatment, and is of limited application.

Nerve Anastomosis.—At the present time the value of nerve anastomosis in the treatment of infantile paralysis is *sub judice*. The results so far obtained have not been very satisfactory, and the number of cases in which this operation should be tried are very few.

Treatment of Deformities.—If the above treatment of infantile paralysis is carried out, no deformity will occur; but patients are frequently brought to the surgeon with deformity already present, the most common deformity being talipes equino-varus, which is often complicated by flexion of the knee and genu valgum.

As in congenital cases, the first step in the treatment is to correct the deformity, and the following methods are employed, the one chosen depending on the severity of the case:

1. **TENOTOMY.**—The tendons generally requiring tenotomy are the tendo Achillis, the tibialis posticus, tibialis anticus, and occasionally the peroneus longus and brevis. The foot should be placed at once in the corrected position, and three weeks given for the tendon to unite. For talipes calcaneus the tendo Achillis may be shortened. **Pes cavus**, with shortening of the plantar fascia, may be treated by division or excision of the fascia.

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2. **PHELPS'S OPERATION.**—This is useful in acquired talipes, and the method of performing this operation is similar to that in congenital cases.

3. **BONE OPERATIONS.**—The bone operations most often performed are—

- (a) Excision of the head of the astragalus in talipes valgus or varus.
- (b) Complete astragalectomy in talipes varus.
- (c) Uneiform tarsectomy in aggravated cases, the operation being performed on the inner side in valgus, and on the outer side in varus.

4. **AMPUTATION.**—In old neglected cases of deformity, with adventitious bursæ and corns, amputation is the best method of treatment.

Spastic Paralysis with Deformity

Spastic paralysis may involve—(1) Half the body—hemiplegia; (2) both lower extremities—paraplegia; (3) both sides of the body—diplegia; or (4) one limb—monoplegia.

CAUSES.—The condition results from injury or disease of the brain, the most common causes being—(1) Congenital defects; (2) birth injuries, usually meningeal hæmorrhages; (3) thrombosis of the cerebral vessels, or cerebral hæmorrhage; (4) meningitis; (5) acute encephalitis; (6) hydrocephalus.

SYMPTOMS — *Moto.* — The muscles of the affected limb are in a stato of spasm (spastic paralysis). They are not wasted; the reflexes are exaggerated, and there is no reaction of degeneration. Mentally, about half the cases are feeble-minded, and about half suffer from fits.



FIG. 113.—SPASTIC DIPLEGIA.

Athetoid movements in the affected limbs occur in about 20 per cent. **DEFORMITIES AFFECTING THE LOWER EXTREMITIES.**—The patient walks on the toes, with the heel drawn up, and the foot in a position of equino-varus (rarely equino-valgus); the knees are kept flexed and touch one another, or the legs may cross one another in walking (scissor gait); the hips are flexed, adducted, and rotated inwards.

The deformities at first will disappear if the spasm is relieved by putting the patient under chloroform; but after a time they become fixed, owing to muscular, ligamentous, bony, and articular changes.

TREATMENT.—In mild cases before deformity is present the treatment consists of careful education of the child in the use of the limb. This education must be unwearying and prolonged, but excellent results are obtained. It should be combined with massage and passive movements.

If education is not sufficient in itself, the child should be given a walking instrument reaching to the pelvis, with a fixed joint at the knee, an uplifting toe-spring, and a varus or valgus T-strap. At night the foot should be maintained in the right-angled position by a light shoe (Fig. 108).

OPERATIVE TREATMENT.—Multiple tenotomies, or excision of portions of the contracted muscles, followed by prolonged retention in the overcorrected position, have given good results if followed by careful education and the use of retentive apparatus.

The prognosis as regards walking is good, unless the child is an idiot, or has fits.

Compensatory Talipes.—Compensatory talipes is usually equinus, the patient walking on the toes to compensate for shortening of the limb. It is seen in the congenital or acquired dislocation of the hip, old tuberculosis of the hip, with shortening, excision of the knee, etc. No *treatment* of the talipes is necessary, but the patient should be given a boot with a sloping sole (see Fig. 599), so that the increased length is obtained, and yet the weight of the body rests on the whole surface of the foot.

Pes Arcuatus (talipes plantaris, pes cavus, claw-foot, hollow-foot).—All these names are given to a deformity of the foot, the cause of which is unknown, but which is a well-marked clinical entity. The following theories of its cause have been held:

1. It results from a mild attack of acute anterior poliomyelitis affecting the interosseous muscles.
2. It is a congenital neuro-muscular defect. In some instances several cases occur in the same family.
3. It is due to habitual posture.
4. It is due to contraction of the plantar fascia, and is analogous to Dupuytren's contraction of the palmar fascia.

None of these theories is satisfactory.

CLINICAL FEATURES.—The deformity begins to appear in early childhood (three to six years), and is steadily progressive. It is first noticed that the gait is awkward, and then that the foot is slightly deformed. The deformity may occur in both feet.

On *examination* of a well-marked case, the following signs are present: The foot is shorter and broader than normal, and when the child stands, it is noticed that the toes do not lie on the ground, but are curled up in a position somewhat resembling hammer-toe. The

Fig. 11

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big toe is often chiefly affected. The dorsum of the foot is strongly arched, and the foot is slightly inverted (varus), and if the knee is extended, it is found that the foot cannot be dorsiflexed beyond a right angle (right-angled equinus). The external malleolus is prominent, and a bursa may develop over it. The foot is more arched on the inner side, though the outer border rests on the ground more heavily than it normally does, and callosities are often present on it. If an impress of the sole of the foot is made, it will be seen that the heel and the heads of the metatarsal bones make a firmer impression than in the normal foot. Corns often develop under the heads of the metatarsal bones and over the contracted interphalangeal joints. The calf muscles are small, but the reflexes and the sensation over the foot are unaltered.



FIG. 114.—PES ARCUATUS.

PROGNOSIS.—The deformity is steadily progressive at first, but after a time comes to a standstill, and the only subsequent trouble is the development of corns and adventitious bursae.



FIG. 115.—IMPRESS OF NORMAL FOOT.

FIG. 116.—IMPRESS OF PES ARCUATUS.

TREATMENT.—The treatment is entirely symptomatic. Massage, passive movements, and the wearing of a *nit* with straps to keep the toes down are all that is advisable in the early stages.

Later, surgical boots with lateral irons, an uplifting toe-spring, and a varus strap may be necessary.

Operative treatment consists of—

1. Tenotomy of the tendo Achillis.
2. Excision of the plantar fascia or fasciotomy.
3. Tenotomy of the extensor tendons of the toes.
4. Excision of adventitious bursa and corns, as necessary.

Great care should be taken to provide the patient with well-fitting boots.

FLAT-FOOT

Flat-foot is a condition in which there is lowering of the longitudinal arch of the foot, combined with abduction and eversion of the foot, the movements taking place chiefly at the mid-tarsal joint—i.e., the joint lying between the astragalus and os calcis behind, and the scaphoid and cuboid in front.

The condition may be congenital or acquired.

Congenital Flat-Foot.—This condition is, as a rule, combined with talipes calcaneo-valgus, and has already been sufficiently considered. The treatment consists of massage, manipulation, and splinting, and later, if necessary, the wearing of a walking instrument. The instrument consists of a surgical boot with lateral irons to the knee, a valgus T-strap, and pads in the boot supporting the arch. If the calcaneus persists, a depressing toe-spring must be added.

Acquired Flat-Foot—General Considerations.—If the bones of a normal foot are articulated together, it will be seen that they form four arches:

1. An anterior metatarsal arch formed by the heads of the first, second, third, fourth, and fifth metatarsal bones, the first and the fifth only touching the ground. This arch becomes obliterated when the patient stands, and is unimportant.
2. The longitudinal arch. The posterior limb of this arch is formed by the os calcis and the astragalus, and is strong and unyielding, while the anterior limb formed by the scaphoid, cuboid, cuneiform bones, and the metatarsals is elastic. This arch rests posteriorly on the os calcis, and anteriorly chiefly on the head of the first metatarsal bone. The apex of the arch is the astragalo-scaphoid joint.
3. The transverse arch. In each foot there is only one limb of this arch, the complete arch being formed by both feet placed together. The apex of this arch is also the astragalo-scaphoid joint.
4. The internal arch. This arch runs along the inner border of the foot from the os calcis to the head of the first metatarsal bone, the inner border of the normal foot being concave. It becomes flatter when the weight of the body is thrown on to the foot, and is the most important of the arches in the diagnosis of *early flat-foot*.

The actual cause of the arches of the foot is therefore the shape of the bones and articular surfaces, and the arches are maintained in position by the ligaments, muscles, and fasciæ of the foot. The most important ligaments are the internal calcaneo-scaphoid or spring ligament, the internal ligament of the ankle-joint, and the long and short plantar ligaments. The chief supporting muscles are the short muscles of the foot, the *tibialis posterior*, and the *peroneus longus*, while the dense plantar fasciæ also forms a strong support for the longitudinal arch.

If the bones of a normal foot are articulated together by springs, so that the joint surfaces can move, and pressure is brought to bear on the foot from above, the following changes occur: The first effect of the pressure is to cause abduction and eversion of the anterior part of the foot at the mid-tarsal joint (Chopart's joint), so that the head of the astragalus becomes prominent on the inner border of the foot, and the lateral arch is obliterated. If the pressure is continued, the foot becomes more and more everted and abducted, and the longitudinal and transverse arches sink until the head of the astragalus and the scaphoid bone touch the ground. The foot is then quite flat, and the anterior part of the foot is abducted and everted on the posterior part, so that there is a shifting of the articular surfaces.

CAUSES OF ACQUIRED FLAT-FOOT.—The cause of acquired flat-foot is a disproportion between the strength of the arch of the foot and the weight it has to bear, or alteration in the application of that weight.

Loss of Strength of the Arch.—This may be due to—

1. Rickets leading to softening of the bones and ligaments and weakness of the supporting muscles. Many cases of flat-foot start in early childhood, and are dependent upon rickets.
2. Infantile and other forms of lower neuron paralysis causing weakness of the supporting muscles. Paralytic flat-foot.
3. Inflammatory conditions of the fasciæ and ligaments of the foot. Rheumatic and gonorrhœal flat-foot.
4. Disorganization of the joints of the foot. Tabetic flat-foot.
5. Weakness of the muscles following a prolonged illness as typhoid.

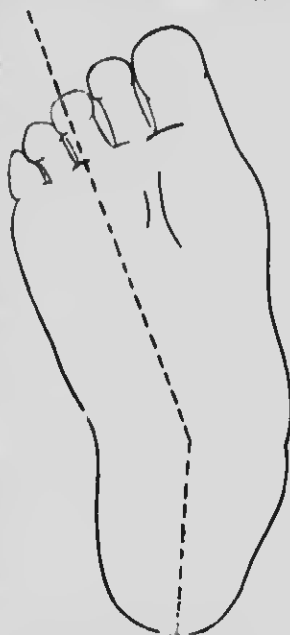


FIG. 117.—OUTLINE OF FLAT FOOT, SHOWING EVERSION AND ABDUCTION.

Increase in Weight borne :

1. Increase in the general weight of the body or the carrying of heavy weights.
2. Increase in the length of time the weight is borne, as in prolonged standing. Static flat-foot.

Alteration in the Application of the Weight :

1. Following injuries, especially Pott's fracture, in which the foot remains everted. Traumatic flat-foot.
2. Improper attitudes of standing and walking. If a person stands or walks with the foot turned out, the centre of gravity falls on the inner border of the foot, and tends to cause eversion. This eversion and abduction is, as has been shown above, the first change in the production of flattening of the arch, and if persisted in, flat-foot results.
3. Other deformities of the legs, especially genu valgum, in which the weight of the body is thrown inwards.

In many cases several of these causes of flat-foot operate at the same time. For example, a boy with ill-developed muscles and slight genu valgum is compelled to carry heavy weights, and to be on his feet for many hours a day.



FIG. 118.—OUTWARD DISLOCATION OF THE FOOT AS A RESULT OF POTT'S FRACTURE-DISLOCATION.

of the foot, and if an impress of the sole of the foot is taken, it is nearly normal. The patient should be made to stand with the toes pointing towards the surgeon, and it will then be seen that the foot

CLINICAL FEATURES.—For the sake of description, a case of adolescent or static flat-foot will be taken: The patient complains of pain in the foot, especially over the astragalo-scaphoid joint; the boots which previously fitted him are uncomfortable, and that he is developing corns. Pain may also be complained of in the calf or knee, and it is usually worse after the patient has been a long time on the feet. Occasionally it is worse after resting, the ligaments being stretched when the patient puts the weight of the body on them.

Stage 1.—If the patient is examined in an early stage, there is no loss of the longitudinal or transverse arches

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is slightly abducted and everted at the astragalo-scaphoid joint, and the internal arch of the foot is lost. The head of the astragalus is slightly prominent on the inner border of the foot.

Examination of the boots will show that the patient is wearing them more on the inner border than the outer. If allowed to stand at ease, he will stand with the foot turned out, and will also walk in this attitude.

This stage of flat-foot is termed the **weak foot**, and is of the utmost importance to recognize, as further progress of the deformity may be arrested by proper treatment.

Stage 2.—The eversion and abduction of the foot is still more marked, and both the longitudinal and transverse arches are flattened.



FIG. 119.—IMPRESS OF NORMAL FOOT.

FIG. 120.—IMPRESS OF EARLY FLAT-FOOT.

The internal concave arch is changed into a convexity, and the head of the astragalus is prominent on the inner side of the foot.

An impress taken of the foot will show that nearly the whole of the sole of the foot rests on the ground.

Examination of the boots shows wearing down on the inner side, and a bulge downwards and inwards of the waist of the boot. The patient stands and walks with the feet turned out and everted.

If the patient is seated, the loss of the arches is not so apparent, and the original shape of the foot can usually be restored by muscular contraction or manipulation.

In a certain number of cases the peroneal muscles will be in a state of rigid spasm, holding the feet in the everted position, and attempts to invert the foot will increase the spasm, and the patient will complain of pain over the peroneal tendons. This condition is called **rigid or spasmodic flat-foot**. It is especially common in cases associated with injury of the foot.

Stage 3.—In this stage there may be very little pain or disability, but the feet are very everted and abducted, and the gait very awkward, all the spring of the foot being lost. Pain may, however, be a prominent feature, and continue during the lifetime of the patient. The

longitudinal and transverse arches are quite lost, and the sole of the foot may even be convex on the inner border. The arches of the foot cannot be restored by muscular action or by manipulation, owing to the changes that have occurred in the shape of the bones and the articular surfaces. New articulations may be formed, the external malleolus articulating with the os calcis, and the scaphoid with the cuboid. Osteo-arthritic changes in the joints are common. Corns and bunions develop over the points of pressure. The deformity is easily recognized by examining the boots which are moulded to the shape of the feet.

Prophylaxis.—The prophylactic treatment of static flat-foot is adoption of proper methods of standing and walking, and the wearing of properly shaped boots. The patient should stand with the toes pointing directly forwards or if there is any tendency to flat-foot, slightly inwards. In walking, the chief movement should be from the hip, and the feet should be kept almost parallel to each other. The weight of the body should be received on the os calcis in order to avoid straining the arch, and then transferred to the heads of the metatarsal bones, especially the first, so that at the end of the step the foot is turned slightly inwards.



FIG. 121.—IMPRESS OF ADVANCED FLAT-FOOT.

A properly shaped boot for the prevention of flat-foot is as follows: The sole should be thick enough for protection, but flexible enough to allow the joints of the foot to move easily. It should be straight along the inner border, the waist stiffened to support the arch, and the heel flat and broad. The front part of the sole should be flat, so that the heads of the metatarsals and the toes rest firmly on the ground. The uppers should be flexible, and there should be plenty of room across the front of the boot.

The common defects of bootmaker's boots are—The front part of the boot is adducted and much too narrow, the waist is excessively hollowed, and the toes are crushed together by the "pointed toe."

TREATMENT—Stage 1.—The principles of treatment in this stage are—Rest combined with massage and exercise of the muscles of the foot and leg, the adoption of proper attitudes of standing and walking, and the wearing of special boots.

Rest is essential, as the cause of the loss of the arch is excessive strain thrown on the ligaments and muscles, and any occupation involving excessive standing must be given up. If this is not practicable, the patient must rest the feet as much as possible. Rest should be combined with massage and exercise to strengthen the muscles of the foot and leg. The two most useful exercises are raising the body on the toes with the feet adducted and alternately standing on the flat of the feet and the outer borders, also with the feet adducted. For outdoor exercise, bicycling is an excellent recreation, as the

muscles of the calf and feet are strengthened, while the weight of the body is taken off the feet. The patient should stand and walk in the manner described under Prophylaxis. The boots should be similar to those already described, but the heel should be carried forward on the inner side to support the waist of the boot, and the sole should be thicker on the inner than on the outer side, so that the weight of the body is thrown on the outer border of the foot, the patient standing and walking with the feet in a position of slight varus.

If the patient is compelled by his occupation to stand for many hours a day, the arch of the foot should be supported by pads or braces fitted in the boots; but in the early stages of flat-foot these should be avoided if possible.

Stage 2.—If there is spasm of the peroneal muscles, this *must be moved by rest* before any other treatment is undertaken. The best

method of giving complete rest to the foot is by putting the patient under an anæsthetic, and placing the foot in the overcorrected position—*i.e.*, adduction and varus—and maintaining this position by means of plaster bandages. The foot is kept in the overcorrected position until



FIG. 122.—ADVANCED FLAT-FOOT.

all spasm has disappeared, and other treatment is then commenced.

Massage, exercises, and special boots are as essential in this stage of the deformity as the first, and it will also probably be necessary to add lateral irons and a valgus T-strap to the boot to hold the foot in the position of varus when the patient stands.

A metal brace may also be used to remedy the deformity. A plaster cast is taken of the sole of the patient's foot when he is *not* bearing weight on it, and from this a metal brace is moulded. This supports the arch in the best possible position, and from time to time, as the deformity disappears, the brace is made more arched, until the original condition of the foot is restored.

Stage 3.—It has already been pointed out that when the foot is quite flat, all the pain may disappear, and beyond an awkward gait, the patient suffers no inconvenience. These cases are best left alone, as treatment to remove the deformity may result in a renewal of the pain. If treatment is necessary, owing to a continuation of the pain, the method of treatment given above should always be tried first, and persevered with for months. Operative treatment is unsatisfactory.

The operations performed consist of—(1) Excision of the astragalo-scaphoid joint and forcible correction, (2) supramalleolar osteotomy of the tibia and fibula, and inversion of the lower fragment so that the patient has to walk on the outer side of the foot. Neither of these operations is likely to be permanently successful, and they often completely fail to relieve the pain.

Flat-foot associated with a badly united Pott's fracture-dislocation may be remedied by an osteotomy and correction of the valgus deformity. If the deformity is associated with inflammatory conditions of the foot, as in gonorrhœal and rheumatic flat-foot, absolute rest in the corrected position until all inflammation has disappeared is essential before other treatment is commenced.

Paralytic cases are treated by the methods described under Infantile Paralysis (p. 287).

Deformities frequently associated with Flat-Foot

1. **Hallux Valgus.**—In this deformity the great toe is abducted to an exaggerated degree. It is usually caused by wearing ill-fitting boots, but it may follow amputation of the second toe for hammer-toe. As the phalanx is abducted on the head of the metatarsal bone, the articular cartilage is exposed on the inner side, and undergoes osteo-arthritic changes. A bursa develops over the prominent bone, and the skin over the bursa becomes thickened and callous. The prominent bone with the bursa and thickened skin form a "bunion." The other toes may be abducted with the great toe, or it may lie over or under them. The deformity is generally bilateral. The patient's chief complaint is of pain in the bunion, which may become inflamed and suppurate.

TREATMENT.—The patient should be provided with well-fitting boots that accommodate the deformity, and the condition of flat-foot, if present, should be treated.

Braces to hold the toe in the corrected position may be used, but, of course, a divided stocking and a special boot are necessary.

Boots can also be obtained containing a "toe-post," which prevents the abduction.

Operative Treatment.—(a) Removal of the superfluous bone on the inner side of the joint together with the bunion.

(b) Excision of the head of the metatarsal bone and formation of a new joint.

(c) Cuneiform osteotomy of the neck of the metatarsal bone.

The second of these operations gives excellent results.

2. **Hallux Rigidus.**—The patient complains of pain and swelling in the metatarso-phalangeal joint of the great toe, and on examination, the joint is held rigid and slightly flexed. Dorsiflexion is painful and limited.

The condition is a peri-arthritis, and is usually due to excessive strain thrown on the joint by developing flat-foot. The changes the joint undergoes are similar to those found in osteo-arthritis.

TREATMENT.—The treatment is that of flat-foot with protection of the inflamed joint.

3. Hallux Flexus.—This is an advanced degree of hallux rigidus, the metatarsal joint sometimes being flexed to a right angle.

TREATMENT.—The treatment for flat-foot is carried out, and the flexed toe accommodated for in the boot; but if a severe degree of flexion is present, excision of the joint is necessary.

4. Overlapping Toes.—These are associated with flat-foot and ill-fitting boots, though in some cases the condition appears to be congenital. The little toe is the one most frequently affected. The condition can often be relieved by the use of a sole-plate with tapes to hold the toes in position. If corns, bunions, or ingrowing toe-nails are present, the toe may be amputated with advantage.

5. Anterior Metatarsalgia (Morton's Disease).—The patient complains of sudden cramplike pains in the space between the third and fourth toes. The pain is induced by slight causes, such as slipping or stubbing the toes, and is generally relieved by taking off the boots and resting. The condition is most common in patients over thirty, who have a mild degree of flat-foot, and is mostly unilateral.

Examination of the foot will show that the fourth metatarsal phalangeal articulation is painful, and there are usually callosities on the foot under the heads of the metatarsal bones. The cause of the pain is believed to be due to flattening of the anterior metatarsal arch (see p. 292), the digital nerves being nipped between the heads of the metatarsals and the ground; or the pressure may be lateral between the heads of two metatarsal bones.

TREATMENT.—The flat-foot should be treated and the depressed heads of the metatarsal bones accommodated for in a boot. A brace, which should support the arch and also the fourth metatarsal bone, is sometimes necessary. A strip of plaster applied round the anterior end of the foot may relieve the pain while walking.

Many cases are unbenefited by any kind of mechanical treatment, the attacks of pain recurring at more and more frequent intervals. In this case cure of the condition may follow excision of the head of the metatarsal bone, and removal of a portion of the digital nerves; but even this treatment is not necessarily followed by relief.

Hammer-Toe

Hammer-toe usually affects the second toe, and is often bilateral. It appears first about puberty, though many cases are congenital in origin, and it may be found in several members of the same family. It is possible that some cases are acquired through wearing too short boots.

DEFORMITY.—The metatarsal-phalangeal joint is hyperextended, the first interphalangeal joint is strongly flexed, and the second hyperextended. A bursa covered by a corn is often present over the first interphalangeal joint, and corns develop under the head of the metatarsal bone in the sole of the foot and over the extremity of the toe.

The nail is deformed. The chief complaint is of pain in the corns, which may become inflamed and suppurate.

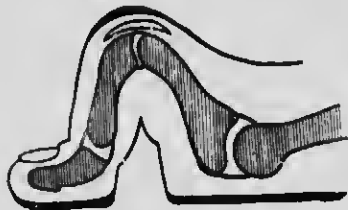


FIG. 123.—DIAGRAM OF HAMMER-TOE.

TREATMENT.—In childhood the deformity may be treated by manipulation and the wearing of a sole-plate with a strap holding the toe in position. If the condition is advanced, the toe may be amputated or straightened. An excellent operation for straightening a bad degree of hammer-toe is—Excision of the corn and bursa over the first interphalangeal joint, excision of the head of the first phalanx, tenotomy of the extensor and flexor tendons, and a plastic operation for lengthening the skin on the under surface of the toe.

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CHAPTER X
INJURIES AND DISEASES OF THE BLOODVESSELS

INJURIES

INJURIES OF ARTERIES

Contusions.—A contusion of an artery is due to a direct blow or crush, and the effects vary with the severity of the injury and the condition of the vessel. Healthy arteries, owing to their muscular and elastic structure, are very tolerant of injury, and no harm may follow even a severe contusion; but if the wall of the artery is atheromatous, thrombosis may result. Should the vessel be one of the main arteries, thrombosis following contusion may lead to gangrene of the extremity, although the injury may have been slight. In some cases a contusion may so weaken the vessel wall as to lead to the formation of an aneurysm.

There is no treatment for contusion of arteries.

Subcutaneous Rupture.—Subcutaneous rupture of an artery is due to blows and strains, and usually occurs in arteries whose walls are weakened by atheroma or calcification of the middle coat. It frequently occurs with fracture of a bone, and may be produced by attempts to reduce an old dislocation, especially of the shoulder-joint, the axillary artery being fixed by adhesions.

The rupture may be partial or complete.

1. **PARTIAL SUBCUTANEOUS RUPTURE.**—When an artery is partially ruptured, it is generally the inner and middle coats which give way, the outer coat remaining intact. The elastic and muscular inner and middle coats retract and curl up inside the vessel, partially occluding its lumen, and a thrombus forms at the site of the injury. If the injury is slight, the thrombus will be small, and will not occlude the lumen; but the weakened part of the arterial wall may give way under the blood-pressure, and an aneurysm result.

SYMPTOMS.—The symptoms of this condition are those due to occlusion of the artery, and if this vessel be a large one, the part below becomes white, cold, and powerless, and pulsation is lost at first in the distal vessels. As the collateral circulation is restored, the pulsation returns, and recovery may be complete; but if the arteries are diseased, gangrene of the extremity may follow.

TREATMENT.—The limb should be carefully cleaned, dried, and wrapped up in gauze and cotton-wool. It should be placed at rest

in a position of slight elevation, so as to favour the venous return without interfering markedly with the arterial supply. It should be kept in this manner until the collateral circulation is fully established, and must be carefully watched for the onset of gangrene, which will require the usual treatment (see p. 160).

2. COMPLETE SUBCUTANEOUS RUPTURE.—Subcutaneous rupture of all the coats of an artery is followed by extravasation of blood into the tissues, leading to marked swelling, a condition spoken of as "**diffuse traumatic aneurysm.**" The divided ends of the vessel communicate with a mass of blood-clot, lying in the tissues, and there is no limiting sac. The swelling usually occurs immediately after the injury, but if shock is severe, it may come on later (see *Intermediary Hæmorrhage*).

SYMPTOMS—Local.—The limb is greatly swollen, and is blue, congested, and œdematous, owing to the mass of blood pressing on and obstructing the veins. Blebs containing blood-stained serum frequently form under the epidermis, and the limb is cold and powerless. Pulsation is lost in the distal vessels. In some cases a bruit may be heard over the swelling, which may pulsate synchronously with the heart; but this is not usual, and the pulsation is always lost when the swelling is extreme.

The *General* symptoms are those of shock and loss of blood.

RESULTS.—

1. The ends of the divided vessel may become occluded, the blood-clot absorbed, and the vitality of the limb restored by the formation of a collateral circulation. This may result in complete recovery, or the limb may always remain more or less ill-nourished.
2. The blood-clot may become circumscribed by the formation of fibrous tissue at the periphery, but the lumen of the artery may not be closed, and a *localized traumatic aneurysm* result.
3. The extravasated blood may be localized, and the clot absorbed, but the serum remain as a blood-cyst, which will steadily increase in size.
4. Pyogenic organisms may invade the blood-clot, and suppuration result. The swelling shows all the characteristics of a large abscess, and if efficient treatment is not carried out, bursting of the abscess and secondary hæmorrhage are to be feared.
5. The occlusion of the main artery, together with the pressure on the surrounding arteries and veins, may completely cut off the blood-supply to the distal part of the limb, and gangrene, usually of the moist variety, will result.
6. Steady increase in size of the swelling until the skin ruptures or sloughs, a condition which frequently results in fatal hæmorrhage.
7. Death from hæmorrhage, especially if the vessel has ruptured into one of the large cavities of the body, such as the peritoneum or the pleura.

TREATMENT.—In the case of rupture of one of the smaller arteries without excessive swelling, the treatment is expectant. The limb should be elevated, dried, wrapped in gauze and wool, and slightly elevated until the blood-clot is absorbed and the collateral circulation completely established.

When one of the large arteries is ruptured, or the extravasation is excessive, no time should be lost in treating the case as one of external hæmorrhage—*i.e.*, cutting down and tying the bleeding-points. A tourniquet should be applied, and a free incision made into the part as if to tie the vessel in continuity. The blood-clot should be removed, both ends of the artery found and secured with ligatures, and the wound closed in the usual way.

If suppuration occurs, the same treatment is carried out; but owing to the sloughing condition of the tissues, it may not be possible to ligature the vessel in the wound, and the artery must be secured above the site of rupture, or the wound firmly packed with gauze. In some cases amputation will be the proper treatment. Gangrene and the other results demand the usual treatment.

WOUNDS OF ARTERIES

Wounds of arteries may be punctured, incised, or lacerated.

Punctured Wounds are produced by stabs, and if the instrument is a fine one, such as a needle, no extravasation of blood will occur, and no treatment is necessary. A larger punctured wound will gape, and bleeding occur, and owing to the retraction of the coats of the artery, the hæmorrhage may continue and threaten life. In the majority of cases, however, healing of the wound takes place, and a weak place is left in the arterial wall, which later may be followed by the development of an aneurysm.

TREATMENT.—The wound in the tissues should be enlarged, and the artery exposed. If the vessel be a large one, the puncture should be closed with fine Lembert sutures introduced on a fine rounded needle, smeared with vaseline; but in the case of the smaller arteries, the vessel should be ligatured above and below the puncture, and then divided. In cases where the punctured artery is very deeply situated, the hæmorrhage may be arrested by pressure, but this method of treatment is likely to result in the formation of an aneurysm.

Incised Wounds.—In incised wounds the artery may be completely or incompletely divided. If the vessel is completely severed, the main symptom is hæmorrhage, and the amount of blood-clot depends upon the size of the vessel which is divided and the treatment adopted. This condition has been considered under Hæmorrhage (p. 191).

When a vessel is incompletely divided, the amount of hæmorrhage largely depends on the nature of the incision. If the incision is clean-cut and in the long axis of the vessel, very little hæmorrhage results, and the wound will readily heal, leaving, however, a weak place in the arterial wall. When the incision is transverse or oblique, the retraction of the muscular middle coat causes the wound to gape, and

as the coagulation of the blood does not completely fill the vessel, the blood-flow is not arrested, and the clot is constantly being washed away. Under these circumstances bleeding may be continuous from a very small artery, and life be threatened from hæmorrhage.

TREATMENT.—The treatment of complete division of an artery is to secure both ends of the bleeding vessel, but in the case of large arteries an attempt may be made to restore the continuity of the vessel. This may be done either by end-to-end anastomosis, or by suturing the proximal end into the side of the distal portion. This operation requires special needles and sutures and an elaborate technique, but in some cases the suture has been successful.

Incomplete incised wounds can be sutured if a main vessel is involved, but in the majority of cases the artery should be completely divided and the two ends ligatured.

In the case of a small branch which has been divided close to a main branch, the bleeding may be severe owing to the high blood-pressure, and it may not be possible to secure the vessel with a ligature owing to the shortness of the proximal portion. The main vessel in these cases must be ligatured above and below the small branch.

Lacerated Wounds.—Laceration of large arteries is most commonly seen in severe accidents, due to machinery, being run over, etc. The vessel is usually crushed or twisted as well as being torn across, and hæmorrhage is seldom severe, owing to the contraction and retraction of the coats and the rapid coagulation of the blood. A large artery, such as the popliteal, may be completely torn across, and very little hæmorrhage occur, and the condition only recognized on careful examination of the wound.

TREATMENT.—The treatment consists of the aseptic treatment of the wound, and the ligature of the vessel if necessary. These wounds are very liable to suppurate, and in the case of laceration of the main vessel of a limb, the question of primary amputation should always be considered (see p. 160).

INJURIES OF VEINS

Veins are liable to the same injuries as arteries, and the effects of injury are very similar, except that venous hæmorrhage is more easily arrested than arterial.

Subcutaneous Rupture.—This is common in fractures, and attempts to reduce old dislocations. The limb becomes swollen and œdematous, and the skin discoloured, this discoloration only appearing after two or three days in the case of the deep veins. The swelling is, as a rule, much less in the case of veins than arteries, and the pulse beyond the site of the injury is not altered to any extent. Gangrene following the subcutaneous rupture of a vein is very rare. Rupture of a subcutaneous vein in the leg, especially if the veins are varicose, is not uncommon, and may occur apparently spontaneously. There is extreme discoloration of the limb, which is swollen and painful.

Infection by pyogenic organisms and suppuration may occur, and in other cases a blood-cyst forms.

TREATMENT.—In the majority of cases the only treatment required is rest, with moderate elevation of the limb, followed by massage to promote absorption of the extravasated blood.

In the case of spontaneous rupture of a large vein, such as the popliteal or the axillary, the vein should be cut down upon, the clot removed, and the two ends of the vein ligatured.

Open Wounds of Veins.—These wounds are similar to those occurring in arteries. In the case of punctured or incomplete incised wounds of veins, the opening can be sutured, or a lateral ligature applied if the vein is an important one; but in the majority of cases the vein should be divided, and the ligature applied to both ends.

Entrance of Air into Veins.—The entrance of a small quantity of air into a peripheral vein is not necessarily attended with any ill-consequences, the danger of the accident depending on (1) the amount of air entering, (2) the speed with which it enters, (3) the distance of the vein from the heart. In performing intravenous saline infusion into the median basilic vein, small quantities of air frequently enter the circulation without ill-effects.

This condition of air embolism is most frequently seen in wounds of the great veins of the neck and axilla, the air being sucked into the vein by the negative pressure in the thorax during inspiration; but it may follow entrance of air into the pelvic veins or the veins of the extremities.

SYMPTOMS.—The symptoms of this accident are a characteristic hissing noise as the air enters, followed by collapse of the patient. The heart's action is embarrassed and irregular, the pulse feeble, the respiration laboured, and the patient becomes pale and cyanosed. These symptoms have been put down to air embolism in the vessels of the brain or of the lungs, but they are most probably due to frothing of the blood in the right auricle and ventricle. This frothed blood interferes with the action of the valves, and the circulation immediately becomes embarrassed. The condition may be rapidly fatal, but if recovered from, no ill-effects are left behind.

TREATMENT—Prophylaxis.—During operations on the neck and axilla, in which the great veins are exposed, the wound should as far as possible be kept filled with warm normal saline fluid, so as to prevent entrance of air if the vein is wounded. An opening in one of the veins should be promptly closed with the finger, and a ligature applied as soon as possible.

Directly the characteristic noise of air entering a vein is heard, the wound in the vessel should be closed by digital pressure, and the vein ligatured, so that further entrance is prevented.

The patient's head should be lowered, and strychnine injected subcutaneously to stimulate the heart's action, the heart failure in this case not depending on exhaustion of the nerve centres.

Puncture and aspiration of the right auricle, or catheterization of the right auricle through the internal jugular vein, and aspiration have been advised but are rather drastic measures, and should be reserved

for cases that are desperate. Stimulation of the vagus by electricity may do good.

Opinions are divided as to the value of artificial respiration in this condition, some surgeons advising this as the most efficacious method of treating air embolism, whilst others denounce it as dangerous. The balance of opinion is in favour of this method of treatment, and it is not likely to cause harm if the vein by which the air entered has been securely closed.

DISEASES OF THE BLOODVESSELS

INFLAMMATION OF ARTERIES

1. Infective (Septic) Arteritis.—This condition may arise in one of two ways: (1) The artery is infected with the other tissues in a septic wound, and undergoes the usual changes that end in suppuration. A thrombosis as a rule forms in the artery before it breaks down into pus and prevents hæmorrhage, but in rapidly spreading suppuration—and especially if a large artery is involved—secondary hæmorrhage may occur (see Secondary Hæmorrhage, p. 184). (2) In cases of general pyæmia, particularly if associated with ulcerative endocarditis, an infective embolus may become lodged in one of the vasa vasorum, and produce a secondary focus of inflammation. This inflammation may terminate in suppuration, and a secondary pyæmic abscess occur in the vessel wall; or if the inflammation is not so severe as to terminate in this way, softening of the wall of the vessel and the formation of an aneurysm may follow. This arteritis, due to infective emboli, is the common cause of aneurysm in young subjects.

TREATMENT.—The treatment of these conditions is the treatment of a septic wound or of a secondary pyæmic abscess.

2. Tubercular Arteritis.—The changes that occur in arteries, due to infection by the tubercle bacillus, are similar to those that occur in other tissues, and the usual formation of giant cell systems takes place. From the surgical point of view the most important result is the weakening of the vessel's wall and the formation of an aneurysm. These aneurysms are usually quite small, but rupture with severe hæmorrhage may result, and is the usual cause of the severe hæmoptysis in cases of tuberculosis of the lungs.

Syphilitic Arteritis.—The most characteristic change in the bloodvessels due to syphilis is a multiplication of the cells of the tunica intima, so that the lumen of the vessel becomes gradually obliterated (endarteritis obliterans). The media and the adventitia at the same time become fibrosed, so that the vessel is harder than usual and cannot dilate. This change is seen in the vessels of all local lesions of syphilis in all stages of the disease, or it may occur independently as a primary disease of the bloodvessels. Endarteritis obliterans is most frequently seen in the smaller arteries of the brain and spinal cord, and results in various paralyses due to degeneration of the nerve tissue supplied by the vessels; but the change may also occur exten-

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sively in the vessels of the limbs, and lead to gangrene from slow obliteration of the blood-supply (see Gangrene, p. 158).

TREATMENT.—Energetic antisyphilitic treatment should be carried out as soon as the disease is diagnosed.

Arterio - Sclerosis (Atheroma, Chronic Arteritis).—The disease which goes under these names is a chronic degeneration of the arteries which tends to occur in all people over middle life, and a slight degree of it may be considered as a normal consequence of advancing years. When it is pathological, it is due to (1) chronic intoxications, such as syphilis, alcoholism, lead-poisoning, chronic nephritis, dia-

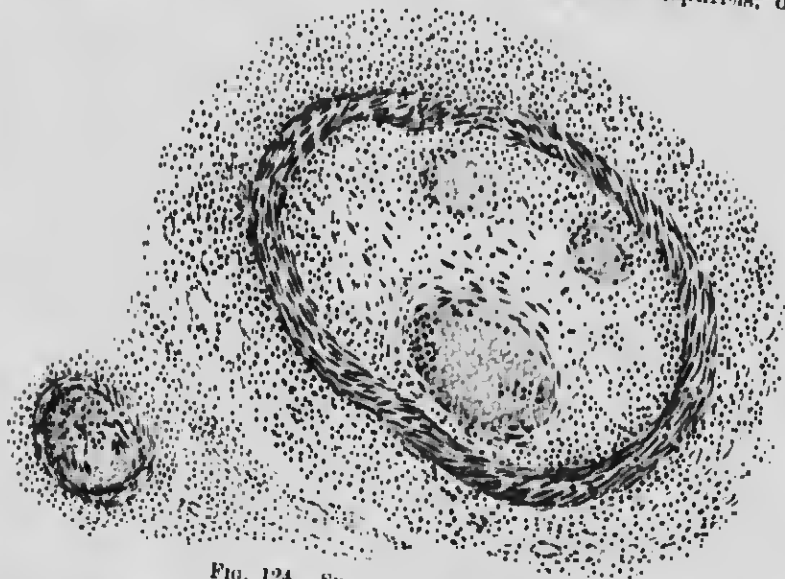


FIG. 124.—SYPHILITIC ARTERITIS.

betes; (2) frequent increased arterial tension due to excessive muscular strain, over-anxiety, sexual excess; (3) infective processes, such as typhoid and rheumatism.

The disease is probably primarily a degeneration of the muscular coat of the arteries with an attempt at compensation by thickening of the intima and adventitia, which terminates in these coats also degenerating. The disease may affect the majority of the small arteries—**diffuse arterio-sclerosis**—or may be spread in patches over the larger arteries, and it is the latter condition that chiefly concerns the surgeon, as it is one of the most potent factors in the production of an aneurysm. In the early stages of the disease there is a hyaline degeneration of the muscular coat, and opposite these areas of degeneration there is a proliferation of the endothelial cells of the intima, so that a small nodule appears on the inner wall of the artery; this nodule is yellow in colour owing to fatty degeneration of the endothelial cells. Fibrosis of the middle and inner coats may occur, or

the degenerated endothelial cells may die and form a soft semifluid mass in the wall of the vessel.

This atheromatous "abscess" may burst into the lumen of the vessel and the degenerated cells be swept away and an atheromatous "ulcer" - salt, or salts may be deposited in the intima and a calcareous plate form in the walls of the vessel, which may subsequently become detached and form an embolus.

The diseased vessel wall is likely to give way under the arterial pressure and an aneurysm result at one of two stages of this degenerative process: (1) When the muscular coat has degenerated and the compensatory thickening of the intima is not marked; (2) after degeneration of the newly formed endothelial cells and the formation of an atheromatous "ulcer."

Another surgical condition due to atheroma is gangrene from gradual obliteration of the lumen of the vessels, and it is this change in the arteries that is largely responsible for senile gangrene.

TREATMENT.—The treatment of this disease is entirely medical, and consists of lowering the arterial tension and treating any cause of chronic intoxication.

DEGENERATION OF ARTERIES

Primary Calcareous Degeneration.—This degeneration is met with in elderly people, and consists of a deposition of calcareous salts in the muscular coats of the arteries of the limbs. As a result, the arteries become hard, tortuous, and brittle (pipe-stem arteries), and the patient has symptoms of defective blood-supply to the extremities. The arteries are liable to rupture during manipulations to reduce old dislocations in elderly people if too much force is used, and the condition also favours senile gangrene; but as the arteries are made firmer by the deposition of the calcareous salts, aneurysm is not likely to result.

There is no treatment for this condition, but every care should be taken to avoid slight injuries to the extremities in elderly people, so that senile gangrene does not occur.

Fatty Degeneration.—This condition is commonly seen in the aorte of the middle-aged, and has no surgical interest.

Amyloid Degeneration (Lardaceous Disease).—This degeneration starts in the middle coats of the smaller arteries, and has been described on p. 75.

Thrombosis

Thrombosis is a term used to denote the formation of a blood-clot in a vessel, the clot being termed a "thrombus." This clotting of the blood is brought about by several factors, the most important being (1) inflammation of the lining endothelium of the bloodvessels; (2) slowing of the blood-stream.

When a thrombus forms in a bloodvessel, the flow of blood through it ceases, and gangrene of the part below may occur if the vessel is

the principal artery of the limb (see Gangrene); but usually a collateral circulation is established, or the thrombus may be disintegrated, and the lumen of the vessel again become free. If a thrombus remains in the vessel, and is aseptic, it undergoes organization, and the lumen of the vessel is obliterated by fibrous tissue, or if it is in a vein, calcareous salts may be deposited in it, and a phlebolith result. These phleboliths frequently give rise to difficulties in the X-ray diagnosis of calculi in the urinary tract.

If the thrombus is infected by pyogenic bacteria, pus is formed and an abscess results, and small pieces of the infected thrombus may be carried by the blood-stream as septic emboli, and give rise to abscesses in distant parts of the body (septicopyæmia).

Embolism

An embolus is a term applied to any body, such as a piece of blood-clot, a calcareous plate in atheroma, or a fragment of new growth that is carried free in the blood-stream, and when it becomes arrested in one of the smaller arteries or capillaries the process is spoken of as "embolism." If an embolus is aseptic, the only result is blocking of the artery in which it is impacted, and possibly gangrene of the part supplied by the vessel; but if it is infected, a pyæmic abscess will result, or a softened spot occurs in the vessel wall, and an aneurysm results from the blood-pressure. Emboli composed of the cells of malignant growth are the cause of secondary deposits in the tissues away from the original tumour.



FIG. 125.—EMBOLUS AT THE BIFURCATION OF THE AORTA.

(London Hospital Medical College Museum.)

ANEURYSM

An aneurysm is a dilatation of the whole or part of the walls of an artery so that a tumour is formed filled with blood, which communicates with the lumen of the vessel.

CAUSE.—The causes of aneurysm are (1) weakness of the vessel wall, and (2) increase in the blood-pressure.

1. *Weakness of the Vessel Wall.*—This weakness is usually due to atheroma of the vessel, and aneurysms are most frequently found in elderly people suffering from this disease; but it may be due to injury of the vessel, either by a contusion or a stab which heals by scar tissue, or to an infective embolus leading to arteritis but not causing suppuration. Syphilis and tubercle

both predispose to the formation of an aneurysm by causing inflammation of the vessel walls. Aneurysm does not often occur in patients with primary calcification of the middle coat of the arteries unless it is combined with injury.

2. *Increase of Arterial Pressure.*—

The usual cause of increase of arterial pressure is increased action of the heart, and conditions that bring this about predispose to aneurysm. The most important are excess of alcohol, sexual excess, hard muscular work—especially if intermittent—and over-excitement; and one of these factors is usually present in a case of aneurysm. In many cases several of these factors are combined, and it is to be noted that these causes also bring about degeneration of the vessels; for example, alcoholic excess not only increases the force of the heart-beat and raises the blood-pressure, but brings about the degeneration of the vessels from chronic intoxication. At the same time it causes degeneration of the kidneys, and this again results in an increase of blood-pressure. The increased peripheral resistance that occurs in atheroma also raises the blood-pressure, and so a vicious circle is established, the atheroma raising the blood-pressure, and this in its turn leading to further degeneration of the artery and increasing the liability to aneurysm.



FIG. 126.—ANEURYSM OF THE AORTA, WITH LAMINATED CLOT. (London Hospital Medical College Museum.)

STRUCTURE.—When an aneurysm is first formed, its walls consist of all the coats of the artery except the thin endothelial lining, which may be absent when the aneurysm is situated at the site of an atheromatous "ulcer," but as it increases in size it is impossible to make out any of the original coats of the vessel, and the wall is formed of fibrous tissue produced by the irritation of the surrounding tissues by the increasing swelling. As the aneurysm increases in size the surrounding structures, nerves, muscles, vessels, etc., are matted up in

the fibrous tissue and form part of the walls of the sac; or if the aneurysm is situated near a bone, the bone forms part of the wall, and becomes bare and eroded.

The blood in a small aneurysm is fluid, but as the sac increases in size clotting of the blood occurs. The clot is at first red and soft, but as it grows older it contracts and is pressed out under the blood-pressure so that it comes to form a thin layer on the wall of the sac; this process continues, and the sac becomes filled more or less with successive laminæ of clot, the oldest being against the wall of the sac. The older laminæ are pale yellow in colour, and are much tougher than the red recently formed laminæ.

VARIETIES.—Aneurysms are divided into—(1) fusiform; (2) sacculated; (3) dissecting.

1. A **Fusiform Aneurysm** is present when the whole circumference of the artery is dilated so that the swelling is more or less spindle-shaped. This variety of aneurysm is most commonly seen in the arch of the aorta, but it may occur in any of the large arteries, and is usually associated with general atheroma. These aneurysms grow very



FIG. 127.—FUSIFORM ANEURYSM.

slowly, and in the aorta may reach enormous dimensions, and cause serious pressure effects. When situated inside the thorax, they are very difficult to diagnose, although the use of the X rays has now made the diagnosis much easier, and they are of little surgical interest, as natural cure never occurs, and the condition is not amenable to surgical treatment. When situated in the other large arteries, the diagnosis and treatment is the same as for the more common sacculated variety. In some cases a saccular aneurysm becomes grafted on to a fusiform one by dilatation of part of the wall. This usually leads to a rapidly fatal result. Such aneurysms are sometimes termed **mixed**.

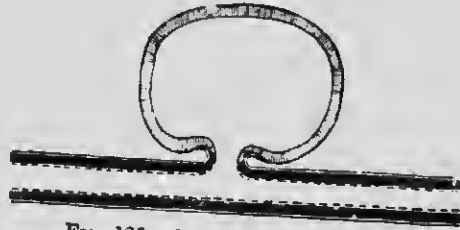


FIG. 128.—SACCULATED ANEURYSM.

2. A **Sacculated Aneurysm** is due to a dilatation of part of the wall of the vessel so that a sac is formed communicating with the vessel by a small opening. The sac is roughly globular in form, but its shape is modified by the resistance offered by the surrounding structures. These aneurysms are formed in any of the large vessels, and are the variety that most frequently come under the care of the surgeon. Their growth is as a rule much more rapid than the fusiform variety, and rupture of the sac frequently occurs, forming a **diffuse aneurysm**.

3. Dissecting Aneurysm.—This variety of aneurysm is mostly found in the aorta, and is more common in women than in men. It has no clinical importance, as it cannot be diagnosed before autopsy. It is formed by the blood being forced between the coats of the artery through an atheromatous patch. The line of cleavage of the coats is through the media, so that half this coat goes with the adventitia and half with the intima, and the blood lies in a cul-de-sac. It may ultimately find its way back into the vessel through a second atheromatous patch lower down, or it may become diffuse and leak into the surrounding tissues. As the condition cannot be diagnosed, there is no treatment.

CLINICAL FEATURES OF ANEURYSM.—Aneurysms are more common in men than in women, and are chiefly seen in elderly men who are engaged in occupations requiring great muscular effort. They, however, frequently occur in men who lead sedentary lives and then suddenly indulge in some violent form of exercise. A history of syphilis, alcoholism, or injury is often present.

SYMPTOMS.—The symptoms and physical signs of an aneurysm may be divided into two groups: (1) The signs due to the presence of a swelling in communication with an artery—*intrinsic signs*; (2) the signs due to presence of a tumour or surrounding structures—*extrinsic signs*.



FIG. 129.—DISSECTING ANEURYSM.

1. Intrinsic Signs.—There is a tumour situated in the course of an artery, irregularly globular in shape, with a diffuse outline and an *expansile* impulse synchronous with the heart-beat. The tumour is tense and cystic to the touch, and may fluctuate. When the artery above the tumour is compressed, the pulsation ceases, and the swelling is diminished in size and may be still further emptied by gentle pressure. On releasing the pressure above, the tumour fills up in two or three beats of the heart, and resumes its former size. If pressure is made on the artery below the tumour, it becomes more tense. On listening over the tumour, a distinct *bruit* is heard, synchronous with the heart-beat, and this is accompanied by a *thrill*.

2. Extrinsic Signs.—The *pulse* beyond the aneurysm is smaller and less forcible than on the opposite side, and is delayed in time, being absent in some cases. The *veins* are dilated and congested, and there is frequently œdema of the part below the aneurysm. The *nerves* are pressed on, causing neuralgic pain, weakness, spasm, or paralysis of the muscles, with wasting. The *muscles* are displaced and wasted, and the *bones* are compressed, causing constant pain, which is worse at night, and finally they become eroded. The *joints* may be disorganized, and the various canals of the body, such as the œsophagus or trachea, may be compressed and obstructed. The heart is usually hypertrophied, and the vessels atheromatous. Embolism from portions of clot escaping from the sac may occur. If the

aneurysm is situated on the main vessel of a limb, it may lead to gangrene of the part below.

The DIAGNOSIS must be made from—(1) A tumour situated near an artery; (2) an artery pushed forward by a tumour; (3) an extremely vascular tumour.

(1) A tumour over an artery has a heaving, but not an expansile, pulsation, and this pulsation is often only felt in part of the tumour or in certain positions of the limb. It may also be possible to lift the tumour away from the artery, and then its pulsation ceases. If the artery is compressed above such a tumour, the tumour does not shrink in size, neither can it be emptied by pressure.

(2) An artery pushed forward by a tumour on superficial examination may be taken for an aneurysm, but on careful examination it will be seen that the pulsation is only in the line of the artery, and that the tumour lying below does not pulsate.

(3) An extremely vascular new growth may pulsate, and the pulsation will be expansile, but on compression of the artery supplying the growth, the tumour will not appreciably diminish in size, and on releasing the pressure the tumour at once returns to its former condition, and does not definitely *fill up* in a given number of beats. The X rays are also useful in differentiating the pulsating tumours of bone from aneurysm.

RESULTS—1. SPONTANEOUS CURE.—Cure of an aneurysm means that the sac becomes filled with clot, and the portion of the artery opposite the mouth of the opening of the aneurysm becomes occluded. This may occur naturally in the following ways:

(a) The sac is gradually filled with laminated clot, and the mouth of the aneurysm is closed. The tumour becomes smaller and harder, the pulsation is less marked, and the bruit and thrill are gradually lost. The extrinsic signs also become less evident or disappear, and the aneurysm changes into a mass of fibrous tissue situated in the course of an artery.

(b) A piece of the clot from the aneurysm escapes into the vessel and lodges as an embolus just below the mouth of the sac. Thrombosis of the vessel, and then coagulation of the blood in the aneurysm, occurs, and cure follows with organization of the clot. In these cases the signs of aneurysm suddenly disappear, and the tumour rapidly shrinks. If the collateral circulation is quickly established, no harm may result, but rapid spontaneous cure may be followed by gangrene of the part below.

(c) Increase in size of the aneurysm may lead to pressure on the vessel above or below the mouth of the opening, and the artery may become obliterated.

(d) Inflammatory conditions, not ending in suppuration round the aneurysm, may lead to thrombosis of the artery, and cure result.

2. RUPTURE, which may be sudden or gradual (leaking). If an aneurysm ruptures into one of the body cavities, the symptoms will

be sudden pain, followed by the signs of internal hæmorrhago, and death may occur in a few minutes. Rupture into the stomach will cause profuse hæmatemesis, and into the lungs profuse hæmoptysis. In the more strictly surgical aneurysms, rupture occurs into the tissues, and the extravasation of the blood may take place quickly or slowly.

The signs of subcutaneous rupture are—Sudden increase in the size of the tumour, which grows more indefinite in outline; loss of pulsation; and œdema of the skin. In a short time the part becomes red and painful, and if fluctuation is present, it may be very difficult to distinguish the condition from an abscess. If the extravasation of the blood is excessive, pulsation is lost in the vessels below the aneurysm, the part is insensitve from pressure on the nerves, and gangrene frequently occurs. The general signs of internal hæmorrhage will also be present.

When extravasation occurs slowly (leaking), the tumour gradually enlarges, and the pulsation becomes less marked, but the blood may track a considerable distance before it is evident. Thus in one case a retropharyngeal collection of blood was opened in mistake for an abscess, and the condition was found to be a leaking carotid aneurysm; whilst in another a lumbar swelling was opened in mistake for a psoas abscess, and the real condition was a leaking aneurysm of the splenic artery. The extravasated blood, both in acute rupture and in leaking, may become infected, and suppuration follow.

3. SUPPURATION.—Suppuration may occur round an aneurysmal sac due to invasion of the tissues by pyogenic organisms. It is more likely to occur if the aneurysm is leaking. The tumour is increased in size from inflammatory œdema, but less definite in outline, and the pulsation, thrill, and bruit, are all less marked. The part is hot, red, and painful, and the patient shows the general symptoms of infection.

If the condition is left alone, the pus finds its way to the surface and bursts, and there is a discharge of pus and blood-clot, usually followed by a fatal hæmorrhage or septicæmia.

In a few cases the vessel may be thrombosed, and suppuration result in natural cure. The signs of suppuration, both local and general, and rupture are very much alike, but it may be generally stated that the symptoms of suppuration are much more severe.

TREATMENT.—The treatment of aneurysm is both general and local.

1. GENERAL TREATMENT.—The aim of general treatment is to reduce arterial tension, and to favour the coagulation of the blood in the sac. The arterial tension may be lowered by lessening the force of the heart's beat and diminishing the total quantity of blood in the vessels. The first of these indications is met by absolute rest, physical, mental, and emotional. The patient should be kept in bed at complete bodily rest, everything being done for him, and opium should be given to relieve the pain and allay restlessness. The total quantity of blood in the tissues should be lessened by giving him

a dry and restricted diet, and if he is very plethoric, by purging and venesection. This treatment should be carried out carefully, or the discomfort caused may produce restlessness and worry.

It is possible that the plasticity of the blood may be increased by giving such drugs as iodide of potassium, calcium lactate, acetate of lead, and perchloride of iron, but it is extremely doubtful if these drugs are of any value.

The general treatment of aneurysm should never be omitted, even if active surgical methods are also used, and in some cases of internal aneurysm reliance must be placed solely on the general treatment.

2. LOCAL TREATMENT.—Judging by previous hospital records, surgical aneurysm was formerly a common complaint, whilst at the present time it is one of the rarer conditions met with in surgical practice, and many of the older methods of local treatment are never used at the present time. This applies particularly to the various methods of compression, which are quite obsolete and will not be considered.

(1) *Matas' Operation: Reconstruction Endo-Aneurysmorhaphy.*—This operation consists of restoring the lumen of the vessel, and obliterating the aneurysmal sac by suturing it in pleats. The operation requires an elaborate technique, and is only suitable for small aneurysms.

(2) *Excision of the Aneurysm.*—This operation, which is at present the operation of election, can be combined with end-to-end suture of the divided artery, the artery being only temporarily occluded during excision of the sac; or the proximal and distal ends of the artery may be tied. This operation brings with it much less risk of gangrene than Hunter's operation, as there is only one block in the circulation, and only one collateral circulation to be established. A tourniquet should be applied to the limb, and the artery supplying the aneurysm and all the vessels coming off from the sac should be tied. The aneurysm should then be excised without opening it, if possible, and the wound closed in the usual way. Care should be taken that the accompanying vein is not injured, and if it is cut, the hole should be sown up. If the wall of the sac is closely adherent to important structures, such as large nerves, it is better to leave a portion of the sac rather than risk serious damage.

(3) *Operation of Antyllus.*—The artery is ligatured above and below the aneurysm, which is then opened, all the blood-clot and part of the sac removed, and the wound closed. This, "the old operation," is rarely used now unless suppuration has occurred in the sac.

(4) *Anel's Operation.*—The vessel is ligatured on the proximal side of the aneurysm, and as near to the sac as possible, so that there is no branch between the ligature and the sac.



FIG. 130.—ANEL'S OPERATION, WITH ONE COLLATERAL CIRCULATION.

(5) *Hunter's Operation*.—The artery is ligatured on the proximal side of the sac in such a position that at least one large branch comes off from the vessel between the ligature and the sac. Hunter's operation has the advantage that it is very easy to perform, the artery being ligatured in continuity at some distance from the sac; but it has the serious disadvantage of introducing two blocks in the circulation, one where the ligature is applied, and the other at the site of the aneurysm, so that two sets of collateral circulation have to be established, and the risk of gangrene is increased. In Anel's operation only one set of collaterals is necessary, but the operation is more difficult to perform, as the ligature has to lie close to the sac.

(6) *Brasdor's Operation*.—This operation is used when an aneurysm is so close to the aorta that proximal ligature is not possible. A ligature is applied to the artery *beyond* the aneurysm, and coagulation of the blood may occur in the sac.

(7) *Wardrop's Operation* is practically limited to aneurysms of the innominate artery. The operation consists of placing a ligature on the right subclavian artery, in the hope that this may be sufficient. If it is not, the right common carotid must be ligatured as well, and the condition is then similar to Brasdor's operation.

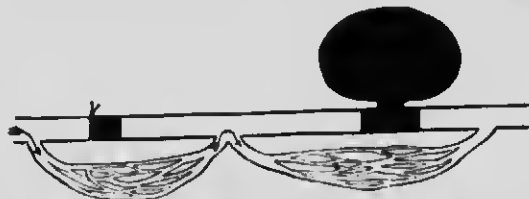


FIG. 131.—HUNTER'S OPERATION, WITH TWO COLLATERAL CIRCULATIONS.

then steadily diminishes in size, and cure follows. In many cases, however, in eighteen to thirty-six hours, as the collateral circulation is established, slight pulsation returns to the aneurysm, and this may pass off in a few hours or become permanent. The limb at first is cold and numb, and gangrene, necessitating amputation, may occur; but usually, as the circulation is established, pulsation returns to the arteries below the aneurysm, and the symptoms pass off. Immediately after ligature the limb should be wrapped in cotton-wool, slightly raised and supported on pillows. If pulsation returns to the aneurysm, digital compression of the main artery may be tried; but if pulsation continues, the artery must be ligatured again, nearer the sac if possible, or the aneurysm must be excised.

(8) *Amputation*.—Amputation for aneurysm may be necessary for various reasons:

- (a) To cure the aneurysm. For example, amputation of the upper extremity may be necessary to cure a subclavian aneurysm, the cure being brought about partly by spreading of the clot up the artery to the aneurysm, and partly by lessening the blood-pressure in the artery by diminishing the amount of blood passing through it.

EFFECTS OF LIGATURE.—In the most satisfactory cases the aneurysm shrinks and loses its pulsation immediately on ligature of the vessel, and

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- (b) If gangrene should occur before or after ligature or excision.
- (c) If secondary hemorrhage should occur and cannot be arrested by any other method.
- (d) For suppuration or rupture of the aneurysm.
- (e) If the aneurysm recurs after ligature, and excision is not possible

(9) *The Introduction of Coagulating Agents into the Sac.*—This method of treatment is limited to aneurysms of the thorax and abdomen, which cannot be treated by excision or ligature. For the most part they are aneurysms of the aorta, and it must be recognized that cure—i.e., obliteration of the artery at the mouth of the sac—is not possible in these cases. All that can be done is to bring about coagula-



FIG. 132.—DISTAL LIGATURE (BRASDOR'S OPERATION).

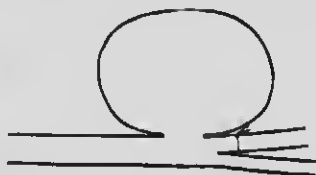


FIG. 133.—WARDROP'S OPERATION FOR ANEURYSM.

tion of the blood in the sac, so that growth of the aneurysm is retarded. The treatment is unsatisfactory. The methods employed are—

- (a) *Acupuncture.* Needles are introduced into the sac in such a manner that the pulsation of the aneurysm causes the point of the needle to scratch the wall of the sac, so that a clot will form at the place scratched.
- (b) *Introduction of foreign bodies,* such as steel wire, into the sac (10 to 30 yards of fine wire), and at the same time an electric current may be passed through the wire.
- (c) *Galvano-puncture.* Needles are introduced into the sac, and a constant current is passed through them until a definite decrease in size and lessening of the pulsation occurs. The needles are then withdrawn, and the process is repeated until cure is brought about.

These methods of treatment are the least satisfactory in bringing about a cure of aneurysm, but some good results may be obtained. Of the three methods, the best results have followed the introduction of fine wire, along which an electric current is passed, the wire finally being left in the sac.

Treatment of a Ruptured Aneurysm—1. *Leaking.*—If the aneurysm is leaking, one of the above methods of treatment should be tried and the one to be chosen is usually ligature followed by rest, elevation of the limb, and general treatment.

2. *Acute Rupture.*—A tourniquet should be at once applied, and the aneurysm cut down upon. All the blood-clot should be removed,

the artery exposed and ligatured above and below the sac. Ligatures should also be applied to all branches coming off from the sac. Extirpation of the sac as far as possible should then be carried out. If the limb is becoming gangrenous from pressure, the best treatment is amputation.

Treatment of an Inflamed Aneurysm.—The limb should be put at rest, and the usual treatment of inflammation carried out; but if this is not quickly successful, active measures should be taken. A tourniquet should be applied to the limb, and then, if possible, the aneurysm should be excised after ligaturing the artery above and below. Drainage of the wound is necessary. If this operation is not possible, the artery should be ligatured above the sac, the sac opened, all blood-clot and pus removed, vessels ligatured, and the wound drained, the cavity, if necessary, being packed with gauze to prevent hæmorrhage.

In some cases the best treatment is primary amputation. Amputation is also necessary if secondary hæmorrhage occurs after ligature of the vessels and drainage of the sac.

ANEURYSMS OF SPECIAL ARTERIES

Thoracic Aorta.—An aneurysm of this vessel is more of medical than surgical interest, but the surgeon has to be able to recognize the condition, as its symptoms may simulate intrathoracic growths, such as carcinoma of the œsophagus. The condition is frequently a fusiform dilatation of the aorta, and is not amenable to surgical treatment, but sacculated aneurysms are not uncommon.

Signs.—In many cases the aneurysm gives no definite signs, and rupture may be the first serious symptom.

1. **TUMOUR.**—The swelling is chiefly found on the right side of the sternum, and may absorb the sternum and appear as a pulsating tumour in the front of the chest, or it may show at the episternal notch. If the descending part of the arch is affected, the swelling may absorb the ribs and appear on the left side posteriorly. The tumour frequently can be made out by percussion, and, most valuable of all, it can be seen as a shadow in a radiogram, and the pulsations may be watched on the screen.

2. **BRUITS and THRILLS** over the aneurysm are common, and *pulsation* is usually well marked, even before a tumour can be recognized. The pulse in the carotids and the arteries of the upper extremity may vary considerably on the two sides of the body.

3. **PRESSURE EFFECTS.**—*Pain* is commonly due to pressure on the bones of the sternum and spine, or to pressure on the intercostal nerves.

Displacement of the heart occurs, and this organ is frequently hypertrophied.

Pressure on veins may lead to congestion, cyanosis, and œdema, and a communication may form between the sac and one of the large veins, causing a characteristic bruit. The trachea, bronchi, or lungs, may be compressed, causing *dyspnoea*. Pressure on the œsophagus

causes *dysphagia*, and if the thoracic duct is closed, *chylous ascites* may result.

Nerves.—Pressure on the recurrent laryngeal nerve causes paralysis of the muscles of the larynx, resulting in aphonia, hoarse cough, and dyspnoea. Pressure on the vagus may cause interference with the heart's action, and the diaphragm may be paralyzed by pressure on the phrenic nerves.

In aneurysms of the transverse arch the trachea may be pulled upon at each pulsation of the aneurysm, causing a characteristic *tracheal tug*.

COURSE.—An aneurysm of the aorta may be rapidly fatal from rupture, but, on the other hand, a patient may live for years with an aneurysm projecting through the thoracic wall. These aneurysms can never be cured, as it is not possible to obliterate the aorta.

TREATMENT.—*General* treatment should be carefully and thoroughly carried out, and may retard the growth of the aneurysm for years.

Local treatment consists of acupuncture, introduction of steel wire through which a constant current is passed, electrolysis, and distal ligature of one of the large branches coming off the aorta.

Innominate Artery—Tumour.—The first physical sign of the swelling is a dulness behind the sternum and inner end of the right clavicle. The aneurysm then appears behind the right sternomastoid muscle, and displaces the clavicle forwards.

The *pulse* in the radial artery and the common carotid on the right side is altered and delayed, and there is œdema and congestion of the right side of the head and neck and the right upper extremity. Pressure on the brachial plexus may cause neuralgic pain and paresis of the right arm. If the sympathetic cord is involved, there is dilatation of the arteries on the right side of the face, profuse sweating, and contraction of the pupil. Dyspnoea and dysphagia may both occur from pressure on the trachea and œsophagus, and death usually occurs from rupture or asphyxia.

TREATMENT—Local.—The following methods may be tried: (1) Electrolysis; (2) introduction of steel wire and the constant current; (3) acupuncture; (4) distal ligature of the common carotid and the third part of the right subclavian (Wardrop's operation). The last method is the one most likely to give good results.

Common Carotid.—Aneurysm of the common carotid is frequently bilateral, but it is more common on the right side than on the left. It is the most common external aneurysm met with in women, and it is most often situated at the bifurcation or at the root of the artery on the right side.

The tumour has the usual characters of an aneurysm, and produces the following pressure symptoms: *Dyspnoea* and *cough*, from pressure on the trachea and recurrent laryngeal nerve; *dysphagia*, from pressure on the *œsophagus*; *contracted pupil*, from pressure on the cervical sympathetic; *giddiness* and *stupor*, from interference with the cerebral circulation.

Death usually occurs from rupture into the air passages or œsophagus, with rapidly fatal hæmorrhage.

The diagnosis has to be made from the following conditions: Tumours of the thyroid gland; enlargement of the cervical lymphatic glands from various causes; bronchial cysts and other cystic tumours of the neck, chronic abscess over the carotid artery, and solid tumours of the neck, such as sarcomata and endotheliomata. It may also be exceedingly difficult to differentiate it from other aneurysms, such as aneurysm of the aorta, innominate or subclavian arteries.

TREATMENT.—If practical, the artery should be ligatured below the aneurysm, and if the aneurysm is small, it should be excised. If it is not possible to ligature below the aneurysm, a distal ligature should be applied (*Brasdor's operation*). Ligature of the common carotid artery is not without risk. In some cases death from syncope occurs immediately after tightening the ligature, but it is more common for hemiplegia or progressive cerebral softening to follow. If the aneurysm is bilateral, an interval of three or four weeks should be allowed to elapse between the operations for tying the vessels, as simultaneous ligature of both common carotid arteries is fatal from cerebral anæmia.

Aneurysm of the Internal Carotid in the neck is rare, and presents the usual signs of aneurysm. The swelling is chiefly seen in the interior of the pharynx, and may simulate an abscess of the tonsil.

TREATMENT.—Ligature of the common carotid.

Aneurysm of the External Carotid.—Aneurysm of this artery is rare. The usual signs of aneurysm are present, and it may cause paralysis of half the tongue, from pressure on the hypoglossal nerve.

TREATMENT.—The aneurysmal sac should be excised, or, if this cannot be carried out, the artery should be tied below the aneurysm, and ligatures should be placed upon all the branches coming off from the sac. When the aneurysm is close to the bifurcation of the common carotid, this artery must be tied, but an attempt should always be made to tie the external carotid, as the consequences are much less serious. Recurrent pulsation is common, owing to the free anastomosis with the artery of the opposite side.

Aneurysmal Varix (see p. 324) may occur in the neck, due to stabs wounding the arteries and veins, the most common being between the common carotid artery and the internal jugular vein. The usual physical signs are present, and there is headache, giddiness, and other cerebral symptoms, due to interference with the cerebral circulation. A well-marked bruit, which is the cause of great discomfort to the patient, is generally present.

TREATMENT.—The treatment should be palliative only, unless the symptoms are very severe, in which case the artery should be tied above and below the seat of the communication with the vein. Ligature of the vein is not associated with serious consequences.

Intracranial Aneurysms.—The common cause of cerebral hæmorrhage is rupture of a small aneurysm of one of the small cerebral

arteries, and these are associated with arterial degeneration, due to valvular disease of the heart, or syphilis. The artery most often affected is the lenticular-striate artery, a branch of the middle cerebral; but the basilar and internal carotid arteries and their branches may be the site of aneurysms. These aneurysms give no clinical symptoms until they burst.

The larger intracranial aneurysms give rise to the symptoms of cerebral tumour (see p. 849), and are rarely to be diagnosed from other causes of intracranial pressure, unless a loud murmur is present, which may be audible both to the patient and to the surgeon. The usual result is rupture, with fatal intracranial hæmorrhage.

TREATMENT.—The treatment is constitutional, and if a history of syphilis is present, mercury and potassium iodide should be given. If it is possible to diagnose and locate the aneurysm on the internal carotid or middle cerebral, the internal carotid artery should be tied in the neck. If aneurysm of the basilar artery is diagnosed, the vertebral artery should be tied.

Pulsating Exophthalmos.—The symptoms of this condition are—Ptosis, with swelling of the eyelids; œdema and congestion of the conjunctiva; pulsation in the orbit; a thrill; and a bruit heard over the temporal region. The muscles of the eyeball become paralyzed, and there is a steary cornea, dilated pupil, and blindness from optic atrophy. The eyeball is very painful and sensitive.

The **PATHOLOGICAL CONDITIONS** which give rise to these physical signs are—(1) Aneurysm of the ophthalmic artery; (2) traumatic aneurysm of the internal carotid in the cavernous sinus; (3) aneurysmal varix between the carotid artery and the cavernous sinus; (4) thrombosis of the cavernous sinus; (5) plexiform angioma; and (6) a very soft vascular sarcoma growing from or invading the orbit. Of these, the most common cause is aneurysmal varix between the carotid artery and the cavernous sinus, which is usually due to fracture of the base of the skull or penetrating wounds of the orbit.

The **DIAGNOSIS** of the exact condition present is often difficult, and depends largely on the history. If the condition is congenital, it is probably a plexiform angioma; if following an accident, an arterio-venous anastomosis, and if there is a history of a sudden pain in the orbit before the proptosis was noticed, it is probably a spontaneous aneurysm.

TREATMENT.—The constitutional treatment of aneurysm should be thoroughly tried, and if pressure on the common carotid in the neck lessens the pulsation and the loudness of the bruit, the internal carotid artery should be tied. In some cases this treatment has been very successful.

Subclavian Aneurysm.—Aneurysm of the subclavian artery is more common on the right side than the left, and is most frequently seen in men who do strenuous work, especially in those who carry weights on the right shoulder. The third part of the artery is the usual site of the aneurysm.

The *tumour* appears in the supraclavicular triangle, and may push the sterno-mastoid forward, or grow downwards and backwards, so that it involves the lungs.

The pressure effects are—(1) Pressure on the vein, causing œdema and congestion of the arm; (2) pressure on the brachial plexus, resulting in hyperæsthesia, anæsthesia, pain, and paralysis of muscles; (3) pressure on the phrenic nerve, with spasm or paralysis of the diaphragm; (4) delay and smallness of the radial pulse. The condition most usually mistaken for a subclavian aneurysm is a normal artery running over a cervical rib.

The condition usually ends in rupture of the aneurysm, but spontaneous cure may result.

TREATMENT.—Treatment so far has been unsatisfactory in the majority of cases, and in all cases the constitutional treatment of aneurysm should be carefully carried out. The following surgical methods may be tried:

1. Ligature of the artery in the second part or at the commencement of the third part, with or without extirpation of the sac.
2. Ligature of the first part of the artery. Up to quite recently this operation was always fatal, but successful cases have been reported.
3. Ligature of the innominate trunk.
4. Distal ligature, with amputation of the upper extremity at the shoulder-joint. Distal ligature alone is unsuccessful.
5. Introduction of foreign bodies into the sac.

Axillary Aneurysm.—This aneurysm, like the former, is more common in men than in women, and more common on the right side than the left. The artery is sometimes injured in dislocation of the shoulder and fracture of the upper end of the humerus. Owing to the laxity of the tissue in the axilla, the aneurysm usually grows very rapidly.

The *tumour* projects forwards just below the clavicle, and may interfere with the free movement of the arm, and there are the usual effects from pressure on the vein and the brachial plexus of nerves. The aneurysm may burst into the shoulder-joint, or may erode the ribs and burst into the thorax. Spontaneous cure is very rare.

TREATMENT.—The best treatment is excision of the aneurysm, but if this cannot be done, the third part of the subclavian artery should be tied. Gangrene does not usually occur after this operation, owing to the very free collateral circulation.

Brachial, Radial, and Ulnar Aneurysms.—Aneurysms of the brachial, radial, or ulnar arteries, are nearly always traumatic in origin, spontaneous aneurysms of these arteries being very rare.

The condition calls for no special mention, and the *treatment* is extirpation of the sac. Gangrene does not occur.

Abdominal Aneurysm.—An aneurysm may occur at any part of the abdominal aorta, but the most frequent sites are the bifurcation

and near the origin of the cœliac axis. The main branches of the aorta, especially the splenic, hepatic, and mesenteric arteries, may also be the seat of aneurysm.

The **DIAGNOSIS** is often difficult, and it is important to remember that the diagnosis of abdominal aneurysm should not be made unless a tumour is present, no matter how marked epigastric pulsation may be, and then only if the tumour has an expansile pulsation, as tumours situated over the aorta very closely simulate aneurysm. The X rays may be very useful in establishing a diagnosis. The aneurysm at first only causes local discomfort, but later it may cause severe pain by erosion of the vertebræ, or pressure on the lumbar plexus of nerves. Death usually occurs from rupture into the abdominal cavity.

TREATMENT.—Constitutional treatment should be given a thorough trial, and if this is not successful, the abdomen should be opened, and the exact condition seen. If the abdominal aorta is involved, the introduction of foreign bodies with electrolysis may be tried; but if the splenic artery or one of the other branches is the site of the aneurysm, ligature may be attempted.

Inguinal Aneurysm.—An aneurysm in the inguinal region may either spring from the external iliac or the common femoral artery, and the sac projects partly into the iliac fossa and partly into the thigh, Poupart's ligament forming a constricting band between the two parts of the sac. The part in the iliac fossa usually grows more rapidly than that in the thigh. There is pain, paresis, congestion, and œdema of the lower extremity, due to pressure on the veins and nerves, and the usual termination is death from external rupture of the aneurysm.

TREATMENT.—The best treatment is extirpation of the sac, and this should be done whenever practicable. Failing this, the external iliac should be ligatured by the extraperitoneal method, or the common iliac transperitoneally.

Aneurysm of the Buttock.—Aneurysm of the gluteal artery is much more common than aneurysm of the sciatic, but the symptoms of the two conditions are very similar. The *tumour* is deep-seated, and may readily escape detection, and when it grows large is apt to be mistaken for an abscess. The chief symptoms are pain and limitation of movement of the hip, and pain and paresis in the lower extremity, due to pressure on the great sciatic nerve. The usual termination is rupture, and the condition may then very closely simulate abscess. The higher on the buttock the tumour is when first seen, the more likely is it to arise from the gluteal artery; while aneurysms of the sciatic artery tend to project into the pelvis, and can be felt *per rectum*.

TREATMENT.—The internal iliac artery should be ligatured by the transperitoneal route, or, if this is not possible, the aneurysm may be treated by electrolysis.

Femoral Aneurysm.—Aneurysm of the superficial femoral artery occurs exclusively in males, and the most common site is at the apex

of Scarpa's triangle. Aneurysm of the profunda femoris also occurs, and is distinguished from aneurysm of the femoral artery by the fact that it causes no disturbance of the tibial pulse.

TREATMENT.—The best treatment is extirpation of the sac, and, failing this, Anel's method of ligature.

Popliteal Aneurysm.—The popliteal artery is the most common seat of external aneurysm, and the condition is frequently symmetrical. It is almost confined to males, and is usually of the sacculated form.

The first symptom is pain, and the patients are frequently treated for rheumatism, especially as there is often stiffness of the knee and effusion into the joint. Pressure on the popliteal vein causes œdema and congestion of the leg and foot, and pressure on the internal popliteal nerve causes pain and paresis of the muscles. As the aneurysm grows, the bone is eroded, and the movements of the joint are greatly interfered with. The condition may be mistaken for popliteal abscess, pulsating sarcoma, or a bursal cyst. If the aneurysm ruptures, there is great danger of gangrene of the leg.

TREATMENT.—If the aneurysm is small, it should be treated by extirpation, and if the vein is torn, it should be repaired by suture; but gangrene does not necessarily follow if the vein is ligatured. In some cases Matas' operation of reconstructive aneurysmorrhaphy may be tried. Ligature of the artery close to the sac (Anel's method) is the treatment of election if these methods are not advisable; and failing this, the superficial femoral artery should be ligatured in Hunter's canal or at the apex of Scarpa's triangle. This method of treatment is very successful.

Aneurysms of the Tibial Arteries.—Aneurysm is very rare below the popliteal artery, and if one occurs in one of the tibial arteries, it is usually traumatic in origin, and should be treated by excision of the sac.

ARTERIO-VEINUS ANEURYSM

An arterio-venous aneurysm is an abnormal communication between an artery and a vein, and two varieties are described—(1) The blood passes directly from the artery into the vein, which becomes distended and pulsates (**ANEURYSMAL VARIX**). (2) A sac is formed between the two vessels, opening on one side into the artery and on the other into the vein (**VARICOSE ANEURYSM**). The latter condition is the more dangerous as the aneurysmal sac may burst and cause death from hæmorrhage. Arterio-venous aneurysm is nearly always due to injury, but the condition may occur spontaneously. It was formerly of common occurrence between the brachial artery and the median basilic vein, when bleeding from the vein was the commonest of operations.

1. **Aneurysmal Varix.**—The common cause of this condition is simultaneous punctured wounds of the artery and vein from stabs or gunshot wounds. The edges of the wounded vessels adhere, and the blood passes freely from the artery into the vein.

The opening between the two vessels is rounded and smooth, and the vein opposite the opening forms a dilated pouch with thickened walls. The dilatation of the vein extends in both directions and involves all the branches, which become tortuous and peached, while the walls shew atherenmateus changes.

SYMPTOMS.—There is an ill-defined tumour in the course of an artery and vein into which dilated veins can be traced both above and below. The tumour has an expansile impulse, a marked thrill, and on listening over it a loud bruit is heard. The pulsation, thrill, and bruit are conducted along the course of the vein and gradually become less and less apparent. If the limb is raised, the tumour gets smaller, but if it is lowered, it increases in size and the pulsation becomes more marked. The part below is œdematous and congested, and may be exceedingly painful, especially in cold weather. There is usually a scar over the tumour indicating the nature of the cause.



FIG. 134.—ANEURYSMAL VARIX.

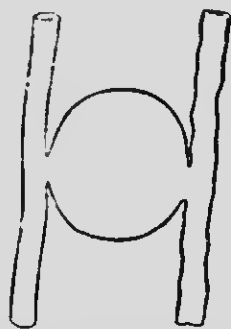


FIG. 135.—VARICOSE ANEURYSM.

2. Varicose Aneurysm.—The causes of this condition are the same as the former—viz., stabs and gunshot wounds which simultaneously injure the artery and the vein. A circumscribed traumatic aneurysm forms between the two vessels, which only differs from the ordinary circumscribed traumatic aneurysm by having an opening into a vein as well as the opening into the artery. The vein undergoes exactly the same changes as in aneurysmal varix.

SYMPTOMS.—The symptoms and physical signs of this condition are those of aneurysm, to which are added the signs of an aneurysmal varix, and it is sometimes possible to distinguish the two parts of the swelling—(1) the aneurysm; (2) the dilated pouch of the vein. When the artery above the sac is compressed, the vein collapses and the aneurysmal tumour becomes more apparent, although it ceases to pulsate. In some cases the condition starts as an ordinary aneurysm, which subsequently forms a communication with a vein. A varicose aneurysm nearly always terminates in rupture with extensive hæmorrhage, and frequently death.

TREATMENT.—In some cases the only treatment necessary for an **aneurysmal varix** is to support the dilated vein with an elastic bandage, as the condition may remain stationary and cause little inconvenience; but if it increases in size and causes pain, the artery should be ligatured above and below the communication with the vein. A **varicose aneurysm**, on the other hand, always requires operative treatment, as the danger of rupture is much greater. The treatment is that of any other aneurysm. The self-evident treatment is ligature of the vessels above and below the opening and excision of the sac. In some cases, however, ligature of the vein is attended with great danger of gangrene, and when it is only possible to save one of the vessels forming an arterio-venous aneurysm, the rule is *to save the vein and not the artery*, the exception being in the case of the common carotid artery and the internal jugular vein.

With the improved methods of operation on arteries and veins, it may be possible to repair the injury in both vessels and not interrupt the flow of the blood, and this should always be done if possible, special care being taken of the vein.

INFLAMMATION OF VEINS

Phlebitis.—Inflammation occurring in veins may be divided into infective and non-infective, but the line of division is very difficult to draw, as a non-infective case may subsequently become infected. The causes of non-infective phlebitis are injury, gout, thrombosis occurring in the vein, or infective inflammation of the surrounding tissues (periphlebitis). Infective phlebitis is due to invasion of the wall of the vein or of a thrombus which has formed in the vein by micro-organisms. It is, however, the termination of the inflammation in a vein and its results that are of the greatest importance.

Non-Infective Inflammation.—The inflammation of the vein leads to thrombosis of the blood in it, and if no infection occurs, one of the following terminations results:

1. The thrombosis breaks up and passes away as small, non-infective emboli, which usually cause no harm, and the vein becomes patent.
2. The thrombosis shifts and passes along as an embolus, and may cause serious or fatal results—*e.g.*, a large embolus may block one of the main branches of the pulmonary artery.
3. The thrombus is said to become organized—*i.e.*, there is, as the result of the inflammation, a formation of cicatricial tissue which obliterates the vein, the thrombus forming a pabulum in which the fibrous tissue is formed.
4. If the thrombus forms in the pouch of a varicose vein, calcareous salts may be deposited in it, forming a phlebolith.
5. The thrombus may become infected by extension or by auto-inoculation, and the condition change to infective phlebitis.

Infective Phlebitis.—This is a more serious condition than non-infective phlebitis, because it may end in suppuration and abscess formation, or septico-pyæmia may result. Suppuration, however, is not the necessary termination of infective phlebitis. In many cases a thrombus forms in the vein, but the inflammation ends either in resolution or fibrosis, and the terminations are the same as those of non-infective phlebitis. It is only in the minority of cases that suppuration occurs and pus is formed, or that the thrombus spreads along the course of the vein. The organisms may gain entrance to the vein as a direct infection through an open wound, from extension from surrounding tissue, as in thrombosis of the pelvic veins, from a septic uterus, or by infection of the clot of a non-infective thrombosis through the blood-stream.

SYMPTOMS.—If the vein is superficial, it feels like a hard cord lying in the tissues, with little knots on it corresponding to the valves. The cord is painful and tender, and the skin over it is red and congested. The part below is slightly œdematous, but in the superficial veins the anastomosis between the various veins is so complete that marked œdema is rarely seen. If the condition goes on to suppuration, the swelling becomes soft in the centre, and the usual physical signs of an abscess are present. The *general* symptoms are rise of temperature and general malaise.

Phlebitis and thrombosis, occurring in the deep veins, have to be recognized by their effects, for there may be no physical signs of the condition itself. For example, in thrombosis of the pelvic veins, such as occurs after a parturition in which the placental site has been infected, or in many cases of phlebitis after typhoid fever or appendicitis, it is impossible to detect the thrombus in the vein, but the condition is recognized by the œdema which results and by a deep-seated pain in the pelvis or thigh. The œdema is at first soft and pits on pressure, but later, and especially when the patient begins to walk on the limb, it becomes more evident, firmer, and harder from the production of fibrous tissue, until ultimately the limb may attain an enormous size (pseudo-*elephantiasis*). If suppuration occur as a result of infective phlebitis, a localized abscess may form, as described above, but in some cases the condition spreads along the vein and its branches, and a large area is quickly invaded (*infective spreading phlebitis*). These cases usually end in septico-pyæmia, small portions of the thrombus being carried as infective emboli all over the body. The onset of this condition is generally marked by rigors.

TREATMENT—General.—The usual constitutional treatment of infection should be carried out.

Local.—The patient should be put in bed and the part kept at rest with the limb elevated in order to favour venous return and prevent œdema. The part should not be touched or interfered with in any way, and for this reason it is better not to use fomentations or any dressing that has to be changed frequently. The limb may be wrapped in cotton-wool, and a many-tailed bandage applied, which should seldom be changed. This *rest* should be continued for three weeks,

and after this it may be considered that there is no danger of the thrombus becoming detached and passing into the circulation as an embolus. The patient should then be allowed up, and if any œdema results from allowing the limb to hang or from walking on it, one of the various forms of bandage recommended for the treatment of varicose veins (p. 331) should be worn combined with gentle upward friction.

This treatment of phlebitis and thrombosis is usually successful, but it is tedious, and there is constant danger of embolism and of suppuration occurring; for these reasons it is frequently advisable to ligature the vein above the upper limit of the thrombosis and remove the inflamed portion. This operation should be done if the vein is superficial and readily dealt with, and it becomes a matter of urgency if the inflammation is likely to spread and end in suppuration. For example, in thrombosis of the lateral sinus due to extension from the mastoid antrum, ligature of the internal jugular in the neck, and removal of the clot in the sinus, is a matter of extreme urgency.

If suppuration has already occurred, the vein should be ligatured above the thrombus, and then all the inflamed tissues should be freely laid open and the infected clot removed.

In some cases this treatment cannot be carried out in its entirety, but in all cases the abscess must be opened and the site of infection thoroughly drained.

Amputation may be the only means of preventing general infection in some cases, and if it is decided upon should be done early.

Varicose Veins

The condition known as varicose veins is a permanent pathological distension of veins. The veins become elongated and tortuous, the valves are incompetent, and the walls of the veins show definite pathological changes.

The condition is most commonly found in the superficial veins of the lower extremity, but on post-mortem examination it will frequently be seen that the deep veins are also affected. The condition also occurs in the abdomen, upper extremity, and head and neck. Two special varieties of varicose veins—viz., varicocele, or varicosity of the pampiniform plexus, and hæmorrhoids, or varicosity of the rectal veins—will be described subsequently. It is here proposed to consider varicosity of the superficial veins, mainly of the lower extremity.

CAUSE.—Two varieties of varicose veins may be described: (1) Compensatory; (2) idiopathic.

1. *Compensatory* dilatation of veins occurs when a main vein is blocked and a collateral circulation has to be established. The condition is most readily recognized when the inferior vena cava or the portal vein is obstructed. In the former case an extensive collateral circulation is established through the veins of the anterior abdominal wall, which become distended and tortuous. Secondary changes occur in the walls of the veins due to the increased pressure, and as the veins distend, the valves become incompetent. The collateral circula-

tion, which is established in cases of blocking of the portal vein, is well known, and advantage is taken of the establishment of a compensatory hypertrophy of veins in the treatment of cirrhosis of the liver, by Talma-Morison's operation. Compensatory varicose veins require no treatment.

2. *Idiopathic*.—The cause of varicosity of veins in the majority of cases is due to some inherited weakness of the vein walls, which causes them to become dilated and diseased under the normal blood-pressure. That this weakness is inherited is suggested by—(1) The condition runs in families; (2) the same segment of vein is frequently affected in several members of a family; (3) the condition arises in young adults—puberty to thirty; (4) in many cases the entire absence of any other cause.

When this inherited weakness is present, secondary causes may hasten the development of the condition and aggravate it. It is important to recognize that the conditions that reveals the presence of varicose veins by causing congestion and pain, such as pregnancy, are not necessarily the cause of the condition. The most usual secondary causes are prolonged standing, severe athletics, pregnancy, pelvic tumours and the wearing of garters.

PATHOLOGICAL ANATOMY.—The vein is dilated, increased in length so that it becomes tortuous, and the walls are diseased. As the vein distends, the valves do not undergo a compensatory hypertrophy, but on the contrary, become shrunken or may disappear altogether, so that the volume of blood in the vein is no longer supported by the valves, the back pressure is increased, and the vein becomes still more varicose. The main change in the walls of the vein is towards cicatricial thickening, so that when the vein is cut across it gapes like an artery. The intima is thickened, and may show similar changes to those that occur in atheroma of the arteries, and calcification may be present. The muscular tissue of the media is at first hypertrophied, but soon becomes replaced by fibrous tissue, so that the elasticity of the vein is largely lost. The adventitia is thickened, and there is a periphlebitis causing obliteration of the periveneous lymph space, the vein becoming adherent to the surrounding tissue, and when cut across, it is held open by the fibrous adhesions. In many cases the vein becomes closely adherent to the skin, so that it is almost impossible to remove the vein without injuring it. Although the veins are usually thickened, in places they may be very thin from the formation of pouches. These pouches are particularly apt to form where the superficial veins join the deep, and may be so big as to form **venous cysts**. A favourite situation is where the saphena vein passes through the saphena opening to join the common femoral vein, and here the cyst may be so large that it simulates a femoral hernia, the likeness of the two conditions being increased by the fact that the venous cyst has an expansile impulse on coughing. Coagulation of the blood frequently occurs in these pouches, and calcareous salts may be deposited in the thrombus, so that a **phlebolith** is formed, which can be recognized by touch, or in the case of deep veins, by

radiography. The changes in the vein wall are probably the result of the increased blood-pressure associated with the over-distension of the vein.

CLINICAL FEATURES.—The condition is most frequently seen between the ages of puberty and thirty, and the sexes are about equally affected. In many cases no discomfort is caused unless there is some extra pressure thrown on the vein, as by prolonged standing or pregnancy, but in other cases there is a good deal of aching pain and discomfort. The pain is at once relieved by recumbency and raising the limb.

The dilated and tortuous veins can usually be seen readily by inspection if the patient is made to stand up, and they can also be brought into relief by bandaging the upper part of the limb. The places where the valves are situated are shown by small knots on the veins, which can also be easily felt. If there is marked œdema of the limb, it may not be possible to see the veins, and their presence has to be assumed rather than demonstrated. In many cases the small veins of the skin are markedly distended, and show as blue lines in a stellate or arborescent manner. Deep varicose veins cannot as a rule be recognized, but they may cause cramp-like pains in the muscles.

Complications—1. **HÆMORRHAGE.**—A varicose vein may be injured as any other vein, or may burst under increased pressure either into the tissues or externally if the skin gives way. In the majority of cases, however, hæmorrhage from a varicose vein is due to ulceration opening up the vein, and the condition is one of secondary hæmorrhage. The loss of blood is usually very rapid, as the dilated vein is prevented from collapsing by its thickened walls and its adherence to surrounding structures, and the valves being incompetent, the blood is lost from both ends. The condition is only serious if it is not recognized early, or if the patient and bystanders are totally ignorant of what to do. The *treatment* consists of laying the patient flat on the back and elevating the limb from which the blood is flowing; this will at once arrest the hæmorrhage, and a pad can be fixed over the wounded vein by a bandage.

2. **THROMBOSIS.**—This may be due to the slow passage of the blood along the vein, but in the majority of cases to mild infective phlebitis, and has the usual clinical features, complications, and results of this condition. The thrombosis may lead to the cure of the condition by obliterating the vein.

The *treatment* is rest, with elevation of the limb; but if the pain is severe, the thrombus becoming larger or spreading, or if the inflammation is severe, ligation of the vein above and below the thrombus, with excision of the intervening portion, is the correct treatment.

3. **PIGMENTATION OF THE SKIN.**—With varicose veins of the lower extremity a deposit of pigment in the skin round the varicose veins is frequently a precursor of the next two complications.

4. **CHRONIC ECZEMA.**—The skin on the inner side of the lower part of the leg of a patient suffering from varicose veins of the lower extremity is frequently eczematous. This condition of chronic eczema

is due to the interference with the nutrition of the skin, and predisposes to the formation of a varicose ulcer.

5. **ULCER.**—These ulcers are mostly chronic, and have been described in Chapter VI., p. 152.

TREATMENT.—In the majority of cases no operative interference is necessary, and in many cases the condition requires no treatment. If there is pain or discomfort, or the veins are large, the patient should wear elastic bandages, which should be put on before he rises in the morning, and taken off just before going to bed. The bandages should be light, porous, and washable, the variety known as "stockinette" being one of the best. Elastic stockings are not so useful in the treatment as bandages. The patient should be cautioned against prolonged standing or severe muscular exertion, the bowels should be kept free, and care taken that the venous return is not obstructed by the use of garters or an ill-fitting truss.

OPERATIVE TREATMENT.—Operative treatment, provided the patient is otherwise healthy, is indicated under the following circumstances:

1. If there are one or two bunches of large veins.
2. If on coughing there is an impulse over the upper end of the saphena vein.
3. When the patient is going abroad or away from proper medical supervision.
4. In cases where there is chronic eczema, and ulceration is commencing.
5. If there are frequent attacks of phlebitis and thrombosis.
6. In cases where the skin over a vein becomes very thin, and there is danger of rupture.
7. If there is severe pain or discomfort, and the case is otherwise suitable.
8. When the patient wishes to join one of the public services.

Operation is contra-indicated when there are a large number of small dilated venules, or if the patient is not in good health, apart from the varicose veins. It is also absolutely contra-indicated if the enlargement of the vein is compensatory from some obstruction to a large venous trunk.

The following methods of operation may be used, or they may be combined:

1. Trendelenburg's operation. The long saphena vein is exposed and divided between ligatures at the saphena opening, and just above and just below the internal condyle of the femur.
2. Excision of large portion of the dilated veins through suitable incisions, with ligature of all their branches.
3. Schedo's operation. An incision is made completely round the limb, dividing all the tissues down to the deep fascia, and ligaturing all the veins.
4. Multiple small incisions are made over the course of the varicose veins, and small portions are excised.

After the operation the limb should be elevated, and the patient kept in bed for three weeks. A bandage should be worn for the first few weeks after the patient is up.

NEW GROWTHS OF BLOODVESSELS

Angeliomata.—The angiomas are innocent tumours—probably always of congenital origin—composed of bloodvessels, and are divided into the following varieties: (1) Capillary; (2) cavernous; (3) plexiform.

CAPILLARY ANGEIOMATA (capillary naevi, or "mother's marks") are situated in the skin or mucous membrane, and appear as bright red or bluish areas, which project slightly above the level of the skin, and are a little uneven on the surface. These tumours are frequently

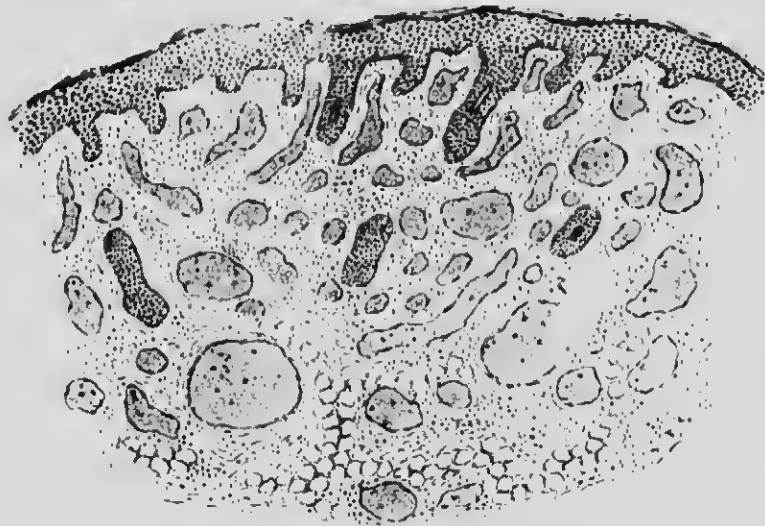


FIG. 130.—SECTION OF AN ANGEIOMA (NÆVUS).

multi and they vary in size from small spots to areas covering a large part of the face or neck, and are usually present at birth. They may increase rapidly in size during the first months of life or at puberty, or they may grow steadily until the patient's general growth ceases. In a large number of cases they undergo spontaneous cure, either by degenerative changes and disappearing in the same manner that the bloodvessels disappear in recent scar tissue, or by the tumour ulcerating and finally being replaced by a cicatrix.

TREATMENT.—As many naevi disappear spontaneously, treatment is only necessary if the tumour is increasing in size, or if it is in an exposed area of the skin and is very disfiguring; but it must be remembered that a scar is always left after operation, which may be as unsightly as the naevus. If the naevus is very large, it is probably best left alone. The following methods of treatment may be used:

1. Excision. This is the best method in the majority of cases.
2. Application of the thermo-cautery, nitric acid, or other methods of cauterization.
3. Application of carbon dioxide "snow." This method is excellent for small naevi, especially those on the face and neck, and the application does not require the use of an anæsthetic.
4. Electrolysis.
5. Application of radium or the X rays.

CAVERNOUS ANGEIOMATA (CAVERNOUS NÆVUS).—Cavernous angiomas are most commonly found in the subcutaneous tissue, but they may occur in internal organs, such as the liver and spleen, and be large enough to form a palpable tumour. In the subcutaneous tissue they form soft, irregularly lobulated, encapsulated tumours, which increase in size when the patient cries or coughs. They are usually bluish in colour, and very frequently the skin over them is the site of a capillary naevus (mixed naevus). They are often multiple, and are of any size from that of a small pea to a tumour as large or larger than the palm of the hand.

Like capillary naevi, they may undergo spontaneous cure from degeneration or ulceration, or they may degenerate to form blood-cysts.

In some cases the naevoid tissue is associated with fat, and a lobulated encapsulated mixed tumour is found—naevo-lipoma.

TREATMENT.—Excision is the best treatment, when practicable, and the tumour should be freely excised, as incision into the tumour is likely to be followed by troublesome hæmorrhage.

Electrolysis.—This method is particularly useful for naevi on the eyelids, on the mucous membranes, or for large naevi which it is not possible to excise. The method consists of passing a constant current through the naevus, and so inducing chemical changes in the blood and surrounding tissue. Oxygen and acids collect at the positive pole, and hydrogen and bases at the negative pole, and the result is a cauterization of the tissues, followed by the formation of cicatricial tissue. The current used is from 20 to 80 milliamperes, and an anæsthetic is necessary, as the process is painful. Several sittings of fifteen to twenty minutes will be necessary in order to cure a moderate-sized tumour, and a slow action is preferred to a rapid, as if the current is too strong or applied for too long a time, sloughing of the tumour may result. Both needles may be thrust into the tissue, or several needles may be used, but if a very slow action is necessary, the needle attached to the positive pole is used, and the negative electrode is applied to the skin as a flat plate.

Caustics, including solid carbon dioxide, X rays, and radium, may also be used in the treatment of small cavernous naevi. Naevolipomata should be removed by excision.

PLEXIFORM ANGEIOMATA (CIRROID ANEURYSM, ANEURYSM BY ANASTOMOSIS).—These tumours may be mainly composed of arteries or veins, or the two varieties of bloodvessels may be present in equal

proportion; the vessels are usually tortuous and arranged parallel to one another. The condition is rare, and is most frequently seen on the head in connection with the temporal or occipital arteries and in connection with the corpus spongiosum.

Plexiform angiomas are congenital in origin, but usually begin to be prominent in young adult life. The tumour is soft, pulsates, a thrill is felt over it, and on listening with a stethoscope a bruit is heard, which is generally audible to the patient himself, and is the most troublesome symptom. When they occur on the scalp, the underlying bone is frequently eroded, and the skin of the scalp is thinned and the hair is lost. Ulceration frequently occurs, leading to severe and often fatal hæmorrhage. Plexiform angiomas of the limbs may be very painful, especially in cold weather.

TREATMENT.—The results of treatment of these cases are most unsatisfactory, and depend on the situation of the angioma. The main artery supplying the tumour may be tied, and the growth arrested for a time, or an attempt may be made to excise the growth, the hæmorrhage being controlled by an elastic tourniquet.

Electrolysis, used in the same way as in the treatment of cavernous naevi, is useful sometimes in arresting the rate of growth.

In the case of plexiform angiomas of the limbs, amputation may be necessary.

Endothelioma and **Perithelioma**, which are malignant new-growths of bloodvessels, are described on p. 228.

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CHAPTER XI

INJURIES AND DISEASES OF THE LYMPHATICS, TENDONS, MUSCLES, AND BURSEÆ

THE LYMPHATICS

Injuries of the Lymphatic Vessels.—Although a large number of lymphatic vessels are cut across during every extensive operation, it is very rare that any evidence of injury to the lymphatics exists unless the vessels have been previously dilated from obstruction (*lymph-angiectasis*). If this condition is present, the lymph may escape from the wound (*lymphorrhœa* or *lymphorrhagia*) as a colourless thin fluid, which rapidly coagulates, and a fistula (*lymphatic fistula*) may result, which generally, however, heals as soon as new lymph channels are formed.

Wounds of the Thoracic Duct.—The thoracic duct usually opens into the junctions of the left subclavian vein and the left internal jugular, but it also has connections with the veins of the thorax, and two or more large openings into the venous system are common.

The duct is often injured during operations on the lower part of the neck, and the wound passes unnoticed. If there are several openings into the venous system, no symptoms follow; but if the main duct is divided, the chyle will escape freely from the wound (*chylorrhœa*), or a fluctuating swelling will appear under the scar, which on being incised is found to contain chyle. If the discharge is abundant and continuous, the patient will die of inanition; but if there are several openings into the veins, the discharge may cease spontaneously.

TREATMENT.—It is rarely possible to suture the divided thoracic duct, and if the injury is noticed at the time of the accident, the duct should be tied, and as the collateral circulation is usually abundant, no ill-results follow. If the condition is only recognized on the escape of chyle, an attempt should be made to find the duct and close it by ligature, and failing this, the wound should be firmly packed with gauze until the discharge ceases. Division of the right lymphatic duct is of no consequence.

The thoracic duct is sometimes torn across in fracture of the spine or crushes of the thorax, and the chyle may escape into the posterior mediastinum, the pleural cavity, or the abdomen, causing chylo-

thorax or chylous ascites. These conditions have also arisen from spontaneous rupture due to back pressure when the thoracic duct has been obstructed.

Lymphangitis

Inflammation of the lymphatic vessels is due to infection with micro-organisms, usually the pyogenic bacteria, which gain entrance to them through an infected wound. The inflammation may be either acute or chronic.

Acute Lymphangitis.—The most common organism causing this is the *Streptococcus pyogenes*, but other bacteria, such as the *Bacillus mallei* and the anthrax bacillus, cause a similar condition. The inflammation affects the walls of the vessels, and may terminate in suppuration, or there may be a perilymphangitis with the formation of abscess in the surrounding cellular tissue, or an acute cellulitis.

SYMPTOMS.—There is usually an infected sore, and from this there are wavy red slender lines running up to the nearest set of lymphatic glands, which are enlarged and tender. The general symptoms are those of sepsis, and may terminate in septicopyæmia.

RESULTS.—The inflammation usually ends in resolution, but suppuration along the course of the lymphatic vessels often occurs, and the lymphatic glands frequently break down. The condition, especially if there have been several attacks, may end in fibrosis of the surrounding tissue, with obliteration of the lymphatic channels, and a solid œdema may result (see Elephantiasis).

TREATMENT.—The source of infection must be treated in the usual way. Heat should be applied in the form of fomentations or baths, and if the infection is in the lymphatics of the limb, Bier's method of passive congestion is useful. Should suppuration occur, the abscess should be opened. After the inflammation has subsided, massage and the use of bandages may be necessary to prevent œdema.

CHRONIC LYMPHANGITIS.—Chronic inflammation of the lymphatic vessels may be the sequel to an acute attack, but is more commonly met with as a result of syphilitic or tubercular infection.

Syphilitic Lymphangitis.—This condition is most frequently seen in the primary stage, and in the lymphatics of the dorsum of the penis running from the primary chancre to the inguinal glands. These lymphatics become hard and tender, but under antisyphilitic treatment the inflammation rapidly subsides. Suppuration never occurs.

Tubercular Lymphangitis. Tubercular inflammation of the lymphatic glands as a clinical entity is most frequently seen in connection with tubercular lesions of the skin of the limb, such as tubercular ulcers or tubercular sinuses. The infection spreads along the course of the lymphatics, which become hard and swollen. Nodules appear along the course of the swollen lymphatics, which break down into abscesses and form ulcers, whilst the lymphatic glands also become tubercular. General dissemination of tuberculosis may occur.

If the condition is extensive, blocking of the lymphatics and elephantiasis may result.

TREATMENT.—The usual general treatment of tuberculosis should be carried out. The primary focus of infection must be thoroughly treated, and as the tubercular abscesses form along the course of the vessels, they should be excised, or, if this is not possible, opened and scraped.

Lymphadenitis

Inflammation of the lymph glands have the same causes and varieties as inflammation of the lymphatics, and the infecting organism reaches the glands by way of the lymph channels. At the same time it must be understood that an acute or chronic lymphadenitis may occur without there being any clinical evidence of the passage of the organisms along the lymphatics.

Acute Lymphadenitis.—This condition is most commonly due to the various septic organisms, and an obvious focus of infection is usually present, but it may also be due to the *Bacillus mallei*, Ducrey's bacillus, anthrax, etc.

SYMPTOMS.—The general symptoms are those of sepsis. Locally, there is a severe throbbing pain in the situation of a group of lymphatic glands, and the glands are felt to be enlarged, tender, and usually matted together, although one gland only may be affected. The overlying skin is red and slightly oedematous. As the swelling increases, the outline of the glands is lost, and there is a large painful mass, covered by red oedematous skin.

RESULTS.—Pus may form in several places in the mass, or the whole may break down and form an abscess confined by the fibrous capsule of the gland. This may burst into the surrounding tissue, and acute cellulitis result, or it may gradually find its way to a free surface and point. In some cases—for example, when the inflammation is due to Ducrey's bacillus—the suppuration is chiefly periglandular, and the gland may have to be removed as a slough. Resolution is also a common termination, or the inflammation may become chronic and the glands remain permanently enlarged and hard. These enlarged glands are prone to secondary infections, particularly tubercle.

TREATMENT.—The *general* treatment for any acute infective condition should be carried out. *Locally*, the source of infection should be carefully treated, heat applied to the inflamed glands in the form of fomentations, and the part kept at rest. In many cases resolution will occur, but if suppuration follows, the pus must be let out by free incision, and fomentations continued, or active hyperæmia carried out by means of suction-glasses.

In the more subacute forms, and especially if there is much periadenitis, the glands should be excised, or suppuration may continue for a long time.

Where the pus is deep-seated and lying amongst important structures, as in the axilla, the abscess should be opened by Hilton's method, and free drainage established.

Chronic Adenitis.—Chronic adenitis may follow an acute attack, or the process may be chronic from the first. It is due to the same

causes as acute adenitis, but most commonly to tubercular or syphilitic infection.

If due to septic infection, the condition is most often seen in the glands of the groin, axilla, or neck, and in children there is frequently a history of a specific infectious fever.

The glands are enlarged, hard, and matted together, and may remain in this condition for weeks or months, or suppuration may occur and the glands become soft. The size of the glands frequently varies with the state of health of the patient, and it is exceedingly common to get a tubercular infection grafted on to chronic adenitis due to septic infection.

TREATMENT.—All possible sources of infection should be removed, such as carious teeth, adenoids, or enlarged tonsils, in the case of chronic adenitis of the glands of the neck, and the general health of the patient should receive attention. In many cases this is all that is necessary, and the glands subside to normal or remain slightly enlarged, presenting no symptoms. If the glands continue to enlarge, and if there is any symptom of suppuration, they should be removed by careful dissection, care being taken that the capsule of the gland is not ruptured.

Tubercular Lymphadenitis.—Tubercular infection of the lymphatic glands is most common in children and young adults, and the common sites of the disease are the glands of the neck and the mesenteric glands. The usual predisposing causes of tubercle are present, and the infection frequently supervenes on a chronic septic adenitis. Amongst the most constant *local* predisposing causes are enlarged tonsils, adenoids, carious teeth, chronic otorrhœa, and impetigo, and in connection with the mesenteric glands, tubercular ulcers of the small intestine, although infection of these glands may occur without definite involvement of the gut.

PATHOLOGICAL ANATOMY.—At first the glands are simply enlarged, and on section look like very hypertrophied normal glands; but soon small whitish nodules appear scattered through the gland. These nodules increase in size and soften, and if this continues, the whole gland becomes soft and semi-liquid, and the suppuration may be hastened by a secondary infection of septic organisms. If the condition advances, the pus bursts through the capsule of the gland and the deep fascia, and a secondary abscess forms in the subcutaneous tissue, communicating by a small opening through the deep fascia with the diseased gland. This abscess finally bursts, and an ulcer with undermined edges results. This ulcer will either spread or degenerate into a fistula leading down to the remnant of the gland.

The fistula will continue to discharge until all the gland has disappeared, or until it has been removed by an operation, and when healed, it leaves a somewhat characteristic scar. The cicatrix is adherent to the deeper part, and is therefore depressed, and it is often furrowed and puckered, and more vascular than is usual.

In many cases, however, the tubercular process is arrested and the gland undergoes no further change, or calcareous salts are deposited

in the degenerated tubercles—a condition which is more common in the mesenteric and mediastinal glands than in the glands of the neck. It can be diagnosed by the use of the X rays.

As well as the inflammation in the glands, there is often some peradenitis, which cause the glands to become matted together and fixed to surrounding structures, so that a large mass of glands may be present showing numerous foci of suppuration.

SYMPTOMS.—The general symptoms are those of a mild infection. *Locally*, there is an enlargement of the glands, which is usually slow and painless, and the patient will frequently state that the glands vary considerably in size. In the early stages they are freely movable and discrete, but as they increase in size become matted together and fixed to surrounding structures.

Later, fluctuation occurs in the mass itself or in the secondary abscess, which forms in the subcutaneous tissue, and the skin becomes thin and reddish-blue in colour. Finally the abscess bursts, and a discharging sinus is left. Pressure effects may be present, especially in tubercular adenitis in the neck and mediastinum, and may cause dyspnoea, dysphagia, or oedema. If suppuration does not occur, and the condition becomes quiescent, the glands are very liable to be the subjects of recurring attacks of inflammation. The diagnosis has to be made from other forms of chronic inflammation, Hodgkin's disease, and primary and secondary new growth in glands.

TREATMENT.—All sources of infection must be treated, and the usual general treatment of tuberculosis carried out. It is in this condition that vaccine therapy has been most successful, and it should always be given a trial before operative methods are used. General treatment, with the treatment of the focus of infection, is frequently all that is necessary; but if the condition does not readily respond to treatment, operative measures should not be delayed, especially if the glands are enlarging and there is any evidence of suppuration.



FIG. 137.—TUBERCULAR ULCERATION SECONDARY TO TUBERCULOUS ABSCESS IN THE LYMPHATIC GLANDS.

The most satisfactory operative procedure is complete excision of the affected glands before the periglandular tissue has become infected, and when the tubercular material is confined within the capsule of the gland. If this is done effectively, the wound may be closed, and healing by the first intention obtained. If this method of treatment is not possible, owing to the late stage at which the case has come for treatment, as much of the gland as possible should be removed by dissection, and the remainder and the granulation tissue scraped away with the sharp spoon. Drainage for a short time is necessary, but should be dispensed with as soon as possible. These operations are not without danger, for the glands become firmly fixed to the veins, and serious hæmorrhage may result, or important nerves may be cut while removing the mass.

If a superficial abscess be found, it is useless to open it and neglect the diseased gland lying under the deep fascia. The abscess must be freely opened and the opening in the deep fascia found. This should be enlarged and the remains of the gland completely removed.

Some surgeons advocate aspiration of the pus from these abscesses and continuing with general treatment, but complete and thorough operation gives the best results.

After extensive suppuration, followed by a complete operation, serious obstruction of the lymphatic vessels may occur and a condition of elephantiasis result. This is more common in tuberculosis of the glands of the axilla or groin than in those of the neck.

Syphilitic Adenitis.—Syphilitic infection of the glands may occur in all the stages of the disease—(1) In *primary* syphilis the glands nearest the chancre are subacutely inflamed. If the chancre is on the external genitals, the glands in the groin are usually discrete and hard, but with extragenital chancres the glands are more acutely inflamed, and become matted together. Suppuration does not occur unless there is a secondary infection. (2) In the *secondary* stage of the disease there is a general subacute adenitis of most of the glands of the body, which rapidly yields to antisyphilitic treatment, and which never ends in suppuration. (3) *Gummatous* infection of the lymphatic glands is one of the rarer forms of syphilitic manifestations, and is more common in



FIG. 138.—GUMMA FORMATION IN LYMPHATIC GLANDS.

(London Hospital Medical College Museum.)

the inherited than in the acquired disease. The condition closely simulates chronic tubercular adenitis, the glands being enlarged and matted together. Degeneration may occur and a gumma form, which may burst and lead to extensive syphilitic ulceration.

The DIAGNOSIS from tubercle is made by the usual methods.

Tertiary syphilitic inflammation of glands is not very amenable to anti-syphilitic treatment, and it is better to dissect out the glands first and then give iodides and mercury than to trust to general treatment alone.

NEW GROWTHS OF THE LYMPHATICS AND LYMPHATIC GLANDS

1. NEW GROWTHS OF THE LYMPHATICS

Lymphangioma.—The lymphangiomas are innocent tumours composed of lymphatics lying in a variable amount of connective tissue. They are congenital in origin, but may not become prominent till later in life. Three varieties are described—(1) capillary lymphangioma; (2) cavernous lymphangioma; (3) cystic hygroma, or lymphatic cyst.

1. CAPILLARY LYMPHANGIOMA.—These tumours closely resemble the capillary naevi, but contain lymph instead of blood. They occur anywhere in the skin or mucous membrane, but are perhaps most commonly seen on the tongue and cheeks. The tumour appears as a slightly raised yellowish patch, with a warty appearance, due to the presence of small vesicles containing lymph on its surface.

TREATMENT.—The patch should be excised or cauterized.

2. CAVERNOUS LYMPHANGIOMA.—These tumours are also met with on the skin and mucous membranes, and resemble the cavernous naevi. They usually have a delicate capsule, and consist of a number of small vesicles, which, on being pricked, exude lymph.

TREATMENT.—Excision or cauterization.

3. CYSTIC HYGROMATA are congenital tumours, which are most frequently met with in the neck (hydrocele of the neck), but which also occur in the axilla, groin, or internally. The tumour consists of a single cyst, or a number of cysts, which in the neck lie below the deep fascia, and ramify amongst the various structures, and may even extend down to the axilla. The cysts vary in size from a pea to a small orange, and the resulting swelling may be so large as to obstruct labour, or may be quite



FIG. 139.—LYMPHANGIOMA OF THE TONGUE.

insignificant in size. On dissection, the cysts are found to be lined with a single layer of endothelial cells, the individual cysts not necessarily communicating with one another. The contents are thin, clear serum, but hæmorrhago may occur into the cysts and alter their appearance. In some cases the skin over the cyst is so thin that the tumour is translucent.



FIG. 140.—CYSTIC HYGROMA.

The *Diagnosis* has to be made from lipomata. These tumours may either disappear spontaneously, or become infected and suppurate.

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TREATMENT.—If small, the cystic hygromata should be treated by excision, but if the tumour is at all large, the operation is very difficult, owing to the extremely thin walls of the cysts and the close connection they have with the important surrounding structures.

The cysts may also be tapped and injected with iodine—a treatment which will sometimes result in cure; or the cysts may be opened and the wound packed with gauze and allowed to granulate.

Macroglossia.—This is a rare congenital defect of the tongue, resulting in enlargement of that organ, so that it cannot be retained in the mouth; secondary changes commonly occur in the jaws and teeth from pressure. The condition is most commonly due to a new growth of the lymphatics of the tongue, and should be classed under the term "lymphangioma"; but considerable enlargement of the tongue may occur from other causes.

Macrochellia is a similar condition occurring in the lips.

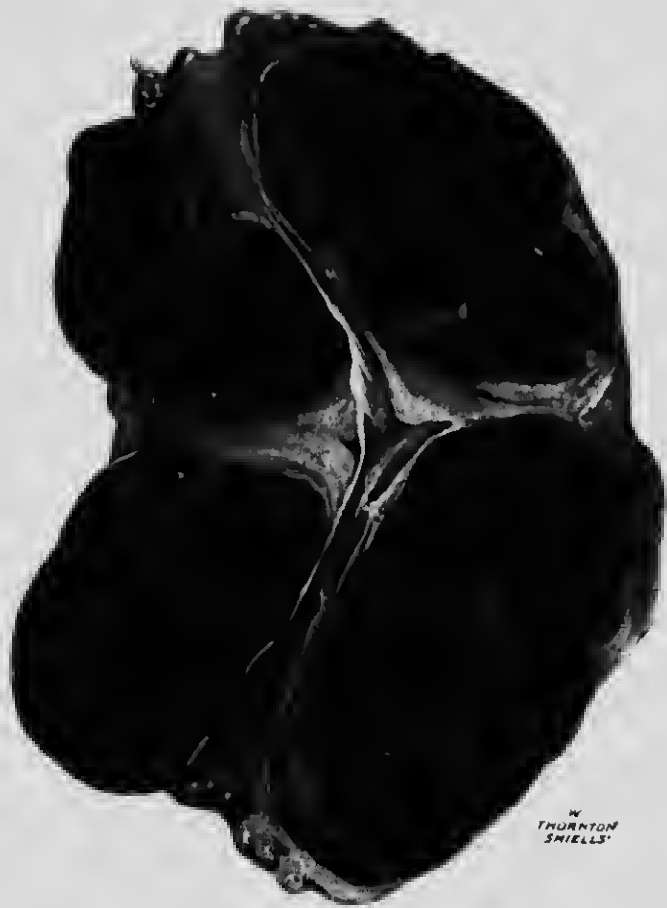
2. NEW GROWTHS OF THE LYMPHATIC GLANDS

There are no innocent tumours arising in lymphatic glands, and the only *primary* malignant tumour is lympho-sarcoma.

Lympho-Sarcoma.—These tumours appear in the neck, axilla, groin, or mediastinum, and are very rapidly growing and malignant. The disease appears to start in one gland, but there is a rapid secondary affection in the neighbouring glands, and the tumour tissue soon spreads beyond the limits of the capsule, matting the glands together, and fixing them to surrounding structures and to the skin.

Besides starting in the lymphatic glands, these tumours appear in

PLATE II.



Secondary Melanotic Deposits in lymphatic glands.

(London Hospital Medical College Museum).

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the lymphoid tissue, such as the tonsils or Peyer's patches in the intestine.

The SYMPTOMS are the presence of the tumour and the effects of pressure and infiltration of the surrounding structures. General dissemination occurs early, and the disease is very fatal.

TREATMENT.—Early and complete excision is the best method of treatment, but too frequently this is impossible when the patient is first seen. In inoperable cases and after operation a course of X-ray treatment should be given.

Secondary Growths in lymphatic glands may be carcinoma, sarcoma, or melanoma. The glands are most frequently affected in carcinoma, and have the following characteristics: The glands are enlarged, hard, become matted together, and fixed to the skin and deeper structures. In cases secondary to carcinoma of the tongue or lips a chronic form of suppuration, due to infection, frequently occurs, and if the abscess is opened and bursts, a large fungating carcinomatous ulcer results. Secondary affection of glands is also common in the melanomata, and enormous enlargement may occur, while the primary growth remains quite small.

The sarcomata that chiefly infect the lymphatic glands are the lympho-sarcomata and the sarcomata of the testes, tonsil, thymus, and thyroid; but sarcomatous growths in glands may occur secondary to sarcoma in any tissue.

Lymphadenoma (Hodgkin's Disease, Pseudo-Leukæmia).—This is a general disease affecting chiefly the lymphoid tissue of the body, and associated with a secondary anæmia.

PATHOLOGY.—The cause of the condition is unknown; two views are held: (1) That it is a form of chronic infection most probably due to an organism; (2) that it is a variety of neoplasm of the lymphatic glands. The former view is probably the correct one.

On section, the glands are fleshy and of a greyish-yellow colour, and the capsule not being thickened by periadenitis, the glands are discrete. On microscopic examination, it may be found that the lymphoid tissue is abundant and the gland soft, or the fibrous tissue may be increased in amount and the gland hard, or in some cases the proportion between the two elements is normal. Increase of lymphoid tissue also occurs in the Malpighian corpuscles of the spleen (hard-hake spleen), and in the liver, kidneys, testes, and other organs. On examination, the blood shows a secondary anæmia with slight increase of the lymphocytes, but no increase of the polymuclear cells unless a secondary infection has occurred.

CLINICAL FEATURES.—The disease is most commonly met with in young adults, but no age is exempt, and boys are more frequently affected than girls. The glands which first become enlarged are usually the glands of the neck, but the disease may start in any group of glands, including the mediastinal or mesenteric glands.

Two types of cases are recognized: (1) The enlargement of the glands is limited to one group, generally those of the neck, for years,

and the disease progresses very slowly and almost without general symptoms. (2) The enlargement rapidly affects many groups of



FIG. 141.—GENERALIZED LYMPHADENOMA.

glands and other lymphoid tissue, and death occurs in under two years. Intermediate cases are, however, common, and curious retrogressions and advances in the condition without apparent cause are a striking feature of the disease. For example, a huge mass of glands in the neck may rapidly disappear at the same time that the mediastinal glands are steadily enlarging, and this without apparent cause, and often without any treatment.

Characters of the Glandular Enlargement.—The individual glands become larger than is usually seen in tubercular disease, and are firm and fleshy to the touch. They remain discrete from one another, and are not fixed to the skin or deep fascia, and the mass may be very large without causing pressure effects. Suppuration does not occur unless there is a secondary infection. On dissection, the glands are very readily removed, and are in striking contrast to tubercular or malignant glands in this respect.

Besides the enlargement of the glands there is a secondary anemia with its usual symptoms, and in the generalized and more rapidly growing form there is an irregular pyrexia, and the glands may become painful, but complaint is rarely made of this symptom.

Pressure effects are most common when the mediastinal glands are affected, as the vessels, trachea, œsophagus, etc., are pressed against the unyielding walls of the thorax by the enlarged glands; but infiltration of surrounding structures is only occasionally seen in the more malignant types of the disease.

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FIG. 142.—MASS OF GLANDS FROM A CASE OF LYMPHADENOMA. (HODGKIN'S DISEASE.)

The **DIAGNOSIS** has to be made from tuberculosis, leucocythæmia, and lympho-sarcoma, and if this is not readily done by the clinical features of the case, one of the glands should be removed and examined microscopically.

TREATMENT.—The medical treatment consists of giving arsenic in full doses for a long period, and maintaining the general health as far as possible. In some cases there is marked improvement with the use of the X rays, the glands and the spleen rapidly diminishing in size; but as a rule the improvement is temporary.

Excision of the enlarged glands is usually very easy, and may be undertaken if the condition is localized to one group of glands, but it rarely succeeds in arresting the disease. Excision of the spleen has also been undertaken for this disease, but it is doubtful if this operation is justifiable.

Lymphatic Leucocythæmia.—Lymphatic leucocythæmia is a disease of the blood-forming organs characterized by enlargement of the spleen, the medulla of the bones, and the lymphatic glands, as well as by blood changes. The characteristic condition in the blood is the great increase of the number of leucocytes and the great predominance of the lymphocytes, which may constitute 95 per cent. of the total number of white cells. Enlargement of the lymphatic glands is a special feature in some forms of the disease, and the condition has to be diagnosed from lymphadenoma. The blood-count is usually distinctive.

Elephantiasis.—Elephantiasis is a condition of hypertrophy of the skin and subcutaneous tissue due to chronic obstruction of the lymphatics. This obstruction is brought about in various ways, but two main varieties are recognized—(1) Filarial, due to infection with the *Filaria sanguinis hominis*; and (2) non-filarial, due to (a) chronic inflammation of the lymphatic glands; (b) extensive operations on the lymphatic glands; (c) obstruction of the lymphatics by secondary carcinoma; (d) chronic and recurring attacks of lymphangitis. The condition is most commonly seen in the lower extremity, but may occur in the arms, breast, scrotum, and face.

PATHOLOGICAL ANATOMY.—The first effect of blocking the lymphatics is to bring about a dilated varicose condition of the vessels (lymphangiectasis), associated with an exudation of lymph from the vessels, so that the limb becomes œdematous. The œdema differs from the œdema due to venous obstruction in being much more solid and pitting with difficulty on pressure. As the condition progresses, there is a hyperplasia of the connective-tissue element in the subcutaneous tissue, with a coarsening and thickening of the skin, which finally becomes warty, and on which the dilated lymphatics may be clearly seen. Rupture of the dilated lymphatic vessels may occur, leading to the formation of a lymph fistula (*lymphorrhœa*). If the main lymphatic vessels are affected, there may be accumulation of chyle in the peritoneum (*chylous ascites*), pleura (*chylo-thorax*), or it may be passed in the urine (*chyluria*).

The increases in size of the limbs or scrotum may be enormous, especially in the filarial type; the scrotum has been known to weigh over 200 pounds.

In the later stages of the affection eczema and ulceration of the

affected tissue are common, and still further aggravate the condition, whilst occasionally gangrene may supervene.

Filarial Elephantiasis (Elephantiasis Arabum, Barbadoes Leg, Lymph Scrotum).—

This condition is due to an infection by the nematode worm, *Filaria sanguinis hominis*, which is found chiefly in the West Indies, Brazil, and Sanea. The embryo of the worm gains entrance to the human body through drinking-water in which the bodies of mosquitoes (which act as the intermediary host) have fallen. The embryos are carried by the blood-stream to the lymphatic glands chiefly in the groin, and in them the adult worms live. The adult females are about $3\frac{1}{2}$ inches long and $\frac{1}{100}$ inch wide, and produce an enormous number of embryos, which enter the blood-stream, where they may either be found at night (*Filaria nocturna*) or in the daytime (*Filaria diurna*). The lymphatic obstruction is probably brought about in two ways—(1) The presence



FIG. 143.—FILARIAL ELEPHANTIASIS OF THE SCROTUM.

(Dr. Stephen's case.)

of the worm predisposes the gland to recurrent attacks of inflammation associated with rise of temperature, and this inflammation may end in suppuration, with discharge of the dead body of the nematode; and (2) the female worm may abort, and, instead of producing free-swimming embryos that can enter the blood-stream, produces

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embryos that are curled up inside an envelope, and which are too large to pass along the lymphatic vessels and so obstruct them.

The life-cycle of the filaria becomes complete by the free-swimming embryos being taken into the body of the mosquito with the blood it sucks from the human being it bites.

Non-Filarial Elephantiasis is more common in women than in men, as the most usual causes are septic infection of the veins and lymphatics associated with septic conditions of the uterus and its appendages, and secondary infection of the axillary lymphatics from carcinoma of the breast. In men the condition is most frequently



FIG. 144.—*Filaria sanguinis hominis*.



FIG. 145.—ELEPHANTIASIS FOLLOWING PHEGEMASIA ALBA DOLENS.

seen in the scrotum and penis, following extensive suppuration in the glands of the groin. The condition may be equally extensive as in the filarial variety.

TREATMENT.—In cases of filarial elephantiasis it may be possible to come to a conclusion in which set of glands the female parent filaria is living, and if this can be done, the glands should be removed; but this is not necessarily followed by retrogression or arrest of the symp-

toms. If this is not possible, the treatment of the filarial variety, as of the non-filarial variety, is symptomatic.

Elephantiasis of the Extremities should be treated by elastic bandaging, massage, and elevation of the limb, and if these are persevered with, some improvement may be hoped for. It is important to guard the patient from slight injuries which may lead to septic infection, or the condition may be greatly aggravated.

Elephantiasis of the Scrotum should be treated by removal of the enlarged tissue as soon as it becomes unsightly or inconvenient. The scrotum should be elevated to drain the blood from the part, and hæmorrhage should be controlled by the use of an elastic tourniquet. The penis and testes should be carefully dissected out and protected from injury; the results are excellent.

Lymphangioplasty.—This operation has been chiefly employed for the relief of lymphatic œdema of the upper extremity, following secondary infection of the lymphatics of the axilla in carcinoma of the breast; but it has been used for the treatment of elephantiasis due to other causes. A number of stout silk threads are buried in the subcutaneous tissue of the affected part, and carried beyond its limits. They drain the lymph away from the affected part to the healthy tissues above by capillary attraction. This operation sometimes affords considerable relief, but the relief is not always permanent, and the condition relapses. It is of the utmost importance that the operation should be carried out perfectly aseptically.

MUSCLES AND TENDONS

INJURIES OF MUSCLES AND TENDONS

Laceration and Division of Muscle or Tendon.—Muscles and tendons may be divided in an open wound, and in the majority of cases the diagnosis is obvious on inspection; but in the case of small incised wounds, especially at the wrist, careful examination is necessary to determine the presence or absence of division of a tendon. If there is any doubt as to the diagnosis, the wound should be enlarged.

TREATMENT.—If the muscle or tendon is divided in its long axis, no special treatment is necessary; but if the division is transverse, there is separation of the ends, and these must be brought together by careful suture.

In the case of the tendons of the foot and hand there is often considerable separation of the ends of the tendons owing to contraction of the muscles, and the tendon sheaths and ligaments have to be freely divided in order to restore the continuity of the tendon. This should always be done, no matter how extensive a dissection is required.

The best materials for suture are fine silk or chromicized gut, and a rounded intestinal needle should be used. The methods of suturing are shown in Fig 154. Every care must be taken to insure aseptic healing, as the success of the operation largely depends on this; if there is much laceration of the part, the wound should be drained.

After the tendon has been sutured, it should be wrapped in Cargile membrane to prevent adhesions forming between it and the surrounding tissue, and, if possible, the sheath should be sutured. The wound is then closed.

A splint should be adjusted in such a manner that the divided tendons or muscles are kept relaxed, and the splint worn for a fortnight; but passive movements should be started on the fourth day. Strong active movements should not be allowed for six weeks. If suppuration occur, the result will probably be disappointing, as the tendon will usually become firmly fixed to their sheaths; but even in these cases considerable improvement may result from vigorous passive and active movements.

Ruptured Muscle or Tendon.—A muscle or tendon is most commonly ruptured by a violent sudden contraction of the muscle, especially if there is some degeneration of the muscle present. Rupture of muscle or tendon may also be due to direct violence from a heavy blow. The chief predisposing causes are degeneration of the muscle from disease, as after the infectious fevers such as typhoid, or fatty degeneration occurring in general obesity, old age, and alcoholism. The accident very frequently occurs in athletic men who make some violent effort when out of training. The rupture may be partial or complete, the former being more common.

Partial Rupture of a Muscle or a sprain of muscle is rupture of some of the fibres of a muscle, and, according to the occupation of the patient and the muscle injured, has been called "labourer's back," "tennis elbow," "jumper's sprain," etc.

The symptoms are sudden pain on attempting a movement, with tenderness on pressure and inability to repeat the particular movement. A day or two later a bruise usually appears on the skin.

TREATMENT.—The part should be bathed in hot water, gently massaged, and then a firm bandage or strapping should be applied. This should be renewed daily, the part being massaged, passively moved, and gently exercised until well.

Complete Rupture of a Muscle is much rarer than rupture of a tendon, and occurs usually near the junction of the muscle and tendon. The divided ends of the muscle retract, and a gap is left which becomes filled with blood-clot. Ultimately the ends of the muscle or tendon are united by fibrous tissue, as in the healing of other wounds; but if the ends are closely approximated, a certain amount of new muscular tissue may develop, especially in young subjects.

SYMPTOMS.—There is a sudden pain in the part during a muscular effort (which may be surprisingly slight), as if the patient had been struck (*coup de fouet*), and in some cases the patient can feel or even hear something give way. The limb becomes powerless, movement is painful, and the part is tender and swollen. Ecchymosis appears later, and when the blood-clot is absorbed, a gap is felt between the divided ends, which becomes larger when the muscle is thrown into contraction.

TREATMENT.—In the majority of cases the best treatment is to cut down on the ends of the divided muscle or tendon, and suture them together as described above, the best time for doing this operation being four or five days after the injury. This method of treatment gives excellent results if the operation is carried out aseptically.

If this treatment is inadvisable for any special reason, or refused, the ends of the muscle or tendon should be approximated by fixing the limb on a splint in an attitude that relaxes the muscle, maintaining this attitude for three weeks, and then starting massage and passive movements. If the diagnosis has not been made at first, **secondary suture** may be tried, but the results are not good on account of the contraction of the muscle or tendon. One of the various methods of lengthening muscles or tendons must be used.

RUPTURE OF SPECIAL MUSCLES

1. Biceps of the Arm.—The part most frequently ruptured is the long head as it lies in the bicipital groove, and the condition is usually predisposed to by osteo-arthritis of the shoulder, the tendon becoming



FIG. 140.—RUPTURE OF THE LONG HEAD OF THE BICEPS.

partially worn by passing over the roughened bone. The final violence that determines the rupture is often slight. After the preliminary pain and tenderness have gone, the amount of disability is often slight, but the deformity is characteristic. On bending the elbow a swelling appears in the arm as if the belly of the biceps were drawn down towards the elbow. In cases with marked osteo-arthritis no treatment is advisable.

2. Quadriceps Extensor.—This muscle is usually ruptured close to its insertion into the patella, and is a fairly common football accident. It is often bilateral, and causes considerable disability. On contracting the muscle, a gap is felt above the patella, and a swelling appears in the front of the thigh.

TREATMENT.—The ends of the muscle should be approximated by sutures four or five days after the accident.

3. **Tendo Achillis.**—This tendon may be ruptured by comparatively slight violence, such as while dancing, and the condition may easily be overlooked at first. The ends of the tendon should be sutured, or if this is not advisable, the patient should be kept for three weeks with the ankle strongly plantar-flexed.

4. **Plantaris.**—This small muscle is frequently ruptured by sudden movements. There is sudden sharp pain in the leg, which becomes painful and swollen. The limb should be massaged and treated for a sprain, care being taken that the patient walks with the heel on the ground.

5. **Common Extensor of the Fingers.**—The common site of rupture of this tendon is close to its insertion into the terminal phalanx of a digit by blows on the finger-tips, and the accident results in "drop" or "mallet finger." The terminal phalanx is flexed toward the palm, and cannot be extended. The tendon should be sutured.

6. **Sterno-Mastoid.**—Rupture of this muscle occurs during parturition, especially in breech presentations or a vertex presentation when forceps have been used. It is slightly more frequent on the right side than on the left, and very occasionally it is bilateral.

SYMPTOMS.—Shortly after birth a rounded firm swelling is found in the substance of the sterno-mastoid muscle (congenital sterno-mastoid tumour). This swelling is inseparable from the muscle, and blends with it above and below. It is not painful.

TREATMENT.—None is necessary, and the tumour will disappear in about three months.

The relationship of this rupture of the sterno-mastoid muscle and congenital torticollis is considered on p. 906.

Hernia of Muscle.—A hernia of a muscle results from a rupture of its fascial sheath, and this rupture is usually the result of a repetition of violent muscular efforts, so that the condition develops gradually.

SYMPTOMS.—The patient is conscious of a weakness of the part, and there is present a soft, rounded mass which gradually in-



FIG. 147.—HERNIA OF MUSCLE.

creases in size. If the muscle is made tense by stretching, the swelling gets smaller, whilst voluntary contraction causes it to become harder and somewhat smaller, or if the contraction is opposed, the swelling disappears. The muscles most frequently affected are the abdominal muscles and the adductors of the thigh.

The **DIAGNOSIS** has to be made from ruptured muscles, a condition which is sometimes spoken of as pseudo-hernia.

TREATMENT.—If the weakness is inconvenient, the gap in the muscle sheath should be sutured, but in the majority of cases the only treatment necessary is the wearing of a bandage.

Dislocation of Tendons.—Tendons may be dislocated from the fibro-osseous canals, in which they run, by sudden violent contraction, when the limb is in a position which favours the dislocation. For example, if the foot is everted, the peroneal tendons tend to have their groove behind the external malleolus, and a sudden movement with the foot in this position may result in a dislocation of the tendon. In some cases dislocation occurs gradually as in some cases of advanced flat-foot. The tendons most frequently dislocated are the biceps, peroneus longus and brevis, and tibialis posticus.

SYMPTOMS.—In sudden dislocations there is severe pain and loss of power of movement in the limb, which becomes swollen and painful. The displaced tendons can usually be readily felt, and the patient is aware of a displacement having taken place.

TREATMENT.—The tendon is easily placed back into its groove by manipulation. For example, with a displaced bicep tendon, the arm is abducted, and with displaced peronei the foot is inverted. The limb is then put up in the position opposite to that in which dislocation occurred, and splinted in this position for six weeks.

In a majority of cases the condition will be recurrent, and if this is so, the tendon must be exposed and sutured into place. If the patient will consent, this is probably the best treatment for the primary dislocation, as it will save the patient time. In cases of gradual dislocation no treatment is necessary.

DISEASES OF MUSCLES

INFLAMMATION OF MUSCLE (MYOSITIS)

1. **Traumatic Myositis** results from contusion of muscles associated with rupture of their fibres. The condition is usually unimportant, but leads to a certain amount of fibrosis, which possibly may cause contraction of the muscle with resulting deformity. In some cases, however, contusion or overstretching of a muscle is followed by an inflammatory condition termed—

Traumatic Myositis Ossificans.—This disease consists of a true ossification occurring in a muscle as a result of injury, and its essential pathology is unknown. The muscles chiefly affected are the extensor quadriceps and the brachialis anticus. The condition is most common in young adults.

CLINICAL FEATURES.—About two weeks after a severe injury of the muscle a hard swelling is felt at the site of the injury, which is definitely in the muscle, and also attached to the bone. This tumour steadily increases in size, and on examination with the X rays, a well-defined shadow is obtained. The presence of the bony mass causes a certain amount of pain and disability.

RESULTS.—If the tumour is left alone, in the majority of cases it will be reabsorbed or become so small that there is little inconvenience.

TREATMENT.—The limb should be put at rest until clinical examination and skiagraphy show that the bony mass is not enlarging. Exercise and massage should then be carried out until the mass has disappeared. In some cases absorption does not take place, and if at the end of a year considerable disability is present, the mass should be excised. Excision is more likely to be necessary in the case of the brachialis anticus on account of the interference with the movements of the elbow than in the quadriceps extensor.

2. Rheumatic Myositis.—“Stiff-neck” (rheumatic torticollis) and lumbago are examples of an inflammation of muscle which follows exposure to wet and cold and which is met with chiefly in people with the “rheumatic” diathesis.

The SYMPTOMS are severe pain and inability to use the affected muscles.

TREATMENT.—Anti-rheumatic remedies should be given, and the affected muscles treated with massage, baths, and stimulating liniments. (For further methods of treatment see textbooks on medicine.)

3. Septic Myositis. This is present in all suppurating wounds that penetrate the deep fascia, or is due to extension from suppuration in bones, glands, etc. Primary septic inflammation in muscle may also occur in conditions of pyæmia.

The TREATMENT follows the usual lines of any septic inflammation, and considerable fibrosis of the muscles with contraction and deformity may result.

4. Tubercular Myositis. Tuberculosis is rarely, if ever, a primary affection of muscle, but invasion of muscle by tubercular inflammation spreading from the bone is a common condition. An excellent example is destruction of the psoas muscle by tubercular inflammation, secondary to tuberculosis of the spine.

5. Syphilitic Myositis—(1) SECONDARY STAGE—(a) *Myalgia.*—This is a dull aching pain in the muscles, which may be generally distributed or be fixed in one muscle, and is usually worse at night. It yields readily to antisyphilitic treatment.

(b) *Contraction.*—Contraction of one or more of the muscles may appear about the end of the first year of the secondary period, the muscles chiefly affected being the biceps, sterno-mastoid, and the trapezius. The muscle becomes firm and stiff, and the electrical reaction is diminished. There is little or no pain. The condition

may last for years, but is rapidly relieved by antisyphilitic treatment.

(2) TERTIARY STAGE.—The muscles may be the seat of gumma formation or sclerosis. *Gummata* in muscles are usually multiple, and are most common in the tongue and sterno-mastoid muscle. They form firm painless tumours which are fixed when the muscle is contracted. Later, they burst, and ulcers result, which are frequently difficult to diagnose from carcinomatous ulcers. In *syphilitic sclerosis* the muscles are increased in size, but are painful and stiff, and on microscopic examination are found to be degenerating. If antisyphilitic treatment is started early, complete recovery may occur, but if fibrosis is present, little benefit will be obtained.

Myositis Ossificans.—The CAUSE of this condition is unknown. It is most frequently met with in males, and usually starts in childhood or youth. Some cases follow an injury.

The disease appears to be an inflammation followed by ossification of the connective tissue of the muscles associated with degeneration of the muscular fibres. The masses of bone formed are not limited to any one muscle, but lie irregularly among the muscles.

SYMPTOMS.—The disease generally originates among the muscles of the back, and the symptoms are limitation of movement, awkwardness, and increasing disability. From the back the condition may spread all over the body; but it does not do so steadily, but progresses by fits and starts. At first a swelling appears in the muscles closely resembling a myositis, and as this swelling subsides, a mass of bone is felt among the muscles, and the movements of the part are limited.

The involuntary muscles are never attacked.

In the majority of cases the big toes present the deformity of hallux valgus, and the thumb may also be turned in towards the palm of the hand.

PROGNOSIS.—The disease is incurable, and death usually occurs in about twelve years from pulmonary complications.

TREATMENT.—No treatment is of any use, but occasionally a mass of bone that is interfering with the movement of a joint may be removed with benefit. When the temporo-maxillary joint becomes fixed, it is necessary to feed the patient artificially.

Ossification in Muscles, Tendons, and Fasciæ.—Ossification in muscles, tendons, and fasciæ from other causes than myositis may occur in the following conditions:

1. Ossification spreading into a muscle from its normal attachment. An example of this is ossification spreading into the adductor magnus tendon from the adductor tubercle.
2. Ossification occurring in muscle as a result of numerous slight injuries. Examples of this condition are "rider's bone" in the adductor longus, and "drill bone" in the deltoid, and pectoral muscles due to bruising of the muscles by the recoil on firing a rifle.

LYMPHATICS, TENDONS, MUSCLES, AND BURSÆ 355

3. Ossification spreading into the muscles during union of a fracture.
4. Ossification of ligaments occurring in *osteo-arthritis*.
5. Ossification, especially in ligaments and intermuscular septa associated with inflammatory conditions of the periosteum.
6. Traumatic myositis ossificans (described above).

Volckmann's Ischæmic Contracture.—Ischæmic contracture of muscle is most frequently seen in the muscles of the forearm, and is usually due to the too tight application of splints or plaster of Paris cases in fracture of the radius and ulna. It may, however, follow the application of a tourniquet, and has also occurred after the blocking of the brachial artery by an embolus for thirty-six hours. The condition is one of atrophy with cicatricial contraction of the muscles due to interference with their arterial blood-supply, and it may be complicated by cicatricial changes occurring in the median and ulnar nerves due to the same cause.

SYMPTOMS.—The muscles waste and become hard and stiff, so that voluntary movement is largely lost and passive movement is painful. Contracture occurs, producing a deformity resembling the claw hand of ulnar paralysis. On electrical examination of the muscles, the reaction of degeneration (R.D.) is *not* present, and the muscle reacts to both the interrupted and the constant current.

If the nerves are also damaged, changes in sensibility are present.

TREATMENT.—The muscles should be massaged, and active and passive movements carried out over a long period, contracture being prevented by the use of splints. If this method of treatment is not successful, one of two operations may be performed:

1. The tendons of the contracted muscle may be lengthened by an open operation.
2. The bones of the forearm may be shortened by removing a piece from the shaft.

The first of these operations gives the better result, for resection of portions of the radius and ulna may be followed by non-union.

NEW GROWTHS OF MUSCLES

Tumours composed of striped muscle are exceedingly rare, and with the exception of striped muscular fibres being found in certain congenital sarcomata of the kidney, the tumours of the voluntary muscles grow from the connective-tissue framework.

The *Innocent* tumours are **lipoma**, **fibroma**, **chondroma**, and **angioma**, but they are all rare, and present no special clinical features.

The *Malignant* tumours are **secondary carcinoma** and **sarcoma**. The only one requiring special mention is the slowly growing **fibrosarcoma** or **recurrent fibroid**. These last tumours are most frequently met with on the anterior abdominal wall, and form firm, slowly growing tumours, which spring from the sheaths of the muscles, and require very complete removal, or they will recur.

Diagnosis of a Tumour of Muscle.—There is a firm swelling lying beneath the deep fascia which becomes fixed, but more indefinitely when the muscle is contracted. It can be moved across the fibres of the muscle, but not up and down.

TREATMENT.—Tumours growing in the muscles should be removed.

Phantom Tumours are produced by contraction of a segment of a muscle, and are most frequently met with in the rectus abdominis. They occur in hysterical patients, but the spasm is sometimes protective, and indicates a source of pain in the abdominal cavity, such as an inflamed gall-bladder or a duodenal ulcer. They disappear under anaesthesia.

DISEASES OF TENDON SHEATHS

INFLAMMATION—Tenosynovitis—1. *Traumatic.*—This condition is associated with over-use of the muscle, especially after a period of rest, and most commonly affects the tendons on the back of the wrist, the biceps brachialis, the tendo Achillis, and the peroneal tendons. There is first an exudation of plastic lymph into the tendon sheath, so that the inner surface becomes roughened, and this is followed by a serous effusion. Recovery is as a rule perfect.

SYMPTOMS.—The patient complains of pain and weakness of the part, and on examination it is found to be slightly swollen, the swelling mapping out the tendon sheath. If the hand is placed over the tendon and the patient contracts the muscle, a characteristic crepitus is obtained, which may be mistaken for the crepitus of a fracture. As the effusion increases the crepitus is lost, to be felt again when the exudate is absorbed.

TREATMENT.—The muscle and tendon are kept at rest by suitable splinting, and the overlying skin is painted with glycerin and belladonna or iodine. Recovery occurs in a week to a fortnight.

2. *Gouty Tenosynovitis.*—A deposit of urate of soda may occur into the subendothelial tissue of the tendon sheaths, associated with attacks of pain and disability.

TREATMENT.—The usual treatment of gout is carried out, but in some cases it may be advisable to remove a mass of urate from the tendon sheath.

3. *Septic Tenosynovitis.*—This form of tenosynovitis is most commonly met with in the sheaths of the flexor tendons of the fingers, and has already been considered under the heading of Whitlow, p. 86. The inflammation usually ends in suppuration, and sloughing of the tendon is common.

TREATMENT.—The tendon sheath should be freely opened and drained, and in the after-treatment, Bier's method of passive hyperaemia may be tried. If the tendon sloughs, it must be removed.

4. *Gonorrhoeal Tenosynovitis.*—The gonococcus is particularly apt to attack the tendon sheaths of the wrist and ankles, causing a subacute inflammation, which in many cases becomes chronic. There is effusion into the tendon sheaths, with limitation of movement and severe pain.

LYMPHATICS, TENDONS, MUSCLES, AND BURSÆ 357

The majority of cases get well under treatment, but in a few cases suppuration or fibrous adhesions between the tendon and its sheath result.

TREATMENT.—The urethral discharge should be treated, and the tendons kept at rest until the acute inflammation has subsided. Afterwards massage, passive and active movements, should be persevered with, and in obstinate cases all forms of baths and heat treatment may be tried.

A gonorrhœal vaccine is useful in some cases.

5. Tubercular Tenosynovitis.—Tubercular inflammation of the tendon sheaths may either be primary or secondary to tubercular disease of the joints or bones, and develops under the same conditions.

Two clinical varieties of this disease are recognized—(1) Hydrops of the tendon sheaths, with the formation of melon-seed bodies; and (2) fungating tubercular tenosynovitis.

(1) *Tubercular Hydrops of the Tendon Sheaths.*—This condition is most frequently seen in the tendon sheaths of the wrist, hand, and ankle. The tendon sheaths become distended with a clear, thin serous fluid in which numerous small bodies, about the size of rice grains, are found. The walls of the sheaths are thickened, and in some cases tuberculous nodules are found on them. Tubercle bacilli and tubercles are occasionally found in the melon-seed bodies, and injection of them into the peritoneal cavity of guinea-pigs is followed by tuberculosis.

SYMPTOMS.—The disease is essentially chronic, and the patient complains of weakness and disability in the tendons affected. The part affected becomes swollen, and the swelling exactly marks out the tendon sheaths. Fluctuation is present. Occasionally there is a characteristic sensation as the melon-seed bodies are moved from one part of the sheath to another.

If the tendon sheaths of the palm of the hand are affected, there is a swelling above and below the anterior annular ligament, and fluctuation can be felt between the two swellings. The swelling may extend to the thumb and little finger. This condition is sometimes called a *compound palmar ganglion*.

The inflammation may remain stationary for months or years, but in some cases the surrounding tissues and skin may be involved in the tuberculous process and a fistulous opening result. Sepsis is then added to the tuberculous process, and the condition will become rapidly worse.

(2) *Fungating Tenosynovitis* is the less common form of this disease, but it has the same etiology as hydrops, and affects the same tendon sheaths. The inflammatory process may only affect one part of the tendon sheath or extend along the whole length, and in the majority of cases suppuration and sinus formation result.

SYMPTOMS.—The symptoms and physical signs of this condition are similar to those of hydrops, but the swelling has a pulpy feel instead of being fluid and fluctuant. The process is chronic, but

ultimately the tendon itself is invaded and destroyed, and there is complete loss of the function of the part.

The *Diagnosis* as a rule is easy, but has to be made from lipoma and other tumours of the tendon sheaths.

TREATMENT.—The usual *general* treatment of tuberculosis with the use of tuberculin is carried out. *Locally* the treatment at first should be conservative; the part should be kept at rest and Bier's method of passive congestion tried. In the case of hydrops the tendon sheath may be punctured and the fluid removed.

If this method of treatment fails, the tendon sheath should be opened, the walls dissected away as far as possible, and the wound closed, without drainage. In cases where secondary infection has occurred, thorough laying open of the tendon and drainage—and in some cases amputation—will be necessary.

In the after-treatment, after incision, passive movements must be regularly and carefully carried out to prevent adhesion of the tendons to surrounding structures.

6. Syphilitic Tenosynovitis.—Inflammation of the tendon sheaths is a rare syphilitic affection, but effusion into the sheath may occur in the secondary stage, and a gummatous synovitis may be found in the tertiary. The treatment is antisyphilitic.

Ganglion.—A ganglion is a cyst filled with a clear, jelly-like material which occurs in the neighbourhood of a joint or tendon sheath.

PATHOLOGY.—Three views are held as to the pathology of these cysts—

1. They are herniæ of the synovial lining of the tendon sheaths.
2. They are retention cysts of the glands that secrete the synovia.
3. They are degeneration cysts of the fibrous tissue forming the capsule of a joint or the sheath of a tendon.

Ganglions are most frequently seen in women during the period of adolescence, and are most common over the dorsum of the wrist, the palm of the hand, the dorsal aspect of the foot, and in connection with the hamstring muscles.

SYMPTOMS.—The patient complains of a swelling near a tendon or joint, weakness, and some pain in the part. The swelling is rounded, cystic and is not attached to the skin. The diagnosis is as a rule easy, but if the ganglion is very tense, it may be mistaken for a solid tumour, such as a lipoma. Ganglions rarely grow to a larger size than a pigeon's egg.

TREATMENT.—In many cases no treatment is necessary, but if the condition is unsightly or causes disability, the ganglion may be crushed by digital pressure; this is frequently followed by recurrence, and a more satisfactory method of treatment is to puncture the ganglion with a tenotomy knife, squeeze out the contents, and apply pressure. If this fails, the ganglion should be excised and it will then be found that it does *not* communicate with the tendon sheath or joint.

Compound Ganglion.—A compound ganglion is tubercular inflammation of a tendon sheath, and the term should disappear.

NEW GROWTHS OF TENDON SHEATHS

Tumour formation in a tendon sheath is rarely seen, the most common being fibroma, lipoma, and sarcoma. The diagnosis has to be made from tubercular disease of the tendon sheath, and this is most difficult in the case of the lipoma, especially if the fatty tumour is branched (*lipoma arborescens*).

The TREATMENT is removal.

OPERATIONS ON TENDONS

Tenotomy.—This operation is used for lengthening a tendon, and is usually performed subcutaneously. The tenotomy knife is introduced on the deep aspect of the tendon, which is then put on the stretch. By a series of small sawing movements the tendon is divided. After division of a tendon the limb is placed on a splint in the corrected position. Union of the tendon occurs in about three weeks, and non-union is rare. The tendons of the biceps femoris and the sternomastoid are usually divided after the tendon has been

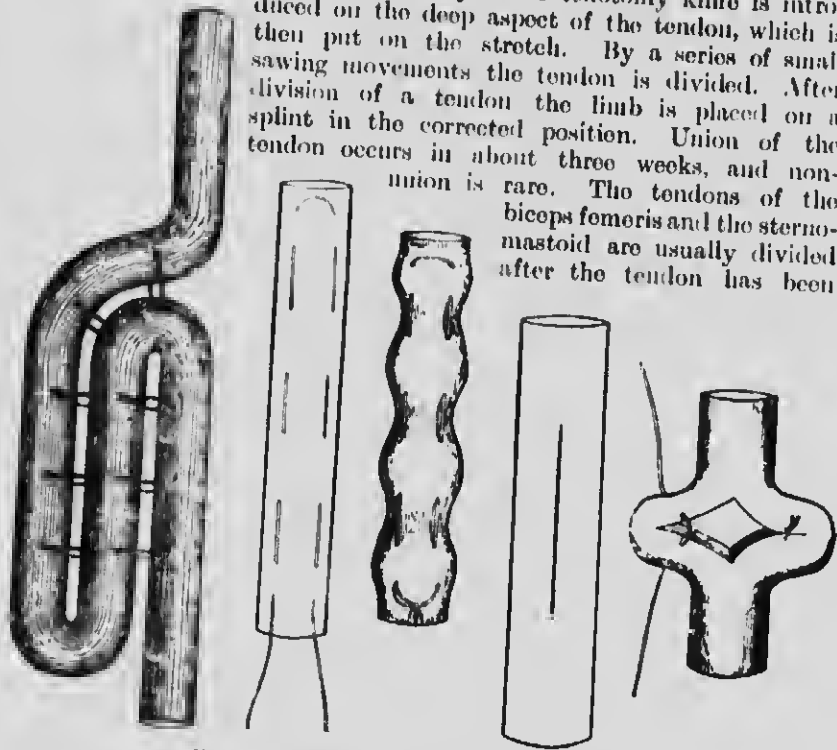


FIG. 148.—METHODS OF TENDON SHORTENING.

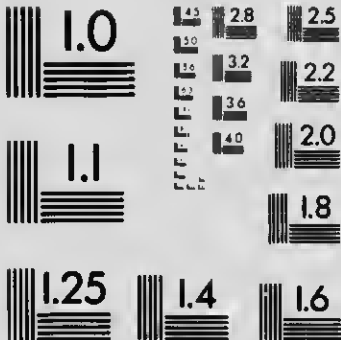
exposed in an open wound, as subcutaneous tenotomy is dangerous on account of the important structures lying beneath these tendons.

Tendon Shortening is an operation that is very rarely required. If it is necessary, one of the methods shown in the diagram should be used.



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Tendon Lengthening is most commonly secured by performing tenotomy, but a tendon may be lengthened by one of several plastic operations. The methods of lengthening a tendon are shown in Fig. 149.

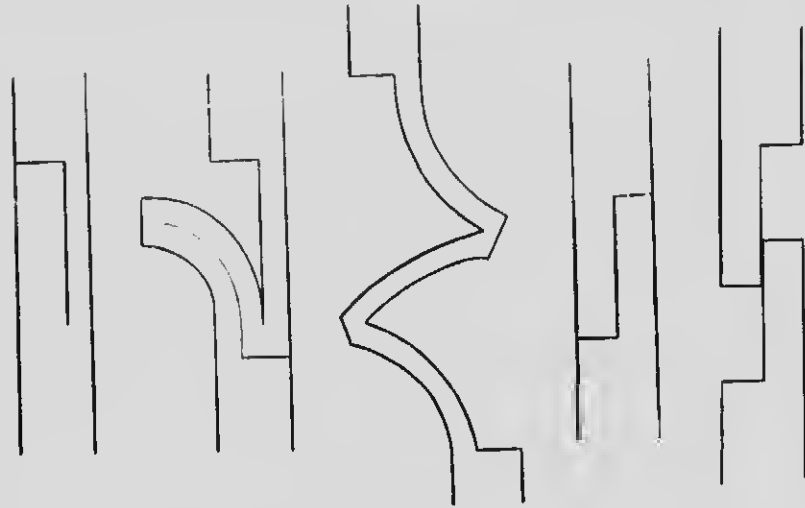


FIG. 149.—METHODS OF TENDON LENGTHENING.

Tendon Transplantation.—In cases where there is loss of muscular function without hope of recovery, a tendon attached to an acting muscle may be transplanted to reinforce a group of paralyzed muscles. This method of treatment has been largely used in the treatment of deformities following acute anterior poliomyelitis, but the results are not very satisfactory (see p. 288).

THE BURSAE

Contusions.—Contusions of a bursa may result in effusion of blood into the bursa, and the hematoma may become infected and suppurate.

TREATMENT.—Rest; but if there is a large hematoma the bursa should be opened and the blood-clot removed.

Wounds.—A wound of a bursa is recognized by the escape of synovial fluid.

TREATMENT.—The usual treatment of any wound is carried out, but in some cases a fistula, discharging synovia, results, and the bursa has to be excised.

INFLAMMATION OF BURSAE

Bursitis—Acute Septic.—Infection of a bursa may occur from a penetrating wound, but it most commonly follows a contusion of a chronically inflamed bursa, especially the bursa patella.

SYMPTOMS.—The already enlarged bursa becomes more swollen and painful and the skin over it is red and hot. The usual general symptoms of infection are present. If suppuration occurs, pus is formed inside the bursa, but soon passes through the wall into the surrounding tissue. The adjacent bones or joint may become infected.

TREATMENT.—The inflamed bursa should be relieved of all pressure and the part kept at rest. Fomentations should be applied to relieve the pain and promote resolution. If suppuration occurs, free incision and drainage of the bursa are necessary.

Traumatic Bursitis ("Trade Bursitis").—This condition is an inflammation of a bursa due to numerous slight injuries frequently associated with the trade of the patient. The best-known example is inflammation of the bursa patella, or "housemaid's knee"; others are "miner's or student's" elbow, and "weaver's bottom."

The inflammation is sometimes acute, and the bursa becomes distended with a plastic exudate; but more frequently it is chronic, and the bursa becomes chronically distended with a serous exudate, while the walls are thickened by fibrous tissue. Fibrous bands may run across the sac. The bursa varies in size from time to time. In other cases there is very little effusion into the bursa, but the walls become enormously thickened by fibrous tissue (chronic fibroid bursitis).

TREATMENT.—In a recent case pressure should first be applied by means of strapping, and potassium iodide given by the mouth. If the enlargement is of old standing, or the walls much thickened, the bursa should be excised.

Gouty Bursitis.—Gouty inflammation of a bursa is not uncommon, and leads to a deposit of urate of soda in the bursa. If the deposit is large, the skin over the bursa may ulcerate and the mass of urate of soda be exposed (chalk stones).

Gonorrhœal Bursitis.—This is frequently associated with gonorrhœal inflammation of the tendon sheaths. It rarely terminates in suppuration.

Tubercular Bursitis.—Tubercular bursitis may be secondary to tubercular disease of a neighbouring joint, or may be a primary affection. It is most often seen in the bursa between the great trochanter and the gluteus maximus, and in the subdeltoid bursa.

As in tuberculous of the tendon sheaths, two clinical varieties are met with—(1) A chronic effusion (hydrops) into the bursa frequently associated with the presence of molar-seed bodies; and (2) invasion



FIG. 150.—CHRONIC BURSAE WITH FIBROID THICKENING.

of the walls by tubercular granulation tissue, which soon breaks down into pus.

TREATMENT.—If the disease starts primarily in the bursa, it should be thoroughly eradicated by dissection, but if it is secondary to affection of the joint, the usual treatment for tuberculosis of the joint should be carried out.

Syphilitic Bursitis.—Syphilitic inflammation of a bursa is most commonly seen in the tertiary stage, and the bursa patelia is most frequently affected. The condition is often bilateral.



FIG. 151. — SYPHILITIC BURSITIS OF PREPATELLA BURSA.

There may be several nodules of syphilitic granulation tissue in the bursa, or the whole bursa may be uniformly enlarged by gelatinous granulation tissue. If treatment is neglected, the whole bursa may become fibrous or the granulation tissue may break down, the skin giving way and an ulcer with the usual wash-leather slough develop.

TREATMENT.—The usual antisyphilitic remedies should be given, but if the bursa is much enlarged it had better be excised.

DISEASES OF SPECIAL BURSAE

Prepatella Bursa.—Inflammation of this bursa is termed "house-maid's knee," and is commonly met with among servant-girls. The bursa does not communicate with the knee-joint, and is frequently multilocular. Chronic traumatic and syphilitic inflammations are more frequently seen in this bursa than any other, but tubercular inflammation is rare. No inconvenience follows its removal.

Semimembranous Bursa.—This bursa lies between the semi-membranous muscle and the inner head of the gastrocnemius. It does not usually communicate with the knee-joint, but may do so. It is frequently distended with fluid, but thickening of the walls of the bursa is uncommon. The bursa is made prominent by extending the knee, and when the joint is flexed the bursa seems to disappear. In many cases the enlargement causes no inconvenience, and it may be left alone, but if necessary it should be excised.

Subpatella Bursa.—This bursa lies between the patella ligament and the head of the tibia, and when it is inflamed there is a swelling on either side of the ligament. The patient complains of pain on walking upstairs, and cannot extend the limb fully.

Achilles Bursa.—The bursa between the tendo Achillis and the os calcis may become inflamed from overuse of the muscle in walking or running. There is pain on contracting the calf muscles, and the

movements of the ankle are restricted. This bursa is not infrequently the site of tubercular and syphilitic inflammation.

The physical signs are a tender swelling over either side of the tendo Achillis.

TREATMENT.—If palliative treatment fails, the bursa should be excised.

Ilio-Psoas Bursa.—The ilio-psoas bursa lies between the ilio-psoas tendon and the pubic bone, and may or may not communicate with the hip-joint. When it does so, diseases of the joint, such as tuberculosis or osteo-arthritis, are associated with disease of the bursa.

If the bursa is primarily inflamed, it may simulate inflammation of the hip-joint, and the limb is held flexed, abducted and rotated out. When fluid collects in the bursa, it pushes the femoral vessels forward, and if the examination is casual, it may be mistaken for an aneurysm.

Subcrurens Bursa.—In the majority of cases (nine in ten) this bursa communicates freely with the knee-joint and shares its diseases, but it may be separate from the joint and become inflamed independently. It then forms a fluctuating horseshoe-shaped swelling above the patella.

Bursa over the Great Trochanter.—This may be a multilocular bursa, or there may be two distinct compartments, one between the tendon of the gluteus maximus and the skin, and the other between the muscle and the bone. This bursa is frequently affected with tubercular inflammation, and this may lead to disease of the underlying bone.

Ischial Bursa.—The ischial bursa lies between the tuber ischii and the tuber ischii, and may become chronically inflamed in those whose trade necessitates long sitting, as weavers and tailors.

Subdeltoid Bursa.—This bursa lies between the deltoid muscle and the head of the humerus, and passes under the acromial process of the scapula. It does not communicate with the shoulder-joint. Both traumatic and tubercular inflammation are common in this bursa, and the effusion into it is sometimes excessive. There is a marked swelling over the upper part of the arm lying over the deltoid muscle. The movements of abduction and rotation are limited, but the bursa may be much enlarged without seriously interfering with the movements of the joint.

Olecranon Bursa.—This bursa, which lies between the olecranon process and the skin, is frequently infected in working men from slight septic wounds over it, and if the condition is neglected, suppuration in it may be followed by acute cellulitis of the whole upper extremity, necessitating free incision and drainage.

This bursa also may be chronically inflamed in those who rest much on the elbows, as students and miners.

Removal of the bursa causes no inconvenience.

Adventitious Bursæ.—Adventitious bursæ are bursæ which are developed over a prominence which is subjected to undue pressure.

Many of these bursæ are associated with certain trades. For example, the bursa over the seventh cervical spine in market-garden porters, the bursa on the head in fish porters, and over the upper part of the shoulder in deal porters. In the foot they are frequently seen over the malleoli of patients who wear surgical boots.

The most common adventitious bursa, however, is the bunion.

A **Bunion** is an adventitious bursa which develops over the inner part of the head of the first metatarsal bone, and is associated with the wearing of ill-fitting boots, and hallux valgus. The boot pushes the big toe inwards at the metatarsal phalangeal joint, and exposes the sensitive cartilage on the inner side, and over this cartilage the bursa develops. Later the exposed cartilage atrophies, and the bone becomes covered with periosteum, and then the bursa often disappears, there being no further necessity for its existence.

A bunion, as all other adventitious bursæ, is liable to all the inflammatory conditions which affect normal bursæ.

TREATMENT.—The most essential part of the treatment is the wearing of properly made boots, and remedying the hallux valgus. In many cases this will demand operative interference, and when the toe is put straight, the bursa may be excised.

Palliative treatment consists of wearing rings and pads to relieve the pressure on the bunion.

NEW GROWTHS OF BURSAE

All tumours of bursæ are exceedingly rare.

CHAPTER XII
INJURIES AND DISEASES OF NERVES

INJURIES

NERVES may be injured by subcutaneous bruising or contusion; in open wounds by cutting or laceration; or the injury may complicate fractures of bones or other lesions. A classification of injuries of nerves may be based on the cause of the injury, but such a classification has little value, as the symptoms and treatment of an injured nerve depend mainly on the loss of conductivity of the nerve, and not on the cause of the injury. This loss of conductivity may be due to actual division of the nerve, but in many cases there is no anatomical division, and the loss of conductivity is due to such conditions as hæmorrhage into the nerve, crushing of the nerve fibres, etc. The loss of conductivity may be complete or partial, and the symptoms vary according to which of these conditions is present, and not according to whether the division is anatomical or functional. The classification adopted, therefore, will be—(1) COMPLETE, and (2) INCOMPLETE DIVISION OF NERVES, ANATOMICAL OR FUNCTIONAL; and in discussing the treatment it will have to be considered whether there is an open wound, or whether the injury is subcutaneous; also whether the injury is complicated by a fracture of an adjacent bone.

Complete Division of a Nerve—PATHOLOGICAL ANATOMY.—If a nerve is completely divided across, the whole of the peripheral distribution of the nerve invariably degenerates, and degeneration occurs in the central portion as far as the first node of Ranvier. This degeneration is simultaneous throughout the length of the nerve, and does not descend gradually from the divided segment. It commences two or three days after the injury. The axis cylinders swell, break up, disintegrate, and finally disappear, while the medullary sheath is broken up into droplets of myelin and gradually absorbed, so that the nerve fibre is ultimately represented by a thin fibrous strand. The time the process takes varies in different animals and at different times of life, but is usually complete in six weeks to two months.

If the divided ends of the nerves are left in contact, and if there is no mass of dense fibrous tissue formed between them, regeneration of the degenerated nerve occurs, and begins before the process of degeneration is complete. Two views are held as to the nature of this degeneration

tion—(1) The older view that "regeneration occurs *entirely* from the central end, and pushes from it to the periphery, being a repetition of the original process of nerve development"; and (2) the modern view that regeneration largely occurs in the peripheral degenerated segment, but that complete regeneration and restoration of function does not occur unless the continuity of the nerve is restored by the peripheral and proximal ends being closely joined. The formation of a dense mass of scar tissue in the nerve is as much a bar to restoration of function as the ends of the nerves being left unjoined.

Whichever of these views is correct, there is no doubt that complete regeneration of a nerve with restoration of function does occur if proper treatment is carried out, but this regeneration in a large nerve is not complete for months or even years.

If the ends of the nerve are not in contact, there is an attempt at regeneration at the central end of the nerve, and as a consequence the end of the nerve, which is embedded in scar tissue and fixed to surrounding tissues, becomes bulbous, and on section curled-up axis cylinders are seen. These bulbous ends of a divided nerve are most often seen in the ends of nerves in amputation stumps, and are called "amputation" or "false neuromata." They are frequently a source of pain, and may need excision; or in some cases a second amputation has to be performed.

Functions of Nerves.—Before considering the symptoms and physical signs produced by complete division of a nerve, it is necessary to say something about the functions of a mixed nerve. A mixed nerve contains afferent or sensory fibres, efferent or motor fibres, and trophic fibres; and if it is divided, symptoms corresponding to loss of these three functions will be produced.

1. **SENSORY FUNCTION.**—The afferent or sensory fibres are divided into three groups: Fibres of (1) deep sensibility; (2) epicritic sensibility; (3) protopathic sensibility.

(1) *Deep Sensibility.*—The fibres which convey this form of sensibility have wide anastomoses, and run with the motor fibres to the muscles, tendons, and joints. They are the means by which the patient is able to estimate the force of muscular contraction, the position of the joints, and to appreciate pressure, both painful and not painful. This sensibility is not lost by division of all the sensory nerves going to the skin, and owing to the wide anastomosis with other nerves, it is not much altered by division of a mixed nerve alone. It is of little importance in the symptomatology of a divided nerve, but it is of the utmost importance to recognize that this deep sensibility does exist, for it has led to great errors of diagnosis, as retention of deep sensibility has been mistaken for retention of cutaneous sensibility, and division of a nerve been missed.

(2) *Epicritic Sensibility.*—The fibres serving this form of sensibility convey light touch sensations, and are capable of appreciating fine variations in temperature (22° to 38° C.). Loss of this form of sensibility is the most important and well-marked sensory symptom of nerve division. It is tested for by (a) lightly stroking the skin with a

piece of cotton-wool, (*b*) by applying the points of a blunt pair of compasses to the skin and ascertaining at what distance apart the patient appreciates the two separate points (the normal distance is 1 to 2 centimetres, depending on the part of the body tested), and (*c*) by asking the patient to discriminate, as cool or warm, test-tubes containing water at 24° and 38° C. In all these tests the patient should keep the eyes closed, and the utmost care must be taken to avoid pressure or pain, otherwise deep sensibility or protopathic sensibility will be elicited. As the epicritic fibres of different nerves overlap, the zone of loss of epicritic sensation will be considerably less than the anatomical distribution of the nerve would indicate.

(3) *Protopathic Sensibility*.—This is the sensibility of pain, and the fibres respond to painful cutaneous stimulation and the extreme degrees of temperature. The sensations are badly localized, and reflex movements owe their origin to this system. Loss of this sensation should be tested for by pricking the patient with a sharp pin, cautioning him not to respond to *pressure or touch*, but only to *pain*, or by using a painful interrupted electrical current.

If these three sensations are tested for after division of a mixed nerve (*e.g.*, the median at the wrist), it will be found that there is an area of loss of sensibility to light touch approximating to the anatomical distribution of the nerve (epicritic sensibility), and an ill-defined area of loss of sensibility to prick (protopathic sensibility) which varies considerably, but that there is practically no loss of sensation to pressure (deep sensibility) unless the tendons are divided at the same time as the nerve.

2. *MOTOR FUNCTION*.—All the muscles supplied by a nerve are completely paralyzed if it is divided, and this paralysis is permanent unless the nerve regenerates. It must be carefully noted that it is the *muscles* that are paralyzed, and not *movements* that are lost. A movement is always carried out by the contraction of several muscles, and the patient may still be able to carry out the movement even if the contraction of the most important of these muscles is lost. For example, in paralysis of the abductor pollicis, the movement of abduction of the thumb can still be carried out by the extensor muscles. If this *movement* only is investigated, a complete division of the median nerve may be overlooked.

The muscles which are paralyzed waste rapidly, and in time will become converted into fibro-fatty material.

If the muscles supplied by a completely divided nerve are examined with the electric current ten days after the division, a characteristic reaction will be present. The muscle will no longer contract if stimulated by the faradic (interrupted) current, and if stimulated by the make and break of a constant current (galvanic), the response will be sluggish, and the strength of the current required will be greater than on the sound side. In testing with the anode and kathode of the constant current, it will be found that the anodal closure contraction (A.C.C.) is greater than the kathodal closure contraction (K.C.C.), which is a reversal of the usual condition. This reaction is called the

"reaction of degeneration" (R.D.), and persists as long as the muscle will contract to the constant current. A muscle may contract in response to the constant current for years after complete division of its nerve. If regeneration of the nerve occurs, and the muscles again contract to cerebral impulses, the reaction of degeneration disappears.

3. **Trophic Function.**—After complete division of a mixed nerve certain changes appear in the skin of the part, especially of that part that has lost its protopathic sensibility. These changes are due partly to the insensitiveness of the part, which does not appreciate injuries,



FIG. 152.—Trophic Ulcer of the Index Finger Following Division of the Median Nerve.

and partly to the loss of the trophic function of the nerve. These changes are most readily seen in the hands. The most important are—(1) The epithelium over the part supplied by the divided nerve is not shed readily, but collects on the surface as dry scales; (2) the part does not sweat; (3) blisters may form on the skin, and if infection takes place, trophic ulcers may follow; (4) the nails become hard and brittle, and lose their gloss; (5) the hair becomes coarse and brittle; (6) thickening of the ligaments of the phalangeal joints may occur, and in some cases fibrous ankylosis follows.

CLINICAL SYMPTOMS.—Immediately after a nerve is completely divided there is loss of sensation to light touch (cotton-wool), rough,

corresponding to the anatomical distribution of the nerve to the skin, and the absence of this sensation is usually sufficient to establish the diagnosis. There is also loss of protopathic sensibility (prick) over a smaller area. This should be tested for in doubtful cases.

The muscles supplied by the nerve are completely paralyzed, and as there is vaso-dilatation, the part is warmer and redder than normal, but this is usually difficult to detect. In a short time various secondary phenomena will develop: (1) The muscles will atrophy and show the reaction of degeneration (R.D.), and if care is not taken, deformities will follow with contracture and overstretching of the muscles; (2) trophic changes as described above will appear in the skin, nails,

hair, and smaller joints; (3) the part will become cyanotic and cold, and chilblains will readily develop; (4) in a few cases changes may occur in the central nervous system.

These symptoms and physical signs are due to interruption of the conducting power of the nerve, and are not necessarily due to anatomical division of the nerve trunk.

TREATMENT.—This must be considered under several headings:

1. **DIVISION OF THE NERVE IN AN OPEN WOUND.**—Primary suture should be carried out. If necessary, the ends of the nerve should be cleanly severed with a sharp scalpel, and the two ends then united with a catgut suture. The nerve is then wrapped in Carbol membrane to

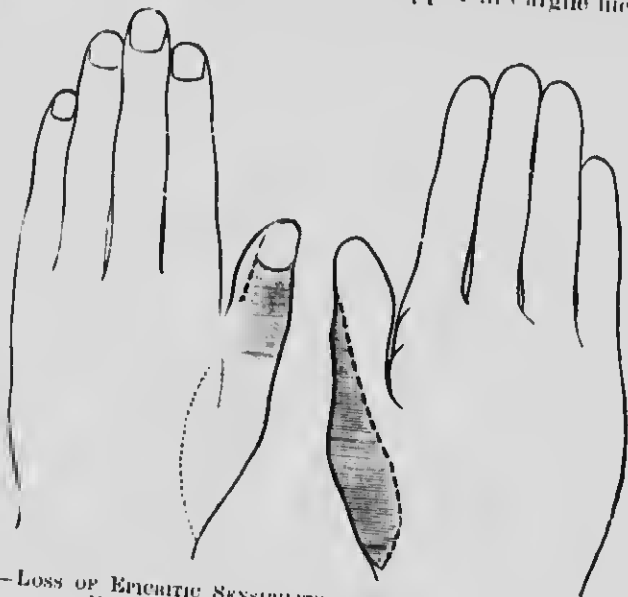


FIG. 153.—LOSS OF EPICRITIC SENSIBILITY CAUSED BY DIVISION OF THE RADIAL NERVE IN THE FOREARM. (AFTER SHERREN.)

separate it from surrounding structures, and if considered necessary, the wound is drained. Aseptic healing is of the utmost importance and no pains should be spared to attain this.

2. **SUBCUTANEOUS INJURY.**—The part should be put at rest on a splint, and massage treatment carried out for a fortnight. If at the end of that time the reaction of degeneration is present in the muscles supplied by the nerve, it should be exposed, and if ruptured, it should be sutured as above. More commonly the nerve will be found to be hard and swollen at the point of injury, and if this condition is found, the swollen part should be excised and the divided nerve sutured. If no reaction of degeneration is present in a fortnight, massage and splint treatment should be continued.

3. **INJURY ASSOCIATED WITH FRACTURE OF A NEIGHBOURING BONE.**—If the nerve lesion is discovered at the time of fracture, the

nerve and fracture should be exposed by operation, the nerve sutured, and the fragments of the bone united by some mechanical means. In the majority of cases the nerve lesion is not discovered until the splints are removed, and the division is due to involvement of the nerve in fibrous tissue. If the signs are those of complete division of the nerve, no time should be lost, but the nerve cut down upon and secondary suture carried out; but if the signs are those of incomplete division (see below), the limb should be kept at rest, and the usual treatment of incomplete division carried out.

4. WHEN THE CONDITION IS NOT DISCOVERED UNTIL SOME CONSIDERABLE TIME (WEEKS) HAS ELAPSED SINCE THE INJURY—**Secondary Suture.**—This should be attempted in all cases if an important nerve has been divided within at least three years after the injury. The

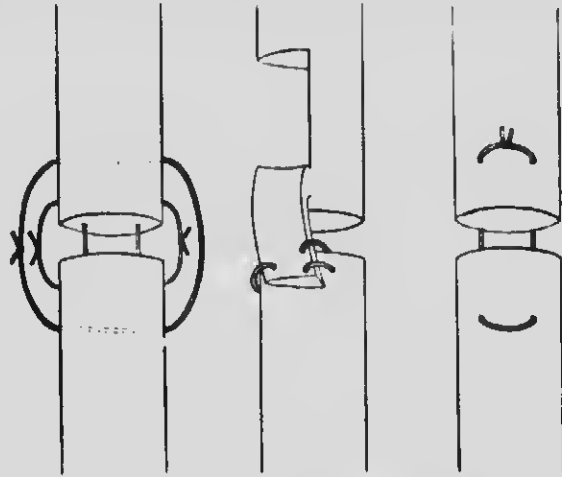


FIG. 154.—METHODS OF SUTURING NERVES.

prognosis will depend on the nature of the lesion, the extent of suppuration in the original injury, and the care with which the muscles and joints have been treated since the injury.

Extensive suppuration in the original wound will make the prognosis very grave as regards recovery. If the muscles have been allowed to contract, their function will not be properly regained, even if the nerve suture be successful in restoring the continuity of the nerve. Muscles which have lost their reaction to the constant current are not likely to recover their power of contraction, no matter how successful the nerve suture may be. It is sometimes advisable to attempt secondary suture for the relief of trophic ulcers, as the trophic fibres may regenerate, although the operation may have no effect on the loss of motor power and operative sensation.

In performing secondary suture, the nerve ends should be exposed, and the bulbous end of the proximal portion carefully removed with a sharp scalpel. A small portion of the distal end should be removed

in the same manner, and then the two ends sutured together with catgut, and the junction wrapped in Cargile membrane. There should be no tension on the suture line, and it may be necessary to flex the joints strongly in order to approximate the ends, and this position of flexion must be maintained by splints until the wound is healed, and then the position should be gradually corrected.

In some cases approximation of the ends is impossible, and one of the following methods of bridging over the gap must be used:

1. The limb may be shortened by removal of a piece of bone.
2. A portion of the nerve of an animal, or, better, a portion of a nerve removed from the patient, may be sutured between the two ends (nerve transplantation).
3. The nerve may be joined to a neighbouring nerve (nerve anastomosis).
4. The nerve ends are surrounded by a "tube" bridging over the gap. The tube can be made of decalcified bone, animal arteries, a superficial vein removed from the patient, or simply strands of catgut.

Of these methods, nerve transplantation of one of the patient's nerves is probably the best form of treatment.

AFTER-TREATMENT.—In the treatment of divided nerves, either by primary or secondary suture, the operation, although essential, is only the starting-point of the treatment. If after-treatment is neglected, the result will be failure, and this after-treatment must be carried out for months or years. The part must be kept at rest until sound healing has occurred, and then the muscles must be regularly massaged and passively moved to maintain their nutrition. In the intervals of massage the part must be kept at rest on a splint, so that the muscles neither become contracted nor overstretched, and no work must be done with the limb. Electricity in the form of the weak constant current may also be valuable in maintaining the nutrition of the muscles. The insensitive part must be carefully protected from injury. As active movement becomes possible owing to regeneration of the nerve, the muscles may be regularly exercised against carefully graduated resistance until the power is fully restored. Then only can splints and other apparatus be completely dispensed with.

Incomplete Division of a Nerve.—By this term is meant an interruption or impairment of the conductivity of a nerve which does not lead to complete peripheral degeneration. The division may be physiological or anatomical, as in the case of complete division. An incision into a nerve, if it involve one-third of it or less, does not necessarily interfere with the function of the nerve, and no symptoms may be present. On the other hand, a contusion of a nerve without division, or pressure on the nerve from callus, may give rise to the symptoms of incomplete division.

The SYMPTOMS of incomplete division are motor, sensory, and trophic.

MOTOR SYMPTOMS.—There is paralysis of some or all of the muscles supplied by the nerve, and at first there may be no distinction between

complete and incomplete division. If, however, the electrical reactions are tested about ten days after the accident, there is no reaction of degeneration (R.D.), and a characteristic reaction may be present. This reaction is: There is no response to the faradic (interrupted) current, but on stimulation by the constant current a contraction is produced by a weaker current than on the sound side, and there is no polar reversal (i.e., K.C.C. is greater than A.C.C.).

SENSORY SYMPTOMS.—If the injury to the nerve is slight, the only symptom present is an altered sensibility of the part supplied by the

nerve, which feels numb; but if the lesion is more severe, there is also loss of epicritic sensibility (light touch). In the more severe lesions protopathic sensibility is lost as well, and the symptoms resemble those of complete division. Loss of epicritic sensibility may be present without loss of muscular power in incomplete division of a mixed nerve.



FIG. 155.—ATROPHIC FINGER DUE TO A NERVE LESION.

TROPHIC SYMPTOMS.—These are not present at first, and in many cases never develop, for they appear to be due to an irritative lesion in a nerve. When they are present, the area supplied by the nerve is tender and painful (hyperalgesic), and the skin shows a curious change known as "glossy skin." If the fingers are

affected, they become tapering from loss of the subcuticular tissue. They are smooth, pink in colour, and shiny. Chilblains may develop on them, and in some cases ulceration occurs. The part sweats profusely, and the nails become brittle and ridged. Pain frequently spreads up the nerve trunk, and may be intense. The condition is termed **Causalgia**.

TREATMENT.—Like the treatment of complete division, this must be considered under various headings—

1. *Anatomical Incomplete Division in an Open Wound.*—The partially divided nerve should be sutured with catgut.
2. *Subcutaneous Injury.*—Massage, passive movements, and splinting should be carried out until recovery occurs. This may be delayed for weeks or months.

PROGNOSIS—AFTER PRIMARY SUTURE.—After the operation there is always an interval of some weeks before any signs of recovery are present, but at a varying time (six weeks to six months) recovery of protopathic sensibility commences and becomes complete. This is followed by restoration of epicritic sensibility (light touch), and this may be complete in one to two years. Motor recovery begins at a varying time, depending upon the distance from the periphery that the nerve was divided, and also largely upon the care that has been taken of the muscles. It may be complete in two years.

The recovery of function after primary suture is largely dependent on the wound healing by the first intention. Suppuration will delay, or in some cases prevent, recovery.

AFTER SECONDARY SUTURE.—The prognosis after secondary suture is not so good as after primary suture, but the method of recovery is similar. Although there are exceptions, it may be taken as a rule that return of function after secondary suture is delayed in comparison with primary suture. Complete restoration of function takes longer, and is not so likely to be complete, especially as regards sensibility. Recovery of motor power will probably occur if the secondary suture is done within three years of the original accident. It may be complete, especially if the muscles have not been allowed to atrophy, and there was only a little suppuration in the primary wound. Perfect sensory recovery is unlikely.

AFTER INCOMPLETE DIVISION.—The prognosis after incomplete division of a nerve is good, restoration of functions, both sensory and motor, usually being complete in a year. In some cases with an irritative lesion pain and tenderness may develop in the course of the nerve, and prove very intractable.

Traumatic Neurosis.—Traumatic neurosis is a functional disorder of the nervous system following an injury. The condition is frequently seen after injuries in which there is severe degree of mental shock (railway accidents or shipwreck), and the actual injury itself may be quite slight. The condition has been termed "railway spine" and "concussion of the spine," but both are misleading terms, for all cases in which the spinal cord is injured, or in which definite lesions appear later, should be excluded.

Traumatic neurosis is most frequently seen in those who, previous to the accident, have suffered from general nervous instability, either inherited or acquired; but a previous history of neurosis is not necessarily present. Another potent factor in producing and maintaining the mental disturbance is the question of compensation for the accident and any litigation arising out of this, which tends to keep the mind centred on the accident and its effects. The successful termination of any litigation will often be the first step in the cure, which may then be surprisingly rapid. It is this relationship to compensation—especially since the passing of the Workmen's Compensation Act—that makes the question of traumatic neurosis so important at the present time, and there is often the greatest difficulty in diagnosing the condition from wilful malingering.

SYMPTOMS.—The symptoms may be divided into two groups—

General.—These symptoms appear some little time after the accident, and are very various, and change frequently. The patient complains of pains all over, muscular weakness, loss of appetite, and general inability to enjoy life. There is lack of power of attention, impairment of memory, and undue fatiguo on attempting to work. Loss of sleep is common, and there is general despondency and mental depression. Pain in the back is a frequent symptom. Many other symptoms may be complained of, such as constipation, furred tongue, and bad taste in the mouth, pain after food, loss of will-power, irritability, and inability to bear loud noises or bright lights; in fact, there is no symptom of any organic disease that the patient may not complain of.

Local.—Complaint is made of pain in the part injured, and if there is a sear, this is usually particularly hyperæsthetic. The pain is generally described as sharp, and though it radiates from the injured part, it does not follow the course of any particular nerve. If a joint has been injured, it cannot be moved freely, and attempts at passive movement are resisted by contraction of the muscles. Very often passive movements do not cause pain, and yet the patient will be unable to move the joint actively. Wasting of the surrounding muscles from disuse is also present.

On examination, there is usually nothing to be found to account for any of the symptoms. The pupils, however, are frequently dilated and the knee-jerks exaggerated.

The **DIAGNOSIS** has to be made from—

1. **MALINGERING.**—This is often very difficult. The previous history of the patient as regards neurosis should be carefully inquired into, and a very careful and common-sense examination of the patient made. Malingerers as a rule exaggerate their symptoms, and will often refuse examination under a plea of excessive pain caused; on the other hand, sufferers from traumatic neurosis usually submit to any examination, and take a morbid interest in it. The patient should be questioned as to whether any work has been attempted, or any effort to find work, and his whole demeanour under examination carefully considered. Malingerers will often make contradictory statements, or they may be "caught" by various tricks during the examination, and on the whole are much more suspicious and liable to resent questioning than patients with a neurosis.

2. **ADHESIONS IN JOINTS.**—Adhesions in a joint will frequently cause pain and difficulty in moving the joint, and yet be almost impossible to detect during the usual examination. Examination under an anæsthetic will frequently demonstrate the presence of adhesions, and the treatment by breaking them down can be carried out at the same time.

3. **DIVISION, COMPLETE OR INCOMPLETE, OF NERVES** (see p. 365).—The diagnosis of this condition is considered under the section of Injuries to Nerves, and a careful examination will readily demonstrate an organic lesion of a nerve.

4. ORGANIC LESIONS OF THE NERVOUS SYSTEM.—The general symptoms of a traumatic neurosis may closely simulate such organic lesions of the spinal cord as insular sclerosis, tabes dorsalis, and general paralysis of the insane. Such organic lesions were once thought to supervene directly on a condition of traumatic neurosis. This term should never be used if there is any evidence of definite pathological change in the nervous system, and the differential diagnosis is made on the ordinary lines laid down in medical textbooks.

TREATMENT.—Any definite symptoms, such as constipation or sleeplessness, should receive appropriate general or drug treatment; but the real treatment of the condition is by suggestion. The patient should be assured definitely that there is no organic lesion, and that there is no reason why perfect cure should not be obtained. Rest from the ordinary routine of business and its worries is important, but the patient should be constantly occupied in some healthy amusement, so that he has not time for morbid introspection. In the case of a working man, such light work as he is able to accomplish should be done, for the condition is frequently aggravated by long periods of enforced rest without any means of passing the time except thinking and talking over the accident and its consequences. It is absolutely essential that all litigation and questions of compensation should be rapidly settled, because the anxiety as to whether adequate compensation will be obtained is often a potent factor in delaying recovery.

Many other forms of treatment are advised and carried out, such as the application of high-frequency currents, vibro-massage, electricity in many forms, baths, administration of drugs acting on the nervous system (strychnine and bromides), rest cures, Weir Mitchell treatment, etc., and any of these may be beneficial in certain cases. They all have the disadvantage, however, of constantly reminding the patient that he is ill, and tend to fix his attention on himself, which is of all things most undesirable in a neurasthenic.

In the case of a traumatic neurosis complicating an injury to a joint, massage and passive and active movements to the joint are important, the most beneficial being active movements of the joint.

DISEASES OF NERVES

INFLAMMATION OF NERVES (NEURITIS)

Acute Neuritis.—The most common form of acute neuritis that concerns the surgeon is due to injury of a nerve with or without infection. It is also associated with the specific infectious fevers, gout, and rheumatism.

The nerve may be felt to be swollen and painful, and microscopically the usual signs of inflammation are present.

The symptoms are pain radiating over the course of the nerve, and tenderness of the skin supplied by it, with paresis or paralysis of the muscles it supplies.

TREATMENT.—The part should be put at rest, and the usual treatment for inflammation carried out. If due to injury of the nerve, the treatment is that of complete or incomplete division of a nerve.

Chronic Neuritis.—This form of neuritis frequently follows injury or mild septic infection of one of the terminals of a nerve, and may supervene some weeks or months after an injury.

SYMPTOMS.—The nerve is swollen, painful, and sensitive to pressure, and there are frequently loss of sensibility and trophic lesions in the area of distribution. The muscles supplied are parietic, the physiological effects being those of incomplete division of the nerve.

TREATMENT.—The usual *general* treatment of chronic inflammation, including the administration of mercury and iodides, should be carried out. *Locally*, the nerve should be treated by counter-irritation, or by the application of analgesics, such as belladonna or menthol.

Radiant-heat baths, Tyrnauer baths, and high-frequency currents may be of benefit, and the muscles should be massaged and stimulated with the constant current. Severe pain should be treated with aspirin or morphia.

If these methods of treatment fail, the nerve should be stretched, or punctured with a needle (acupuncture). If the nerve is purely sensory, a portion should be excised, or the nerve-trunk injected with alcohol, but no method of treatment is certain to give relief.

Multiple Neuritis.—Inflammation of a number of peripheral nerves mainly concerns the physician. The following classification is used: (1) infectious form, following diphtheria, typhoid, tubercle, syphilis, etc.; (2) toxic form, due to poisoning by lead, arsenic, alcohol, mercury, carbon disulphide, etc.; (3) atrophic form, associated with anemia, marasmus, diabetes, cancerous cachexia, etc.; (4) spontaneous form, following exposure to cold, overexertion, etc.

For a description of the symptoms and treatment of these conditions, a textbook on medicine should be consulted. The surgeon is concerned with the secondary phenomena, due to contraction and overstretching of muscles and tendons. These should be prevented by splinting, massage, passive and active movements, and if they should occur, must be remedied by splinting and tenotomies.

Neuralgia.—By "neuralgia" is understood a disease of the nerves, for which there is no adequate pathological explanation. The chief symptom is pain, usually occurring in paroxysms.

CAUSE.—In many instances the cause can only be found in the neurotic temperament of the patient, associated with overwork, mental anxiety, and worry. Some cases are associated with infective conditions affecting the terminals of the nerves, as in some cases of trifacial neuralgia. The condition may also be associated with gout, syphilis, lead and mercury poisoning, or chronic lesions in the central nervous system.

SYMPTOMS.—The chief symptom is pain of varying intensity, mostly intermittent or remittent. In many cases the attacks are definitely produced by exposure to cold. The skin supplied by the

nerve may be hypersensitive, and pressure may relieve or increase the pain. Other symptoms are—spasm of the muscle supplied by the nerve occurring during the attacks of pain; herpes in the course of the nerves, or an attack of herpes may be the starting-point of the neuralgia; and hypersecretion from the lachrymal or sweat glands.

TREATMENT.—The *general* treatment consists of improving the general health in every way, and giving tonics—iron and arsenic if the patient is anæmic, mercury and iodides if there is a syphilitic history. Sedatives, such as antipyrin, aspirin, nitikamma, etc., or morphia, should be given to relieve the pain; but this last drug should be used with great caution, as in these cases a morphia habit is easily contracted. The various forms of electrical treatment, bath treatment, vibration, massage, etc., may all be tried, with varying degrees of success.

OPERATIVE TREATMENT—1. *Sensory Nerves*.—(1) **NEUROTOMY**: The cutting of a nerve as a rule gives only temporary relief. (2) **NEURECTOMY**: Excision of a portion of the nerve is more satisfactory, and may give permanent relief; but recurrence of the pain is the rule. (3) **NERVE EXTRACTION**: This is a form of neurectomy, the nerve being divided, and then the central end being seized with forceps and pulled out. (4) **INJECTION OF RECTIFIED SPIRIT OR ABSOLUTE ALCOHOL INTO THE NERVE TRUNK**: This is successful in many cases, and can be tried before neurectomy. (5) **DIVISION OF THE POSTERIOR ROOTS OF THE NERVE AFFECTED IN THE SPINAL CANAL**: This will give relief, but it is not always permanent, and the operation is a severe one.

2. *Mixed Nerves*—**NERVE STRETCHING**.—The nerve is exposed, and stretched by pulling on it with the finger and thumb, care being taken to graduate the force used so that the nerve is not torn across. Good results are sometimes obtained by this method, but the reason of the production of the results is not fully understood. In the case of the great sciatic nerve, the stretching can be done without open operation by forcibly flexing the hip with the knee-joint extended. An anæsthetic is necessary. There is no method of treating neuralgia that is uniformly successful, and in many cases no treatment does more than temporarily relieve the condition.

Amputation Neuromata.—After every amputation there is a growth of the axis cylinders of the divided nerve which become rolled up in a mass of fibrous tissue, forming a bulb at the end of the nerve. These amputation neuromata rarely give rise to symptoms, but if closely involved in the scar tissue, may cause much pain, which may appear years after the amputation.

The **SYMPTOMS** are pain at the end of the stump, often radiating over the distribution of the nerve in the limb which has been removed. For example, a patient after amputation of the lower extremity through the thigh, may complain of pain in the foot, and exactly describe the position of the pain, in addition to localizing the foot in space. In this way the nerve responsible for the condition may be diagnosed.

TREATMENT—Preventive.—In every amputation the principal nerves should be pulled upon and crushed with forceps as high as possible, and then divided with scissors. If this is done, the end bulbs will be small, the nerve not involved in the scar, and no symptoms will arise.

If symptoms are present, the amputation neuromata, with 2 or 3 inches of the nerve, should be dissected out, or an amputation performed higher up the limb, special care being taken to prevent the adherence of the nerve trunk to the scar tissue. In some cases the pain persists in spite of the treatment, and then the division of the posterior nerve roots in the spinal canal is necessary.

Involvement of Nerves in Scar Tissue.—As the scar tissue of a wound contracts, it may press upon a nerve, or scar tissue may develop in the nerve itself, and symptoms may follow due to interruption of the conductivity of the nerve. These symptoms will vary with the condition present.

1. *Pressure on the Nerve Trunk.*—This pressure may lead to—
(1) Complete division of the nerve; (2) incomplete division. The symptoms are described above.

TREATMENT.—The nerve should be cut down upon, freed from the scar tissue, and wrapped in Cargile membrane. If necessary, one portion of the nerve should be excised and the ends sutured.

2. *Scar Tissue causing an Irritative Lesion of the Nerve Trunk.*—There is pain and tenderness over the area of distribution of light touch, and in severe cases glossy skin and trophic changes (*Causalgia*).

TREATMENT.—The damaged portion of the nerve should be removed and the ends sutured.

3. *Scar Tissue causing an Irritative Lesion of the Terminal Branches of a Nerve.*—When a peripheral branch of a nerve is involved in a scar, it may cause pain and tenderness, radiating over the whole area supplied by the nerve, together with loss of power in the muscles, and trophic changes in the skin and nails.

The condition has been ascribed to neuritis, but in the majority of cases there is no evidence of an inflammation of the nerve. The subjects of this condition (especially if entitled to compensation for the injury) are frequently designated "malingerers" or "hysterics."

TREATMENT.—The nerve should be exposed, and the damaged portion removed with end-to-end suture. If this is not possible, on account of the smallness of the nerve involved, the scar should be excised or the part amputated. Cure does not necessarily follow this treatment, but it is more likely to be successful if the operation is done soon after the onset of the symptoms.

If a true neuritis is present, and no relief is obtained from the operation, the only treatment is division of the sensory roots of the nerve, and even then the pain frequently returns.

New Growths of Nerves.—These are described in the section on Tumours (p. 218).

SURGERY OF THE VARIOUS NERVES

Cranial Nerves—1. **Olfactory.**—Injury to this nerve is usually associated with fracture of the anterior fossa of the base of the skull. It results in anosmia (loss of the sense of smell).

2. **Optic.**—This nerve may degenerate as a result of—(1) Injury frequently associated with fracture of the base of the skull; (2) optic neuritis due to syphilis, albuminuria, glycosuria, etc.; (3) pressure due to intracranial neoplasm; (4) inflammation from extension from an orbital cellulitis; or the degeneration may be primary, as in tabes dorsalis. Degeneration of the optic nerve causes blindness in the corresponding eye.

3. **Oculi Motor.**—In complete paralysis of this nerve the following physical signs are present: (1) Ptosis; (2) the eye looks outwards and downwards, and cannot be moved upwards or inwards; (3) the pupil is dilated, and does not contract to light; (4) there is loss of power of accommodation; (5) there is a slight degree of exophthalmos.

The following conditions may cause paralysis of the nerve, and each demands its appropriate treatment (1) Intracranial tumours; (2) aneurysms of the internal carotid artery; (3) thrombosis of the cavernous sinus; (4) gummata; (5) fracture of the base of the skull.

4. **Trochlear.**—The causes of paralysis of this nerve are the same as those that cause paralysis of the third. The eye is directed upwards and inwards, and there is paresis of the downward and outward movements.

5. **Trigeminal.**—Any one of the three trunks of this nerve may be injured after it has left the Gasserian ganglion, but such injuries are rare. On the other hand, this nerve is the cranial nerve that is most frequently the seat of neuralgia, especially of the more severe type known as *epileptiform neuralgia, tic douloureux, or neuralgia major*. The leading features of this condition have been summarized by Jonathan Hutchinson, junr.:

- (1) "The subjects of this disease at its onset are usually adults between the ages of thirty to fifty. Males are more often the subject of it than females.
- (2) "No cause can as a rule be assigned for the onset of the disease, but talking, eating, or exposure of the skin to slight cold or light pressure, invariably brings on the attack when the disease is well established.
- (3) "It is almost invariably unilateral.
- (4) "It commences in the distribution of either the second or third division of the fifth nerve, and tends to involve both to the same extent.
- (5) "The first (ophthalmic division) is involved comparatively little, but radiations of pain in this division and that of the cervical nerves often occur.

- (6) "The attacks of pain are paroxysmal or spasmodic, and tend to steadily increase in severity, whilst the intervals of freedom from pain shorten.
- (7) "During the attacks there is usually spasm of the facial muscles on the affected side.
- (8) "Its progress is one of steadily increasing severity, lasting an indefinite number of years.
- (9) "Spontaneous cure is almost unknown.
- (10) "Medical treatment, excepting increasing doses of morphia, has little or no effect."

Microscopical examination of the Gasserian ganglion and of its branches after removal usually shows that there are no apparent pathological changes.

TREATMENT.—All peripheral sources of irritation should be removed, such as adenoids, suppuration in the antrum of Highmore, nasal polypi, or carious teeth; but it is useless to remove teeth that show no signs of disease. The only medical treatment of value consists of giving increasing doses of morphia to relieve the pain.

Operative Treatment.—The operative treatment of this condition consists of—(1) Operations on the branches of the nerve; (2) operations on the Gasserian ganglion.

(1) Operations on the peripheral branches are—Nerve stretching, neurotomy, neurectomy, and excision of Meckel's ganglion. All these operations may give relief, but they are nearly always followed by recurrence of the condition. It is therefore better to attack the Gasserian ganglion as soon as the diagnosis is established.

(2) Operations on the Gasserian ganglion are—(a) Injection of the ganglion with alcohol; (b) excision of the lower two-thirds of the ganglion, leaving intact, if possible, the upper one-third, from which the ophthalmic division comes off, and the motor-root of the infra-maxillary division.

(a) *Injection of the Ganglion with Alcohol.*—Schlosser's operation: The needle of the injecting syringe is passed through the foramen ovale from the temporal region and injected into the ganglion.

(b) *Excision of the Lower Two-Thirds of the Gasserian Ganglion.*—This operation, in the majority of cases, results in complete and permanent cure of the condition, and although a severe proceeding, the mortality in recent operations is slight. If the ophthalmic division of the ganglion has been spared, the forehead, upper eyelids, the cornea, and conjunctiva retain their sensation, and ulceration of the cornea is not to be feared. Taste is very little interfered with, and although the muscles of mastication on one side are usually completely paralyzed, there is very little interference with eating. The disfigurement is slight. The most serious complication is sloughing of the cornea and loss of the eye when the ophthalmic division is damaged. This is always to be feared, and may occur even months or years after the operation.

6. **Abducens.**—The causes of paralysis of this cranial nerve are the same as those that cause paralysis of the third and fourth. The eye looks *inwards* and cannot be turned outwards. The treatment consists of treatment of the cause.

7. **Facial.**—This is a motor nerve supplying all the muscles of expression, and paralysis may result from—Lesions of the brain and its membranes; disease of the temporal bone; or lesions involving the nerve after it has left the stylo-mastoid foramen. The nerve is most commonly paralyzed as a complication of otitis media or mastoiditis; it may either be involved in the inflammation or damaged during the operation of mastoidectomy (see p. 1007). Another frequent cause of facial paralysis is fracture of the middle fossa of the skull, whilst in some cases the nerve becomes paralyzed without obvious cause (Bell's palsy). The symptoms will vary with the part of the nerve involved.

(1) *Lesions above the Nucleus of the Nerve in the Pons.*—The paralysis in this case is on the *opposite* side to the lesion, and only the muscles of the lower half of the face are paralyzed, the nerves of the eyelids and the occipito-frontalis not being affected.

(2) *Lesions from the Nucleus to the Internal Auditory Meatus.*—There is complete paralysis of the facial muscles on the same side, and some deafness, due to paralysis of the stapedius muscle.

(3) *Lesions in the Temporal Bone.*—There is complete facial paralysis on the same side, and dropping of the soft palate with deflection of the uvula to the same side, due to involvement of the petrosal nerves.

(4) *Extracranial Lesion.*—While there is complete facial paralysis on the same side as the lesion, there is no alteration in the palate or uvula.

Besides the paralysis of all the muscles of expression, the following conditions are also present when the seventh nerve is paralyzed: The tears run over the cheek (*epiphora*), as the lower lid is not applied closely to the conjunctival sac; the food collects between the cheek and the teeth owing to the paralysis of the buccinator; the eye cannot be shut, and foreign bodies are apt to get into the conjunctival sac.

TREATMENT.—The cause of the condition should be found, and, if possible, removed. If this cannot be done, the treatment is the same as that of any other nerve injury, and depends upon whether the division is complete or incomplete.

NERVE ANASTOMOSIS.—Primary or secondary suture of the seventh nerve is seldom possible, and the spinal accessory or the hypoglossal may be utilized for nerve anastomosis. Of these the hypoglossal is the nerve of election. After facio-hypoglossal anastomosis, there is very little interference with the movements of the tongue, and the slight atrophy of half the tongue which follows quickly disappears. The return of movements to the face takes from three months to a year, and is quicker and more complete if the wound heals by the first intention. Although the patient at the end of a year may be able to move the muscles of the face voluntarily, involuntary emotional movement is still absent, and will usually take years to return.

8. **Auditory Nerve.**—This nerve is injured in fractures of the middle fossa of the skull, and if torn across, complete deafness on the same side results. It is usually associated with facial paralysis due to injury of the seventh nerve.

9. **Glossopharyngeal.**—This nerve is so rarely (if ever) injured alone that it has no clinical importance.

10. **Vagus.**—The vagus nerve may be injured in fractures of the posterior fossa of the skull, but this is rare. More commonly it is damaged during operations on enlarged glands of the neck or ligation of the carotid vessels. It may also be pressed upon by malignant growths or aneurysms, or it may be pulled on by retractors or caught in artery forceps. Complete division of one vagus nerve below the origin of the recurrent laryngeal is a matter of little importance, and the nerve should be divided, if necessary, in removing malignant glands. If it is divided above the origin of the recurrent laryngeal, hoarseness with paralysis of the corresponding vocal cord will result. On laryngoscopic examination, the cord will be seen motionless lying midway between adduction and abduction. If the nerve is damaged by retractors or caught in forceps, alarming symptoms may follow from temporary cessation of the heart's action and the respiratory rhythm. Pressure on the nerve from aneurysm or malignant growth causes hoarseness from paralysis of the muscles of the larynx, the abductor action (crico-arytenoideus posticus) being first lost.

If both nerves are divided, death follows from laryngeal paralysis, cardiac failure, and œdema of the lungs.

TREATMENT follows the usual lines of nerve injury.

11. **Spinal Accessory.**—Injury of the spinal accessory nerve is most commonly caused by division during operation on tubercular or malignant glands of the neck. It is seldom injured in fractured base of the skull. If the division occurs in the anterior triangle of the neck, the sterno-mastoid and upper fibres of the trapezius are paralyzed, but the paralysis is of little importance, and the deformity produced is very slight. Division of the nerve is more common and more serious in the posterior triangle after it has passed through the sterno-mastoid. Division in this situation is frequently associated with division of the third and fourth cervical branches to the trapezius, and complete paralysis of the muscle follows. This causes considerable deformity and disability.

TREATMENT.—If the nerve is known to be divided in the course of an operation, it should be immediately sutured. Secondary suture should also be tried if the lesion is not discovered at once, or the nerve may be anastomosed with the third or fourth cervical nerve.

12. **Hypoglossal.**—Injury to this nerve is uncommon, and the effects of complete division unimportant. The tongue on the side affected is paralyzed, and when protruded it points to the paralyzed side, and atrophy follows. Beyond a slight awkwardness in mastication, deglutition, and articulation, which soon passes off, there is no functional disability.

Spinal Nerves—Phrenic.—The phrenic nerve, coming off the anterior divisions of the third, fourth, and fifth cervical nerves, is sometimes injured in operations at the root of the neck. Death has followed division of the nerve on one side, but this is rare. A patient may continue to live after division of both phrenics, respiration being carried out by the intercostal muscles.

Brachial Plexus.—Injury to the brachial plexus may be due to a variety of causes, such as stabs, gunshot wounds, direct contusion, overstretching, etc., and the lesion may be very extensive or mainly confined to one root or nerve. The following classification gives the types of paralysis most frequently met with, and their most usual causes:

1. *The whole plexus is involved.* This is due to severe crushes or gunshot wounds above the clavicle. All the muscles of the arm and shoulder girdle are paralyzed except the rhomboids and serratus inagans, and the arm hangs flaccid at the side. There is loss of sensibility over the whole forearm and hand, and over the *outer* surface of the arm in its lower two-thirds. The sympathetic fibres to the eyeball from the first and second dorsal nerves are also paralyzed, and there is slight pseudo-ptosis, enophthalmos, contraction of the pupil, which does not dilate with cocaine, and absence of sweating over the side of the face and upper limbs.
2. *Erb-Duchenne, or upper arm type.* This is due to falls on the shoulder, and is frequently associated with a fracture of the clavicle. It is also the common *birth palsy* of the upper extremity, being caused by traction on the arms in vertex and breech presentations. This birth palsy is more common on the left side than the right.

This type is due to a lesion of the anterior division of the fifth and sometimes the sixth cervical nerves. The position of the arm is characteristic; it hangs down by the side with the forearm extended, strongly pronated, and the patient is unable to abduct the arm or flex or supinate the forearm, but the fingers move freely. The muscles paralyzed are the deltoid, supraspinatus, infraspinatus, biceps, brachialis anticus, and the supinators, and in some cases the extensors carpi radialis longior and brevier. There is no loss of sensibility.

The *Prognosis* as regards the birth palsy is good, the majority of cases recovering without operation, and the treatment following the usual lines of nerve injuries.

3. *The Klumpke, or lower arm type.* This type usually follows overstretching of the plexus, and occurs when a patient tries to save himself by clutching at a bar during a fall from a height.

The nerve injured is the anterior primary division of the first dorsal.

THE PRACTICE OF SURGERY

All the intrinsic muscles of the hand are paralyzed, and the hand becomes claw-shaped. There is loss of sensibility over the inner side of the arm and forearm, and as the orbital sympathetic fibres leave the cord by this root, there are the characteristic symptoms of sympathetic paralysis.

4. *Injuries of the plexus below the clavicle.* These most commonly result from direct violence sustained from the head of the humerus in subcoracoid dislocation of the bone, or from attempts to reduce the dislocated shoulder by the heel in the axilla method.

The chief nerve injured is the inner cord of the plexus.

The muscles paralyzed are those supplied by the ulnar in the forearm—viz., flexor carpi ulnaris, and the inner half of the flexor profundus digitorum—and all the intrinsic muscles of the hand supplied by the ulnar and median. There is loss of sensibility over the ulnar side of the forearm and hand.

TREATMENT.—The treatment of lesions of the brachial plexus follows the usual rules of treatment of nerve lesions. There is nothing to add to what has already been said in the preceding paragraphs, but the carrying out of primary or secondary suture is difficult on account of the anatomical situation of the nerves.

Brachial Neuritis.—This is a term used for neuralgia of the brachial plexus which may be associated with clonic spasms of the muscles of the upper extremity. The condition is often extremely intractable, and every form of medicinal, electrical, and balneological treatment is often tried in vain. In some cases *stretching* of the brachial plexus may be followed by cessation of the pain, but it usually returns, and even division of the nerves of the plexus is not necessarily followed by cure.

Nerve of Bell (Fifth, Sixth, Seventh Cervical).—Injury to this nerve causes paralysis of the serratus magnus muscle, and the patient is unable to perform pushing movements. If an attempt is made to push, the scapula projects posteriorly, and even when still the scapula is more "winged" than on the sound side. The projection of the scapula is more marked if the lower fibres of the trapezius are paralyzed at the same time from injury of the third and fourth cervical nerves supplying them.

If the lesion is due to a blow on the shoulder, the prognosis is good.

Circumflex Nerve.—This nerve is injured in dislocation of the shoulder, fractures of the surgical neck of the humerus, and falls on the shoulder. Lesions of the circumflex nerve must be carefully distinguished from lesions of the fifth cervical, which will also cause paralysis of the deltoid combined with paralysis of the supra- and infra-spinatus muscles.

The symptoms are loss of power of abduction, and invariably a patch of loss of sensibility over the deltoid muscle. Later, if the

nerve does not recover, the muscle wastes, and the acromion process becomes unduly prominent, but the power of abduction is regained by the education of other muscles. The loss of sensibility remains. There is loss of power, also, in the *teres minor*, but this is difficult to determine.

PROGNOSIS.—Recovery is the rule.

TREATMENT.—The usual treatment of nerve injury is carried out, but if the division is complete, it is a matter for consideration if nerve suture should be attempted. The disability is not great, and the position of the loss of sensibility unimportant.

Musculo-Spiral Nerve.—This nerve is more liable to subcutaneous injury than any other nerve in the body. The following are the usual accidents which cause paralysis of it: (1) Fractures of the humerus, especially due to direct violence; the nerve may be injured at the time of fracture, or secondarily involved in callus; (2) pressure from the use of crutches ("crutch palsy"); (3) pressure between a hard substance, usually the back of a chair, and the humerus, especially during drunken sleep ("Saturday night or sleep paralysis"); (4) dislocation of the humerus; (5) pressure and overstretching during anaesthesia, especially with the patient in the Trendelenburg position.

SYMPTOMS.—MOTOR.—If the arm is extended, the wrist drops and the forearm is pronated. Extension of the wrist and fingers is not possible owing to the paralysis of the following muscles: Radial and ulnar extensors of the wrist, and the extensors of the fingers and thumb; but the forearm can be supinated by the biceps. Owing to paralysis of the extensors, the flexors cannot act properly, and there is marked weakness of grasp. In these cases, such as in crutch palsy, where the injury has occurred high in the axilla, the triceps and anconeus are paralyzed, and active extension of the forearm is not possible.

SENSORY.—In mild cases of compression there is tingling and numbness along the course of the radial nerve; but even if the division is complete and occurs in the lower third of the arm (the most usual situation), there is no loss of sensation when the musculo-spiral nerve is alone involved. On the other hand, if the nerve is damaged above the origin of its external cutaneous branches, or if the posterior division of the musculo-cutaneous nerve is also involved, there is loss of sensibility over the back of the hand.

PROGNOSIS.—The majority of cases recover without operation within six weeks of the injury.

TREATMENT.—The treatment follows the usual lines of nerve injury, but it is well to emphasize the importance of preventing overstretching of the muscles during the period of recovery of the nerve. If the hand is not carefully splinted, the extensor tendons will become stretched, and when the nerve has recovered, there will still be considerable loss of power.

In cases of complete division the nerve must be sutured, and if the gap between the ends is large, the radial nerve may be utilized to bridge it over; or nerve anastomosis with the median may be carried out.

Radial Nerve.—Division in the upper two-thirds of this nerve causes no loss of sensibility, but division in the lower third causes loss of sensibility over part of the thumb. No treatment is necessary.

Median Nerve.—The median nerve is most frequently injured at the wrist, as it lies between the palmaris longus and the outmost tendon of flexor sublimis digitorum by punctured wounds. The nerve is here subcutaneous, and may be completely divided without division of any tendons or important bloodvessels. It may be noted that division of the median nerve at the wrist causes no loss of deep sensibility. If loss of sensibility be tested *casually*, the lesion will be over-

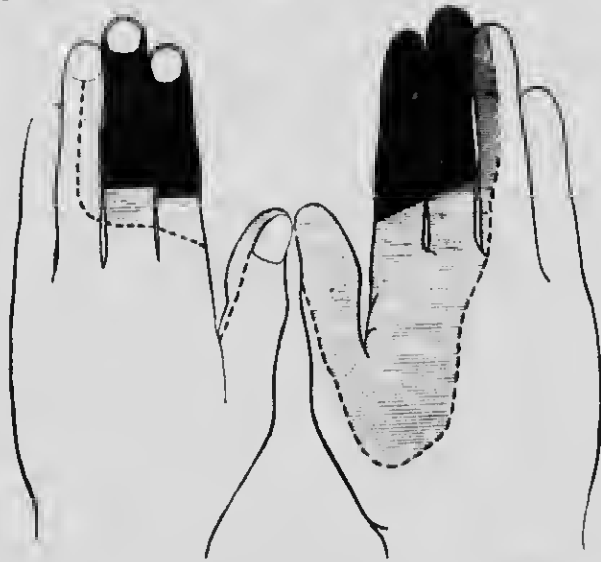


FIG. 156.—LOSS OF SENSIBILITY AFTER DIVISION OF THE MEDIAN NERVE.
(AFTER SHERREN.)

Dark = Protopathic loss, dark and light = epicritic loss.

looked, especially as the motor symptoms are easily missed. It is the most frequent nerve injury to remain undiagnosed in the first examination and treatment of a wound.

SYMPTOMS—Sensibility.—There is loss of epicritic sensibility over the palmar aspect of the radial side of the hand, and over the thumb, index, middle, and half the ring fingers. On the dorsal aspect there is loss of epicritic sensation over the upper part of the index, middle, and ring fingers. There is no loss on the dorsum of the thumb (see diagrams). Loss of protopathic sensibility occurs over a smaller area, and there is no loss of deep sensibility. If the median is divided at or above the elbow, the loss of epicritic and protopathic sensibility is the same as if it is divided at the wrist, but loss of deep sensibility is also present.

Motor.—As stated above, the loss of motor power requires careful investigation. The most characteristic and easily ascertained loss—

if the nerve be divided above the elbow—being the inability to flex the terminal phalanx of the thumb. The index finger also can only be flexed at the metacarpal phalangeal joint, and pronation of the forearm is only feebly carried out. The loss of power in the hands is limited to the outer group of short muscles of the thumb (abductor pollicis, opponens pollicis, and the outer flexor brevis pollicis) and the two outer lumbricals. These latter produce no symptoms that can be recognized, and the extensors of the thumb can mimic abduction, so that very careful examination is necessary to detect the lesion. Later, of course, wasting of the thenar eminence and the reaction of degeneration makes the diagnosis clear.

PROGNOSIS.—This is good if primary suture is carried out and there is no suppuration.

TREATMENT.—This follows the usual line of the treatment for nerve injuries.

Ulnar Nerve.—The ulnar nerve may be injured (1) at or above the elbow, (2) in the forearm above the dorsal cutaneous branch, (3) at the wrist.

1. *At or above the Elbow.*—The nerve may be injured in the axilla by crutch pressure, or at the elbow as a complication of dislocation or fracture. It is sometimes divided during the excision of the elbow.

MOTOR SYMPTOMS.—The following muscles are paralyzed: Flexor carpi ulnaris, the ulnar half of flexor profundus digitorum, the intrinsic muscles of the little finger, all the interossei, the two inner lumbricals, and the three muscles of the thumb on the ulnar side of the long flexor—viz., adductor transversus, adductor obliquus, and the inner flexor brevis pollicis. The hand assumes a characteristic position; all the fingers are flexed at the interphalangeal joints; the index and middle fingers are extended at the metacarpo-phalangeal joints, the little and ring fingers are hyperextended at those joints, and the little finger is held abducted. This position, when it becomes fixed by wasting of the muscles (interossei and hypothenar eminence) and contraction, is termed the "claw-hand."

SENSORY SYMPTOMS.—*Epicritic sensibility* is lost over the little and half the ring finger, both back and front, and also over the ulnar surface of the hand. *Protopathic sensibility* is lost over a varying smaller area, and loss of *deep sensibility* closely follows loss of *protopathic*.

2. *Division in the Forearm above the Dorsal Branch.*—The loss of sensibility is much the same as after division at the elbow, but there may be no loss of deep sensibility. On the other hand, division of tendons is very common with division of the ulnar nerve, and loss of deep sensibility may be due to this cause. The loss of power in the hand is much the same as before, and "claw-hand" will develop.

3. *Division below the Dorsal Branch.*—This lesion is very frequently overlooked, as the loss of sensibility is slight. *Epicritic sensibility* is lost over the ulnar side of the palm of the hand and over the little and half the ring fingers; but on the dorsal aspect the loss only concerns the last two phalanges of the little and ring fingers. *Deep sensibility*

is ovewhro retained, and this has led to frequent errors in diagnosis from casual testing of sensation. The ulnar artery and tendons are usually divided with the ulnar nerve. The necessity of stopping hamorrhago and the obvious division of tendons frequently causes

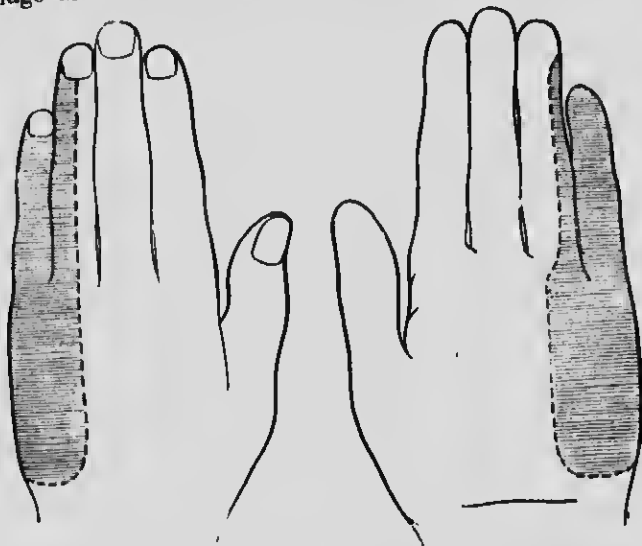


FIG. 157.—LOSS OF SENSIBILITY PRODUCED BY DIVISION OF THE ULNAR NERVE ABOVE THE DORSAL CUTANEOUS BRANCH. (AFTER SHERREN.)

search for a nerve lesion to be casual or neglected. The condition is frequently not discovered until "claw-band" has resulted.

TREATMENT.—This follows the usual lines of nerve injury, but it is especially important that careful splinting and massage be carried out during the stage of nerve regeneration.

Dislocation of the Ulnar Nerve.—Dislocation of the ulnar nerve from the groove between the internal condyle of the humerus and the olecranon may result from sudden violence, or may occur gradually. The nerve can be felt on the internal condyle, and may slip in and out of the groove on flexing and extending the elbow.

SYMPTOMS.—The condition may cause no symptoms, or there may be pain and tingling along the course of the nerve, and the nerve is also exposed to injury.

TREATMENT.—If symptoms are present and severe, the nerve should be cut down upon, wrapped in Cargile membrane, and placed in the groove. A sheath of fascia is then formed and stretched over the nerve, retaining it in position. The results are excellent.

Great Sciatic Nerve.—The great sciatic nerve is rarely injured, except by gunshot wounds, and the division is seldom complete. Both in gunshot wounds and in subcutaneous injuries, such as occur sometimes with dislocation of the hip, the external popliteal portion

is much more frequently divided than the internal (Makins, 90 per cent.); but no satisfactory explanation of this is known.

MOTOR SYMPTOMS.—There is paralysis of all the muscles of the leg, so that the foot cannot be moved; and if the lesion is sufficiently high, the hamstring muscles are also paralyzed, although flexion of the knee can still be accomplished by means of the gracilis.

SENSORY SYMPTOMS.—There is marked loss of epicritic sensibility below the knee, but the foot retains its sensibility in part, as the long saphena nerve is not affected.

TREATMENT follows the usual rules for nerve injury.

External Popliteal.—This nerve may be injured in fractures of the neck of the fibula; during tenotomy of the biceps tendon; or be part of an injury to the great sciatic nerve.

MOTOR SYMPTOMS.—The foot falls into a position of paralytic talipes equino-varus from paralysis of all the extensor muscles and the peronei, and cannot be extended or overted.

SENSORY SYMPTOMS.—The loss of sensibility varies with the site of the injury, but in the most common situation, just as it winds round the head of the fibula, the loss of epicritic sensibility only involves the dorsum of the foot and a varying position of the foot and outer side of the leg. There is usually no loss of deep sensibility.

TREATMENT.—During the period of regeneration of the nerve great care must be taken to prevent the development of talipes equino-varus.

Internal Popliteal.—If this nerve is injured in the popliteal space, there is paralysis of the large muscles of the calf, the tibialis posterior, the flexor longus digitorum, and the flexor hallucis, so that the foot falls into the position of talipes calcaneo-valgus, and flexion of the toes and inversion of the foot is not possible. Epicritic and protopathic sensibility are lost over the sole of the foot, but there is no loss of deep sensibility. The accident is rare.

The anterior tibial nerve is rarely injured.

CHAPTER XIII

AFFECTIONS OF THE SKIN

Callosity.—A callosity is a simple diffuse thickening of the skin due to friction, and is seen chiefly in the hands and feet. It is a protective thickening, and cannot be considered a pathological condition.

Corns.—A corn is produced by pressure, and is rarely seen on any part of the body except the feet of boot-wearing people. It differs from a callosity in having a central downgrowth of epithelium which displaces the papillæ of the skin; and from carcinoma, in that the cells do not grow through the basement membrane. The cells in the epithelial downgrowth undergo extensive keratinization. The papillæ of the skin at the edges of the corn are hypertrophied and congested, and very liable to become inflamed; it is this inflammation that causes pain. A bursa may develop under a corn, and in some cases hæmorrhage occurs into the epithelial downgrowth.

Corns on the exposed part of the foot are usually hard, but between the toes *soft* corns may develop. In these cases the epithelium is softened, owing to the absorption of sweat; these corns are often exceedingly painful.

Corns are most likely to occur in patients who suffer from various deformities of the foot, as hammer-toe and flat-foot.

COMPLICATIONS—Inflammation.—The papillæ round the corn may be inflamed, or the inflammation may be in the bursa lying under the corn. In either case the corn is exquisitely tender and the skin round it reddened. The inflammation may end in suppuration (suppurating corn); and if this occurs in the bursa under the corn, the pus may find that the path of least resistance is upwards, thus causing a **perforating ulcer**. This result is more likely to recur in patients suffering from a nervous lesion of the foot, but it may also ensue in patients without any nerve complication.

TREATMENT.—The source of pressure must be removed. The patient should wear well-fitting boots, and the corn may be protected from pressure by a ring corn plaster. The corn may be softened by soaking it in hot water, and the keratinized epithelium cut away; no bleeding should be caused. Various patent preparations for softening corns are sold; many of them are excellent, the majority containing some form of salicylic acid. The following formula is a useful one: Salicylic acid, 15 grains; extract of cannabis indica, 8 grains; alcohol,

15 minims; ether, 40 minims; flexile collodion, 75 minims. The application is painted on the corn three times a day for a week, and the corn can then be easily removed. If the corn is situated on a deformed toe and very troublesome, amputation of the toe may be advisable.

Soft Corns are treated by cleanliness, separating the toes by pieces of cotton-wool, and removal of the corn after it has been softened in hot water or with a preparation of salicylic acid.

Perforating Ulcer.—Perforating ulcers are a result of suppuration occurring under a corn, and the pus passing upwards into the foot instead of downwards. They are usually chronic, and most commonly associated with defective innervation of the foot, such as occurs in tabes dorsalis, syringomyelia, injury and disease of peripheral nerve trunks, and peripheral neuritis associated with chronic alcoholism or diabetes. They may, however, be present in patients who have no nervous disease.

SYMPTOMS.—Perforating ulcers are usually found in one of the following positions: (1) Under the metatarsal phalangeal joint of the great toe; (2) under the same joint of the little toes; (3) under the pulp of the great toe; (4) under the heel. These are, of course, the points of maximum pressure of the foot, and the places where corns generally form. Two or more perforating ulcers may be present on one foot; both feet may be affected. The suppuration takes place in the bursa under the corn, and an ulcer—or, more correctly, a sinus—develops, which on exploration is found to extend deeply into the tissues, sometimes penetrating the metatarsophalangeal joint or reaching down to necrosed bone. The condition may be unsuspected until the indolent suppuration appears on the dorsum of the foot (perforating ulcer).

Perforating ulcers are generally painless, owing to the defective innervation. Occasionally the process is more acute, and a definite slough may form.

The **DIAGNOSIS** is made by finding a corn discharging slightly at one side. A probe introduced into the sinus passes a variable distance



FIG. 158.—PERFORATING ULCER OF THE FOOT IN A CASE OF TABES DORSALIS.

in the soft tissue, and may be felt projecting on to the dorsum of the foot. The signs of the various lesions predisposing to the condition are usually present. An examination of the ulcer shows that there is a downgrowth of epithelium along the walls of the sinus, and this prevents healing.

TREATMENT.—The corn should be carefully pared away, all the thickened epidermis and necrosed bone, if present, being removed and the sinus thoroughly scraped. Fomentations should be applied, or the sinus packed with gauze, and complete rest given to the foot until the ulcer heals. Recurrence is common. In some cases amputation of the foot, or part of it, is necessary. The disease causing the lesion should receive appropriate treatment.

Boil (Furuncle).—A boil is an acute, circumscribed, infective inflammation of a sweat gland, sebaceous gland, or hair follicle, ending in necrosis and suppuration.

Boils may occur on any part of the body, but are most common in the neck, face, forearms, and buttocks. They may be found singly or in groups, and in the latter case successive crops of boils may



FIG. 159.—STAPHYLOCOCCUS SEEN IN A SECTION THROUGH A FURUNCLE (BOIL).

appear for months or years—a condition spoken of as “furunculosis.” Although occurring in patients who otherwise have good health, boils are more common in people suffering from diabetes, albuminuria, anæmia, or in those who have recently recovered from one of the specific infectious diseases. The infecting organism is usually the

staphylococcus, and the exciting cause of the boil is often friction, pressure, or chronic irritation from sea water or chemicals.

PATHOLOGICAL ANATOMY.—The organisms gain entrance to the gland, and excite an acute inflammation, which ends in necrosis of the gland and a small area of the subcutaneous tissue. Round the central slough or core is an area of acute inflammation, which ends in suppuration and separates the slough, which is discharged through a central opening. The lesion then heals by granulation tissue in the usual way.

Occasionally the inflammation subsides without suppuration, the condition in this case being spoken of as a "blind boil."

SYMPTOMS.—The boil starts as a painful, reddened induration of the skin, gradually enlarging until there is a rounded swelling, deep red in colour, with a yellowish centre, encircled by a bright red areola. The nearest lymphatic glands are often inflamed and painful, and are liable to suppurate. The middle of the boil softens, gives way, and exposes the central slough, which is discharged in the next day or two. The inflammation then quickly subsides, and the small cavity, left by the separation of the slough, fills with granulation tissue. If fomentations are used in the treatment of a boil, a crop of small boils often appear round the original lesion. The pain and constitutional disturbance are out of proportion to the size of the boil.

If the boil does not "come to a head," the tissues remain thickened and indurated for weeks.

TREATMENT.—The general treatment is that of any infectious disease, and in cases of furunculosis vaccines may be valuable. It is best to prepare the vaccine from the organisms present in the boil; but if this cannot be done, a stock vaccine of *Staphylococcus albus* may be used.

Local.—In many instances the simplest and best treatment is to protect the boil and allow it to burst naturally, but the use of active hyperæmia by means of Klapp's suction apparatus may hasten the cure. Antiseptic fomentations may be applied in order to bring about the more rapid separation of the slough; their use is, however, apt to cause secondary infection round the boil. When suppuration has occurred, the boil may be incised and the core squeezed out.

Chilblain (Pernio).—A chilblain is an inflammatory condition of the skin, usually found on the extremities of young people with defective circulation. The determining cause is exposure to cold.

CLINICAL FEATURES.—After being at first anæmic, the part becomes shiny, red, and swollen. It itches or burns. The inflammation sometimes subsides at this stage, but in other cases an exudation is present beneath the cuticle, and a blister ensues. This blister breaks (broken chilblain), and a superficial ulcer results, or in some cases small sloughs may form. Chilblains and the subsequent ulceration are often very troublesome in patients with infantile paralysis, who may be subject to them even in the summer months.

TREATMENT.—The general health should be improved in every way, and the patient should take plenty of exercise. The hands and feet

must be warmly covered in the winter. The patient should always wash in warm water and dry his hands thoroughly.

When the chilblain is forming, calamine lotion may be applied, or the part may be painted with tincture of iodine. If the chilblain bursts, it should be treated with the usual aseptic precautions, and some simple ointment applied.

Bier's method of passive congestion and the application of X rays are both used in the preventive treatment of chilblains.

Sebaceous Cysts.—A sebaceous cyst is a retention cyst of one of the sebaceous glands of the skin. They usually occur in adults, and are most common on the face, head, neck, shoulders, scrotum, and labia, though they may be found on any part of the skin. There is no apparent reason for their appearance.

PATHOLOGICAL ANATOMY.—The cyst wall is formed of fibrous tissue lined with a stratified epithelium. The cyst at first is only attached to the skin in one place, where a small puncture may be seen, through which sebaceous matter may be squeezed; otherwise the cyst lies freely in the subcutaneous tissue. Later, especially if irritated, the cyst becomes firmly attached both to the skin and to the subcutaneous tissue. It contains a soft, pulpy, yellowish-white material with a stale odour, which, on microscopical examination, is seen to consist of fatty degenerated cells, cholesterol, and epithelial debris.

CLINICAL COURSE.—The cyst first appears as a small, firm nodule situated in the skin, the punctum being as a rule obvious. It may remain in this condition for years, or it may increase steadily in size from a round soft swelling the size of a walnut to the size of a tangerine orange. The skin is closely adherent to the cyst.

COMPLICATIONS.—Attacks of inflammation are common, the swelling becoming painful and reddened. Each attack leaves the cyst more adherent. One of the attacks may end in suppuration and the cyst may burst, discharging sebaceous matter and pus. If the condition is neglected, especially if on the head of a woman who does not keep the hair clean, a large granulating surface forms, which discharges a foul pus. This condition may easily be mistaken for a carcinoma, and has been called Cock's peculiar tumour. Carcinomatous change is, however, very rare.

In some cases calcareous salts are deposited in the contents and in the cyst walls.

Sebaceous Horns are formed by the sebaceous matter oozing out of the punctum and drying. Such a horn has been known to reach several inches in length. The base of the horn may become ulcerated, and carcinoma may develop in the ulcer.

DIAGNOSIS.—The diagnosis has to be made from dermoid cysts, lipomata, and tubercular abscesses in the subcutaneous tissue.

TREATMENT.—The cyst should be removed by dissection. A simple method is to transfix the cyst, squeeze out the contents, and pull out each half of the cyst wall. If the skin is closely adherent, an elliptical piece of it should be removed with the cyst.

Suppurating cysts should be treated by incision and removal of the cyst wall, a sharp spoon being used if necessary.

Sebaceous horns should be treated by excising the piece of skin on which they are growing. Cock's peculiar tumour should be excised and the bare area left, covered by skin-grafts.

Sebaceous Adenomata are described in connection with diseases of the nose, as the condition is most frequently seen in that organ.



FIG. 160.—HORNS DEVELOPING IN A CARCINOMA OF THE BACK OF THE HAND.

Molluscum Contagiosum.—This disease shows itself by the appearance on the skin of small, pearly-white, umbilicated nodules contained in a definite capsulo. The contents consist of epithelial cells lying in a fibrous stroma.

The CAUSE of the condition is unknown, but it is definitely contagious. It is most common in children, and the mollusca occur in crops, generally on the face, eyelids, and neck. They may appear at any age and on any part of the body. On the penis, scrotum, and labia they may be mistaken for venereal sores. There are no complications.

TREATMENT.—The mollusca should be cut off with scissors or incised and squeezed out of their capsulos.

Moles.—A mole is a pigmented patch of skin, either congenital or appearing shortly after birth. The colour varies from a yellowish-brown to a deep black, and the mole may be of any size, from a pin's head to a patch covering most of the face or a large part of the body. Many moles are covered with a profuse growth of hair, and they are often very vascular.

A mole grows with the growth of the patient, and may cause no trouble beyond its unsightliness. Pressure and irritation may cause ulceration and severe hæmorrhage.

Melanomata occasionally arise in moles, which may also be the site of origin of rodent ulcers.

TREATMENT.—Moles should be completely excised if treatment is considered necessary. Any gap left may be closed with Thiersch's skin-grafts.

Large moles on the face are best left alone; but if they are covered with hair, this may be removed by application of the X rays.

Warts (Verruca).—Warts, or hard papillomata, are met with on any part of the skin as well as in the vagina, the anal canal, and on

the glans penis. They consist of a central core of vascular connective tissue, covered with a squamous epithelium, and appear to be a hypertrophy of the normal papillæ of the part. They are frequently multiple, spreading round an initial growth, and are often associated with an irritating discharge, such as gonorrhœa, or are found in connection with syphilis. It is possible that warts may be infected from one patient to another, or from one part of the body to another.

CLINICAL FEATURES.—Warts are more general in children than in adults, commonly occurring on the hands. They may persist for years, appearing in crops; but they often disappear spontaneously, especially if the irritating discharge upon which they depend ceases. Warts on moist, warm parts, especially round the anus and genitals, may grow very luxuriously, and form a large soft mass, which has a foul-smelling discharge. In elderly people—particularly if the part is irritated—a carcinoma may develop at the site of the wart.

TREATMENT.—Warts will sometimes disappear after a course of sulphate of magnesia, sufficient being given to cause two or three watery evacuations a day. The treatment should be continued for two or three weeks.

LOCAL TREATMENT consists of removal of the warts, the following methods being used:

1. Removal by such chemical caustics as nitrate of silver, chromic acid, salicylic acid, or nitric acid.
2. Removal by Pacquelin's cautery.
3. Ligature of the wart with silk and allowing it to slough off.
4. Snipping off the warts with scissors.
5. Excision of the wart.

AFTER-TREATMENT.—The parts should be kept dry and clean.

Lupus Vulgaris.—Lupus vulgaris is a chronic tuberculosis of the skin, most frequently seen on the face. It may also involve the mucous membranes of the mouth and nose by extension from the skin lesion. The condition generally begins in young adult life. The course is essentially chronic, for the disease may continue to spread for many years.

PATHOLOGICAL ANATOMY.—The main pathological feature is a small round-celled infiltration of the skin with a scanty formation of new bloodvessels; the granulation tissue is therefore flabby and anæmic. Occasionally giant cells are seen, and they may be surrounded by endothelioid cells forming giant cell systems. Tubercle bacilli may—but not easily—be found in the granulation tissue, which gradually replaces the skin. There is formation of fibrous tissue, but owing to the scanty blood-supply, the scar is weak and liable to break down. Extension of the tubercular inflammation usually takes place into fresh tissue, while the scar is forming. The disease brings about a gradual destruction of the tissues: such obvious deformities as the loss of the tip of the nose or part of the lips may result.

The following varieties are recognized:

LUPUS ULCERANS.—In this form the destruction of tissue is more rapid, and definite ulcers form, which heal by dense cicatricial tissue. Secondary infection is always present.

LUPUS HYPERTROPHICUS is a condition in which a solid oedema is associated with the formation of granulation tissue. The upper lip often becomes greatly thickened when this is the site of the disease.



FIG. 161.—SECTION OF LUPUS VULGARIS, SHOWING GIANT CELLS.

LUPUS VERRUCOSUS.—In this form the horny epithelium round the patch of granulation tissue is heaped up. It is most common in lupus of the hands and feet.

Occasionally a carcinoma will develop either in the patch of granulation tissue or in the scar that is left after healing. The carcinoma is usually slowly growing and of low malignancy.

CLINICAL FEATURES.—In the early stages the disease appears as a few spots about the size of a pin-head. They are dull red or yellowish, the colour not disappearing on pressure. These spots gradually grow into little reddish-brown nodules, which are somitranslucent in appearance. They have been compared to "apple jelly." The formation of scar tissue may be present in one part, with extension of the disease in another; or definite ulceration may occur with the secretion of pus, a secondary infection by the pyogenic organisms being present. The disease spreads very slowly. If situated on the nose, it may ultimately destroy all the outer soft parts and the nasal cartilages, but the bone is never directly affected. The progress of the disease is irregular, and appears to vary with the general health of the patient. Spontaneous cure may occur, the whole of the granula-

tion tissue changing to scar tissue; but recrudescence is common, even after years.

Although most common on the face, no part of the skin is exempt from the disease; but it is rare on the scalp, the upper eyelids, the



FIG. 162.—EXTENSIVE LUPUS VULGARIS.
(Dr. Sequiera's case.)

genitals, the palms of the hands, and the soles of the feet.

The patient may complain a little of the itching or burning of the part, but the chief complaint is of the disfigurement caused by the disease.

DIAGNOSIS.—The diagnosis is made from the chronic course, the characteristic appearance of the "apple-jelly" nodules, the age of the patient, and the absence of a syphilitic history. Syphilitic affections of the skin are much more rapidly destructive, and at the present time can always be excluded by the absence of the Wassermann serum reaction.

Redent ulcer may also be mistaken for lupus, but it usually begins later in life,

and has a definite rolled edge. Microscopical examination of a small piece of the edge will establish the diagnosis in doubtful cases.

TREATMENT.—If a small patch of lupus is present, it should be excised, especially if on a part of the body where the presence of a scar is of no importance. Unfortunately the disease is seldom seen in such a situation, and in the majority of cases that apply for treatment excision is not possible.

FINSEN LIGHT CURE.—This consists of exposing the patient to the concentrated light rays of the sun or the light from a powerful arc lamp, the heat rays being excluded by passing the rays through a water-cooled lens. Each sitting lasts for about half an hour, and in the case of a large patch of lupus, a hundred or more sittings may be required. A slight inflammatory reaction follows the sitting, and the lupus patch should be covered with a simple ointment. The results in most cases are excellent, a thin white scar being formed. The apparatus is expensive, however. The Finsen light cure is more useful in simple cases than for *lupus ulcerans* or *verrucosus*.

X RAYS.—Exposure of the lupus patch to the Röntgen rays will often bring about scarring and cure. The rays should only reach the surface that is actually diseased, the surrounding skin being protected, and the dose of the X rays carefully measured. The

treatment should be left entirely in the hands of experts, for serious effects may follow too long or too frequent exposure to the rays.

RADIUM.—Radium rays have also been used, and this form of treatment is still under consideration, but the cost is a great obstacle to their general use.

In cases of severe ulceration of the verrucosus variety, the surgeon is not infrequently asked to prepare the surface for light treatment by cutting away the edge and scraping the granulation tissue. No attempt, however, should be made to remove the whole of the disease.

If the above special methods of treatment are not available, the older methods of scraping with a sharp spoon and applying a Paquelin cautery, or the application of such caustics as strong salicylic acid or zinc chloride, may be tried. Skin-grafting may be necessary after these energetic methods. Relapses are common.

The general health should always be attended to while the local treatment is being carried out, and injections of tuberculin may be given.

OTHER FORMS OF TUBERCULOSIS OF THE SKIN

1. Inoculation Tuberculosis.—Tubercle can be directly inoculated into the skin through a wound; but considering the prevalence of tuberculosis, the cases are rare. The lesion appears as a very indolent ulcer covered with flabby granulations and with little tendency to heal. The lymphatics leading to the nearest set of lymphatic glands are chronically inflamed, and the chronic tuberculous abscesses which form in their course burst, leaving tuberculous ulcers with the usual characteristics (see p. 118). The lymphatic glands also become infected and suppurate.

TREATMENT.—The primary lesion should be excised, and tubercular abscesses in the course of the lymphatics and in the lymphatic glands should also be excised if possible. If excision cannot be performed, the abscesses should be opened and thoroughly scraped. General treatment for tuberculosis, which is of the utmost importance, should be carried out at the same time.

2. Multiple Tubercular Foci in the Subcutaneous Tissue.—These are most common in children, and appear as small, firm nodules in the subcutaneous tissue in any part of the body. The nodules enlarge and soften, the skin over them is reddened, and a small tubercular abscess forms. This bursts and leaves a tubercular ulcer.

TREATMENT.—The best treatment is complete excision; but if this is not possible, the small abscess should be opened, scraped, and dressed with a stimulating antiseptic ointment or lotion. X-ray treatment may also be beneficial.

3. Tuberculous Ulcer in the Skin Secondary to Tuberculosis of Glands, Bones, etc.—Tuberculous ulcers of the skin usually result from the bursting of a subcutaneous tuberculous abscess, which is secondary to a focus of deep-seated tuberculosis, especially in the lymphatic glands of the neck. The ulcer has ragged, undermined

edges; the floor is covered with soft, anæmic granulations, and there is a scanty secretion in which the tubercle bacillus may be found.



FIG. 163.—PRIMARY TUBERCULAR ULCERATION OF THE FACE.

(Dr. Sequeira's case.)

There is little tendency towards spontaneous healing.

TREATMENT.—The original cause of the abscess must be removed, if possible—*e.g.*, a suppurating tubercular gland of the neck should be excised. The ulcer, if not too extensive, should also be excised, and the bare area covered with skin-grafts. If this cannot be done, it should be thoroughly scraped, the edges being cut away with the scalpel or scissors. The wound should be dressed with a stimulating antiseptic ointment or lotion. General treatment of tuberculosis should always be carried out, and local X-ray treatment is often beneficial.

4. Anatomical Tubercle (*Verruca Necrogenica*).—

Anatomical tubercle occurs in the knuckles and interdigital folds of post-mortem porters, pathologists, and slaughter-house men, and is a very chronic form of direct inoculation tuberculosis. It is very rare.

The disease appears as a flat, irregular, watery mass, slightly reddened. It has a sero-purulent exudate, which dries and forms crusts. It may spread for years, or undergo spontaneous cure, leaving a slight flexible scar.

TREATMENT.—The tubercle should be cauterized with acid nitrate of mercury, nitric acid, or Paequelin's cautery, and the resulting wound dressed antiseptically. The prognosis is good.

5. Bazin's Disease (*Erythema Induratum*).—

This form of tuberculosis of the skin is most frequently met with in young girls, being very rare after the age of twenty-five.

Clinically it shows itself as symmetrical swellings, usually situated on the calves, occasionally on the arms, which break down into ulcers having the usual characteristics of tubercular lesions. The bacillus is difficult to demonstrate.

TREATMENT.—The usual general treatment of tuberculosis should be carried out. The patient should be put at rest, and the ulcers thoroughly scraped and treated with ointments. Healing is very slow.

Rodent Ulcer.—A rodent ulcer is a carcinoma arising in connection with the sweat or sebaceous glands. Microscopically, it differs from the squamous-celled carcinomata of the skin in consisting of small cells arranged in columns or in an alveolar manner. The growth spreads superficially without long downgrowths of branching columns of cells, and cell-nests are very scanty. The lymphatics are seldom invaded.

CLINICAL FEATURES.—Rodent ulcer occurs in elderly people, and is most common in the region of the naso-facial furrow, especially at the inner or outer canthus. It may, however, arise on any part of the body, but apart from the face it is a rare growth of the skin. It begins as a soft, flat-topped, brownish-red nodule, traversed by dilated veins. It may remain in this form for years, but ultimately



FIG. 164.—RODENT ULCER.

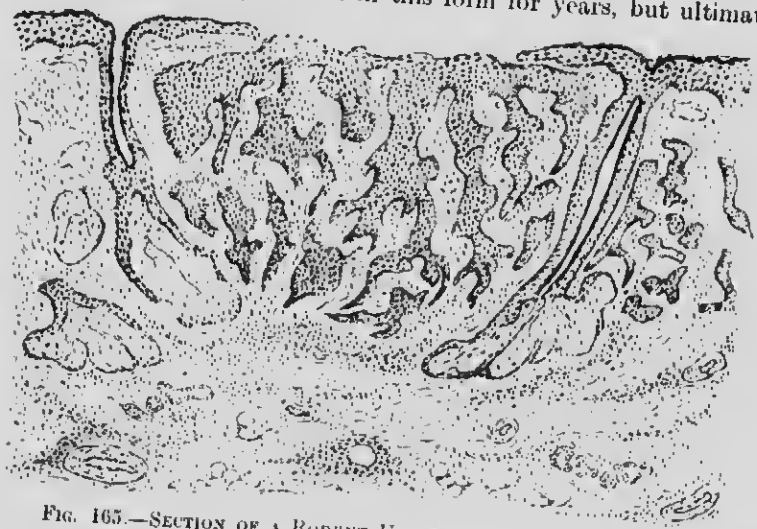


FIG. 165.—SECTION OF A RODENT ULCER. (Compare with Fig. 71.)

it ulcerates, and continues to spread slowly and superficially. It destroys all structures in its path, causing hideous deformity. The ulcer is circular, has an irregular edge, which is slightly raised and rounded (rolled). The floor shows few granulations, but the ulcer may

heal in one place while it is spreading in another. The base is slightly indurated. The secretion is, as a rule, scanty, and tends to form a crust on the surface of the ulcer. The lymphatic glands may remain unaffected for years, and it is rare to find them involved even in the later stages. Occasionally a squamous-celled carcinoma may develop in a rodent ulcer; the ulcer then spreads rapidly, and glandular involvement ensues. Erysipelas, or other infective complications, may supervene, and lead to the death of the patient.

DIAGNOSIS.—The diagnosis has to be made from squamous-celled carcinoma and lupus. From the former the diagnosis is usually easy, for the rate of growth, absence of healing, and the early glandular involvement, are characteristic. From the latter the age of the patient is an important diagnostic point, for lupus generally occurs in early life, and rodent ulcer is rare below thirty. Cases of rodent ulcer have, however, been described in patients below the age of twenty.

TREATMENT.—In the early stages, especially before ulceration has occurred, the growth should be freely excised, and the prognosis is good.

X-RAY TREATMENT gives excellent results in rodent ulcer, and should be employed—



FIG. 166.—CRATERIFORM ULCER.

1. If operation is refused in early cases.
2. In cases that recur after excision.
3. In cases in which excision would involve loss of the eye.
4. In cases with involvement of the orbit or nose who apply for treatment late.

The treatment may have to be continued for months, but ultimately healing with a flexible scar may be obtained, and recurrence is not common.

If the edge of a rodent ulcer is exuberant, it should be excised before the application of the X rays.

Radium has also been used with success in the treatment of rodent ulcer.

Crateriform Ulcer.—A crateriform ulcer is a squamous-celled carcinoma affecting the same region of the face as the rodent ulcer, but growing much more rapidly, and infecting the glands early. It appears as a rounded lump, which ulcerates in the centre and spreads, but there is little discharge and practically no pain. It requires the usual treatment of a squamous-celled carcinoma.

AFFECTIONS OF THE NAILS

General Skin Lesions.—In various cutaneous affections, such as eczema or psoriasis, the nails may share in the skin lesion and become thickened and scaly, or they may be lost. Disturbance of growth may also occur in the general infective diseases, as smallpox and typhoid fever. Trophic changes in the nails may follow nerve lesions; they are described on p. 368.

Onychia and Perionychia.—Suppurative conditions of and round the nails have already been described on p. 84.

Onychia Maligna.—This disease occurs in children who are badly nourished and sometimes suffering from inherited syphilis. It is insidious in its onset. The nail matrix is changed into granulation tissue, the end of the finger is swollen and inflamed, the part round the nail being bluish-red, and the nail becomes loosened. More than one finger may be affected.

TREATMENT.—The nail should be removed, and the granulation tissue scraped away or treated with strong antiseptics. A useful dressing consists of lint soaked in silver nitrate solution, 2 grains to the ounce. Iodoform ointment is also useful. Attention should be given to the general health.

Onycho-Gryphosis.—In elderly people who neglect the care of their feet, and especially in bedridden patients, a hypertrophy of the nail may occur owing to heaping up of the horny epithelium. The condition is most marked in the great toe, where it may form a twisted horny mass 1 or 2 inches in length. The name "onycho-gryphosis" has been given to the condition. The other toe-nails may suffer in the same way.

TREATMENT.—If considered necessary, the nail should be removed. Occasionally ulceration takes place round the base of the horny mass, and a carcinoma may develop.

Ingrowing Toe-Nail.—This condition is most frequently seen in the great toe of young subjects, and is largely the result of wearing ill-fitting boots. The patient's feet generally sweat freely, and the nails have been carelessly cut. As a consequence of the pressure of the boot, the skin on the inner side of the toe grows over the free edge of the nail. The condition causes no symptoms unless the nail cuts the skin, when unhealthy granulations form over the edge of the nail, and there is a purulent discharge. The part then becomes exquisitely tender, and may completely incapacitate the patient



FIG. 167. — ONYCHO-GRYPHOSIS.
(London Hospital Medical College
Museum.)

from walking. The condition may develop on the outer side of the great toe, or on one of the other toes.

The Diagnosis is obvious.

TREATMENT.—In an early case the treatment consists of removing the pressure, cutting the nail properly, cleanliness, and destroying the granulation tissue by such caustics as silver nitrate or copper sulphate.

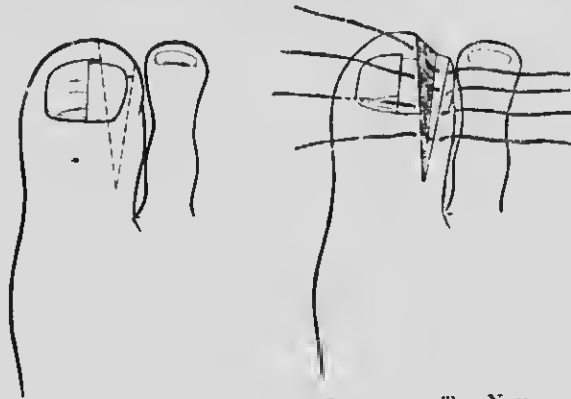


FIG. 168.—OPERATION FOR INGROWING TOE-NAIL.

If this treatment is not successful, or the growth of skin is exaggerated, operation is necessary. The nail and a wedge-shaped piece of tissue from the inner side of the toe, including part of the nail matrix, should be relieved. The edges of the gap left are united with sutures. Unless there is a free removal of tissue and careful attention to the after-treatment, the condition will recur.

Subungual Exostosis.—A subungual exostosis is a mass of bone growing from the dorsal aspect of the terminal phalanx of the great toe. It is doubtful if it should be considered as an osteoma or an inflammatory exostosis due to pressure of the nail.

Clinically, the bony growth pushes up the matrix of the nail and shows between the nail and the tip of the toe, the appearance being quite characteristic. The patient complains of pain. Ulceration may occur over it.

TREATMENT.—A flap of tissue, including the nail, should be turned upwards, and the excess of bone removed with a chisel, or the terminal phalanx may be excised.

CHAPTER XIV

INJURIES OF BONES—FRACTURES

Contusions.—When a bone is struck, the injury falls chiefly on the periosteum, and an immediate slight extravasation of blood occurs between it and the bone. The injury is followed by traumatic periostitis, with inflammatory exudate, but this as a rule subsides rapidly. In some cases, however, the injured periosteum lays down new bone, and a permanent node is left on the bone. A contusion of bone is sometimes followed by infection, either tubercular or septic. The pain of a contusion of bone may last for weeks.

TREATMENT.—The bone should be put at rest, and fomentations applied if the pain is severe. Should the inflammatory oxidate be abundant, it should be removed with an aspirating needle.

Incised Wounds of bones are incomplete compound fractures, and require the usual treatment of compound fractures.

FRACTURES

DEFINITION.—A fracture is a solution in the continuity of a bone, suddenly produced by violence.

VARIETIES—Spontaneous or Pathological Fracture.—A spontaneous fracture is a fracture produced by such violence as would not fracture a normal bone, and indicates a pathological condition of the bone. In every case of fracture a careful history of the accident should be obtained before the case is treated, otherwise a serious disease of the bone, such as malignant new growth, may be overlooked, and valuable time wasted.

Spontaneous fractures occur under the following conditions:

- (1) Atrophy of the bone from disuse, a condition occurring in bedridden patients, especially if the muscles are paralyzed.
- (2) Atrophy of the bone from pressure of an aneurysm or a simple tumour.
- (3) Diseases of the nervous system, as tabes dorsalis and general paralysis of the insane. These diseases may be associated with a general atrophy and brittleness of the bones, so that slight degrees of violence may lead to fracture. The fractures are most common in the ribs and long bones, and their occurrence may lead to charges of undue violence against nurses and attendants who are looking after the insane.

(4) General diseases affecting the skeleton, the most important being rickets and osteomalacia.

(5) Local inflammatory conditions in bones, especially those associated with suppuration, as tubercle, syphilis (gumma), infective osteomyelitis, and chronic abscess.

(6) Malignant new growth in bone, either primary sarcoma or secondary carcinoma.

(7) Cysts of bone, the most common being hydatid cysts and blood-cysts forming in endothelioma of bone.

(8) *Fragilitas ossium* or congenital osteo-psathyrosis, a condition associated with undue brittleness of the bones without any definite pathological change. In one reported case the patient sustained over a hundred fractures of the various bones. The fractures as a rule unite firmly in the usual time.

TREATMENT OF SPONTANEOUS FRACTURES.—The treatment of these fractures varies with the cause. In those cases where there is no local lesion in the bone requiring treatment, the fracture is treated in the same manner as a traumatic fracture.

Simple Fracture.—A fracture is simple when there is no external wound allowing the air to communicate with the fractured ends of the bone.

Compound Fracture.—A fracture is compound when there is a wound over the fracture, leading down to the fragments.

Complicated Fracture.—A complicated fracture is one in which there is extensive laceration of the soft parts, injury to an important bloodvessel or nerve, or dislocation of the fractured bone.

Complete Fracture.—A fracture is complete when the bone is broken into two or more pieces, and **incomplete** when the fracture does not extend completely through the bone.

Greenstick Fracture.—This is a variety of incomplete fracture, the bone being partially broken and partially bent. The break is always on the convexity of the bend, and the bone is usually splintered. This variety of fracture is most common in the clavicle, and occurs chiefly in children between the ages of three and ten years. The periosteum is usually intact.

Greenstick fracture is diagnosed by seeing and feeling the deformity, and the presence of the local pain and loss of function; crepitus is slight or absent. Radiography will at once establish the diagnosis.

TREATMENT OF GREENSTICK FRACTURE.—The deformity should always be corrected, an anæsthetic being given if necessary; and if the fracture is made complete, it is unimportant. The usual treatment for the particular fracture should then be carried out.

Union occurs in the usual time.

Comminuted Fracture.—A fracture is said to be comminuted when the bone is broken into fragments, or one or more pieces are broken off the primary fragments. Comminuted fragments are usually due to direct violence, and on the whole are more difficult to treat than simple fractures.

Double Fracture.—A double fracture is present when the bone is broken in two places, separated by a considerable piece of whole bone. They are rare. It is very difficult to keep the fragments in apposition during treatment.

Impacted Fracture.—A fracture is impacted when one of the fragments is driven into the other. In the treatment, the fragments should be disimpacted unless the impaction has occurred in a good position, or in those cases, as in fracture of the neck of the femur near the head, in which union commonly does not occur.

Fractures, according to their shape and position, are also termed "transverse," "longitudinal," "oblique," "T- or Y-shaped," and "spiral." These terms explain themselves.

Separated Epiphyses

Separation of an epiphysis like a fracture may be pathological or traumatic.

Pathological Separation of the Epiphyses.—The usual cause of pathological separation of an epiphysis is an inflammatory condition of the bone on the diaphysial side of the epiphysial line, the common causes of the inflammation being tubercle, inherited syphilis, and septic conditions. Other causes are rickets, scurvy, and new growth. The epiphyses become separated by very slight violence, and in the case of syphilis two or more epiphyses may be separated at the same time.

Traumatic Separation of the Epiphyses.—Traumatic separation of the epiphyses occurs in young subjects up to the age of twenty-five, and most frequently between the years of ten and eighteen. The causes of the separation are similar to those that cause fracture and dislocation, and it may be stated broadly that a violence which will produce a dislocation in a young adult will produce a separation of the epiphysis in a child.

The epiphyses most frequently separated are the lower epiphyses of the femur, humerus, and radius. Separation is more common in boys than girls, probably because they are more exposed to violence.

SITE OF THE SEPARATION.—This has been a matter of considerable controversy, but the following facts seem established:

1. The most common site of separation is through the juxta-epiphysial bone on the diaphysial side of the cartilage, so that the cartilage remains attached to the epiphysis, and is covered with spicules of bone.



FIG. 169.—SEPARATION OF LOWER EPIPHYSES OF THE FEMUR.

2. That pure separation through the cartilage does occur, especially in young subjects before ossification of the epiphyses is far advanced.

3. That separation may occur some little distance from the cartilage, and yet the most important condition is the separated epiphysis.

4. That in many cases the line of separation is irregular, and involves both the cartilage and the juxta-epiphysial bone.

A separated epiphysis may be simple, compound, or complicated, and usually the periosteum is extensively stripped off the shaft of the bone, and may be a serious hindrance to reduction.

Suppuration of a simple separated epiphysis sometimes occurs, and usually leads to necrosis of the epiphysis and disorganization of the neighbouring joint.

SYMPTOMS.—The symptoms are similar to those of fracture, but owing to the proximity of the epiphysis to the joint, it may be difficult to diagnose the condition from dislocation. The chief point in establishing the diagnosis between these two conditions is in the relative positions of the parts of the two bones which form a joint. In the case of a dislocation the relative positions are altered, but in a separated epiphysis they remain normal. The X rays will at once establish the diagnosis.

The other symptoms are pain and tenderness at the site of the injury, characteristic deformity, undue mobility of the epiphysis, crepitus—which, if the separation takes place through the cartilage, is "soft"—loss of power in the limb, and the signs of local trauma.

RESULTS.—The results of traumatic separation of the epiphysis are good on the whole. If there is only slight separation, or if the epiphysis is accurately replaced, growth usually proceeds normally, and a year or two after the accident the restoration of the limb may be perfect.

In some cases arrest of growth may occur from diminution of the bone-forming activity of the epiphysial cartilage, and if the bone be one of two parallel bones (*e.g.*, radius and ulna), the hand will become directed towards the side of the shorter bone as growth proceeds. More infrequently still there may be irregular growth at the epiphysial junction, or even increased growth. Deformity is more apt to occur after separation of the lower end of the humerus than elsewhere, as it is difficult to readjust the epiphysis.

If suppuration occurs, either in a simple or compound separation, the prognosis as regards the limb is bad. Many of the patients die from septicæmia.

TREATMENT.—The same principles govern the treatment of separated epiphyses and fractures. The special methods of treatment will be described with each lesion.

Partial Separation of the Epiphyses (Juxta-Epiphysial Strain).—Since the introduction of radiography in the diagnosis of injuries to the bones, partial separation of the epiphysis has been found to be much commoner than was formerly supposed. The condition causes

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some pain and disability; but the possible sequelæ are of more importance. These sequelæ are—(1) Infection of the damaged bone; (2) deformity.

1. **INFECTION OF THE DAMAGED BONE.**—It is probable that the majority of cases of tubercular and acute osteomyelitis owe their origin to a juxta-epiphysial strain. This strain determines a point of lowered resistance in the body, and if organisms are circulating in the blood, this forms a nidus for their development.

2. The most important **DEFORMITY** following juxta-epiphysial strain is coxa vara, which is frequently due to an accident causing a partial separation of the upper epiphysis of the femur.

This condition is fully described in the chapter on Deformities, p. 269.

Cause of Fractures

The causes of fracture are predisposing and determining. The predisposing causes are—

1. Age of the patient. Fractures are most common between the ages of thirty and forty, and old people are more liable to fracture than children.
2. Sex. Males are much more liable to fracture than females up to the age of seventy, but after this age fractures predominate in females, owing to the prevalence of Colles's fracture and fractures of the upper part of the neck of the femur.
3. Occupations. Obviously some occupations render those pursuing them liable to fracture, but details of the various trades are wanting.
4. Various pathological conditions, already described under the heading of Pathological or Spontaneous Fracture.

The determining causes of fracture are—(1) Direct violence; (2) indirect violence; (3) muscular action.

1. A fracture is due to **direct violence** when the bone is broken at the place where the violence is applied. These fractures are usually transverse, and are frequently compound or associated with severe bruising of the soft parts over the broken bone.

2. A fracture is due to **indirect violence** when the fracturing force is transmitted from the part struck to the seat of the fracture and the bone is broken by bending, compression, or torsion. These fractures are usually oblique or spiral, and the soft parts frequently escape without obvious damage; but the skin, muscles, vessels, or nerves may be lacerated from within by the fragments, more particularly if the patient tries to use the limb after the fracture has occurred.

3. Pure **muscular action** is only responsible for a small minority of fractures, but it contributes probably in some degree to many of the fractures due to indirect violence. The fracture is usually caused by some sudden muscular action with the limb in a position that favours the fracture. The best-known example is fracture of the patella by sudden contraction of the quadriceps extensor muscle

when the knee is flexed and the patella resting on the condyles of the femur. Muscular action also frequently tears off a bony projection, such as the coronoid process or an epiphysis. The ribs may be fractured by muscular action during sneezing, coughing, or the expulsive action during parturition.

In all cases in which muscular action is alleged to be the cause of a fracture, a careful examination should always be made for one of the predisposing causes of spontaneous fracture, or that condition may be overlooked.

Clinical Features of Fractures

The symptoms and signs of fracture are pain and signs of local trauma, loss of function, deformity, abnormal mobility, and crepitus.

1. PAIN AND TENDERNESS.—When the pain and tenderness are over the point struck, they are of little diagnostic value, although one *very* tender localized spot is suggestive of fracture. If the fracture is due to indirect violence or muscular action, however, the presence of a sharply localized pain in the bone is one of the most important physical signs of fracture. In some cases pain and tenderness are not at all marked, and their absence is characteristic of some pre-existing nervous lesion, such as locomotor ataxia.

2. LOSS OF FUNCTION.—As a rule fracture of a bone leads to complete loss of power. If, as in the case of fracture of the fibula, one—and that the less important of two parallel bones—is fractured, the loss of power may be very slight, and in cases of impacted fractures, even of such an important bone as the femur, the patient may still be able to walk. On the other hand, a severe sprain may cause complete disability, so that loss of function is not a very important sign of fracture.

3. DEFORMITY.—Deformity after a fracture is due to swelling and the displacement of the bones. The swelling, in the first place, is due to extravasation of blood, and later to inflammatory exudates. It may be so severe as to interfere with the circulation through the limb, and is one of the chief causes in preventing replacement of the fragments in their normal position.

Displacement of the fragments may be angular, lateral, longitudinal, or rotatory, and is due to the following causes: The fracturing force; the pull of the muscles; the elasticity of the soft parts; the weight of the limb; and external violence applied after the fracture has occurred.

The usual result of displacement is to cause shortening of the limb, and in all cases of suspected fracture measurements of the two limbs should be compared. The finding of shortening is *not* diagnostic of fracture for the following reasons: (1) The limbs may not be naturally equal in length, and the patient may be unaware of this; (2) shortening will occur in dislocations as well as fractures; (3) the swelling of a limb from a severe sprain may make the surface measurements unequal on the two sides; (4) in stout subjects it is difficult to be sure of the exact position of the bony points from which the

measurements are taken. Deformity, although not diagnostic, is a very important sign of fracture, and in the cases of greenstick and impacted fracture the diagnosis is mainly made on the deformity present.

4. **ABNORMAL MOBILITY.**—When abnormal mobility is present in the length of a bone which was previously uninjured, it is a certain sign of fracture, but fracture may be present in its absence. It cannot be detected in many incomplete and firmly impacted fractures or in the case of a bony prominence being torn off, as it may be impossible to grasp the small fragment so as to be certain of abnormal movement.

5. **CREPITUS.**—Crepitus, when it is obtained, is diagnostic, but it may be absent under the following conditions: (1) Incomplete fractures; (2) from impaction of the fragments; (3) with wide separation of the fragments; (4) interposition of soft parts between the fragments; (5) wide overlapping. In many cases it is a sign of extreme value, but it is not always necessary to obtain it. When a fracture can be diagnosed without its aid it should not be sought for, as it causes pain, and may lead to further injury of the soft parts. It is simulated by crepitation due to surgical emphysema, blood-clots, tenosynovitis, and the grating of an osteoarthritic joint.

Abnormal mobility and crepitus are more readily obtained when the patient is under anesthesia. When any doubt exists, therefore, as to the presence of a fracture, and the patient cannot be radiographed, he should be given a general anesthetic and carefully and thoroughly examined for these physical signs. If they are elicited, the fracture should be at once set so that a second anesthetic is unnecessary.

Radiography in Fractures.—Radiography has proved of the utmost value in the diagnosis and treatment of fractures, but like all new aids to exactness, it brings with it its own difficulties. Before pronouncing that no fracture exists, radiograms must be taken in at least two planes, as a fracture which may not be detected in one view will sometimes appear quite plainly in another.

Some experience is also necessary in translating radiograms, the most common error being to mistake the epiphysal lines for fractures.

Radiography is exceedingly useful in ascertaining the position of the fragments after the fracture has been "set" and placed in splints; but it must always be remembered that the fracture will be distorted and the fragments are in better position than they appear. This distortion is due to the fact that the rays of light which are intercepted by the bone are not parallel, and therefore the shadow which they cast is not an accurate picture of the bone. The amount of distortion will vary with the position of the limb as regards the plate and the position of the tube. The nearer the plate is to the limb and the more directly the tube is over the fracture, the less the distortion will be. It is necessary in estimating the apposition of the fragments to take two radiograms at right angles to one another, as in one plate there may appear to be little displacement, and in the other it may be found that the bones are hardly in contact.

In many cases fractures can only be diagnosed by radiography, the usual physical signs completely failing. An excellent example of this is simple fissured fracture of the skull, which can frequently only be detected on radiographic examination.

The early callus by which a fracture is united does not show in a radiogram, so that this method of examination is useless to ascertain if union is proceeding normally, and even when union is firm, a radiogram may be very deceptive in showing displacement which is really distortion of the fragments due to perspective. This distortion can be easily increased by not having the limb and the plate parallel, and clinical examination is of more value than radiography in giving an opinion as to the result of treatment of a fracture.

COMPLICATIONS

1. **Shock.**—A certain amount of shock is present after every fracture. It is rarely severe except in old people, when it may prove fatal. After the majority of simple fractures there is a rise of temperature (aseptic traumatic fever) for about forty-eight hours due to the absorption of some pyrogenic substance, probably fibrin ferment. No treatment is necessary. In compound fractures wound infection may occur, with the usual alteration in the temperature.

2. **Injury to Large Bloodvessels.**—After any fracture there is some extravasation of blood, but it is usually unimportant. In some cases a large vessel may be torn across, and the extravasation of blood so excessive as to threaten gangrene of the limb. In these cases large blebs containing blood-stained fluid form on the injured limb. The main arteries of a limb—for example, the popliteal and tibial arteries—may be pressed upon or torn across by the fragments of bone, and gangrene of the limb may follow. Injuries to the large veins are not so important, but thrombosis in the veins may be followed by pulmonary embolism and death.

3. **Injury to Nerve Trunks** may occur in one of two ways—(1) The nerve is damaged by the fragments of the bone at the time of the accident; or (2) it subsequently becomes involved in callus.

The nerves most liable to injury are the musculospiral in fractures of the humerus, the brachial plexus in fractures of the clavicle, and the external popliteal in fractures of the fibula.

The diagnosis and treatment has been considered in the chapter on Nerve Injuries, p. 365.

4. **Fat Embolism.**—Fat embolism is a common complication of injuries, and especially of fractures. It is rarely of any importance. The fat may be found after death in the lungs and in the kidneys, but opinions differ as to the frequency with which it is found in the urine during life. Fat embolism has been considered to be the cause of death in some cases after fracture in which the onset of the symptoms occurs two or three days after the accident.

SYMPTOMS.—There is dyspnoea with crepitation heard over the lungs, a subnormal temperature, and death in coma. Fat has been found in the sputum.

There is no treatment for this condition.

5. **Suppuration** with necrosis of bone is rare after simple fractures, but it may occur with the usual symptoms and sequelae. Suppuration is common with compound fractures.

6. **Delirium Tremens** frequently complicates fractures in patients who are addicted to the use of alcohol, especially those who are at the same time debilitated in health. The symptoms and treatment are given on p. 205. As regards the *local* treatment, it is better in the majority of cases to sling the fractured limb completely, as the patient is then less likely to cause further damage. A fractured femur will not prevent a delirious patient from trying to walk. Acute mania may follow fracture as it will other injuries.

7. **Hypostatic Pulmonary Congestion.**—This complication most frequently occurs in old people suffering from fracture of the lower extremity, who are kept in bed in the recumbent position. In old people with fractures, this complication should be guarded against by having the patient well propped up in bed, and by placing the limb as soon as possible in a fixed case, so that prolonged stay in bed is unnecessary.

REPAIR OF FRACTURES

The repair of a broken bone is brought about in exactly the same way as repair of any other tissue by the formation of granulation tissue, but the process proceeds beyond fibrosis into the formation of new bone.

Immediately after a fracture has occurred, the broken fragments are found to be lying in the midst of a blood-clot, the surrounding tissues are more or less torn, and the periosteum lacerated and stripped from the bone to a varying extent. The following changes occur during the next few weeks. The blood-clot becomes broken up, and after causing extensive staining of the tissues, is absorbed, and takes no part in repair. The usual local phenomena of inflammation follow a fracture, the part becomes more vascular, exudation of serum and cells occur, and there is the usual proliferation of cells to form a small round-celled exudation. This exudate becomes vascularized by the budding out of new bloodvessels from the pre-existing capillaries, and the fragments become embedded in a mass of granulation tissue, which is also found in the medullary canal and between the ends of the fragments. This granulation tissue repairs the surrounding tissues, muscles, fascia, tendons, etc., by the formation of fibrous tissue in the usual way.

The periosteum becomes softer and more vascular, and is repaired by the formation of scar tissue. The sharp ends of the fragments are absorbed by osteoblasts, and the fragments become rounded and smooth. The mass of granulation tissue gradually becomes ossified,

forming the **callus**, and different names have been given to the various parts. The callus surrounding the fragments, and holding them together, is called the "provisional" or "ensheathing" callus, and ultimately will be largely absorbed; that in the medullary canal is the *internal callus* or medullary plug, and if the apposition of the fragments is good, this will also disappear. The callus growing between the ends of the fragments is termed the *definite* or *permanent* callus, and may ultimately become so much a part of the bone, that it is impossible to say that a fracture has occurred.



FIG. 170.—FORMATION OF CALLUS (SEMI-DIAGRAMMATIC).

The ossification of the granulation tissue is brought about by the osteoblasts, which are derived from the following sources: (1) From the osteoclastic cells set free by the injury and the subsequent absorption of bone; (2) from the bone cells in the open ends of the fragments; (3) from the osteoblastic cell of the periosteum.

The ossification starts from many places at once, and the bone of the callus is at first loose, spongy, vascular, and irregularly laid down, but it gradually becomes denser and firmer, and ultimately is indistinguishable from normal bone.

The compact tissue in the fragments is the last in which these changes occur, and the ends of the bone are firmly embedded in callus long before union occurs between the fragments.

The amount of callus formed, and the amount of callus which remains ultimately unabsorbed, depends largely on the correctness of the apposition of the fragments.

If this is exact, the amount of callus is small, and ultimately all excess will be absorbed, and the restoration in continuity of the bone is perfect. The farther apart the fragments are, the more is the amount of callus formed, the fragments being kept in apposition by a large mass of ensheathing callus, and the medullary cavity remaining closed by a mass of new bone. In young subjects, more especially if the fragments are not immobilized, the ossification of the granulation tissue may be preceded by a stage of cartilage formation, but otherwise the process of repair is similar to that in adults. If the bone is comminuted, the various fragments become embedded in the mass of callus, and if small, they may be absorbed. Larger fragments become incorporated in the new bone, and aid in the process of repair. If the fragments of a fractured bone are widely separated from one another, as in the case of traumatic fracture of the patella, or if the soft parts intervene between the fragments, the callus may not bring about union. If

the articular cartilage of an end of the bone be involved, it unites by fibrous tissue, which is gradually replaced by cartilage; while the rib cartilage unites by fibrous tissue, which frequently becomes ossified.

The following approximate times in the union of a fracture may be given: At the end of the first week the blood-clot has been largely absorbed, and granulation tissue is being actively formed. At the end of the second week the outline of the periosteum and the callus can be made out, and deposits of bone salts can be recognized in the angle between the bone and the attached periosteum. Ossification is well advanced at the end of a month, and no further displacement is likely to occur from slight violence, but bending of the newly formed bone will readily happen. It is months before the process of repair and absorption of unnecessary callus is complete.

TREATMENT OF FRACTURES

The treatment of fractures involves a consideration of the following: First-aid treatment; reduction of the deformity; retention in the corrected position; and removal of the extravasation; and the healing and restoration of function of the surrounding tissues which are also damaged.

First-Aid Treatment.—The object of first-aid treatment is to prevent further damage from occurring, and to make the patient as comfortable as possible until deliberate treatment of the fracture can be carried out. In the case of simple fractures, the most serious damage that is likely to occur from incautious movement is laceration of the skin by one of the fragments, and thus making a simple fracture compound.

If a fracture be diagnosed or suspected, the limb should be secured in such a way that no movement can take place between the fragments of the bone. Temporary splints should be applied outside the patient's clothes if possible, and firmly secured in such a way that movement of the joints above and below the fracture is impossible. In the case of the lower extremity the limbs should be bandaged together. Temporary splints may be made of walking-sticks, umbrellas, newspapers, covers of books, etc., and handkerchiefs, scarves, and neckties can be utilized as bandages. In fractures of the lower extremity the limb should be extended, and the patient not allowed to place the foot on the ground. In fractures of the upper extremity the elbow should be flexed, and after splints have been applied, the elbow should be supported in a sling. In hospital a convenient method of supporting the fragments in the lower extremity is to tie a softly padded cushion round the limb.

When the patient is in bed, the limb should be placed in the position that gives the greatest general relaxation of the muscles. Thus the lower limb should be flexed and placed on its outer side with a thin pillow under the knee, and this position maintained by placing fracture cloths across the limb and securing them with sandbags.

In fractures of the upper extremity the arm should be supported

on a pillow with the elbow flexed. The bed on which a case of fracture should be nursed must be narrow in order that the patient can be easily attended to from both sides. It should have a firm mattress, preferably of horsehair. Feather-beds are to be avoided. In fractures of the lower extremity the mattress should be kept level by placing a fracture-board beneath it.

Before reduction and the application of splints, the limb should be well washed, sponged with 1 in 1,000 perchloride of mercury, and dusted with horacic powder. This will prevent decomposition of sweat and sebaceous matter on the surface of the skin, and itching.

Reduction of the Deformity.—In uncomplicated cases, as a general rule, reduction of the deformity (setting of the fracture) should be accomplished immediately after the complete examination of the fracture, in order that all necessary pain may be got over in one bout. Before attempting reduction, a careful examination should be made for injury to nerves and other lesions complicating the fracture. The rule may be stated thus: *Reduction of the deformity should be done within twelve hours of the accident.* The following conditions make immediate and accurate reduction of the deformity inadvisable:

1. Crushing of the spongy tissue of the bone such as occurs in fracture of the neck of the femur in old people.
2. Extensive swelling of the limb due to extravasation of blood, which causes the limb to become shorter.
3. Profound shock due to the fracture or other injury.
4. Damage to the main vessels of the limb threatening gangrene.
5. Extensive wounds of the skin.

In these cases the limb should be supported between sandbags, and the further treatment will depend upon the condition present.

USE OF ANÆSTHETICS IN THE REDUCTION OF DEFORMITY—General anæsthesia is advisable in the case of children and nervous people who will not bear the necessary pain, also in the case of strong, muscular men in whom the pull of the muscles is difficult to overcome by manipulation, especially in the case of fracture of the femur. In the other cases of simple fracture a general anæsthetic is better avoided as a violent fit of struggling whilst anæsthesia is being induced may render a simple fracture compound, and during recovery from the anæsthesia the patient may disturb the splints that have been applied, and reproduce the deformity. There is also increased risk of death from anæsthesia in these cases, as the patients have not been properly prepared for the administration of an anæsthetic. The pain of reduction can be relieved in the following ways:

1. By the administration of a full dose of morphia.
2. By compression of the main artery of the limb.
3. By the injection of 3 minims of a 4 per cent. sterilized solution of cocaine between the fragments, and a few minutes later 40 minims of a similar solution, part superficially, and part deeply. Immediately after the last injection a tourniquet is applied above the fracture, and in five minutes the limb can be manipulated without pain.

Causes of Deformity.—The forces producing and maintaining the deformity are—

1. The fracturing force and any subsequent violence.
2. The unsupported weight of the limb below the fracture—
e.g., gravity.
3. The contraction of surrounding muscles.
4. The locking of the fragments together, or the fragments being caught in the soft tissues, such as the muscles or the periosteum.
5. The swelling of the limb.

1. The **fracturing force** and subsequent violence cease to act before the reduction is attempted, and so do not tend to reproduce the deformity once reduction has been accomplished; but it is these forces that may wedge the bones together or force them amongst the soft parts in such a way that reduction is made difficult or impossible.

2. The action of **gravity** is overcome by supporting the limb below the fracture on a suitable splint, and it is to counteract this force that fracture-boards are placed under the mattress of the bed. The force of gravity is sometimes utilized in fractures of the upper extremity to maintain extension and counteract the pull of the muscles which tend to produce shortening.

Gravity is also instrumental—for example, in the case of a fractured femur, in producing rotatory deformity, and this must be prevented by careful splinting.

3. Contraction of the Surrounding Muscles.—The muscles are always in a state of tonic contraction, so that when a bone is broken, they tend by their contraction to cause shortening and overlapping of the fragments. This contraction becomes exaggerated in the case of a fracture by the muscles going into spasm, especially when attempts at reduction are made. The spasm of the muscles will in many cases reproduce the deformity directly the attempts at reduction are discontinued.

This force can be overcome in the following ways:

- (1) Manipulation. The limb is placed in such a position that the muscles chiefly acting on the fracture are relaxed—
e.g., in reducing the deformity in the case of a fracture of the tibia and fibula the knee is flexed.
- (2) Extension. Steady traction is made in the direction of the long axis of the limb until the muscles are tired out, and the two limbs are the same length, rotatory deformity at the same time being overcome by suitable rotation of the lower fragment. It must be remembered that in fractures at certain parts of the bones the upper fragment tends to assume a certain attitude that is only faintly indicated by the form of the limb. An example of this is fracture of the upper third of the femur; the upper fragment is flexed, abducted, and rotated out, and the lower fragment must be adjusted into a corresponding position, the rule

being that the lower fragment should be manipulated and placed into apposition with the upper.

(3) *Anæsthesia.* General anæsthesia relaxes the muscles, and usually renders reduction easy; but when the effects of the anæsthetic have passed off, the spasm of the muscles will return and reproduce the displacement if this is not prevented by suitable apparatus.

(4) *Tenotomy of the contracted muscles.* This method of treatment is effective, but it is not often used now, other methods having taken its place. It is, however, sometimes useful in the treatment of Pott's fracture-dislocation, the tendo Achillis being divided in cases of marked backward displacement.

4. *The locking of the fragments together or the fragments being caught in the soft tissues such as the muscles and periosteum.* When a fracture is impacted, reduction of the deformity means that the impaction must be broken down. This is generally advisable, the exceptions being certain fractures which commonly do not unite, such as fracture of the upper part of the neck of the femur in elderly people, and when impaction has occurred in a good position, as it will, for example, in some cases of Colles's fracture. Considerable force is often necessary to break down impacted fractures, and an anæsthetic is generally advisable. When the fragments of a broken bone become "button-holed" through the periosteum or entangled in the muscles, reduction of the deformity by manipulation may be impossible. Radiography will not show the reason for the continued displacement, and often it can only be ascertained by open operation on the fracture.

5. *The Swelling of the Limb.*—The swelling of the limb following a fracture is due at first to the extravasation of blood, and later to inflammatory exudates under the deep fascia. As the deep fascia may be considered to be inextensible, any increase of its size in one direction must be compensated for by diminution in another, so that if the limb increases in girth, it must be shortened in length. According to some surgeons, the swelling of the limb is the most important factor in maintaining the overlapping of the fragments, and two views have been held as to the treatment of the condition: (1) That if there is marked swelling, no attempt should be made to reduce the deformity until several days have elapsed and the swelling has subsided; (2) that the bones should be fixed in position by an open operation. Manipulation is, of course, quite unable to overcome this difficulty in reduction of deformity.

OPERATIVE TREATMENT.—At the present time a somewhat wide difference of opinion exists as to the treatment of simple fractures, and this difference is represented by the following views:

1. That only under exceptional circumstances is it justifiable to operate on a simple fracture.

2. That in all fractures where accurate anatomical reduction of deformity cannot be brought about by manipulation, an open operation should be performed.

It is, however, agreed that certain fractures should always be operated upon if there is no contra-indication in the patient for operative interference. The fractures are those in which bony processes are torn off, and which cannot be retained in position; and in fractures such as fractures of the patella and olecranon where bony union does not occur unless operation is resorted to, and in which restoration of function is brought about much more readily by operative measures. As regards other fractures, the following questions require answers before an opinion can be given as to the advisability of operation:

1. Is reduction by manipulation and retention in splints generally successful?
2. Does a good functional result depend upon a good anatomical result?
3. Can operation be depended upon to bring about accurate reduction?
4. The fate of plates, bands, etc., used in the operative treatment.

(1) *Is reduction by manipulation and retention in splints generally successful?* It may be stated generally that accurate reduction of the deformity is not possible by manipulation if the fracture is oblique and if marked displacement has occurred. An examination of a series of radiograms of all varieties of fracture after they have been "set" and placed in splints will show that it is rare for the reduction to be anatomically perfect, and clinical examination of patients and the examination of museum specimens will show that after the great majority of fractures some deformity is left. In some cases, as has been shown above, reduction of the deformity by manipulation is not possible, owing to the swelling of the limb, the interlocking of the fragments and the fragments being caught in the soft tissues, or owing to the wide separation of the fragments.

(2) *Does a good functional result depend upon a good anatomical result?* The examination of a series of patients after union of a fracture will show that a large number with very bad anatomical results have good use of the fractured limb. For example, a patient with ununited fractures of both patellæ continued his work as a meat porter without inconvenience; and a patient with $2\frac{1}{2}$ inches shortening from a fractured femur continued to work as an engine-driver, and suffered little inconvenience. On the other hand, deformity after a fracture may interfere seriously with a man's capacity for work and seriously lower his market value. The patient's work is, of course, an important factor in considering the amount of disability he will suffer. For example, a bad functional result to a fractured tibia would hardly interfere with a clerk's work, whilst it would absolutely forbid a sailor from following his employment. It may be accepted that a bad anatomical result to a fracture, especially one of the lower extremity, will seriously diminish a patient's value in the labour market, especially if he be of the labouring class.

(3) *Can operation be depended upon to bring about accurate reduction of the deformity?* In the majority of cases an almost perfect anatomical result can be obtained by operative measures, but the operation demands considerable surgical skill and a very careful aseptic techniquo.



FIG. 171.—RESULT OF PLATING A FRACTURE IN THE SHAFT OF THE FEMUR.

(4) *The fate of the plates, bands, etc., used in the operative treatment?* If the operation has been performed under a perfect aseptic technique, the plates and band may remain buried in the tissues for years without giving rise to any symptoms; but if the least infection occurs, the plates are discharged with more or less necrosis of the bone. In some cases where the infection is mild the wound may apparently heal by the first intention, and it is not until months later that a chronic abscess forms, leading down to the foreign body, which has to be removed before healing will occur. If the infection is more virulent, the results are often disastrous, and extensive suppuration and necrosis of bone may demand amputation to save the patient's life; or if the limb is ultimately saved, it is more or less useless. In such a case certainly the result will be much worse than if the non-operative treatment of fractures had been carried out.

To sum up. (a) In certain fractures, such as fractured patella, fractured olecranon, fractured great trochanter, and other bony processes, where there is separation of the fragments, operation should be advised.

(b) In fractures involving joints, where there is displacement of the fragments and partial dislocation, operation is advisable.

(c) In certain fractures, such as oblique fractures of the upper third of the femur, where a good anatomical result is known by past experience to be difficult or impossible to obtain, operation should be advised.

(d) In other cases manipulation should be tried, and if a good anatomical result is obtained, as shown by clinical examination and examination under X rays, splint treatment should be carried out; but if after manipulation and splinting, fairly accurate reduction of the deformity is not obtained, the fracture should be operated upon, especially if the fracture is of the lower extremity.

(5) Cases complicated by injury to nerves, unreduced dislocation of a joint, or injuries to important bloodvessels, should always be operated upon.

It is, of course, presumed in all the above cases that the patient is healthy, and that there are no contra-indications for operative procedures.

Retention of Fragments in Position after Reduction.

—Retention of the fragments in position is maintained by the use of splints. Splints may be classified as *internal* and *external*.

Internal Splints are splints used in the operative treatment of fractures, and consist of metal plates and screws, silver wire, metal bands, ivory pegs, etc. These splints remain in the limb for years if the wound remains non-infected.

External Splints are divided into two varieties—movable and fixed.

MOVABLE SPLINTS are applied with ordinary bandages, and are easily removed and reapplied. They have the advantage that they admit of examination of the fracture and massage treatment, and can be tightened or loosened as the swelling disappears or increases. On the other hand, the patient can remove them himself, and this may seriously interfere with the healing of the fracture.

FIXED SPLINTS are made of materials which harden after they have been applied. They do not permit of examination of the fracture, and massage treatment cannot be

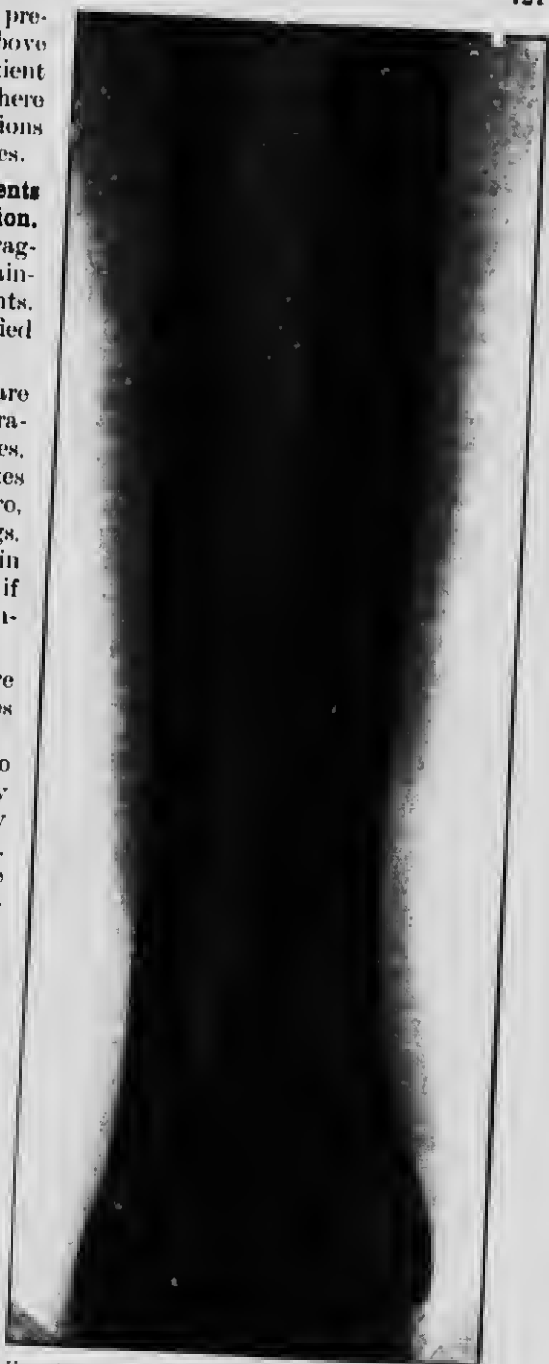


FIG. 172.—A TIBIA PLATED WITH LANE'S PLATE AND SCREWS.

carried out. They render the fragments immobile, and do not want such careful watching as movable splints. Their great disadvantage is that they cause wasting of the muscles, and favour the formation of adhesions. It can be taken as a rule that fixed splints should only be used on patients who cannot afford the time or expense of more scientific treatment, or where it is expedient to keep the fragments immobile, as in delirious patients, or when the patient has to be moved from place to place.

Movable Splints are made of wood, iron, zinc, gutta-percha, leather, plaster of Paris, etc., and may be specially shaped, like Hodgen's, MacIntyre's, or Cline's, or moulded on to the particular limb, like poroplastic or gutta-percha. They are usually padded with tow or padding wool, and covered with linen, the padding being a little wider than the splint itself. Small movable pads are also used to put under hollows and to prevent pressure on prominent parts.

GUTTA-PERCHA SPLINTS.—Gutta-percha is softened by placing it in hot water for a short time. It is then cut roughly to the shape required, a paper pattern of the splint being first made. The limb is thoroughly oiled, and the softened gutta-percha laid on it, folded over in the concavities and stretched in the convexities, then secured with a firm bandage. The gutta-percha hardens slowly, so that sufficient time can be taken to obtain an accurate fit. Hardening may be hastened by placing the splint in cold water either before or after removing it from the limb. After removal, the edges can be smoothed down by pressure with a hot iron. Numerous holes are punched in the splint, which should be lined with chamois leather. These splints are not very rigid, and are most suitable for the treatment of fractures and dislocations of the hand and foot bones.

POROPLASTIC FELT.—This material may also be softened by placing it in hot water, but it is better to put it in front of a fire or in an oven. The limb should be bandaged with a flannel bandage, the softened and roughly shaped splint quickly applied, and quickly and firmly bandaged, for poroplastic hardens rapidly. It is generally necessary to cut notches opposite the concavities, and this weakens the splint. On removal, the splint can be strengthened by fixing strips of steel in places where pressure is expected, and it may be lined.

It is convenient to fix hooks to the edges of the splint, and to fasten it with laces.

LEATHER SPLINTS.—Leather can be softened by soaking for twenty-four hours in cold water. It is moulded to the limb in the same way as poroplastic or gutta-percha, but with patience a more accurate fit can be obtained. It takes a long time to harden, and must be kept bandaged on the limb for some hours. The splint should be lined with chamois leather.

PLASTER OF PARIS may be used to make either movable or immovable splints. The best-known forms of movable splints are Croft's splint and the Bavarian splint. They are described under Fractures of the Tibia and Fibula.

Immovable Splints.—Plaster of Paris to form an immovable splint is applied in the form of bandages.

The limb is shaved if necessary, washed, and sponged with 1 in 1,000 perchloride of mercury, then dried, and lightly powdered with boracic acid.

A flannel bandage is applied smoothly, but loosely, to the limb, so as to cause no constriction. It should be a simple spiral bandage, without reverses or figure-of-eight turns.

A prepared plaster bandage is then placed end upwards in a basin of warm water, deep enough to cover it completely. Salt may be added to the water if it is necessary for the plaster to set quickly. When all the air has escaped from the bandage, it is taken out and squeezed to get rid of the excess of water, and applied smoothly to the limb without reverses, the bandage being allowed very much to take its own course. As the bandage is applied, it is rubbed with the hands to squeeze out any air, and, if necessary, some plaster made into a cream may be rubbed in with the hands. The plaster case may be strengthened at any point by incorporating pieces of tin between the layers of the bandage. In an ordinary case about three layers of bandage will be sufficient. The plaster case will harden in about ten minutes, and the limb must be held in position for this time.

The case may be made impervious to water by varnishing, or by pouring melted paraffin-wax upon it.

Moulded poroplastic splints, secured with a few turns of plaster of Paris bandage, makes an excellent light, fixed splint.

SILICATE SPLINTS.—Silicate of soda solution can be obtained ready prepared, and should be of the consistency of syrup. Thin, open, muslin bandages are thoroughly soaked in the solution and applied in the same way as plaster of Paris, four or five layers being used. It dries in about twenty-four hours, and makes a clean, light case. A silicate splint-case may be cut down the centre and used as a movable splint.

STARCH SPLINTS.—The limb is surrounded by some antiseptic wool made into rollers and applied like an ordinary bandage.

This allows of some swelling, and being elastic, accommodates itself to the subsequent decrease in size. Over this are moulded splints made of bookbinder's millboard (in children strips of brown paper may be used), well soaked in hot water, and saturated with a strong starch solution, the splint being held in position by pieces of bandage, which are removed as the starch bandages are applied. Stout unbleached calico bandages are soaked in hot water, wrung dry, drawn through a strong solution of starch, and then rolled up. They are at once applied over the millboard splints, three or four thicknesses being used. These bandages take about forty-eight hours to dry, and the splint is fairly light and rigid.

It can be cut down, the middle removed, and reapplied with bandages.

Massage in Fractures.—Massage after fractures is efficacious in removing the extravasated blood and exudates; in preventing the

formation of adhesions between muscles and their sheaths; in maintaining the nutrition of the skin and muscles; and in preventing atrophy. In cases where a joint is injured at the same time as the bone is fractured, massage will prevent adhesions forming between the joint surfaces, and so avoid the subsequent stiffness which so much delays convalescence, and prolongs the time of functional disability. Its skilful and systematic use, combined with passive and active movement, if the joint has been injured, is therefore of great value in the treatment of fractures; but its employment must be secondary to the correct apposition of the fragments. In cases where, after reduction, there is no tendency for the fragments to become separated again, or where such a method as wiring or pegging has been adopted, massage should be begun at once, or as soon as the wound is healed, and used during the whole treatment of the injury. In fractures where splints are necessary to maintain apposition of the fragments, massage can still be employed to some extent, especially if carried out under the direct supervision of the surgeon, who sees that the fragments are not shifted during the massage. But in those fractures where recurrence of the deformity readily occurs when the splints are removed or extension is taken off, massage must not be used in the early stages of treatment, but only adopted when the union between the two fragments of bone is so secure that recurrence of the deformity does not occur if the splints are removed with ordinary care.

In many cases where movable splints are used, one-half of the splint will give sufficient protection whilst massage is performed after removal of the other.

It is the inability to employ massage and movements to joints that makes treatment by fixed splints undesirable.

Massage is performed lightly, rubbing towards the trunk, at first with the fingers, and subsequently with the whole hand. The sitting should last for ten minutes in a recent case, the time being gradually extended to fifteen or twenty minutes. Massage is repeated daily.

Ambulatory Treatment of Fractures.—The treatment of fractures of the lower limb by encasing it in plaster of Paris or some other form of fixed apparatus, and allowing the patient to get about on crutches, has been discussed in the above paragraphs. This treatment is usually limited to fractures of one bone of the leg when the danger of displacement is slight.

Following the suggestion of a German instrument maker, an attempt has been made to extend this method of treatment to fractures of both bones of the leg, of the patella, and even of the femur. It is alleged that much loss of time and earning capacity is thereby saved, the patient being able to walk a few days after the injury. The ultimate results are also claimed to be satisfactory. That this method has advantages is undeniable, and good results have been obtained; but the disadvantages, and even the dangers, are considerable. It cannot be employed until the swelling has subsided, and the apparatus used has to be made specially for each patient; the expense, therefore, is considerable. Good apposition of the fragments is difficult to

obtain, and the risk of healing with deformity is great. The movement of the recently fractured limb is also not free from the danger of causing embolism from the thrombosed veins, and sudden death may result.

If it is essential that the patient should get about with a fractured femur, it is probably safer to enclose the damaged limb in a plaster case, fix a patten on the sound limb, and allow the patient to get about on crutches.

Treatment of Compound Fractures

First Aid.—The wound should first be treated in the usual way (see p. 56), and after it has been covered by a dressing, the fracture should be treated as if it were a simple fracture. No time should be lost in carrying out more deliberate treatment, so that wound infection is guarded against as much as possible.

Deliberate Treatment.—The first question to be decided is that of primary amputation, which may be the best method of treating the condition. The rules for arriving at this decision are given on p. 168, and there is nothing further to add to them here.

If amputation is decided against, the first thing to be done is to render the wound aseptic. The various methods of doing this have already been described, but special care should be taken to thoroughly disinfect the ends of the fragments of the bone, especially if they have projected through the skin.

Fragments of muscle and fascia—particularly if dirty—and severely damaged pieces of skin should be removed. Any fragments of bone that are quite loose should be taken away, but if attached to the periosteum or other soft parts may be left if the chances are in favour of the primary healing of the wound.

Search is made for foreign bodies, the wound being enlarged if necessary. Nerves, muscles, tendons, and fascia, if cut across, should be sutured, and arrangement made for deep drainage of the wound, unless an attempt is to be made to secure primary union.

Reduction of the deformity is made in the same way as a simple fracture, but can be aided by direct pressure on the fragments. If reduction is prevented by a protruding fragment of bone, it should be removed.

SPLINTS.—The splints used are similar to those used for the treatment of simple fractures, but the padding is advantageously covered with jaconet or mackintosh. If possible, the splints should be arranged in such a way that the wound can be dressed without removing them. If removal of the splint be necessary, the limb should be carefully held in position whilst the dressing is changed. The wound must not be dressed frequently.

Suppuration in compound fractures should be treated in the usual way by incision and drainage; but if it cannot be checked speedily, the limb should be amputated.

It is of the greatest importance in these cases to have the limb well splinted, so that the fragments of bone do not shift every time the

wound is dressed. Any of the complications of sepsis may occur, and necrosis of the bone to a greater or less extent is the rule.

Vicious union and pseudo-arthrosis are unduly frequent results.

PLATING AND WIRING BONES IN COMPOUND FRACTURE.—The advisability of plating or wiring the bone in a compound fracture depends on the likelihood of sepsis supervening. If the wound is reasonably clean, and can be treated with full aseptic technique, it is most advisable to apply some form of internal splint. If there is much laceration and damaging of the tissue, however, or if it is not possible to carry out the rules of asepsis completely, it is better not to leave foreign bodies in the wound; for if suppuration should follow, it will inevitably be necessary to remove them, and necrosis of the bone is almost certain to occur.

RESULTS OF FRACTURES.—A simple fracture is rarely the cause of death of a patient, but it may result from shock, pulmonary embolism, hypostatic pneumonia, and bedsores. In compound fractures death from shock or infection is not infrequent.

In the majority of cases the broken bone unites firmly, but with more or less deformity, and the following approximate times may be taken as the average in the union of simple fractures:

Phalanges .. .. .	.. 2 to 3 weeks.
Meta-tarsal, tarsal, metacarpal, and carpal .. .. .	.. 3 to 4 ..
Clavicle, forearm, and fibula .. .. .	.. 5 ..
Humerus and tibia .. .. .	.. 6 to 7 ..
Both leg bones .. .. .	.. 8 ..
Femur .. .. .	.. 10 to 12 ..

Compound fractures as a rule take a little longer to unite than simple fractures, and fractures unite more quickly in children than in adults. Among the most common causes of delay in restoration of the function of the limb are atrophy of the muscles from pressure and disuse, œdema of the limb, and adhesions forming in the neighbouring tendon sheaths. Since the routine use of massage and passive movement in the treatment of recent fractures, these complications have become much less common.

Rheumatoid arthritis frequently follows a fracture near or involving a joint, and requires the usual treatment of this condition. In a few cases a sarcoma arises in the callus of a recent fracture, but how close the connection is between these two conditions it is impossible to say.

Delayed Union is said to be present when the fragments of the bone are only feebly united at the time when union should be firm. This delay in union is due to many causes, the chief being want of rest various constitutional complaints as syphilis and rickets, and local causes such as the intervention of muscles and other soft tissue between the fragments, and lack of proper circulation in the limb, due either to tight splinting or injury to the main artery of the limb.

TREATMENT.—Constitutional treatment should be carried out, the patient being given tonics and allowed to get out in the fresh air.

If a syphilitic taint be present, union may be brought about by the administration of iodides of mercury, one case being reported of union occurring under iodides after it had been delayed for four years (Hutchinson). *Locally*, the bone should be securely immobilized in a good position. If union still be delayed in a bone of the lower extremity, the limb may be encased in plaster of Paris, or an injection of a 10 per cent. solution of chloride of zinc, or a few drops of tincture of iodine into the site of the fracture may be tried, and the patient allowed to walk. If these methods fail, the patient may be given an anæsthetic, and the callus broken through, and the two fragments forcibly rubbed together, so that an inflammatory reaction occurs.

Another method of treatment is by passive congestion. If the union is delayed in a fractured humerus, the hand and forearm are bandaged up to the elbow, and a thin, wide india-rubber band is then bandaged round the upper part of the arm and round the shoulder, so as to cause congestion. This band is applied once daily for one or two hours. Should union still be delayed, the fragments should be cut down upon, the ends freshened, and then pegged or screwed into position.

Ununited Fracture.—This term is used to indicate a fracture the fragments of which have not united *by bone* long after the usual time for union. It has been arbitrarily fixed that after twelve months delayed union becomes non-union; but the term "united fracture" should be reserved for those cases in which the changes at the ends of the bone are such that bony union cannot occur without operative interference.

The CAUSES of non-union are similar to those of delayed union, but in many cases, especially non-union of the tibia and fibula in children, no cause can be discovered, and even after operation union may not take place.

Three varieties of non-union are described—(1) Union by fibrous tissues; (2) absolute non-union; and (3) false joint.

1. **Fibrous Union** is the most common variety. It follows wide separation of the fragments, and also those cases (for example, fracture of the neck of the femur) in which the smaller fragment is poorly supplied with blood. The fibrous tissue may be long and loose, or short and dense, and the utility of the part usually varies with the amount of mobility of the fragments.



FIG. 173.—OLD CASE OF FRACTURE OF THE NECK OF THE FEMUR, WITH FIBROUS UNION.

(London Hospital Medical College Museum.)

2. Absolute Non-Union.—The ends of the fragments become smooth and rounded, and covered by a periosteum, so that union cannot occur until this is removed. The amount of disability is usually extreme, and amputation often necessary.



FIG. 174.—ABSOLUTE NON-UNION OF THE TIBIA AND FIBULA.

(London Hospital Medical College Museum.)

cartilage. The fragments are then fixed together by dovetailing, wires, plates, ivory pegs, or any other method that is suitable for the particular case. In some instances bone-grafting will be necessary. In children with ununited fracture of the tibia a living graft has been taken from the sound tibia and fixed into the fractured bone.

Union does not necessarily occur after operation, and it has been stated that it only follows in 60 per cent. of the cases.

If operation ends in failure to secure union, or if the patient is unsuitable or unwilling to undergo an operation, an attempt should be made to obtain a useful limb by the use of apparatus; but if this is unsuccessful and the limb is useless, amputation is necessary.

Disunion of Fracture.—Disunion occurs when the newly formed callus uniting a fracture is absorbed. It is a rare condition, but may follow the onset of an acute disease, such as scurvy or one of the exanthemata during the course of the union of a fracture.

TREATMENT.—The original treatment of the fracture should be continued, and union will ultimately be secured.

Vicious Union.—Vicious union is union with marked displacement of the fragments. It is due to want of primary reduction of the deformity or

3. False Joints (Pseudo-Arthrosis).—This is the rarest form of non-union. A joint of the ball-and-socket variety is formed between the fragments, the ends of which become covered with cartilage. A dense fibrous capsule, which is fairly distinct from the surrounding tissues, holds the ends together, and becomes lined on its inner surface with an endothelium which secretes synovial fluid. This false joint may be the subject of osteoarthritic changes.

TREATMENT.—The treatment of an ununited fracture is operative. The fragments should be thoroughly exposed, and their ends freshened by removing all fibrous tissue and

to subsequent displacement of the fragments, but is not always due to want of skill and care of the surgeon, although there is less excuse for it since the discovery of the X rays. Vicious union may be of comparatively little importance, but in the majority of cases it leads to shorten-

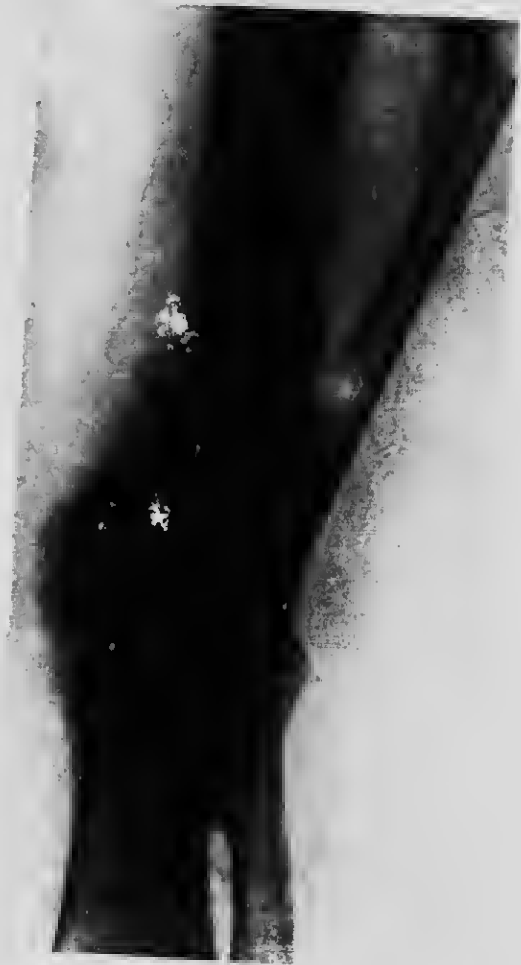


FIG. 175.—FRACTURE OF THE TIBIA AND FIBULA, WITH VICIOUS UNION.

ing of the limb and marked functional disability. A special variety is *bridge callus*, which occurs when two parallel bones are fractured and all four fragments become united by callus. It is only of importance in the forearm bones, where it prevents pronation and supination.

TREATMENT.—In the early stages of callus formation forcible movement or refracture under an anæsthetic may be used to correct the deformity; but when the union is firm and treatment is necessary,



FIG. 176.—BRIDGE CALLUS FROM FRACTURE OF THE RIBS.
(London Hospital Medical College Museum.)

the deformed bone should be exposed by open operation, divided by a chisel and saw, and the fragments fixed together in a good position by plates or bands.

Tumours of Callus.—Tumours developing in callus are very rare, and it has yet to be proved that their presence is more than a coincidence. In many reported cases it is probable that neoplasm was the cause of the fracture. It is also difficult to establish the exact origin of the tumour, whether from the callus or from the adjacent bone or surrounding tissues. The most common tumours met with at the site of fractures are sarcomata. The usual treatment of tumours of bone is necessary.

FRACTURE OF THE INDIVIDUAL BONES

Fractures of the Clavicle

The clavicle is, next to the radius, the commonest site of fracture. A large proportion of the fractures occur in children, and are of the greenstick variety.

CAUSE.—In the majority of cases fracture of the clavicle is due to indirect violence, such as falls on the outstretched hand, but some cases are due to muscular action and direct violence. The bone is most frequently fractured in the middle third at the junction of the two curves, where it is weakest and least supported by the surrounding muscles.

1. **Sternal End.**—Fracture here is rare, and usually due to direct violence or muscular action. The outer fragment is generally displaced in front of and below the inner.

2. **Separation of the Sternal Epiphysis.**—This epiphysis appears about seventeen, and joins the shaft at twenty-five, and it very rarely becomes separated. The sternal end of the clavicle appears to be dislocated forwards, but the bone is sharp instead of rounded. X rays will establish the diagnosis, and the treatment is that of fractured clavicle.

3. **Middle Third.**—This is the common fracture of the clavicle, and is mostly due to indirect violence. The line of the fracture is oblique from above downwards and inwards, and there is the following displacement: The inner fragment is slightly pulled up to the sternomastoid, but this displacement is counteracted by the rhomboid ligament; the outer fragment is displaced downwards by the weight of the arm, and forwards and inwards by the pull of the muscles. As a consequence, the inner fragment rides on the outer, and the deformity is obvious. The point of the shoulder is more prominent than usual, and the patient supports the arm by resting the elbow upon the other hand. The clavicle is shortened by about an inch, and crepitation is obvious, except in the case of a greenstick fracture. In very young children the diagnosis is often not made until the formation of a mass of callus calls the mother's attention to the clavicle.



FIG. 177.—FRACTURED CLAVICLE, SHOWING THE USUAL DEFORMITY.
(London Hospital Medical College Museum.)

4. **Interligamentous Fracture.**—This fracture is usually due to direct violence, and occurs between the coraco-clavicular ligaments—i.e., the conoid and trapezoid. The displacement is very slight, and

the only symptoms are a localized spot of tenderness over the site of the fracture and an occasional "click" on manipulation of the arm.

5. **Acromial End.**—This fracture is usually due to falls on the point of the shoulder, and is most frequently transverse. The inner fragment does not move, but the scapula swings forward and rotates the outer fragment, causing it to lie at right angles to the inner. The shoulder is also dropped by the weight of the arm, and the condition may somewhat resemble upward dislocation of the acromial end of the clavicle.

COMPLICATIONS OF FRACTURED CLAVICLE.—The fracture is rarely compound, and the complications are those of injuries to the artery, veins, and nerves.

Aneurysm of the subclavian artery may follow fracture of the clavicle, owing to injury to its walls.

The subclavian vein may be torn, but more usually it is pressed on, causing œdema of the arm.

Injury to the brachial plexus is more common, especially injury to the fifth and sixth cervical nerves; and in some cases there is evidence of injury to the sympathetic nerve.

RESULTS.—Union is generally firm, occurring within twenty-one days, but as a rule with some deformity. Functional disability even for the most arduous work is rare.

Treatment—SAYRE'S METHOD.—Two pieces of strapping plaster, 3 inches broad, and long enough to go one and a half times round the body, are necessary. The first piece is fastened around the arm on the injured side as near the axilla as possible, with the non-adhesive side towards the skin, and secured by stitching. A folded piece of boracic lint is placed in the axilla. The surgeon then draws both shoulders fully back, and the assistant carries the strip of plaster, which has had turpentine slightly smeared on its adhesive side, across the back, under the sound arm, and round the chest in front.

This fixes the shoulder in the position in which it is held by the surgeon. The patient's hand and arm on the injured side are now laid on the chest, so that the fingers just rest on the opposite clavicle, a piece of boracic lint being placed between the two skin surfaces.

The second strip of plaster is then fastened at the junction of the neck and shoulder of the uninjured side, and carried obliquely across the back to the tip of the olecranon of the injured side. The assistant now draws the elbow forwards, thus throwing the shoulder and the outer fragment backwards, and at the same time lifts the arm upwards, whilst the surgeon manipulates the fragments into position. As soon as the position is satisfactory, the strip of plaster is carried along the anterior surface of the arm slightly to the ulnar side, across the shoulder, and firmly fixed over the scapula. No hole should be cut in the second strip to fit the olecranon into, or pressure may fall on the ulnar nerve and cause paralysis. The arm should be further secured in position by a bandage following the lines of the two pieces of strapping. The strapping must be worn for three weeks, after



FIG. 178.—SAYRE'S METHOD OF TREATING A FRACTURED CLAVICLE.

which the arm is carried in a sling for another three weeks. Forceful movements of the arm should not be made until eight or ten weeks have elapsed from the receipt of the injury.

THREE-HANDKERCHIEF METHOD.—This is a convenient method of rendering "first aid" to a patient with a fractured clavicle. A large handkerchief folded diagonally so as to form a soft thick band is placed round *each* shoulder, so as to lie in front in the hollow between the coracoid process and the head of the humerus. The ends are



FIG. 179.—THREE-HANDKERCHIEF METHOD OF TREATING A FRACTURED CLAVICLE.

secured by a single knot behind the shoulders, and then twisted so as to form a single cord. The two cords thus formed are knotted together in the middle line, the shoulders being first pulled forcibly backwards and the deformity reduced. A pad is placed under the knot to prevent it hurting the back. The third handkerchief is used as a sling, raising and supporting the elbow.

In children, especially with greenstick fractures, which are common in this bone, it is seldom necessary to do more than fix the arm to the side, and raise and support the elbow with a flannel bandage. Union will be firm in three weeks, and there is frequently no resulting deformity; or should slight deformity occur, it will usually disappear with advancing years.

Both these methods will only give moderate results, in the majority of cases some deformity being left, but as a rule very little functional disability. If it be important that there should be a minimum of deformity, the patient may be kept in bed flat on the back on a firm mattress. The head is slightly raised on a small pillow so as to relieve the pull of the sterno-mastoid, and the elbow of the injured side is fastened to the side or chest.

If the patient can bear it, a firm narrow cushion is placed along the spine between the shoulders. This position must be maintained without change for three weeks, and the patient is then allowed up with the arm in a sling.

Fractures of the Scapula

Fractures of the scapula are chiefly due to direct violence, and are frequently comminuted. They may be divided into—

1. **Fracture of the Body.**—This may be broken by a severe blow, the bone usually being smashed into several pieces. The diagnosis is made by local tenderness, crepitus, and in some cases by abnormal mobility between two parts of bone. There is as a rule a little overlapping of the fragments, but no marked displacement, the fragments being held in position by the muscles. Bony union usually occurs without serious disability.

TREATMENT.—Support the arm well in a sling, and employ massage and passive movement from the first to prevent stiffness. The patient may be allowed to use the arm in three weeks.

2. **Fracture of the Acromion.**—This process of bone is generally broken by direct violence, or by the humerus being driven up against it. The usual signs of fracture are present, the shoulder is a little flattened, and the power of abduction of the arm is limited. The acromion process has separate centres of ossification, but it is doubtful if separation of the acromial epiphysis occurs. In some cases X-ray examination has shown that the acromial process is separated from the rest of the bone, and it has been suggested that it is due to non-union of the epiphysis; others, again, believe it is non-union of an old fracture. The condition is sometimes bilateral.

Union after fracture of the acromion is by fibrous tissue, but there is little functional disability.

TREATMENT.—Sayre's method of treating a fractured clavicle gives good results, but if bony union is desired, it is necessary to plait the fragments into position.

3. **Fracture of the Coracoid Process.**—This piece of bone has occasionally been torn off by muscular action, but it is usually fractured by direct violence, such as by the "kick" of a gun. The displacement is generally slight, but the fragment may be pulled downwards by the pectoralis minor. Union occurs by fibrous tissue; the resulting disability is slight.

TREATMENT.—Keep the arm well supported by a sling, and employ massage and passive movement from the first.

4. Fracture of the Surgical Neck.—The surgical neck of the scapula runs from the suprascapular notch to the axillary border just below the glenoid cavity, and the fragment broken off includes the coracoid process and the glenoid process. The usual signs of fracture are present, with flattening of the shoulder, tension of the deltoid, slight lengthening of the arm, and mobility of the fragment. The condition may be mistaken for subglenoid dislocation of the shoulder, but the deformity disappears when supporting the arm, to reappear as soon as the support is removed.

TREATMENT.—Sayre's method of treating a fractured clavicle answers well. Movements should be begun in about two weeks, and either fibrous or bony union may occur.

Fractures of the Humerus

FRACTURES OF THE UPPER END OF THE HUMERUS

1. Fracture of the Surgical Neck.—The surgical neck of the humerus lies between the tuberosities and the muscles attached to them, and

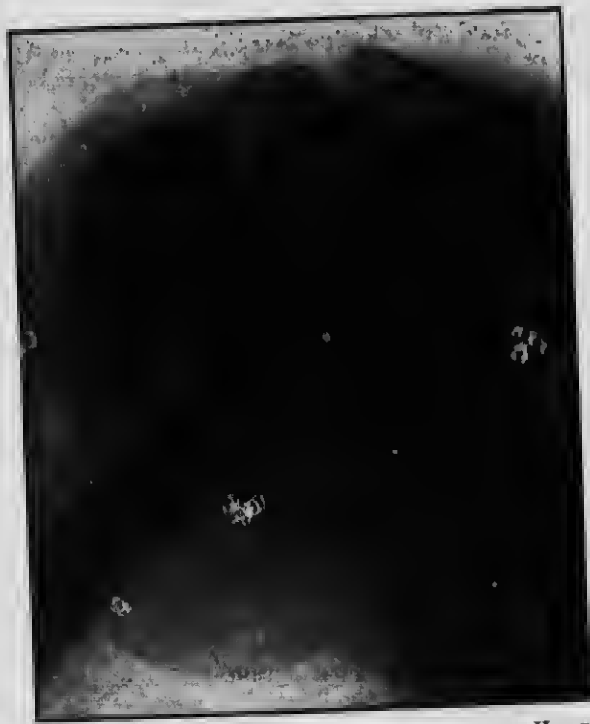


FIG. 180.—FRACTURE OF THE SURGICAL NECK OF THE HUMERUS.

the attachments to the humerus of the pectoralis major and the latissimus dorsi, and it may be fractured either by direct or indirect violence.

DISPLACEMENT.—The upper fragment is usually abducted slightly and rotated out, while the lower fragment is adducted and drawn upwards. Impaction is not uncommon, the outer part of the lower fragment penetrating the cancellous tissue of the neck.

The *signs* of fracture are—The roundness of the shoulder is preserved, but there is a depression below; the deltoid is tense, and the axis of the arm runs inwards. On rotating the lower end of the humerus, it will be found that the tuberosities do not move, and crepitus is obtained. The arm is slightly shortened. If impaction is present, the signs are less marked, and a radiogram may be necessary to establish a diagnosis.

Compound fractures are rare, but the condition is frequently complicated by dislocation of the head of the humerus. If this complication is present, the condition resembles a simple dislocation; but on rotating the lower end of the humerus, the tuberosities do not move, and crepitus is obtained. A radiogram at once establishes the diagnosis.

TREATMENT—EXTENSION.—An extension apparatus is applied from the wrist to the middle of the arm in a similar manner to that of the leg (see p. 462). The patient is kept in bed, the limb placed on a firm pillow, and traction made in the abducted position over the pulley placed at the side of the bed, a weight of 5 to 10 pounds being used for an adult. Counter-extension can be made, if necessary, by a sling passing round the chest, and lateral traction can also be made on the upper arm by means of a weight passing over a second pulley. Extension is rarely necessary for more than two weeks.

ERICHSEN'S SPLINT.—A piece of leather or poroplastie felt, about 2 feet long and 6 inches broad, is taken and bent upon itself to the middle, so that half can be applied lengthwise to the chest, and the other half to the inside of the arm. The angle formed by the bend is well pressed up into the axilla, and covered with padding to maintain the shape. The splint is secured by bandages round the arm and round the chest, and the wrist supported in a sling. With this, as with all other forms of apparatus applied to the upper arm, the extremity should be bandaged from the fingers upwards to prevent œdema.



FIG. 181.—ERICHSEN'S SPLINT AND SHOULDER-CAP APPLIED.

It is useful to combine with this splint a shoulder-cap of poroplastic felt, which gives some support, and protects the shoulder from further violence. Extension can also be combined with this splint by fastening an extension apparatus on to the arm, and hanging a bag of shot from it.

MIDDELDORFF'S TRIANGLE (MODIFIED).—This consists of a stout, well-padded, metal splint arranged in the form of a triangle. The base



FIG. 182.—MIDDELDORFF'S TRIANGLE APPLIED.

lies against the chest, and is secured by bandages passing round the chest. The upper angle should reach the axilla, and the arm rests upon the upper limb of the splint to which it is bandaged. The lower limb is adjusted so that any angle of abduction of the arm may be obtained, and the forearm may be either bandaged to it or left free.

If fracture of the humerus is complicated by dislocation, the dislocation *must* be reduced before the fracture is treated. The best method of procedure is to cut down on the upper fragment, reduce the dislocation, and plate or screw the two fragments together. Massage and passive movement can then be started early without fear of causing displacement of the fragments.

2. Fracture of the Anatomical Neck.—The anatomical neck lies between the head of the humerus and the tuber-

osities, and if a fracture occurs, which is rare, it is always due to direct violence.

DISPLACEMENT.—The head of the bone may be displaced almost in any direction, and may be completely everted; the inner fragment is slightly displaced inwards.

SIGNS.—There is some flattening of the shoulder, crepitus, and pain on manipulation, but the diagnosis is made mainly by radiography.

TREATMENT.—If the fracture is impacted, the impaction should not be broken down, as impaction gives the best chance of bony union. Any of the methods advised for treating fracture of the surgical neck are suitable for fracture of the anatomical neck; but if the head is not

In a good position as regards the shaft, the best result will be obtained by operative measures. The head of the bone may either be fixed in position on the shaft, or may be removed.

3. Separation of the Upper Epiphysis.—The upper epiphysis of the humerus comprises the head and the two tuberosities, and ossifies from three centres. These three centres fuse and form one piece of bone at six years, becoming united to the shaft at about twenty years of age. The capsule is almost entirely attached to the epiphysis, and the subscapularis, supra- and infra-spinatus, and the teres minor muscles are inserted into it. Separation of the epiphysis takes the place of dislocation of the shoulder in patients under twenty, and the usual cause is indirect violence.

DISPLACEMENT.—This is similar to displacement of fracture of the surgical neck.

SYMPTOMS.—The deltoid is tense, and the long axis of the arm runs too much inwards. The upper end of the shaft forms a fulness below the coracoid process, and the tuberosities do not move when the lower end of the humerus is rotated. In cases of slight separation, radiography is essential to diagnosis. Union nearly always occurs, but there may be some shortening due to alteration in growth.

TREATMENT.—The treatment is the same as for fracture of the surgical neck, but if reduction of the deformity is difficult, the epiphysis should be exposed and accurately fixed into position.

4. Fracture of the Tuberosities.—Fracture of the lesser tuberosity only occurs with dislocation of the humerus, and is so rare as to be unimportant.

Fracture of the **great tuberosity** is generally due to direct violence, but it may also be caused by muscular action. The piece of bone is dragged upwards and backwards, and the width of the shoulder is increased. A distinct gap can usually be felt between the fragment and the shaft of the bone.

TREATMENT.—The fragment should be cut down upon and fixed into position by a screw, plate, or wire.

FRACTURE OF THE SHAFT OF THE HUMERUS

Fracture of the shaft of the humerus occurs from all varieties of violence, but the bone is undoubtedly frequently broken by muscular action. The fracture is usually transverse in children and oblique in adults.

DISPLACEMENT.—The displacement depends largely as to whether the fracture is above or below the insertion of the deltoid.

1. Displacement with fracture between the insertion of the deltoid and the pectoralis major. The upper fragment is drawn inwards, and the lower outwards and upwards.

2. Displacement with fracture below the insertion of the deltoid. The upper fragment is drawn outwards, and the lower upwards. The nearer to the lower end the fracture is, the more will the displacement tend to be antero-posterior.

SIGNS.—All the common signs of fracture are well marked. This fracture is frequently complicated by injury to the musculo-spiral nerve, either at the primary accident or subsequently by involvement in callus. Non-union is more frequent with this fracture than in any other fracture of a long bone.



FIG. 183.— FRACTURE OF THE SHAFT OF THE HUMERUS ABOVE THE INSERTION OF THE DELTOID.

TREATMENT.—1. Weight extension, with the patient in bed, and Middeldorpf's triangle, are both suitable for treatment of the fracture.

2. An internal rectangular, poroplastie splint is moulded to the side of the chest, the axilla, the arm, and forearm, and a shoulder-cap of the same material is moulded over the shoulder and down to the external condyle. These are secured to the arm with bandages, and then the whole is fixed to the side of the chest.

If necessary, a weight extension may be fixed to the arm.

3. The bandaged forearm and arm are laid on an internal rectangular splint, and then three pieces of padded Gooch's splinting are placed on the front, the back, and the outer side of the arm respectively. The splints are secured above the fracture by a webbing strap and buckle, and then extension is made until the deformity is reduced. Counter-extension is made by pulley on a towel looped round the axilla. A second strap and buckle is now fastened round the splints below the fracture, and then the whole secured by a bandage. A sling supports the wrist, and, if necessary, a weight extension is placed on the arm. The splint should be worn for four weeks, and then the arm kept in a poroplastie splint for three weeks longer, supported by a sling.

In cases of very oblique fractures, where it is difficult to obtain a good position, or if union does not occur, the fragments should be fastened together by an open operation, care being taken to avoid the musculo-spiral nerve. The rules for the treatment of the fracture if the musculo-spiral nerve is injured are given on p. 369.

FRACTURES OF THE LOWER END OF THE HUMERUS

These fractures are most common in patients below twenty years of age, and are due either to direct or indirect violence. The elbow-joint is frequently involved, and, partly owing to difficulty in reduction and partly to exuberant formation of callus, deformity and functional disability commonly result. In some cases ossification of the brachialis anticus occurs (traumatic myositis ossificans).

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1. **Supra-Condylar Fracture.**—This is usually a transverse fracture crossing the bone above the epicondyles.

DISPLACEMENT.—The lower fragment, carrying with it the radius and ulna, is displaced backwards on the upper, and tilted backwards by the triceps muscle. The lower end of the upper fragment projects forward.

SYMPTOMS.—There is displacement of the forearm backwards, and the elbow is prominent as in a backward dislocation of the elbow; but the epicondyles and the olecranon are in their normal relative positions. The elbow is flexed, but the joint movements are normal. The arm is slightly shortened.

The deformity is easily reduced, but reproduces itself if extension is not maintained.

In some cases of very low transverse fractures, the lower fragment is displaced forwards.

2. **T- and Y-shaped Fractures.**—These consist of a more or less transverse fracture, joined by a vertical fracture running through the articular surface. They are generally due to direct violence, and are more common in adults than in children.

DISPLACEMENT.—The displacement is usually similar to that of a simple transverse fracture, but almost any displacement may occur if the violence is severe.

SIGNS.—The usual signs of fracture are present, and the two condyles can be moved on each other. The relative position of the olecranon and the condyles is altered to some extent.

These fractures are frequently comminuted and compound.



FIG. 184.—CUBITUS VALGUS, FOLLOWING SEPARATION OF THE LOWER EPIPHYSIS OF THE HUMERUS, TREATED WITH AN INTERNAL ANGULAR SPLINT AND A SLING.

3. **Separation of the Lower Epiphysis.**—The lower end of the humerus ossifies from four centres—one for each of the two epicondyles, one for the trochlear, and one for the capitellum. The centres

for the trochlear capitellum and external epicondyle join about the age of puberty, to form one epiphysis which unites with the shaft at about seventeen years, but the internal epicondyle remains on a separate epiphysis, and joins the shaft at about eighteen.

Separation of the epiphysis is most common in children from five to ten years of age, and is usually due to falls on the elbow. The separation of the epiphysis is rarely clean, the line of separation passing through the spongy tissue on the diaphysial side, and the epiphysis is frequently crushed as well.

The periosteum is often widely stripped from the bone, especially from the posterior aspect, and union occurs with the formation of a large amount of callus, which interferes very seriously with the movements of the joint.

DISPLACEMENT.—The epiphysis is usually displaced backwards, and there is also some lateral displacement as well.

SIGNS.—The signs are similar to those of a transverse supracondyle fracture, but in cases of partial separation radiograms may be necessary for correct diagnosis, especially if the injury is not seen at once, as the amount of swelling is usually excessive. Union as a rule takes place rapidly, but with some displacement.

4. Fractures of the Epicondyles.—Fracture of the **External Epicondyle** is rare, and there is little displacement of the fragment. Bony or fibrous union may occur, and there is no functional disability.

Fracture of the **Internal Condyle** is chiefly due to direct violence, but it may also result from muscular action. The elbow-joint is opened. Up to the age of eighteen the injury is a separated epiphysis.

DISPLACEMENT.—The fragment is displaced downwards.

SIGNS.—The fragment can be felt out of position, and an excessive amount of lateral movement of the elbow is present. Union generally takes place by fibrous tissue, and the ultimate functional result is good. The fragment may press on the ulnar nerve and require removal.

5. Fracture of either Condyle alone, especially the external, or fractures of the trochlear or capitellum, may occur, and are usually due to direct violence. The diagnosis is made on the general signs of fracture and radiography.

DIAGNOSIS OF INJURIES OF THE ELBOW.—The injured part should be examined as soon as possible after the accident. The swelling generally being excessive, it is impossible in many cases to make an exact diagnosis unless an anæsthetic is given or the elbow radiographed. The two elbows should be held symmetrically in each hand with the forefingers on the olecranon, and the thumb and middle fingers on the epicondyles.

The relative positions of the bony points are then readily compared, and it will be found that the distance between the olecranon and the epicondyles is much increased in dislocation, but is normal in fracture. In dislocation the movements of the joint are very limited, whilst in fracture the joint movements are usually free, and there is also abnormal mobility of the fragments. Reduction of the

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deformity is more difficult in dislocation than in fracture, but after reduction has been accomplished, there is no tendency for it to recur, whilst the opposite occurs in the case of fractures.

The usual signs of fracture, such as crepitus, may also be present, and a radiogram is, of course, absolutely diagnostic.

DEFORMITY AFTER FRACTURES OF THE LOWER END OF THE HUMERUS.—Before discussing the treatment of fractures of the lower

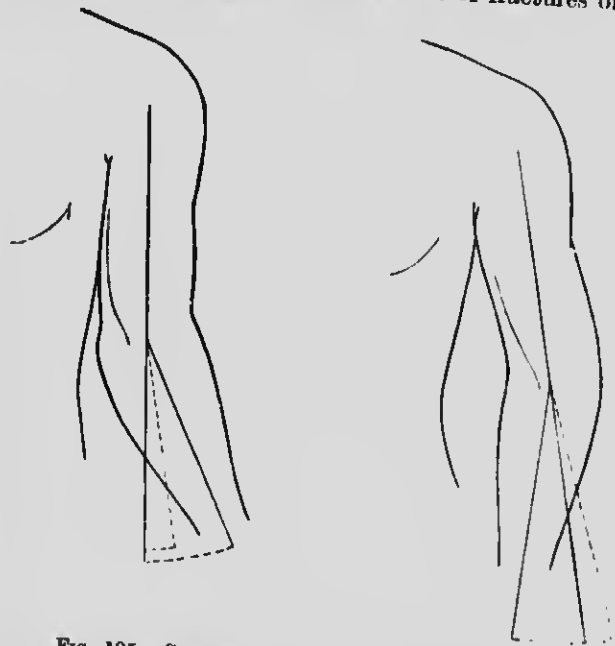


FIG. 185.—CUBITUS VALGUS AND CUBITUS VARUS.

end of the humerus, attention must be directed to two common deformities that may follow these injuries—**cubitus varus** and **cubitus valgus**.

When the elbow is extended, there is normally an angle of about 170 degrees outwards between the arm and the forearm, which allows the forearm to clear the crest of the ilium. This angle is known as the "carrying angle," and after fractures of the lower end of the humerus, it may be much increased, cubitus valgus; diminished or reversed so that the angle is inwards, cubitus varus; the latter being the more common deformity. Both these deformities are favoured by the use of lateral splints, which push the lower fragments outwards or inwards, and cubitus varus is also caused by the custom of slinging the forearm across the body in a position of semipronation. To avoid these deformities, lateral splints should *not* be used in the treatment of fractures of the lower end of the humerus, the forearm should be kept supinated, and the arm should be slung at the side and *not* across the body.

Treatment of Fractures of the Lower End of the Humerus.—

All these fractures are treated on similar lines, and in every case a careful examination of the fracture must be made and the deformity reduced. An anæsthetic is generally needed in order to do this thoroughly. The method of treatment should then be decided upon and carried out. After the splint has been adjusted, a radiogram should be taken so that it can be determined whether reduction is exact or not. If the position is not satisfactory, another method of treating the fracture should be tried, and if a good result cannot be obtained, the fracture should be cut down upon and the fragments fixed in position by plates or screws. In some cases of badly comminuted fractures, it may be necessary to remove part of the bone; if so, it should be removed freely, as it is more usual to get a stiff joint after operative interference with the elbow than one with too free movement. Cubitus varus and cubitus valgus, although giving an angular appearance to the arm, do not interfere much with its function if the deformity is not excessive.

METHOD A.—The deformity is reduced under anæsthesia, and the elbow flexed to a right angle with the forearm supinated. Either an anterior or posterior splint made of moulded poroplastio or plaster of Paris is then applied, and the patient kept in bed with the forearm vertical for a week. After this time the splint is removed daily for massage and passive movement, the patient being allowed up with the arm in a sling by the side. This method is very suitable for separated epiphysis and supracondylar fractures.

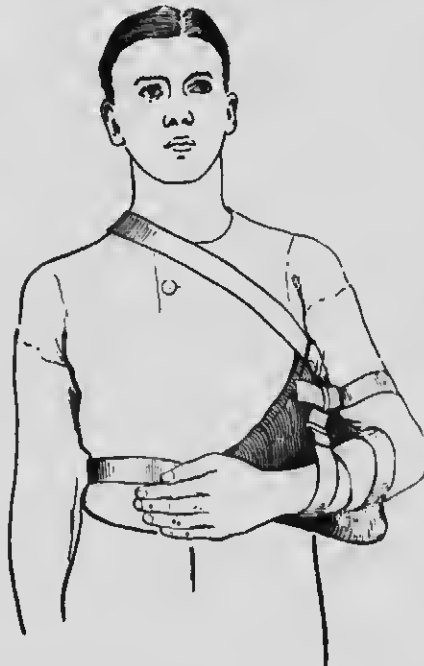


FIG. 186.—STROHMEYER'S CUSHION APPLIED.

METHOD B.—The deformity having been reduced, the elbow is placed in full flexion, and retained in this position by a bandage for a week, when gentle, passive movement is started.

Compound Fractures of the Humerus are treated according to the usual rules. An excellent method of treatment, if frequent dressing is necessary, is to keep the patient in bed with the arm supported on

a Strohmeier's cushion. This has the form of a triangular pyramid 12 to 15 inches long, and should be firm enough to keep its shape under pressure. The apex of the triangle is upwards and reaches the axilla.

The cushion is secured to the arm and chest by means of straps, and the wound can be readily dressed without much disturbance of the fracture.

Fractures of the Ulna

1. Fracture of the Olecranon.—Fracture of the olecranon is usually brought about by a fall on the elbow, but as there is frequently no bruising of the skin, it is probable that muscular action plays a large part in its production, and that the olecranon is broken across the trochlear largely by a violent contraction of the triceps. Fracture from pure muscular action does occur, but is rare.

DISPLACEMENT.—The displacement is always upwards, but the amount varies according to whether the aponeurotic expansion of the triceps over the olecranon is torn. If it is not, the separation of the fragments may be very slight. The line of the fracture is generally through the articular surface, and the elbow-joint is opened.

SIGNS.—The joint is swollen, but the gap between the fragments can usually be readily felt. Active extension of the forearm is not possible unless the aponeurosis is untear, and there is only slight displacement. There may be a forward displacement of the ulna.

RESULTS.—Union by fibrous tissue occurs unless the aponeurosis remains intact. With short fibrous union there may be very little disability, but in some cases the upper fragment will become united to the humerus, and the elbow-joint fixed.

TREATMENT.—The treatment of election is to expose the upper fragments by a Ω -shaped incision passing above it, and wire it into position. The wound is covered with a gauze dressing, but no splint is necessary, and active and passive movements are commenced as soon as the stitches are removed. If the separation is very slight, the arm may be kept in a sling for a week, and then passive movements carried out. Active movements are started at the end of three weeks.

When the separation of the fragments is marked, and operation is refused or contra-indicated by the general condition of the patient, the arm should be placed in a slightly flexed position, and a moulded anterior splint applied from the axilla to the wrist. The displaced fragment is then strapped down by an oblique band of strapping, and the splint fixed by a bandage. Passive movement is begun at the end of a fortnight, and active movement in three weeks. Union by fibrous tissue will result. In cases of old-standing fracture where the union is by long fibrous tissue and a weak joint has resulted, operative treatment may be carried out, but there is often considerable difficulty in approximating the fragments.

Compound Fracture of the olecranon is rare, and it is unusual for the ulnar nerve to be damaged by the accident.

2. Separated Upper Epiphysis of the Ulna.—The upper epiphysis of the ulna is usually a small flake of bone on the upper end of the olecranon process, but it may be larger, and take part in the formation

of the articular surface. It is the epiphysis which is least often separated.

3. Fracture of the Coronoid Process.—Fracture of this process may complicate backward dislocation of the forearm, and should be suspected if, after reduction, the dislocation readily recurs, but an exact diagnosis is only to be made by radiography. There is little separation of the fragment.

TREATMENT.—Keep the elbow flexed and place the arm in a sling. Passive movement should be started at the end of ten days.

4. Fracture of the Shaft of the Ulna without fracture of the radius is a comparatively rare accident, and mostly occurs from direct violence. It is often complicated by forward dislocation of the radius, and this should always be sought on examination if fracture of the upper third of the ulna is diagnosed, otherwise the dislocation of the radius may only be discovered after the ulna has united firmly and the splints are removed. The subcutaneous position of the ulna makes the diagnosis of fractures of the shaft easy.

TREATMENT.—The fracture should be treated in the same way as a fracture of both bones of the forearm, and the splints worn for a fortnight.

5. Separation of the Lower Ulna Epiphysis.—The centre of ossification of the epiphysis appears at five years of age and joins the shaft at twenty. It is rarely separated.

Fractures of the Radius

1. Fractures of the Head.—This fracture may result from direct or indirect violence, and may be complicated by other fractures at the elbow or by dislocation.

SIGNS.—Pronation and supination of the forearm are limited, and the separated fragment may be felt. Radiography is the best means of diagnosis.

TREATMENT.—Massage and passive movements should be carried out from the first, but if there is much interference with movement, the broken fragment should be removed, and an excellent joint will result.

The upper radial epiphysis is entirely intracapsular. It appears at five and joins the shaft at eighteen years of age. It is rarely separated.

2. Fractures of the Shaft of the radius are more common than fractures of the shaft of the ulna, and are frequently due to indirect violence.

DISPLACEMENT.—The displacement varies with the position of the fracture.

- (1) Above the insertion of the pronator radii teres the upper fragment is flexed and supinated by the biceps, and the lower fragment is semiprone and displaced inwards.
- (2) Below the insertion of the pronator radii teres the upper fragment is semiprone and pulled forward by the biceps, whilst the lower fragment is approximated to the ulna by the pronator quadratus.

FIG. 18

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SIGNS.—The usual signs of fracture are well marked, and the head of the radius does not move when the lower end of the bone is rotated.

TREATMENT.—The treatment is similar to that of fracture of both bones.

3. Fracture of the Lower End of the Radius (Colles's Fracture).—

This injury most commonly occurs in elderly people, usually females, from falls on the outstretched hand, the fracture resulting from over-extension of the wrist. In the majority of cases the fracture is impacted, and the lower fragment is frequently comminuted. The fracture starts on the anterior surface of the radius, $\frac{1}{2}$ to 1 inch above the articular surface, and runs backwards and slightly upwards. The styloid process of the ulna may be broken at the same time, but more usually there is rupture of the internal lateral ligament of the wrist-joint.

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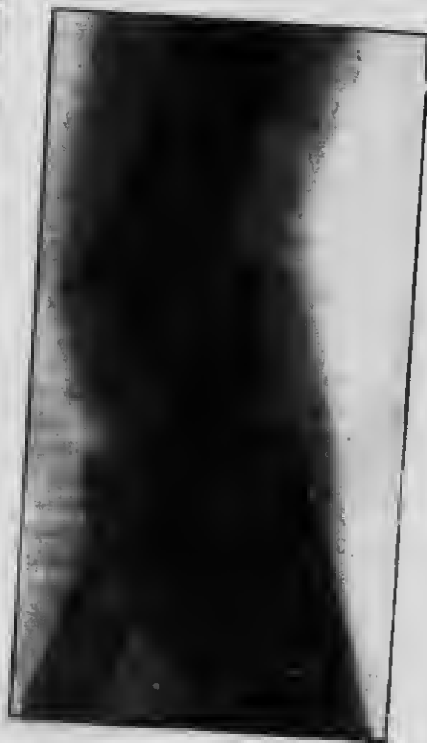


FIG. 187.—COLLES'S FRACTURE: ANTERO-POSTERIOR VIEW.

FIG. 188.—COLLES'S FRACTURE: LATERAL VIEW.

DISPLACEMENT.—The lower fragment is (1) displaced backwards; (2) rotated backwards on the upper fragment, as on a hinge; (3) displaced to the radial side; (4) rotated outwards. The carpus and hand follow the lower fragment. The upper fragment is pronated and drawn closer to the ulna by the pronator quadratus.

SIGNS.—The deformity is characteristic, though it may be very slight. The wrist and fingers are held flexed, and the hand is radially adducted. On the dorsum is a prominence, due to the displaced lower fragment on the radius, the upper fragment projecting on the anterior aspect of the wrist. The styloid process of the ulna is prominent on the inner side, and on comparing it with the position of the styloid process of the radius, it is found to be either on the same level or below, an inversion of the normal relationship. The deformity has been likened to the appearance of a dinner-fork. Pronation and supination are as a rule lost, but there may be no crepitus on manipulation, owing to the firm impaction of the fragments. The X rays are necessary to diagnose some cases of this fracture, as the condition may easily be mistaken for a sprain. The median nerve may be injured at the time of the accident, or become involved in callus later.

TREATMENT.—The following points should be remembered in the treatment:

- (1) That deformity can only be avoided by accurate reduction at the time of the first setting.
- (2) That reduction must be accomplished by direct pressure on the lower fragment, and not by the position in which the hand is placed.
- (3) That massage, passive and active movements to the fingers, must be carried out from the first to avoid stiffness.
- (4) That slight deformity, which is in many cases unavoidable owing to the comminution of the fragments, is unimportant compared with freely moving fingers.

REDUCTION.—If reduction is easy, no anaesthetic is necessary, but with impaction it is advisable. Two assistants are useful: one grasps the arm above the elbow to steady it, the other grasping the fingers with his left hand and the thumb with his right, makes steady traction towards the ulnar side. In some cases it may be necessary to work the hand to and fro to break down the impaction.

The surgeon then presses on the lower fragment till he is satisfied it is in position. If he is single-handed, he should sit opposite the patient and grasp the injured hand as if shaking hands, while his other hand grasps the patient's forearm. Extension is then made until the lower fragment is free, when the wrist is flexed and the hand carried to the ulnar side.

As a rule there is little tendency for the deformity to recur, so that very simple splinting is all that is necessary. The special splints—Carr's, Gordon's, and "pistol" splints—used for this fracture are unnecessary. If reduction has not been accomplished by manipulation, the splints are of no use; and if reduction has taken place, the deformity is not likely to recur.

RETENTION.—The deformity having been reduced, and the hand held in a position of radial abduction, a plaster of Paris bandage, about 4 inches wide, is applied over cotton-wool to the lower end of the forearm, extending to the bases of the metacarpal bones. The arm is supported by a sling round the wrist. This apparatus is worn

for a week. Movements of the fingers may be carried out from the first. At the end of the week the plaster is cut down the centre, removed, and replaced as a movable splint, being fastened with a bandage; or a fresh splint of moulded plaster of Paris or poroplastic may be applied. Passive and active movements should be carried out at the wrist. The splint can be dispensed with entirely at the end of a month. In some cases where there is little displacement and reduction of the deformity has not been attempted, a broad wristlet is all that is necessary, and massage and passive movements of the fingers and wrist are carried out from the first day.

4. **Separation of the Lower Epiphysis of the Radius.**—The centre of ossification of the lower end of the radius appears at two years, and joins the shaft about twenty.

The causes of displacement and the signs are similar to those of Colles's fracture, except that the lower end of the shaft projects with greater sharpness on the under surface of the wrist. There is no radial adduction, and the deformity is readily reduced. Both Colles's fracture and separation of the lower epiphysis of the radius are distinguished from backward dislocation of the wrist by the normal relation which the styloid process of the ulna bears to the carpus.

TREATMENT.—The treatment is the same as that of Colles's fracture.

RESULTS.—As a rule union is good, and no interference with growth occurs, but in some cases the bone ceases to grow, and the continued growth of the ulna causes the hand to become displaced to the radial side.

5. **Chauffeur's Fracture.**—This is a fracture of the lower end of the radius, produced by a motor-engine back-firing whilst it is being started. The injury may be due to direct violence, the handle striking the wrist; but more commonly it is due to hyperextension of the wrist. The situation of the fracture varies. In some cases it is similar to a Colles's fracture; in others it is a fracture through the lower third of the radius, and in young subjects it may be a separation of the lower radial epiphysis. The diagnosis and treatment are the same as for Colles's fracture.

Fracture of the Shafts of both Radius and Ulna

This injury may result from direct or indirect violence, and the two bones are usually broken at the same level, the commonest site being the middle. In children the fracture is very frequently of the greenstick variety.

DISPLACEMENT.—This is very variable. There is often an angular deformity either to the radial or the ulnar side, and the two fragments may be drawn together in the interosseous space. If the fracture of the radius is above the pronator radii teres, the upper fragment of the radius is flexed and supinated; and if the lower fragment is not placed in the same position, after union occurs the power of supination will be lost.

SIGNS.—All the signs of fracture are usually well marked, and there is as a rule obvious deformity.

TREATMENT.—The deformity must first be reduced by manipulation, and if a greenstick fracture, the bones *must* be straightened, even if they are snapped across in doing this.

If the fracture is below the middle, the forearm should be placed between anterior and posterior splints with the elbow flexed to a right angle, and the forearm semiprone.

The splints, which should be well padded, must be wide enough to overlap the forearm, so that the bandages do not press the two bones together. They should extend as far as the hand, the fingers being left free.

Care must be taken that the fragments do not sag between the splints, or an angular deformity will develop on the ulnar side. Should this be difficult to prevent, the forearm must be placed between anterior and posterior moulded splints of poroplastic or plaster of Paris. The whole of the forearm should be supported in a sling.

If the fracture is above the middle—i.e., above the insertion of pronator radii teres, a posterior angular gutter splint should be used, and the forearm kept in the *supine* position with the elbow flexed to beyond a right angle.

Massage and passive movements of the elbow and superior and inferior radio-ulnar joints should be carried out early, and the splints can be removed after three weeks, but the arm should be kept in a sling for six weeks.

RESULTS.—Good bony union is the common result, but the following complications may follow:

- (1) **NON-UNION.**—This will sometimes occur in spite of the most careful treatment, and union does not necessarily follow if the bones are wired or plated together.
- (2) **VICIOUS UNION.**—This usually takes the form of bridge callus, the four fragments becoming united together, the power of pronation and supination being lost.
- (3) **PERSISTENT ANOULAR DEFORMITY.**—This can usually be prevented by the use of moulded splints.
- (4) **GANGRENE.**—Gangrene may occur from bandaging too tightly, or from flexing the forearm to place it in a sling after bandaging the elbow in the extended position.
- (5) **VOLKMANN'S ISCHÆMIC CONTRACTION** (p. 355).—More frequently follows after fracture of the forearm bones than after any other injury. It is due to too tight bandaging or swelling of the limb after the splint has been applied.

Fractures of the Carpal Bones

Fractures of the carpal bones, apart from severe crushes, with extensive laceration of the soft parts, were formerly considered to be rare; but since the systematic use of X rays in the diagnosis of injuries, many cases which were formerly believed to be sprains of the wrist are now known to be fractures of the carpal bones.

The bone most commonly fractured is the scaphoid, the fracture running through its narrowest part. It may be suspected if there is

a tender swelling on the radial side of the wrist, and pain which is increased on adduction. The diagnosis is made exact by radiography. **TREATMENT.**—The carpus is kept at rest on a splint for a week, but massage and passive movements are used from the first. If there is much disability with a displaced fragment, it should be removed. Compound fractures are treated along the usual lines.

Fractures of the Metacarpal Bones

The metacarpal bones most commonly fractured are those of the third and fourth fingers. If the violence is direct—as is usually the case—the fracture is transverso; while with indirect violence the fracture is oblique. There is not much displacement as a rule, the adjacent metacarpals acting as lateral splints. The usual signs of fracture are well marked, but radiography will be necessary to detect some cases.

TREATMENT.—An excellent method of treatment is to bandage the hand over a rounded pad, such as a roller bandage or a tightly rolled ball of cotton-wool, with a figure-of-eight bandage. Massage, active and passive movements are carried out from the first to prevent adhesion of the extensor tendon to the bone. The splint is dispensed with in a fortnight, and union is usually firm in three weeks.

Bennett's Fracture.—This is an oblique fracture of the base of the first metacarpal, and is most commonly sustained when boxing. The usual method of its production is a swinging punch at an opponent's head, so that the striker's thumb is in a position of slight abduction when it strikes against the skull. The base of the metacarpal receives the full force of the blow, and is driven against the trapezium.

The fracture is oblique, and the smaller fragment carries most of the articular surface, while the larger fragment slips backwards over the metacarpo-trapezial joint, where it forms a prominence. The condition is usually diagnosed as a partial backward dislocation of the thumb, but radiography will make the diagnosis clear. Exact diagnosis is important, as the resulting disability may be serious, and also, unless properly treated, pain and impairment of function will last for months.

TREATMENT.—A Bennett's splint (Fig. 190), which should be thickly padded over the site of the displaced bone, is applied on the

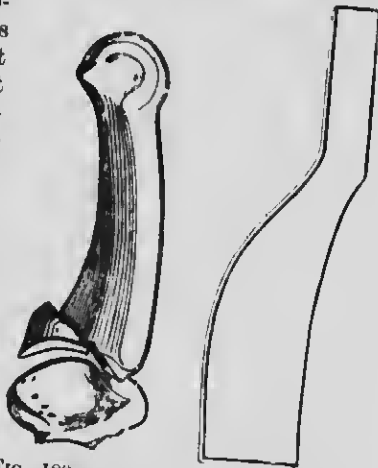


FIG. 189.—BENNETT'S FRACTURE.

FIG. 190.—SPLINT FOR BENNETT'S FRACTURE.

palmar aspect of the thumb. The splint is first fixed to the extremity of the thumb in the extended and abducted position by strapping, and then, while strong extension is being made, the base of the splint is fixed to the wrist.

Passive movements and massage should be started at the end of one week, and the splint should be worn for three weeks.

Fractures of the Phalanges

Fractures of these bones usually result from direct violence, and are very frequently compound. The usual signs of fracture are generally well marked, and there may be angular deformity, with the apex of the angle towards the palm. Union occurs in three weeks.

TREATMENT.—The finger should be fixed in a moulded poroplastic or gutta-percha splint for two weeks, and massage and passive movements should be employed from the first.

Compound fractures require very careful and conservative treatment, and a finger should never be amputated unless absolutely necessary.

Fractures of the Pelvis

Fractures of the pelvis may be divided into *incomplete* and *complete*, but in both varieties the seriousness of the accident depends more on injury to the surrounding soft parts—as the bladder and urethra—than on the fracture itself.

Incomplete Fracture.—An incomplete fracture of the pelvis occurs when one of the individual bones forming the pelvis is fractured but the pelvic ring is not broken. These fractures are nearly always due to direct violence, and there is usually a very large hematoma, so that diagnosis without radiography is extremely difficult.

1. **ILIUM.**—Parts of the crest of the bone are frequently broken off in "run-over" accidents, and it may be possible to grasp the fragment and move it, so that crepitus is elicited, especially if the muscles attached to it are relaxed. There is as a rule very little displacement, and bony union without functional disability occurs in about four weeks.

Treatment.—The patient is kept in bed, and the fragment kept in position by broad bands of strapping passing round the pelvis.

2. **ISCHIUM.**—Fracture of this bone alone is rare, and there is very little displacement of the fragments. Rest in bed is all that is necessary for the treatment.

3. **PUBIS.**—Fracture of the pubis has occurred from muscular action, and from pressure of the fetal head during parturition. The symphysis has also been driven in by direct violence.

4. **SACRUM.**—In fractures of this bone the rectum may be injured, or damage done to the sacral plexus of nerves. The fractures can be diagnosed by careful manual rectal examination, and the deformity, if any, should be reduced at the same time.

5. **COCCYX.**—Fracture of this bone may be due to a kick or other direct violence, but it is more commonly broken during parturition.

and as a result the patient may complain of severe pain, especially during defecation and on sitting. The diagnosis is made by rectal examination.

Treatment.—The deformity should be reduced by manipulation with the finger in the rectum, but if the fragment projects forwards and the deformity readily recurs, the coccyx should be removed. Removal should be undertaken if, after union, the patient complains of pain in the coccyx—i.e., coccydynia.

Complete Fracture.—In this fracture the bony ring of the pelvis is fractured. The injury is most commonly due to direct violence of the nature of forcible compression.

The most common fracture is a fracture of the horizontal pubic ramus and of the pubic arch below it, with a fracture of the sacrum on the same side behind, more or less parallel with and close to the sacro-iliac synchondrosis.

The pubic symphysis or the sacro-iliac synchondrosis may be torn apart, or the head of the femur may be driven against the acetabulum and cause a star-shaped fracture.

CLINICAL SIGNS.—In some cases the displacement is obvious, but there may be none, and the fracture only be detected on X-ray examination. Crepitus and undue mobility may be sought for, but extreme gentleness is necessary to avoid damage to the bladder or urethra. Pain referred to a particular spot on all manipulations and a large localized hæmatoma are signs of diagnostic value, and the line of fracture may be felt on vaginal or rectal examination.

In every case of fracture, or suspected fracture, the perineum and orifice of the urethra should be examined for hæmorrhage, and a soft catheter passed to ascertain if the urethra and bladder are intact.

The rectum should also be examined for laceration, and the usual examination made for accompanying injury to nerves and blood-vessels.

TREATMENT.—Reduction is accomplished by manipulation of the ilia, assisted by a finger in the vagina or rectum if necessary.

FIXATION.—The patient is laid flat on a firm mattress and the pelvis covered with a stout fracture-cloth, a sandbag being laid on each side. The knees should be tied together, the lower extremities kept immovable, and similar precautions taken with the nursing as in fractured spine. At the end of fourteen days the patient may be fitted with a well-padded leather belt round the pelvis, or a moulded poroplastic or plaster of Paris splint may be applied in a manner similar to that recommended for fractured spine.

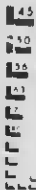
Union will occur in about six weeks, but the patient should not be allowed to stand till the eighth week, when he is allowed up on crutches, the pelvic band being retained. The crutches are discarded as the patient feels he can bear more and more weight on the pelvis. Some lameness frequently results.

Fractures of the Acetabulum.—The acetabulum is fractured by the head of the femur being violently driven against it, and several types of fracture are described.



MICROCOPY RESOLUTION TEST CHART

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1. The deep posterior part of the rim of the acetabulum may be broken off in a dorsal dislocation of the head of the femur. The signs are those of dorsal dislocation, and reduction is readily effected with crepitus, but the deformity returns directly the extension is removed.

TREATMENT.—The broken piece of the rim of the acetabulum may be pegged into position, and the dislocation reduced by the open method; or the case may be treated by extension applied to the femur until union of the fracture has occurred—*i.e.*, about one month.

2. A fissure or star-shaped fracture of the acetabulum without displacement.

3. The head of the femur may be driven through the floor of the acetabulum, so that it projects into the pelvis. The physical signs will somewhat resemble those of fracture of the neck of the femur, but the lower extremity will be immovable, and the head of the femur will be felt in the pelvis on rectal or vaginal examination.

TREATMENT.—The head of the femur must be freed by manipulation under an anæsthetic, and, if necessary, the joint must be exposed to do this. Extension is then made on the femur, but massage and passive movements must be started early, or the joint will become ankylosed. The patient should be able to get about in six weeks.

Fractures of the Femur

1. **Fracture of the Neck of the Femur.**—The anterior aspect of the neck of the femur lies wholly inside the capsule of the hip-joint, whilst the base of the neck posteriorly is extracapsular. Any part of the neck of the femur may be fractured, but two well-marked clinical varieties are described: (1) Fracture of the neck near the head (intra-capsular fracture); and (2) fracture near the base of the neck (extra-capsular fracture).

(1) **FRACTURE OF THE NECK OF THE FEMUR NEAR THE HEAD.**—This fracture is usually due to indirect violence—*e.g.*, tripping over a mat, the patient falling after the fracture has occurred. It is most commonly met with in elderly people, usually females. The fracture is of the nature of a spontaneous fracture, atrophy of the cancellous and compact tissue of the neck of the femur associated with old age being the predisposing cause. The line of the fracture may be transverse or oblique, and some of the reflected fibres of the capsule of the hip-joint running along the neck are usually untern, and hold the head of the bone more or less in position. Impaction is uncommon, and when it occurs the neck is driven into the cancellous portion of the head.

DISPLACEMENT.—The upper fragment remains in the acetabulum. The lower fragment is displaced backwards, drawn upwards, and rotated outwards.

Before discussing the signs of fracture of the neck of the femur, two clinical signs must be described, as they are useful in determining the relationship of the great trochanter to the ilium—

(a) **NÉLATON'S LINE.**—This is a line drawn from the anterior superior spine of the ilium to the most prominent point of

At fracture of neck of femur
the head of femur
is in the acetabulum

the tuber ischii. Normally, with the leg in its usual position, the top of the great trochanter should just touch this line, and, if elevated above it, dislocation of the femur, fracture of the neck, or absorption of the head and neck from disease, must be present.

- (b) **BRYANT'S TRIANGLE.**—The patient is placed lying flat on the back with the legs extended, and a *vertical* line is drawn down from the anterior superior spine. A second horizontal line is drawn from the top of the great trochanter to meet the first line at right angles, and the triangle is completed by drawing a line from the top of the great trochanter to the anterior superior spine. A comparison of the length of the *horizontal* lines on the two sides of the body will enable elevation of the great trochanter to be discovered, and the same deduction can be drawn as above (see Nélaton's line).

SIGNS.—The patient complains of pain at the hip, being unable to move the joint unless there is impaction, but there are no signs of local trauma. The leg is everted, the great trochanter raised above Nélaton's line, and about an inch shortening is found. Crepitus may or may not be obtained; the ilio-tibial band is slackened, but the great trochanter is not broadened.

Radiography will not only decide the diagnosis, but shew the exact position of the fracture, and enable an opinion to be given as to the likelihood of bony union occurring.

RESULTS.—In some cases where the fracture is near the head, atrophy of the upper fragment of the bone will occur, with atrophy of the neck and displacement of the femur upwards on the dorsum ilii, so that the shortening steadily increases. In other patients fibrous union of the fragments occurs with great disability; but in a good proportion of cases bony union occurs if the fracture is treated properly.

TREATMENT.—The treatment to be adopted depends on the general condition of the patient, and more particularly on the condition of the heart and lungs. If the patient has chronic bronchitis, a failing heart, or any condition that makes the onset of hypostatic pneumonia likely, the usual treatment of a fracture should be considerably modified.

The patient should be put to bed for three or four days so as to get over the shock of the accident, and the injured leg kept between sandbags. If there is any difficulty in breathing, the patient should be well propped up in the bed, and stimulating expectorants should be given. At the end of the three or four days the limb should be fitted with some splint, as a Thomas's hip-splint or a poroplast or leather case, in order that the patient can be got out of bed or readily moved from side to side. The splint can be dispensed with in about six weeks.

If this method of treatment is carried out, bony union is only likely to occur if the fracture is impacted.

In the majority of cases, if careful nursing is obtainable, there is

no necessity for ambulatory treatment, and the fracture should be treated by the usual methods.

If impaction is present, it should not be broken down if the patient is elderly; but in young subjects the deformity must be corrected. The limb is put up in the abducted position with extension, a Hedgen's splint being very useful, as it allows great freedom to the patient with-



FIG. 191.—FRACTURE OF THE NECK OF THE FEMUR.

out disturbing the fragments. If this splint cannot be adjusted, the limb may be put up in a long Listen splint, but this will inevitably lead to deformity. MacIntyre's splint is also useful in the treatment of this fracture.

(2) FRACTURE OF THE NECK OF THE FEMUR NEAR THE BASE.—
These fractures are most common in young adults, due to direct vio-

lence, but may occur at any age. The neck of the bone is driven into the cancellous tissue of the great trochanter, where it may become impacted, and frequently comminution of the trochanter is present.

Signs.—There is pain in the hip, and usually marked signs of bruising over the trochanter where the violence was applied. The limb cannot be moved as a rule, although in some cases with impaction the patient has been able to walk. The limb is generally everted (inversion may occur in some cases owing to the position of the limb when the violence was applied, and to impaction occurring), and there is marked shortening (2 to 3 inches). The great trochanter is broadened or comminuted, and elevated above Nélaton's line, and the horizontal line of Bryant's triangle is shortened. Crepitus is as a rule readily obtained, and the ilio-tibial band is loosened.

RESULTS.—Bony union with some shortening and adduction displacement is the rule.

TREATMENT.—The deformity should be reduced, the impaction being broken down, if necessary, by traction, abduction, and internal rotation, and one of the following methods of retention should be used:

- (a) The limb should be placed in a long external splint, which is jointed opposite the hip-joint, so that the lower limb can be abducted to any extent; a weight and pulley extension is applied, and the limb put up in abduction. A radiogram is taken to ascertain if the fragments are in good position.
- (b) A Hodgen's splint with the limb well abducted.
- (c) The fragments may be united by means of a screw. An incision is made over the great trochanter, and, after the deformity has been reduced, a screw is driven obliquely through the trochanter and neck of femur.

The patient should be kept in bed for six weeks, and at the end of that time massage and passive movement should be started, and the patient allowed up, but he should not be allowed to bear weight on the limb till the end of ten weeks.



FIG. 192.—IMPACTED FRACTURE OF THE NECK OF THE FEMUR LOW DOWN (EXTRA-CAPSULAR FRACTURE).

(London Hospital Medical College Museum.)

2. **Separation of the Upper Epiphysis of the Femur.**—The epiphysis of the upper end of the femur forms the head of the bone, and is entirely intracapsular. Separation of the epiphysis is usually



FIG. 193.—SEPARATION OF THE UPPER EPIPHYSES OF THE FEMUR.

due to violent wrenching, such as getting the limb between the spokes of a moving wheel, but it is not a common injury. The symptoms resemble those of an intracapsular fracture, and the diagnosis is suggested by the age of the patient. Radiography will confirm the diagnosis.

TREATMENT.—The treatment is similar to that of intracapsular fracture, but in every case careful reduction of the deformity is absolutely essential.

PARTIAL SEPARATION of the head of the femur is more common than complete separation, and is a condition that is important to recognize, on account of the frequency with which it is followed by coxa vara. The accident producing the separation is generally slight, and does not prevent walking. The condition is frequently only recognized when the characteristic deformity of coxa vara develops some weeks or months later. The diagnosis is made by X-ray examination, and the patient should be kept in bed with extension in the abducted position for six weeks.

3. **Fracture of the Great Trochanter**, or separation of its epiphysis, is an uncommon accident, and is always due to direct violence. The diagnosis is made by moving the separated fragment and obtaining crepitus, and by radiography.

TREATMENT.—If the separation of the fragment is so great that bony union is unlikely, it should be pegged into position.

4. **Fractures of the Shaft of the Femur**—(1) **UPPER THIRD.**—Fracture in this situation is due to indirect violence, and is generally oblique.

DISPLACEMENT.—The upper fragment is flexed, abducted, and rotated out, whilst the lower fragment drops back, is pulled upwards, and externally rotated.

SIGNS.—All the usual signs of fracture are well marked. The leg is shortened, the foot markedly everted, and there is a forward projection of the upper fragment, which is easily seen and felt.

TREATMENT.—As the surgeon has very little control over the displacement of the upper fragment, the lower fragment must be brought into line with it, and only those splints which allow flexion and abduction of the hip, as Hodgen's or MacIntyre's, should be used. In the majority of cases the only method of getting a good anatomical result is by open operation.

(2) **MIDDLE OF THE SHAFT.**—The fracture may be due to direct or indirect violence, and is most common in children in whom the fracture is frequently transverse. In adults oblique or spiral fractures are the more common.

DISPLACEMENT.—The displacement varies with the situation and the direction of the fracturing force; but as a rule the upper fragment is slightly flexed, adducted, and externally rotated, while the lower fragment drops back, is pulled upwards so as to overlap the upper, and is markedly everted.

SIGNS.—The usual signs of fracture are well marked, and there is usually angular deformity, which is exaggerated when a voluntary attempt is made to lift the leg.

TREATMENT.—An extension apparatus is applied to the leg, and the deformity is then reduced by manipulation. The leg is placed in one of the splints described below, and kept in it for eight weeks. After this time massage and passive movements are started, and the patient is allowed up, with the leg



FIG. 104.—FRACTURE OF THE FEMUR, SHOWING MARKED DISPLACEMENT, WITH CALLUS FORMATION.

(London Hospital Medical College Museum.)

either in a movable plaster of Paris or poroplastic splint. Full weight may be borne on it at the end of three months, and all splints discarded. These times can be shortened in the case of children.

The results of this method of treatment in fractures of the femur in children are excellent in the majority of cases, but with adults there is usually from 1 to 2 inches shortening, and some degree of angular or rotatory deformity. Non-union is uncommon.

OPERATIVE TREATMENT.—With oblique and spiral fractures of the femur, there is great difficulty in reducing the deformity, and if the patient is willing, the fracture should be operated upon, and the fragments pegged or plated in position. Excellent anatomical and functional results are obtained by this method of treatment.

5. Fracture of the Lower End.—

(1) Transverse or oblique supracondylar fracture. This fracture is usually due to direct violence, and is most common in adults.



FIG. 195.—FRACTURE OF THE LOWER THIRD OF THE FEMUR.



FIG. 196.—FRACTURE OF THE LOWER END OF THE FEMUR INTO THE JOINT

DISPLACEMENT.—The lower fragment is drawn directly backwards by the pull of the gastrocnemius muscle, and projects into the popliteal space, when it may lacerate the popliteal vessels or nerves.

SIGNS.—The limb is shortened and everted, and the usual signs of fracture are present.

TREATMENT.—The deformity must be reduced by flexing the knee, and the limb must be placed in one of the splints which allows flexion, as MacIntyre's or Hodgen's. In some cases it may be necessary to divide the tendo Achillis before the deformity can be reduced. The lower fragment may be "buttonholed" through the torn periosteum, and an open operation will be necessary to effect reduction.

(2) **T- and Y-shaped Fractures** are due to direct violence, and are similar to supracondylar fractures, with a vertical fracture separating the two condyles.

The method of treatment is similar to that given above, but massage and passive movement must be started early in order to prevent stiffness of the joint. If good reduction cannot be obtained by manipulation, the fragments should be secured together by an open operation.

(3) **Separation of the Lower Epiphysis.**—The centre of ossification of the lower epiphysis of the femur appears at birth, and joins the shaft at twenty. It includes the whole of the articular surface of the femur, and the epiphysal line runs through the adductor tubercle.

Separation of this epiphysis is usually due to indirect violence of the nature of a wrench, but it may also occur by direct violence. It is most common in boys about fourteen years old.

DISPLACEMENT.—The epiphysis is carried *forwards*, so that it rests obliquely on the lower end of the diaphysis, the periosteum being widely torn away from the popliteal surface of the femur. Very occasionally the epiphysis is displaced backwards.

TREATMENT.—After reduction has been effected by manipulation, the limb may be placed in a MacIntyre's or

Hodgen's splint; but a better method of treatment is by flexion. The patient is placed under an anæsthetic, and the knee is strongly



FIG. 197.—SEPARATED LOWER EPIPHYSIS OF THE FEMUR, WITH FORWARD DISPLACEMENT.

flexed, while the epiphysis is manipulated into position. The leg is then bandaged to the thigh in the flexed position, care being taken that there is not sufficient pressure on the popliteal vessels to cause loss of the tibial pulsation.

After maintaining this position for three weeks, the limb is gradually straightened in a MacIntyre's splint. The patient may begin to walk in eight weeks.

RESULTS.—If replacement is good, the results are excellent. Growth may not be interfered with, but in some cases it ceases. Compound separations are not uncommon, and the results of treatment have been so poor that primary amputation should always be considered.

Apparatus used in the Treatment of Fractures of the Femur.—

1. **EXTENSION APPARATUS.**—An extension apparatus consists of two wide bands of strapping connected by a piece of wood, which is broader than the sole of the foot. In the centre of this piece of wood a hole is bored. The two bands of strapping should be on each side of the limb, going well above the knee, and the wooden cross-bar is about 3 inches from the sole of the foot and at right angles to it. The bands are fastened to the limb by strips of lead plaster evenly applied to the

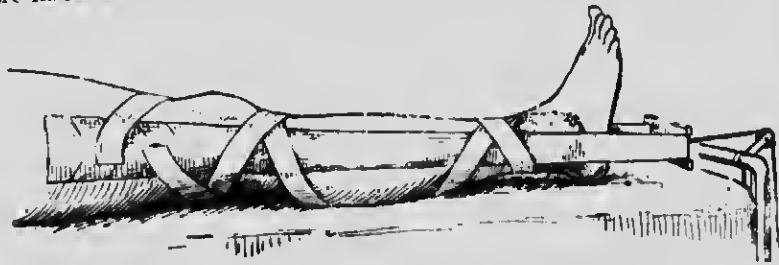


FIG. 198.—EXTENSION APPLIED TO THE LOWER EXTREMITY.

leg from below upwards, each strip overlapping by about two-thirds of the one below, and crossing on the front of the leg. A layer of Gangee tissue is used to prevent the bony prominences of the malleoli being cut by the strapping. A cord passes through the hole in the piece of wood and runs over a pulley fixed to the foot of the bed, and to it a weight is attached. The amount of weight depends on the muscular power of the patient, and should be just sufficient to prevent shortening.

This apparatus is used in connection with the various splints employed in the treatment of fractured femur.

2. **VOLKMANN'S SLIDING FOOT-REST.**—This consists of a short back splint with a footpiece, which rests on a wooden tray carrying two runners. The object of the foot-rest is to diminish the amount of friction which the weight extension has to overcome.

3. **HODGEN'S SPLINT** consists of two parallel iron bars, slightly bent at points corresponding to the knee and hip, and connected at

the lower end by a straight bar, and at the upper end by a curved one set obliquely. On the parallel bars are two pairs of hooks, so that the splint can be suspended.

The lower bar should project 3 to 6 inches below the sole of the foot. The inner end of the upper bar should lie above and just in



FIG. 199.—HODGEN'S SPLINT APPLIED.

front of the pubic spine, and the outer end above and just in front of the anterior superior spine of the ilium, the oblique bar being parallel with Poupart's ligament.

An ordinary extension apparatus (see above) is fixed to the limb, which lies on the splint, supported by strips of flannel, which pass under it, and are secured to the sides of the splint. These strips should be of varying length to accommodate the curves of the limb. The amount of flexion of the knee on the thigh should be an angle of 170 to 180 degrees, and may be altered by increasing or diminishing the length of the strips that support the thigh. The cord for the extension is firmly fixed to the lower bar of the splint, and if there is much external rotation, the foot must be secured to the inner side of the splint.

Beyond the foot of the bed, and at least 4 feet above it (better 6 or 8 feet), is fixed an upright from which the splint is to be hung. Cords are attached to the hooks at the sides of the splint, and pass by means of a third cord over a pulley on the upright bar. The obliquity of the supporting cord should be 15 to 30 degrees, and it may be secured to the upright, or, better, have a weight suspended to it.

By altering the obliquity of the cord and by increasing the weight, which rarely needs to be more than 5 pounds, the amount of extension can be increased.

The heel of the patient should be 2 or 3 inches from the bed, and the leg parallel to the surface of the mattress. Counter-extension is

made by the weight of the body, and to increase its efficiency the foot of the bed should be raised on blocks. A common error in the application is to have too short a splint, so that the upper oblique bar crosses the middle of the thigh, and frequently rests on it. When the splint is properly applied, the patient can be propped into a sitting position without disturbing the fracture.

This splint is generally useful for all fractures of the femur, but particularly for fractures of the upper end and the shaft. The splint wants very careful adjustment, but allows the lower fragment to be flexed to any degree, so that all deformity can be corrected. It is not suitable for the treatment of a fractured femur in a child.

4. **MACINTYRE'S SPLINT.**—This is an iron posterior gutter splint, consisting of a thigh and leg piece jointed together and fitted with a screw, so that the angle between the two pieces can be varied at will. The leg-splint is fitted with a footpiece sliding in lateral slots, so that



FIG. 200.—MACINTYRE'S SPLINT.

extension may be carried out after the foot is fixed to it. The foot-piece can be fixed in any position in the slots by screwing up the nuts found on each side. The splint is padded and the footpiece is loosened and pushed well up to the top of the lateral slot. The patient's foot is covered with a flannel sock, to the heel of which a tape is firmly sewn. The limb is placed in the splint and the tape carried down to the top of the footpiece and fastened round a button on the under surface, the foot being thus held up without pressure on the heel. It is further fastened to the footpiece by a few turns of bandage or by strips of strapping, care being taken that the toes are pointing outwards across the footpiece.

MacIntyre's splint is chiefly used for transverse fractures of the lower end of the femur, where moderate flexion is necessary to maintain the correct position, and it is also a useful splint for supporting the femur after the fragments have been fixed together by an open operation.

5. **LONG LISTON SPLINT.**—Liston's long splint consists of a straight bar of wood reaching from the axilla to well below the foot, with the

lower end let into a heavy crosspiece, so that lateral movement is prevented. An extension apparatus is fixed to the limb below the site of fracture and the weight applied until the shortening is overcome. The limb is then fixed to the splint by means of bandages, and the upper end is secured by a broad flannel bandage passing round the chest. The counter-extension is made by the weight of the body, and it is frequently necessary to raise the foot of the bed to increase the weight of counter-extension. A Volkmann's sliding foot rest can be used with this splint.

Liston's long splint has many disadvantages and should not be used in the routine treatment of fractured femur. It is uncomfortable, and necessitates the patient lying flat on his back, which makes it difficult to nurse him and to keep the perineal region clean. There is no control over the upper fragment, and if this is flexed, as it always is in fractures of the upper third, angular deformity must result. The foot also is fixed in the vertical position, and as the upper fragment tends to roll outwards, there is usually a rotatory deformity as well. This splint should only be used when there is some special indication for keeping the patient still—*e.g.*, if the patient is delirious, or if he has to be transported from place to place, as in fractures sustained during campaigns.

6. GOOCH'S KETTLE-HOLDER SPLINTING.—This splinting is frequently used in the treatment of fractured femur to form short splint which are placed on the thigh to support the fracture at the same time that a Hodgen, long Liston, or other form of splint is being used.

7. BOX SPLINT.—This splint in principle is a double long Liston, and has its disadvantages; but it is very useful in the treatment of fractures of the shaft of the femur in children when there is slight displacement. It consists of two long, straight, external splints, reaching from the axilla to below the feet, and joined together at the foot end by a crossbar.

The side splints are carefully padded, and at the top, just below the axilla, are hooks for securing the upper bandage. A broad flannel bandage is fastened to the hook on one side, passing over the splint, and is fastened again to the hooks, thus holding the patient in a kind of sling. A few turns are then taken round the chest and splint, fastening every turn by the hooks. The sound limb is firmly bandaged to the side splint, the bandage coming well past the middle of the thigh, care being taken to support the foot in the right-angled position, so as to prevent talipes equinovarus.

The fractured limb, with an extension apparatus applied, is lightly bandaged to the side splint, and from the crossbar of the extension a cord runs through a hole in the bottom bar of the splint over a pulley, supporting a weight.

8. GALLOW'S SPLINT.—In children, an excellent method of treating a fractured femur is by vertical suspension, and for this treatment a gallows splint is useful. This consists of two uprights, connected above by a crossbar. An extension apparatus is applied to both legs, and the cord passed through holes in the crossbar and then over pulleys fixed to the top of the splint.

Weights of from 3 to 6 pounds, according to the weight of the child, are attached to the cord, so that the buttocks are just lifted off



FIG. 201.—GALLOW'S SPLINT APPLIED.

the bed. The legs are bandaged to the sides of the splints, which are suitably padded. Vertical extension may also be used with a single splint, or without any support.

Fractures of the Patella

Fracture of the patella is much more common in men than in women, and is rare below the age of twenty. The fracture may be due to direct violence or muscular action, the latter being the more common.



FIG. 202.—STAR-SHAPED FRACTURE OF THE PATELLA.

If due to direct violence, the fracture is star-shaped, or the bone may be split longitudinally, or a piece clipped off it; but the fibrous expansion of the quadriceps extensor muscle is not torn, and there is little or no separation of the fragments. When due to muscular action, the bone is broken by a violent contraction of the quadriceps, as it rests on the condyles of the femur, generally in attempting to save a fall. The fracture is usually transverse, and somewhere near the middle of the bone. The fibrous expansion of the quadriceps running over the bone is torn across as a rule, and there is wide

(1 inch) separation of the fragments. In some cases the expansion is not torn, and the patient is able to walk. In these cases, if the fracture is overlooked, a second accident in a day or so may cause the aponeurosis to give way, and the fracture becomes obvious.

Fracture of one patella is frequently followed by fracture of the second at a subsequent accident, especially if fibrous union only is present, and the same patella may be broken two or three times. In a case of fracture of the patella the knee-joint is opened, and the synovial cavity quickly becomes filled with blood.

Signs.—The patient frequently hears and feels the snap of the breaking bone before he falls to the ground. The knee is distended with fluid and is painful. Later there is marked staining of the skin. As a rule the gap between the two fragments can be readily felt, and they can be moved on one another, causing crepitus. If the aponeurosis is torn, the patient cannot lift the heel from the bed, but with fracture due to direct violence, with an untern aponeurosis he may be able to walk. Should the case not be seen for some hours, the swelling may be so great that diagnosis is not possible unless the fluid in the knee is removed by aspiration, or an X-ray photograph is taken.

Union.—Bony union occurs in star-shaped and longitudinal fractures, without separation of the fragments; but in all cases of transverse fractures, with tearing of the aponeurosis, union occurs by fibrous tissue, unless the fragments are brought into close apposition by wiring. The chief causes for the absence of bony union are—(1) Want of apposition of the fragments; (2) the stretched and torn aponeurosis falls into the gap between the fragments and rapidly adheres to the raw surfaces; and (3) tilting of the fragments.

TREATMENT.—The routine treatment of transverse fractures of the patella is by operation, and the best time for operation is five or six days after the accident has occurred. A curved incision is made half round the patella, and a flap of skin and subcutaneous tissue turned up until the fragments are thoroughly exposed. The blood-clot is removed from the joint, and the torn aponeurosis covering the raw surfaces of the fragments is cut away. Two holes are then bored in each fragment in such a manner that when the fragments are drawn together by the wires, the broken edges of the articular surfaces come closely into apposition. Strands of silver wire are then threaded through the holes and drawn tight, twisted, cut off, and the ends hammered down. The rent in the capsule of the joint is sutured with chromicized

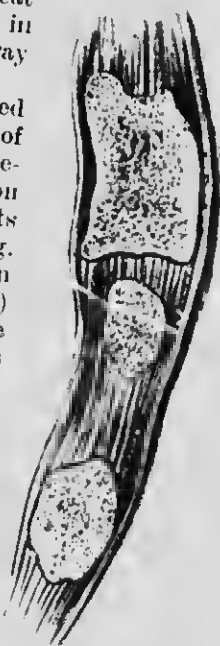


FIG. 203.—FRACTURED PATELLA WITH LONG FIBROUS UNION.

catgut, and the wound closed. A large dressing is applied, but there is no need to use a splint. The stitches are removed on the eighth day, and massage and passive movement started at once. The patient is allowed to walk on the tenth day. Bony union with full functional use of the knee-joint is the usual result.

TREATMENT BY EXTENSION.—If this method of treatment is refused or contra indicated for any surgical reason, such as inability to carry out full aseptic technique, or the general condition of the patient, the following method can be used: Two broad U-shaped pieces of



FIG. 204.—METHOD OF STRAPPING A FRACTURED PATELLA.

strapping are cut, one of which is fixed just below the lower fragment, the tails being carried upon the thigh, so as to pull the fragment upwards.

The other U is fixed just above the upper fragment, and to its tails two stout pieces of elastic are fastened. The limb is then bandaged to a long posterior splint, with a footpiece, the turns of the bandage immediately above and below the patella being placed obliquely, so as to draw the fragments still closer together.

The ends of the elastic of the upper U-shaped piece of strapping are then fastened to the footpiece of the splint, so that elastic traction is maintained. The limb is kept elevated on an inclined plane.

The apparatus is removed in a month, and the limb placed in a moulded plaster of Paris, poroplastic, or leather case, and daily massage is commenced. At the end of another month the case is left off at night, and passive and active movements started, and at the end of the third month the splint should be entirely discarded.

FUNCTIONAL DISABILITY.—The functional disability with fibrous union of a fractured patella varies greatly. In some cases with long fibrous union there is apparently no loss of function, and the patient is able to do heavy porter's work without disability, although there is always a liability to fracture of the other patella. In one case a patient with long fibrous union of both patellæ was able to follow his occupation as a deal porter. In other cases there is weakness of the limb, and the patient may be unable to walk without a leather knee-cap, or the upper fragment may become fixed to the femur by bony tissue, with corresponding loss of power and stiffness of the knee.

Patients with star-shaped and longitudinal fractures of the patella should be kept at rest for a week to allow the swelling to subside, and, if necessary, the knee-joint should be aspirated. At the end of this time massage should be started, and the patient, wearing a moulded posterior splint, allowed up. Massage, passive and active movements,

should be carried out daily, and at the end of six weeks the splint should be discarded.

Compound fractures of the patella are rare, and should be treated by wiring.

Treatment of Old Fractures of the Patella with Functional Disability.—The fragments should be exposed in the usual way, and all the fibrous tissue cut away, so that new bony surfaces are prepared. If necessary, the upper fragment must be detached from the femur. The chief hindrance to reduction will be the contracted condition of the quadriceps extensor muscle, and it will be necessary to divide the muscle partially in order to bring the fragments into apposition. When this is done, the fragments are wired as in a primary operation. In some cases, however, the fragments cannot be brought exactly together; if this is so, they should be drilled as usual, and the wires passed and tightened as much as possible, the hip being flexed and the knee extended whilst this is being done. A second operation is performed later, and the fragments will then be able to be brought into apposition.

Fractures of the Tibia

1. **Separation of the Upper Epiphysis of the Tibia.**—The centre of ossification for the upper epiphysis of the tibia appears just after birth, and joins the diaphysis at twenty-one years of age. The epiphysis extends downwards in front to include the tubercle of the tibia, and has on it the articular surface for the fibula. Separation of the epiphysis is rare.

Schlatter's Disease.—This condition is a partial separation of that part of the epiphysis that forms the tubercle of the tibia, and which may have a separate centre of ossification. The cause of the condition is usually a violent contraction of the quadriceps muscle, but frequently no definite history can be obtained of such a strain. It is more commonly met with in boys than in girls, and the subject is athletic.

SYMPTOMS.—The first symptoms are pain and tenderness about the tubercle of the tibia, usually the right (sometimes both). At first the pain is only felt on or after severe muscular effort, but it gradually becomes continuous and more severe.

On examination, a swelling is felt over the tubercle of the tibia, which is tender and painful.

The **DIAGNOSIS** is made definite by X-ray examination. The exact condition found varies a little; in some cases there is fracture of the tubercle and partial separation, and in others there is separation only. There is always some formation of new bone in the ligamentum patellæ, due to a subacute inflammation of the periosteum.

TREATMENT.—In mild cases of short duration the patient must be warned not to take any violent exercise, but it is not necessary to keep the leg at complete rest. In more severe cases absolute rest to the knee-joint is essential at first.

As the pain diminishes, the amount of exercise allowed can be increased, and the condition will gradually disappear in one to six

months. Schlatter's disease is not uncommonly mistaken for tuberculosis, and the condition considered much more serious than it really is.

2. Fracture of the Upper End of the Tibia.—Fractures of the tuberosities of the tibia are uncommon, and are due to direct violence. The diagnosis is difficult without radiography, owing to the large amount of swelling that rapidly follows this accident.

The **TREATMENT** consists of rest on a back splint, with massage and passive movement to the knee. If there is marked displacement, the fragment should be pegged into position.

3. Fracture of the Shaft of the Tibia.—Fracture of the shaft may be due to direct or indirect violence, and may be transverse or oblique.

The diagnosis is, as a rule, readily made by feeling an inequality on the subcutaneous border of the tibia, but there is little displacement owing to the fibula acting as a splint. In some cases radiography is necessary to establish the diagnosis.

TREATMENT.—The limb should be kept at rest for a few days on a back splint, and then placed in a movable plaster case till union has occurred. Massage should be started from the first.

If there is any difficulty in securing reduction of the deformity, an open operation should be performed.

4. Fracture of the Internal Malleolus (Wagstaffe's Fracture).—The internal malleolus, carrying with it part of the articular surface of the ankle-joint, is sometimes broken off by direct violence. The fragment is displaced upwards, and can be moved on the rest of the bone, causing pain and crepitus.

TREATMENT.—As the ankle-joint is involved in this fracture, unless apposition of the fragment is very accurate, it is likely to be followed by disability, and the best treatment is to peg the fragment into position. If this treatment is inadvisable or refused for any reason, the foot should be placed at rest on back and side splints for a few days, and then put in a movable plaster of Paris case, massage and passive movement of the ankle-joint being used from the first.



FIG. 205.—UNITED FRACTURE OF THE TIBIA. (London Hospital Medical College Museum).

Fractures of the Fibula

Fractures of the fibula alone are by no means uncommon, and are chiefly found at the lower end. There is, as a rule, very little displacement; but there is localized tenderness, crepitus, and pain

referred to the site of the fracture when the tibia and fibula are pressed together. If the fracture is above the inferior tibio-fibular joint, there is loss of fibular spring.

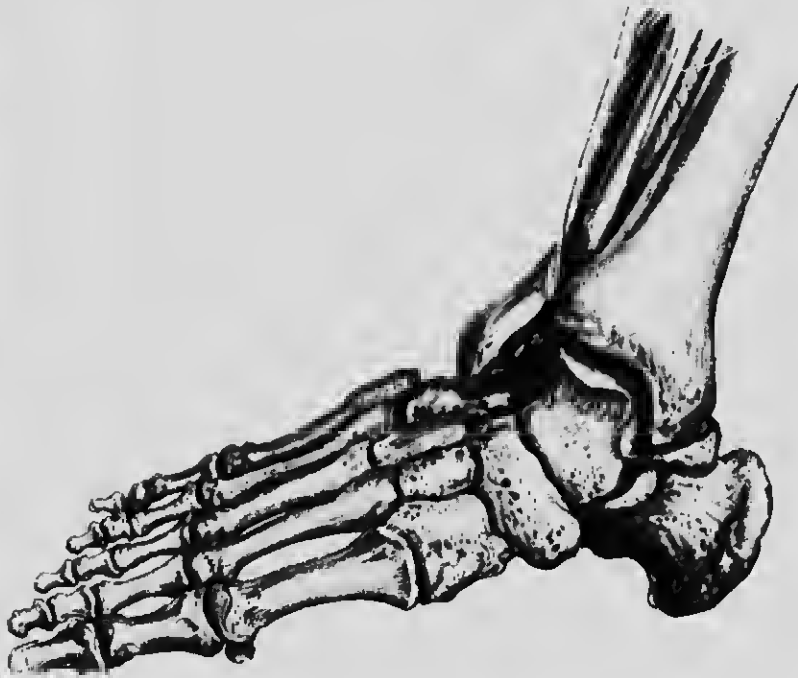


FIG. 206.—FRACTURE OF THE LOWER END OF THE FIBULA.

TREATMENT.—The limb should be kept at rest for a few days, and then placed in a movable plaster case, massage and passive movement of the ankle being carried out from the first.

Fracture of the Shafts of both Tibia and Fibula

Fracture of both bones of the leg is one of the commonest fractures, and occurs at all ages. It is due to either direct or indirect violence. If due to indirect violence, the tibia is usually fractured obliquely at the junction of the middle and lower thirds, and the fibula about the middle of the bone. The fracture of the tibia usually runs downwards, forwards, and inwards, and the sharp-pointed upper fragment may penetrate the skin, making the fracture compound. Fractures due to direct violence are usually transverse, and both bones are broken at the same level. These fractures are frequently comminuted and compound.

DISPLACEMENT.—The upper fragment of the tibia generally comes forward in front of the lower fragment, which is displaced backwards

and drawn up. Lateral displacement is also common, and the foot with the lower fragment is usually rotated outwards. In some cases the lower fragment comes forwards in front of the upper, and reduction of the deformity is more difficult than usual.

SIGNS.—All the common signs of fracture are present, and crepitus easily elicited. The deformity is so obvious that the diagnosis is made at a glance.

TREATMENT.—During reduction of the deformity the hip and knee joints should be flexed, and traction made on the foot. Counter-traction is made by an assistant, who grasps the thigh just above the knee, and direct pressure is made on the fragments to get them into position. In many cases reduction is conveniently accomplished after the foot is fixed in the splint.

Transverse fractures, as a rule, can readily be retained in position by suitable splints, those most commonly used being back and side splints, Lane's, MacIntyre's, Neville's, and Cline's splints; and in cases of oblique fractures where reduction is successfully accomplished, these splints will also answer admirably. On the other hand, in certain cases of oblique fracture it is difficult or impossible sometimes to obtain a satisfactory position, and open operation—plating the bone in position—is the best method of treatment, especially if the patient is a manual labourer, whose livelihood depends on absence of functional disability in the lower limbs.

The time the limb should be kept in these splints depends on the tendency for the displacement to recur, but massage should be started as early as possible. As soon as any union has occurred, and there is no tendency for the fragments to become displaced, the limb should be put in a movable plaster case, and massage and passive movement of the knee and ankle carried out daily.

At the end of a month or six weeks weight can be borne on the foot, and at the end of eight weeks (in an average case, all splints should be dispensed with.

If it is absolutely necessary for the patient to get about at an early date, the limb should be placed in a fixed plaster of Paris case a few days after the accident, and the patient allowed about on crutches; but this treatment is likely to be followed by stiffness of the limb for a considerable period.

Apparatus used in the Treatment of Fractures of the Tibia and Fibula

1. **NEVILLE'S SPLINT.**—This consists of an iron back splint and foot-piece, with two wooden lateral splints. The leg is placed on the back splint, and the foot and leg below the fracture securely fastened to the foot-piece by bandages, or, better, by strapping. Extension and counter-extension are now made, and while these are maintained, a bandage or strapping is carried from the fracture to the top of the splint.

The side-pieces are fastened on by webbing bands and buckles, and the splint is slung in a *Bloxam's cradle* by means of straps passed

through lateral projections from the back splint. Instead of the metal back splint, an ordinary wooden back splint may be used. With these splints, as in all cases of fractured tibia and fibula, care should be taken that the foot is not placed vertically on the footpiece, but

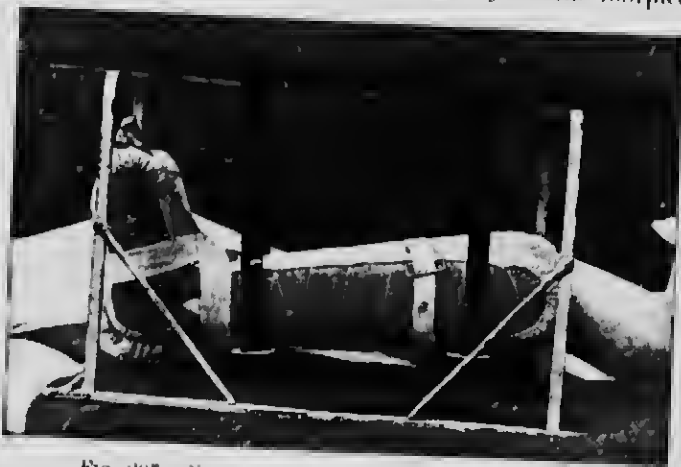


FIG. 207.—NEVILLE'S SPLINT IN A BLOXAM CRADLE.

inclined outwards and upwards at an angle of 30 to 45 degrees to the perpendicular. The reason for this is that in the resting supine position the thigh, and therefore the upper fragment, rotates outwards on the pelvis to an angle of 30 to 45 degrees with the vertical, and the



FIG. 208.—LANE'S POSTERIOR SPLINT, WITH SIDE SPLINTS.

lower fragment must be placed in a similar position, or rotatory deformity will occur. Instead of placing the foot obliquely on a vertical footpiece, Lane's splint can be used. This is provided with a footpiece inclined at an approximate angle of 35 degrees to the vertical.

2. CLINE'S SPLINT.—These are two lateral wooden splints, shaped to roughly resemble the leg, which are secured by means of webbing bands and buckles. The limb is then placed on its outer side, lying on a pillow with the knee and hip flexed, or it can be slung in a Salter's cradle.

Several varieties of traction splints, such as Neill's, have been suggested, but they have never come into general use.

Moulded splints can be made of plaster of Paris, such as the Bavarian and Croft's splint.

3. CROFT'S SPLINT.—Four pieces of house-flannel, two for each side, are cut to the shape of the leg and foot. They are of such a size that they will just meet in the middle line, both back and front. Four pieces of lint are cut out in the same way, but should be slightly larger than the flannel.

The leg is shaved, cleaned, and oiled. Two of the pieces of house-flannel are put into a basin of water, and while they are soaking, one of the pieces of lint is wrapped round the inner side of the limb, and is made to fit smoothly by making cuts where necessary. The assistant holds this piece of lint on the leg in the proper position, and the two pieces of flannel that have been soaking are taken separately, and a thick cream of plaster of Paris rubbed into them. They are then quickly applied one over the other to the inner side of the limb, evenly and smoothly, and the second piece of lint is applied over the plaster. A bandage is used to bind the case on the limb, so that when the plaster sets, an exact cast of one-half of the leg is taken.

A cast of the outer side of the leg and foot is made in the same way before the first is removed, and the two kept bandaged on for twenty-four hours, hot-water tins being placed in the bed to hasten drying. On cutting the bandage and removing the casts, it will be found that they form two halves of a firm splint exactly fitting the limb.

4. BAVARIAN SPLINT.—Two pieces of house-flannel of a size to fit the limb are cut roughly to the shape of the leg and foot and stitched together along the median line for the length of the leg, the footpiece being left free. The flannel pieces, soaked in water, are placed under the limb so that the seam reaches from the popliteal space to the heel. The sides of the inner piece are brought together over the oiled leg and foot, and fixed in front and along the sole by pins; they should each overlap the middle line by $\frac{3}{4}$ inch. The limb is then turned on one side, and whilst the outer piece is laid back, a layer of plaster of Paris, of the consistency of thick cream, is spread evenly over the inner piece, passing to the seam behind and to the mid-line in front. The outer piece is then folded over this, and pressed down till the plaster sets. It should just touch the middle line in front and along the sole. When it has set, the limb is turned over, and the process repeated on the other side. When both sides have set firmly, the pins are taken out and the splint is removed, the seams serving as a hinge. The edges of the plaster are trimmed, and those of the inner flannel turned over and stitched down to the outer piece. The splint is then re-

adjusted and fixed by a bandage. Strips of thin tin may be incorporated in the plaster to give strength to the splint.

If the limb is put up into a fixed plaster of Paris case, the foot and heel should be included in the case, and care should be taken that the foot is at right angles to the leg, or talipes equinus will result and the deformity will be difficult to correct.

Compound Fractures of the Tibia and Fibula can be treated by the application of any of the above splints after the wound has been thoroughly cleaned, but it is perhaps better to secure the dressing with moulded plaster of Paris splints, after the manner of Croft's, so that one-half can be removed at a time, the fracture being supported on the other half.

Union of both bones should be firm at the end of eight weeks, of the tibia in seven weeks, and of the fibula in six weeks, and all apparatus can be discarded at the end of these times.

If union is still feebly, the leg may be encased in plaster of Paris and the patient allowed to walk on it, or one of the other methods for treating delayed union carried out (see p. 426).

Fracture Dislocations of the Ankle-Joint

1. **Pott's Fracture Dislocation.**—This injury is due to indirect violence, the usual history being that the patient has slipped on the kerb. The tibia is broken just above the inferior tibio-fibular joint, and the tip of the internal malleolus is broken off, or the internal lateral ligament of the ankle-joint is torn through; the foot is dislocated outwards and backwards, and everted.

In many cases there is rupture of the interosseous tibio-fibular ligament, or a scale of bone is torn off the tibia where this ligament is attached. The deformity, when present, is characteristic, the internal

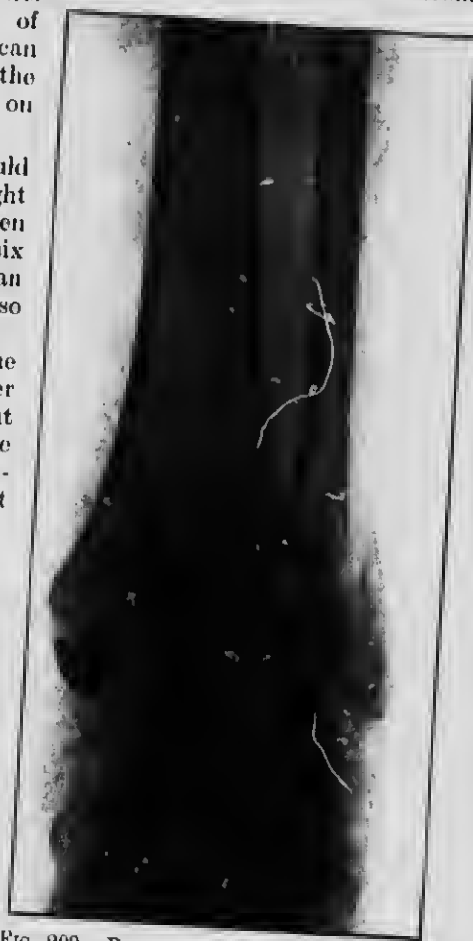


FIG. 209.—RADIOGRAM OF POTT'S FRACTURE DISLOCATION.

malleolus projecting under the skin on the inner side of the leg, or piercing the skin, making the fracture compound.

The ankle-joint is opened, and laceration of the tendon sheaths in front and behind the ankle is generally present.

2. Dupuytren's Fracture Dislocation.

—The fracture is the same as in Pott's fracture dislocation, but the astragalus, carrying the foot with it, is driven up, outer edge first, between the tibia and fibula.

Signs.—The foot is greatly everted and displaced outwards, and there is great increase of width between the two malleoli.

3. The fibula may be broken in the usual place combined with transverse fracture of the lower end of the tibia or separation of the lower tibial epiphysis, and the foot, with the two malleoli, displaced outwards and backwards. In these cases the heel projects markedly backwards, and the lower end of the upper fragment of the tibia forms a projection in front.

It must be clearly understood that these three are only types of outward and backward fracture dislocation of the ankle, and that a number of slight differences in the position of the fractures and the extent and direction of the dislocations occur.

TREATMENT.—Reduction of the deformity is all-important as in a dislocation.

The knee is flexed to a right angle, and counter-extension is made by an assistant grasping the lower third of the thigh. The surgeon places one hand against the back and outer side of the heel, pressing forwards and inwards, the other hand maintaining traction on the foot.

It is useless to put the limb into splints before complete reduction has been effected, and if this is not possible, or if the deformity readily recurs, the fracture should be exposed by open operation, the deformity reduced, and the fragments plated or wired into position. If this is not done and the fracture unites with deformity, the resulting disability is very great, and an aggravated form of flat-foot is likely to follow, which may necessitate operation. An operation performed for deformity after union has occurred is much more difficult and less likely to be followed by a satisfactory result than one carried out at the time of the accident.



FIG. 210. —POTT'S FRACTURE DISLOCATION.

Splints used in maintaining the Correct Position after the Dislocation has been reduced—1. **ROUGHTON'S SPLINT.**—This is a shaped external splint with a footpiece. The patient is placed lying on the side of the fracture, with the hip flexed and the knee bent to a right angle to the thigh, so as to relax the calf muscles. Reduction being effected, the heel is fastened to the splint by oblique pieces of strapping



FIG. 211.—ROUGHTON'S SPLINT APPLIED.

which hold it forwards. Strips of strapping plaster are then carried round the limb and splint above the fracture to hold the upper fragments steady, and the whole limb is then secured to the splint by a bandage. This splint prevents outward displacement, but it is sometimes inefficient in controlling the backward displacement.

2. **DUPUYTREN'S SPLINT.**—This is a splint without a footpiece and the padding increases in thickness towards the lower end. The knee being bent and reduction effected, the inner aspect of the leg is laid on the splint in such a manner that the padding does not descend below the upper fragment, so that the thickened lower end forms a fulcrum, across which the foot can be drawn to the inner side. The bandage is applied first to the upper part of the splint, and should not go above the knee, and when it reaches the foot should pull it into a position of inversion.

3. **POSTERIOR AND LATERAL PLASTER SPLINTS.**—These are made of double thicknesses of house-flannel soaked in plaster of Paris cream, after the manner of a Croft's splint (see p. 474), but unshaped, being merely straight strips of flannel 3 to 4 inches wide. Reduction having been effected, and the foot held at right angles to the leg, the posterior splint is applied from the toes along the side and up the calf nearly to the knee. The lateral splint is then applied, starting just in front of the external malleolus, passing over the dorsum of the foot to the inner side, then under the sole and up along the outer side of the leg to the same height as the posterior splint. These splints are moulded and bound to the limb, whilst still wet, with a roller bandage, which should be removed when the plaster is dry, its place being taken by a few turns of bandage above the ankle and at the upper end of the splint. Whilst the plaster is setting, the heel should rest on a

sandbag, with the limb rotated outwards, so that the foot is pushed forwards and inwards.

Whatever form of splint is used, it is important that the fracture should be inspected at the end of three or four days to make sure displacement has not occurred; and in the case of plaster splints, fresh ones are usually required, as the swelling and œdema will have disappeared, leaving the leg smaller than it was. As soon as the tendency to displacement has disappeared—and this can be only

obtained by carefully removing the splints—or from the first if there is no displacement, massage and passive movement to the ankle and toes should be started, in order to prevent the stiffness that is the most serious disability after Pott's fracture.

After three weeks, or as soon as there is no tendency to displacement, the limb should be fitted with a Croft's, Bavarian, or some other form of moulded splint, and the patient allowed up. Massage and movements should be continued daily.

At the end of six weeks all apparatus is left off, and the patient gets about on crutches, and at the end of another two weeks he should be walking with the aid of a stick only.

Dupuytren's fracture dislocation and the other various forms of fracture dislocation about the ankle-joint should be treated on the same principles as Pott's fracture dislocation.

Pott's Fracture with Inversion.—If the force which produces a fracture dislocation of the ankle is applied on the outer instead of the inner side, the foot is carried inwards and in a position of inversion instead of the outward displacement, but the fibula and tibia are fractured at the usual situations.

TREATMENT.—The same principle applies as in treatment of the other cases of fracture dislocation of the ankle, but the splints must be adjusted on the opposite side of the limb.

Fractures of the Tarsal Bones

Fractures of these bones practically always arise from direct violence, such as falls on the foot and from "run over" accidents. The bones most frequently injured are the os calcis and the astragalus. The fractures are frequently comminuted.

Fractures of the Os Calcis.—The most common cause of fracture of this bone is fall from a height on to the feet. The injury is frequently bilateral. The amount of deformity varies, but is usually not excessive, the soft parts holding the fragments together. The most usual displacement is for the posterior part of the os calcis to be drawn upwards by the contraction of the tendo Achillis, so that a certain amount of flattening of the posterior limb of the arch of the foot results. The diagnosis is often only made by radiography, especially as there is generally extensive swelling and bruising of the soft parts, and crepitus is difficult to elicit even in comminuted fractures.

TREATMENT.—The fragments should be manipulated into position as far as possible, and the limb placed on a back splint with a foot-

piece. Passive movement and massage are started from the time of the accident.

The patient should not be allowed to walk till about one month after the accident, and if there is any tendency to flat-foot, he should be given a *volgus* pad to wear in the boot.

Fracture of the Posterior Tubercle into which the tendo Achillis is inserted is not very uncommon, and if there is any upward displacement, the fragment should be pegged into position.

Separation of the Posterior Epiphysis of the Os Calcis, the centre of ossification of which appears at ten years and joins the body of the bone at sixteen, may be complete or incomplete. If it is complete, there is upward displacement, and the epiphysis should be pegged into position. In the incomplete form, pain and tenderness about the heel, increased on exertion, are present, and the condition resembles Schlatter's disease of the tubercle of the tibia. The treatment is rest; but recovery is slow, and the patient may be partially disabled for a year or more.

Fracture of the Astragalus.—This bone is most frequently fractured in the same way as the os calcis, and the position of the fracture varies considerably; it is frequently comminuted. There may be displacement of the foot in any direction, but as a rule there is no marked deformity, and crepitus is difficult to obtain. The diagnosis is made by radiography.

TREATMENT.—The treatment is similar to that of fractures of the os calcis but if there is any marked deformity that is difficult to reduce, and the functional ability of the foot is likely to be considerably impaired, the bone should be excised.

Fracture of the Metatarsals and Phalanges

Fractures of these bones are generally due to crushes, the soft parts often being considerably bruised. The diagnosis is made by eliciting crepitus or by the use of X rays. If radiography is used as a routine, many so-called sprains of the foot will be found to be fractures of the metatarsals; but the diagnosis is of little importance, except from a medico-legal point of view, as the treatment of these fractures is rest, passive movement, and massage.

CHAPTER XV

DISEASES OF BONE

GENERAL CONSIDERATIONS.—A growing bone consists of a diaphysis, epiphyses, periosteum, and bone marrow. The *epiphyses* are separated from the *diaphysis* by a layer of non-vascular cartilage, and in the majority of cases the epiphyses are covered by the joint cartilages. They increase in size with the growth of the bone, but do not contribute much to the increase in length, finally fusing with the diaphysis by the disappearance of the epiphysal cartilage. This disappearance of the cartilage takes place at various ages in the different bones, but is complete in every bone at the age of twenty-five. The growth in length of a bone takes place chiefly on the diaphyseal side of the epiphysal line, and generally is more marked at one end of the diaphysis than the other. For example, growth is more active at the lower ends of the femur and radius than at the upper ends, and at the upper ends of the tibia and humerus than at the lower. The site of greatest growth—*i.e.*, the place where physiological change is most active—is the site at which inflammation and other diseases of bone are most common. It is also the weakest part of the bone, as the newly formed tissue is soft, spongy, and vascular, and so-called separation of an epiphysis usually takes place through this soft bone. The *periosteum* is a thick vascular membrane in the young, but thinner and more fibrous in the adult, that covers the whole of the bone except those parts covered by articular cartilage. It consists of two layers: an outer fibrous layer, and an inner vascular layer which has the property of laying down new bone (osteogenetic layer). It is this deposit that causes the increase in girth of the bone. Numerous bloodvessels run from the periosteum into the bone at right angles, anastomosing in the Haversian canals with the branches of the nutrient artery of the bone. The periosteum is very firmly attached to the epiphysal cartilage, and at the edge of the articular surfaces blends with the articular cartilage, and also becomes continuous with the capsular ligament of the joint.

The *bone marrow* has at least two functions—being partly concerned with the absorption and regeneration of the bone, and partly with the formation of new blood-corpuscles. As age advances, the blood-forming elements tend to disappear, except in the bodies of the vertebræ, and the bone marrow becomes fatty.

Inflammatory conditions which are due to infection of the bone

by blood-borne organisms are most likely to affect the rapidly growing bone on the diaphysial side of the epiphysial line or under the periosteum, than the other parts of the bone, as it is more vascular and more liable to slight injuries (juxta-epiphysial strain), which afford a site of lowered resistance to bacterial invasion. They are also more liable to occur in children than in adults, in whom there is no longer active growing bone.

The pathological phenomena associated with inflammation of bone are similar to those in the soft tissues, but certain peculiarities must be noted. The bloodvessels of bone run in unextensible canals, and when dilatation of the vessels and exudation occurs in inflammation, swelling of the part is impossible. As the exudation increases, therefore, the bloodvessels become more and more pressed on, until finally stasis of the blood occurs from occlusion of the vessels. This occlusion of the vessels, owing to the inability of the bone to swell, accounts for the large number of cases in which inflammation, and especially acute inflammation of bone, ends in necrosis. The veins lying in the Haversian canals of the bone do not possess valves; therefore when thrombosis occurs in them owing to infection, small emboli readily enter the general blood-stream, and septico-pyæmia results.

Atrophy of Bone.—Atrophy of bone is due to disuse, and is chiefly seen in bedridden patients, especially if they are suffering from paralysis. All the parts of the bone are atrophic; the cancellous tissue is a fine open network, and the compact tissue in such a bone as the tibia may not be thicker than paper. The interstices of the cancellous tissue are filled with fat, and the periosteum is much thinner than normal. The usual ridges and hollows for the attachment of muscles almost disappear. Atrophy of the skeleton is a normal phenomenon of old age, and accounts for the frequency of Colles's fracture and fracture of the neck of the femur in the aged.

Hypertrophy of Bone.—This term implies an increase in all the elements of a bone with increased strength, and must be distinguished from increase in density of the bone. The latter is a pathological condition, while hypertrophy is physiological, and occurs in response to increased work thrown on the

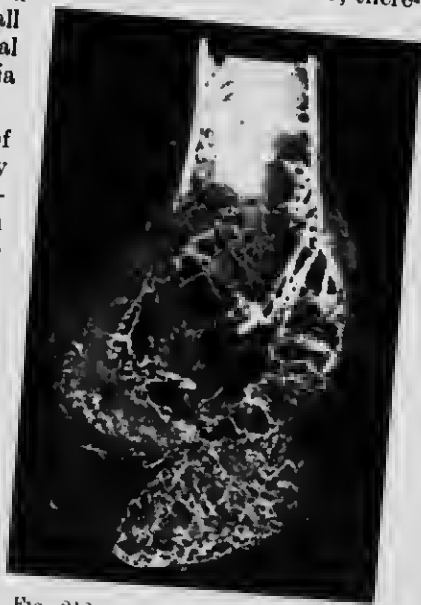


FIG. 212.—ATROPHY OF BONE FROM DISUSE.

(London Hospital Medical College Museum.)

skeleton. The ridges and hollows for the attachment of muscles are accentuated, and the bone becomes larger and heavier.

Regeneration of Bone.—When a part of a bone has been destroyed by accident or disease, the same changes as those that lead to the formation of granulation in soft tissues occur in the bone, and the gap becomes filled with granulation tissue. In some cases granulation ends in the formation of fibrous tissue, but in the majority of cases the granulation tissue becomes changed into bone by the activity of the bone-forming cells that have not been destroyed. These bone-forming cells (osteoblasts) are chiefly found in the deeper layer of the periosteum (osteogenetic layer), and it is on the integrity of the periosteum that new bone formation chiefly depends. There are, however, osteoblasts in the bone marrow, which help in the regeneration of the bone. The capacity of the periosteum to form new bone varies in the different bones, being most marked in the long bones. The bones of the skull are peculiar in having a very thin pericranium on one side and the dura mater on the other, neither of which possesses much osteogenetic power. Defects of these bones are liable to remain permanent. The bones of the face and jaw, which are largely developed in membrane, have also little power of regeneration, and gaps in them are usually filled by fibrous tissue. Defects in the articular cartilages are repaired by fibrous or bony tissue, and there is very little regeneration of the cartilage.

INFLAMMATION OF BONE

The causes, pathological phenomena, clinical features, and results of inflammation of bone are similar to those of inflammation of the soft tissues; but a large amount of confusion has arisen owing to the different names that have been used to describe the same pathological condition. Inflammation in a bone may start either in the periosteum, or in the bone itself, and in the case of a young subject it may originate in and be limited to an epiphysis or the diaphysis. From the site at which the inflammation begins the following terms have been used: Periostitis, osteomyelitis, epiphysitis, and diaphysitis. Inflammations of bone have also been named according to the result of the inflammation, as acute necrosis of bone, quiet necrosis, caries of bone, suppurative osteomyelitis, and sclerosis of bone, and other names, have been given to the condition indicating vaguely the cause, such as infective osteomyelitis, and septic osteomyelitis. In every case of inflammation of bone the periosteum and the medulla are both involved to a varying extent; therefore all inflammation of bone can be termed **periosteomyelitis**, although it is convenient to use the term "periostitis" in certain conditions when the periosteum is almost solely involved, such as traumatic periostitis. The term "periosteomyelitis" is, however, not complete, for it gives no indication of the cause of the condition, and if a complete diagnosis is to be made, the cause must be indicated. The full diagnosis,

therefore, must be given by prefixing to the term "periosteomyelitis" an adjective indicating the cause of the condition, such as staphylococci periosteomyelitis, tubercular periosteomyelitis, or syphilitic periosteomyelitis.

DEFINITIONS—Necrosis.—This term is applied to death of a large piece of bone. It is generally a result of inflammation, but may also be due to interference with the blood-supply. The dead piece of bone is termed a **sequestrum**.

Caries.—Caries of the bone indicates death of the bone in small pieces, the bone crumbling away, and is equivalent to ulceration occurring in the soft tissues. The condition results from a chronic inflammation of the bone, frequently tubercular, in which the bone becomes replaced by granulation tissue. In the majority of cases the granulation tissue breaks down into pus, and if this pus is examined under the microscope, small particles of bone will be found in it. In some instances, especially in tuberculosis of the vertebræ (Pott's disease), and in tubercular arthritis of the shoulder, no pus is found, and the bone is destroyed. The process is called **caries sicca**.

It sometimes happens that an inflammation that is causing caries of the bone becomes more acute, and a large piece of the bone dies and forms a sequestrum. This condition is termed **caries necrotica**. When the inflammatory condition causing the caries ends, the bone heals by the formation of new bone from the periosteum.

Sclerosis of Bone (Osteosclerosis).—This condition is an increase in the osseous tissue of a bone which becomes denser and harder, so that in some cases the cancellous tissue disappears entirely. It is generally due to an inflammation of the bone, and corresponds to fibrosis of the soft tissues resulting from chronic inflammatory processes. Sclerosis of bone is also seen round the union of a fracture, especially if there has been much displacement. In such a case it corresponds to the scar tissue of soft structures. When rickety changes have ceased to occur in a bone, it frequently becomes harder and denser than normal owing to its increased blood-supply.

Osteoporosis.—Osteoporosis or rarefaction of bone is a term applied to a disappearance of the bony tissue due to a chronic inflammation; the inflammatory condition sometimes is spoken of as a **rarefying osteitis**. The condition is similar to caries, and some pathologists make no distinction between the two conditions. Others, however, speak of osteoporosis when the bone is simply invaded by granulation tissue, and absorbed, there being no evidence of death of all particles of bone. The granulation tissue which invades the bone is associated with large multinuclear cells (osteoclasts), which are one of the normal constituents of bone marrow, and which have the function of bringing about the absorption of bone.

Classification of Inflammatory Conditions of Bones

1. BACTERIAL.—Acute Pyogenic $\left\{ \begin{array}{l} \text{Staphylococci} \\ \text{Streptococci} \\ \text{Pneumococci} \\ \text{Typhoid} \end{array} \right\}$ periosteomyelitis.
 Chronic pyogenic periosteomyelitis.
 Tubercular periosteomyelitis.
 Syphilitic periosteomyelitis.
2. NON-BACTERIAL.—Traumatic $\left\{ \begin{array}{l} \text{Gouty} \\ \text{Rheumatic} \end{array} \right\}$ Periostitis.

ACUTE PYOGENIC PERIOSTEOMYELITIS.—The bacteria causing the inflammation may reach the bone (1) by the blood-stream, or (2) by direct infection. The latter condition is seen in compound fractures and amputation wounds, which become infected, the infection being usually mixed. In the former the infection is generally pure, and the organism most frequently present is the *Staphylococcus pyogenes aureus*.

Acute Staphylococci Periosteomyelitis.—This disease is most frequently met with in children. There is often an antecedent history of injury. Staphylococci infection of the skin, such as impetigo, or infection following a slight injury, as a graze on the heel, is common in children, and form the focus from which the organism enters the blood. The slight trauma, as has been shown above, is most likely to injure the soft, vascular, newly formed bone on the diaphysial side of the epiphysial line, and produces a nidus of lowered resistance for the growth of the organism. The disease is most common among children living under bad hygienic conditions, and in those who are debilitated by a recent attack of one of the infectious fevers. It is convenient for the sake of description to divide the disease into stages.

STAGE 1—Invasion and Acute Inflammation of the Bone.—**PATHOLOGY.**—The site of the disease may be in the epiphysis or diaphysis, the latter being (for reasons given above) by far the more common, and an area of bone of varying size becomes acutely inflamed. This inflammation usually rapidly terminates in suppuration.

On examination, within twenty-four hours of the onset of the disease, the inflamed area is infiltrated with pus, and thrombosis has occurred in the vessels in the Haversian canals. The periosteum is swollen, reddened, and softer than usual, and pus is beginning to collect between it and the bone. The inflammatory condition is limited to the diaphysis or to the epiphysis, the non-vascular epiphysial cartilage preventing the spread from one to the other, while the firm attachment of the periosteum to the cartilage prevents spread along the side of the bone. In very acute inflammation, both epiphysis and diaphysis may be affected. If the epiphysis is affected, or if the juxta-

epiphyseal bone lies inside the capsule of the joint, as in the case of the hip, there is usually an effusion of pus into the joint secondary to disease of the bone (acute arthritis of infants).

The soft tissues round the bone become acutely inflamed, and if surgical relief is not given, the pus breaks through the periosteum, and forms an abscess in the surrounding tissue, which if the patient survives, will find its way to the surface and burst.

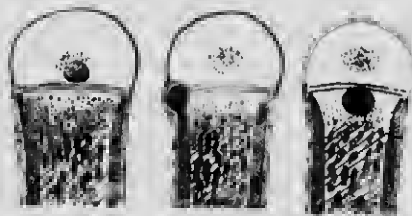


FIG. 213. — DIAGRAM SHOWING FOCI OF SUPPURATION IN ACUTE PERIOSTEOMYELITIS.

CLINICAL FEATURES.—The

General Symptoms are those of any acute infective disease—rise of temperature, rigors, increased pulse and respiration rate, sweating, and frequently delirium.

Local physical signs, beyond exquisite tenderness of the bone, which may be masked by the delirium, are frequently absent at first; but later there is a deep-seated brawny swelling over the bone, usually near a joint, and the skin over it is red and oedematous. Later a fluctuating swelling and the usual signs of abscess are present. In many cases, especially those in which the upper and lower ends of the femur are involved, there is a purulent effusion into the neighbouring joint.

COMPLICATION.—The complication of this stage of the disease is the onset of septicopyæmia due to infective emboli from the veins entering the general blood-stream. In some cases the only diagnosis that can be made is general septicopyæmia, and the focus of infection in the bone is only found on post-mortem examination. Infection of the serous membranes is common, the one most frequently attacked being the pericardium, and infection of the growing ends of other bones frequently occurs.

DIAGNOSIS.—Acute periosteomyelitis is most frequently mistaken for acute articular rheumatism, and the mistake is a serious one, valuable time being lost in giving exit to the pus. The main points in the differential diagnosis are—The severity of the general symptoms, the involvement of one joint only, the site of maximum tenderness being chiefly above the joint, the history of injury and the absence of history of previous attacks of rheumatism. If there is any doubt as to the diagnosis, the bone and joint should be explored with an aspirating needle.

TREATMENT OF THE FIRST STAGE.—As soon as the diagnosis is made, the pus should be evacuated. If the bone affected is in one of the limbs, a tourniquet should be applied above the site of inflammation, and an incision made over the place of maximum tenderness, or where the pus is pointing. The incision should be deepened, passing between the muscles if possible, until the periosteum is reached. This is freely incised in the line of the skin incision, and the bone exposed. Pus will usually be found between the periosteum and the bone. The

bone should then be freely opened with a mallet and chisel, enough being cut away to establish free drainage; but care should be taken that sufficient is left to prevent spontaneous fracture. The amount of bone removed depends on the extent of the disease.

The cavity should be packed with gauze, a large dressing applied, and the limb put into a comfortable splint. The tourniquet should then be removed. If there is fluid in the neighbouring joint, it should be aspirated, and if considered advisable, the joint should be opened and drained.

If the case is not seen early, or if a very large area of the bone is affected and the patient is suffering severely from toxic absorption, the question of primary amputation should be considered, and in some cases this is by far the best treatment.

The usual *general* treatment of any acute infective condition should be carried out, including vaccine therapy.

STAGE 2—The Period of Separation of the Sequestrum.—In every case of acute staphylococcal periosteomyelitis ending in suppuration, some necrosis of bone will result, and the sequestrum to be separated may be of any size, from a small flake to the whole of the diaphysis. This separation takes place by suppuration occurring in the living bone lying next to the dead.

PATHOLOGY.—The living bone and the periosteum are in a state of great activity. The tissue immediately next to the sequestrum is acutely inflamed and breaking down into pus, but at a little distance from the focus of disease the inflammation results in the formation of new bone (osteosclerosis). This new bone is principally formed by the periosteum, so that a sheath of new bone (the involucrum) surrounds the

sequestrum. In the involucrum are openings (cloacæ) by which the pus escapes, and sinuses lead from these openings to the skin. The amount of formation of new bone varies in the different bones; in the jaw and skull bones it is usually absent, no involucrum being found.



FIG. 214.—ACUTE PERIOSTEOMYELITIS.

- (1) Lower end of the femur; (2) disorganized knee-joint; (3) upper epiphysis of tibia; (4) sequestrum; (5) cloaca; (6) shaft of tibia; (7) lower epiphysis of tibia.

(London Hospital Medical College Museum.)

CLINICAL SYMPTOMS.—*Locally* there is a constant discharge of pus from the sinuses, with the occasional formation of a new sinus if drainage is not efficient. *Generally* the patient shows evidence of

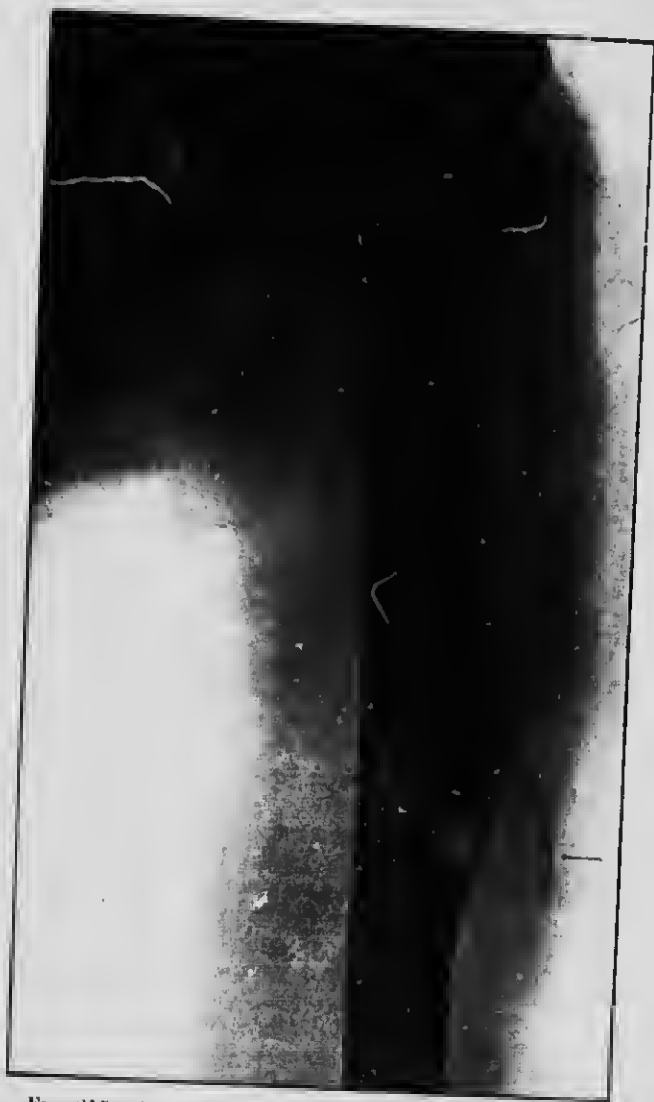


FIG. 215.—SEQUESTRUM WORKING OUT THROUGH A SINUS.

septic absorption, whether the drainage is free or not. This absorption is due to the inflammation going on in the living bone in order to separate the sequestrum. There is usually a hectic temperature, rise of pulse and respiration rate; the patient wastes and becomes anæmic.

COMPLICATIONS.—Septico-pyæmia is a constant danger, the principal foci of secondary infection being other bones, joints, and the pleuræ. If the suppuration continues for a long time, lardaceous degeneration of the arterioles may occur, or the patient may die of exhaustion.

TREATMENT.—The general treatment is that of any chronic septic intoxication, the chief indications being good feeding, fresh air, and sunshine. Vaccine therapy may be of value.

Locally, the limb must be carefully splinted to prevent contraction of the joints and spontaneous fracture of the diseased bone. Careful aseptic dressing, with free drainage of the sinuses, is absolutely essential. If, in spite of careful local and general treatment, the patient continues to lose ground, the limb should be amputated, especially if the joints are involved as well as the bone.

STAGE 3—The Period of Healing.—Before healing can occur, the sequestrum must be removed. Small sequestra may be discharged from the sinuses, but in the majority of cases the sequestrum is too large for discharge to occur in this manner, and it must be removed by operation, otherwise the discharge will continue indefinitely.

PATHOLOGY.—The sequestrum or sequestra will be lying in a cavity in the bone lined with granulation tissue, which is constantly breaking down into pus. The pus escapes through the cloacæ in the newly formed involucrum, and reaches the surface along the sinuses. The surrounding bone is denser than normal.

DIAGNOSIS.—The presence of a separated sequestrum may be diagnosed by feeling it to be loose on introducing a probe through one of the cloacæ, or by means of the X rays, the sequestrum showing as a distinct shadow. It may also be judged to be loose by the time that has elapsed from the onset of the illness, six weeks to three months being the time usually occupied in the separation of a sequestrum.

(London Hospital Medical College Museum.)

TREATMENT.—In those cases in which the whole of the diaphysis is affected and is loose, it may be removed at the primary operation; but to avoid deformity it is generally better to leave it until an involucrum has formed. This is not always necessary, and the whole of such a bone as the clavicle may be removed and replaced ultimately by a new bone formed from the periosteum.

When the necrosis is more limited and separation of the sequestrum



FIG. 216.—A DRIED SPECIMEN SHOWING SEQUESTRUM FORMATION AFTER ACUTE PERIOSTEOMYELITIS.

is waited for, before the operation for its removal is undertaken consideration should be given to the question of whether amputation is not the better treatment. If there is extensive destruction of the periosteum so that new bone formation is defective, or if there is separation of the epiphysis and disorganization with pathological dislocation of the neighbouring joint, amputation is indicated; but in the majority of cases a useful limb can be obtained with careful treatment.

One of two methods can be used for the removal of the sequestrum—

1. After the limb has been made bloodless and a tourniquet applied, the existing sinuses—if they are conveniently placed—are opened up, and the involucrum between the cloacæ chiselled away. The bone cavity is thus opened, the sequestrum broken up if necessary, and all the dead bone removed. The bone cavity is then scraped with a sharp spoon, so that all granulation tissue is removed and a cavity is left, the walls of which are formed by healthy bone.

2. **Osteoplastic Resection.**—A flap of periosteum and newly formed bone is turned up with the soft tissues, so that the bone cavity, with the sequestrum lying in it, is exposed. The sequestrum is removed and the cavity scraped with a sharp spoon as before, and the osseous periosteal flap replaced.

Treatment of the Bone Cavity.—The bone cavity left may be treated in one of four ways—

1. The cavity is lightly packed with gauze, which is changed daily, so that it granulates from the bottom, the granulation tissue ultimately changing to bone. In the majority of cases this is the most satisfactory method of treatment, but it is painful and tedious.
2. A rigid metal (aluminium or silver) tube, with a flange to retain it, is placed in the cavity, and permanent drainage carried out until healing occurs.
3. The cavity, after being rendered as dry and aseptic as possible, is filled with one of the following—aseptic mutton-fat, a mixture of iodoform and spermaceti, aseptic wax, blood-clot, decalcified bone, or living bone with periosteum attached—and the soft tissues sutured. If union occurs by the first intention, the foreign bodies form a pabulum for the growth of ossifying granulation tissue, and healing occurs without the tedium of constant dressing.
4. The soft tissues can be allowed to grow in and line the bone cavity. This is the method usually adopted in the case of removal of necrosed bone in the radical mastoid operation, the bone becoming lined with epithelium and drained through the external auditory meatus (see p. 1007).

RESULTS.—Regeneration of bone which is thicker and denser than normal with surprisingly little deformity or shortening is the rule, but the following results are not infrequently seen: (1) Separation of the epiphysis, with deformity; (2) disorganization, with ankylosis or pathological dislocation of the neighbouring joint; (3) shortening from interference with growth at the epiphysial junction; (4) Increase in growth from the excessive vascularity of the epiphysial junction; (5) stiffness of muscles from suppuration in the tendon sheaths or amongst the muscle fibres; (6) persistence of the sinuses, owing to the difficulty of removal of all dead bone; (7) no new formation of bone with a useless limb; (8) spontaneous fracture, with resulting deformity.

RELAPSES.—After an attack of acute osteomyelitis, with the formation of a sequestrum, relapses are not uncommon, and may occur within a few months, or not until years after the sinuses have apparently healed; several recrudescences of the disease may occur after the primary attack.

CLINICAL FEATURES OF RELAPSES.—The general symptoms associated with a relapse are usually slight, the temperature and pulse and respiration rate being only slightly raised. The limb becomes somewhat swollen, and there is tenderness at the site of the old scars. The pus is a long time coming to the surface, and usually breaks through at the situation of the old sinuses; but new sinuses may develop. Spontaneous fracture sometimes occurs owing to an abscess forming in the bone.

TREATMENT.—An X-ray photograph should be taken to show the extent of the disease and to ascertain the presence of a sequestrum. The bone should be opened at the site of maximum tenderness, or if a sinus is discharging, it should be thoroughly opened up. Any sequestrum must be removed and the cavity treated by one of the methods described above.

Chronic Staphylococcal Periosteomyelitis—Chronic Abscess of Bone.
—Infection of the bone by the *Staphylococcus aureus* may be of all degrees of acuteness, from an attack which terminates in septico-pyæmia and death in forty-eight hours to a chronic abscess which will take months to reach the surface. The pathology is similar in every case. The most frequent cause of chronic staphylococcal abscess of bone is a relapse after an acute attack, as described above; but in some cases chronic suppuration is the primary condition, and is probably associated with an attenuated organism.

Chronic abscess of bone is most common in young adults, and the cancellous bone on the diaphysial side of the epiphysial line is most frequently affected. The head of the tibia, the lower end of the femur, and the upper and lower ends of the humerus, are the most frequent sites of the disease.

PATHOLOGICAL ANATOMY.—The abscess cavity, which is usually situated near the centre of the bone, is surrounded by dense sclerosed bone, which is gradually invaded as the abscess spreads. Necrosis of pieces of bone is common. The inflamed periosteum lays down

new bone, so that there is steady increase in size of the bone. When the pus reaches the periosteum, it escapes through it by a small hole, and an abscess forms in the superficial tissue. Occasionally the pus may burst into the neighbouring joint and cause a suppurative arthritis.

SYMPTOMS.—The general symptoms are those of mild sepsis.

The first local symptom is pain of a dull aching character, which is worse at night. The pain may be intermittent, and the patient is at first often treated for "rheumatism." On careful examination, the bone is found to be enlarged and tender, a localized spot of great tenderness at the spot where the pus is making its way to the surface being frequently present. Serous effusion into the neighbouring joint is not uncommon.

An X-ray examination will show that the trabeculae of the bone are blurred, and there is a light patch in the centre of the bone in which darker shadows are seen. The radiogram, however, may not be characteristic, and the appearance seen varies with the amount of necrosis and sclerosis of the bone present.

DIAGNOSIS.—The diagnosis has to be made from tubercular abscess, syphilis, and central sarcoma of the bone. The method of investigation is along the usual lines, but the differential diagnosis between staphylococcal abscess and tubercle can usually only be made by bacteriological examination.

TREATMENT.—The soft tissues over the bone should be incised and the periosteum stripped from the bone. The bone is then trephined or opened with mallet and chisel until the abscess cavity is reached. The cavity is freely exposed, all sequestra removed, and the cavity treated by one of the methods described on p. 489.

Quiet Necrosis.—In some cases, especially in those occurring in elderly people, there is no formation of pus, and on exploratory operation being performed for the above symptoms and physical signs, a sequestrum is found lying in the midst of dense sclerosed bone. This condition is spoken of as "quiet necrosis," and needs the same treatment as chronic abscess. The condition is very difficult to differentiate from sarcoma.

Serous Periosteomyelitis.—In all cases of acute periosteomyelitis suppuration is not inevitable, and it is probable that some cases

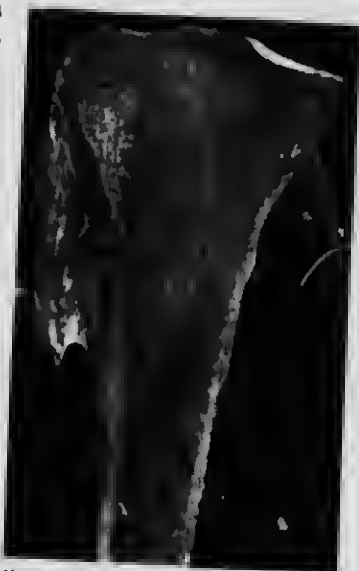


FIG. 217. — SEQUESTRUM IN A CASE OF CHRONIC ABSCESS OF THE UPPER END OF THE TIBIA.

(London Hospital Medical College Museum.)

end in resolution. It happens occasionally that on cutting down on to a focus of acute inflammation of bone the periosteum is found to be swollen and congested, and there is a layer of inflammatory lymph between it and the bone, which is also infiltrated with inflammatory products. The condition clears up without suppuration or necrosis of bone, and is termed "serous" or "albuminous periosteomyelitis." The organism present is frequently the *Staphylococcus albus*.

Streptococcal Periosteomyelitis.—This condition exactly resembles osteomyelitis due to the staphylococcus, but the inflammation is not so acute, and is less liable to terminate in extensive suppuration and necrosis. The treatment does not differ from that given for staphylococcal infection.

Typhoid Periosteomyelitis.—Inflammation of bone in connection with typhoid fever may occur within the first three weeks of the onset of the disease, or may be delayed for a year or more. Bacteriologically, there may be a pure culture of the typhoid bacillus found, or it may be a mixed infection with other pyogenic bacteria.

The condition is most frequently met with in the tibia and ribs, and the inflammation is usually subacute or chronic. It may terminate after months of inflammation in suppuration or resolution, but extensive necrosis of bone is unknown.

CLINICAL FEATURES.—There is the usual aching pain in the bone, worse at night, and the bone becomes tender and thickened. The soft parts over it are red and oedematous, the pain and oedema being aggravated by movement. Later, if suppuration occurs, there is fluctuation. The general symptoms are those of slight malaise. The symptoms and physical signs are often intermittent, and the course of the disease may spread over months or years. The diagnosis is made from the history of typhoid, the presence of Widal's reaction, and bacteriological examination of the exudate.

TREATMENT.—The part should be put at rest, and if a bone of the lower extremity is affected, the limb should be elevated on an inclined plane, and fomentations applied for the relief of pain. If this treatment is not followed by relief, the soft parts should be incised and the inflamed periosteum slit up. If suppuration and necrosis of bone are present, the dead bone must be removed and the cavity drained; in the case of the ribs, the inflamed portion of the rib should be resected.

Pyogenic Periosteomyelitis due to Direct Infection.—The most frequent conditions leading to direct infection of bone are compound fractures; gunshot wounds of bone; amputations; operations on fractures; suppurative conditions of a mucco-periosteum, as in the middle ear; suppuration in the soft parts over the bone, especially in the skull; and infection from suppuration round the teeth in the jaw. The infection is frequently a mixed one.

The pathological changes in the bone are precisely similar to those that occur in the blood-borne infection, but septico-pyæmia is not so

common in this form of the disease, as pus is not usually pent up in the bone.

CLINICALLY, the condition is not as a rule so acute. The presence of the suppurating wound of the soft parts may make the diagnosis easy. In amputation stumps the pus runs up the medulla of the bone, the end of which is often exposed in the wound. The sequestrum which separates has a characteristic appearance, showing the cross-cut of the bone below, and being cone-shaped.

In compound fractures healing is considerably delayed, as a sequestrum forms inside an involucrum and the dead bone has to be removed before union occurs. Non-union is more common in compound fractures than simple. Relapses months or years after apparent healing are not uncommon, with further discharge of dead bone.

In the skull and jawbones separation of the sequestrum is usually very slow, and no involucrum is formed.

TREATMENT.—The treatment follows the lines already described for periosteomyelitis.



FIG. 218.—SEQUESTRUM FROM AN AMPUTATION STUMP.

(Lancet Hosp. Medical College Museum.)

TUBERCULOUS DISEASE OF BONE

Tuberculous inflammation of the skeleton, which is invariably secondary to some other tuberculous focus in the body, as tuberculosis of lymphatic glands, is most commonly met with in children or young adults before the epiphyses have united with the diaphyses. Like the inflammatory diseases of bone due to pyogenic organisms, the inflammation is most likely to start under the periosteum (tubercular periostitis), or in the juxta-epiphysal bone (tubercular osteomyelitis), and in the latter situation the neighbouring joint is usually involved early, so that clinically the condition is often first recognized as a tubercular arthritis. This is particularly common in tuberculosis of the upper end of the femur, as the epiphysal line is situated inside the capsule of the joint. In the small bones of the wrist and foot no distinction can be made between tuberculous inflammation of the joints and of the bones, and the condition is termed "tubercular disease of the carpus or tarsus."

In the case of tubercular disease of the bones it is convenient for the sake of description to make a distinction between tubercular periostitis and tubercular osteomyelitis, although this cannot always be done, either clinically or pathologically, and ultimately the two conditions become associated as a tubercular periosteomyelitis.

Tubercular Periostitis.—The bone just beneath the periosteum is most frequently affected in the case of the ribs, sternum, skull, and the bones of the pelvis; the inflammation usually results in the formation of pus, with superficial caries of the bone. The pus breaks through the periosteum, and forms an abscess which often tracks down

the muscle sheaths. The earliest intimation of the disease may be the formation of such an abscess, and its connection with the bone is only recognized on operative interference or by means of radiography.

CLINICAL FEATURES.—There is some dull aching pain in the bone, but pain is not a prominent feature of the disease. The bone feels enlarged, and is a little tender; later, a soft fluctuating swelling appears over it. This finally involves the skin, which becomes thinned and blue, and the abscess bursts, leaving a sinus which leads down to the carious bone.

DIAGNOSIS.—The usual diagnosis has to be made from syphilis and other forms of chronic infection; but, before fluctuation can be detected, the chief difficulty lies in diagnosing the condition from periosteal sarcoma. Radiography helps in differentiating the two conditions, as, in the case of tubercle, there is usually a superficial erosion of the bone; while with many forms of sarcoma there is a fair amount of new bone formation. The general symptoms do not aid, as, with rapidly growing periosteal sarcoma, there are frequently nocturnal rises of temperature and general malaise. The final test is an exploratory operation, followed by microscopic and bacteriological examination of the diseased tissue.

Tubercular Osteomyelitis.—Tubercular disease of the centre of the bone is most common in the tarsus, carpus, tibia, femur, and other long bones, originating generally on the diaphysial side of the epiphysial line, but sometimes affecting the epiphysis itself. The inflammation leads, as a rule, to the formation of sequestra, and round the focus of tubercular infection there is usually a sclerosing osteitis, so that the whole bone becomes thickened and larger. The progressive enlargement of the bone may also occur from a diffuse tuberculous periosteomyelitis without any localized focus of disease.

Abscess formation—at first in the bones, and later, by bursting through the periosteum in the surrounding soft tissue—is common, and the clinical features of the disease are those of chronic abscess of bone. The *Diagnosis* from chronic abscess due to other organisms has to be made by the usual methods.

In those cases in which the bone involved forms part of a joint, the diagnosis is that of tubercular arthritis; and in the case of the vertebræ (Pott's disease) the diagnosis



FIG. 219.—NECROSIS OF THE UPPER AND LOWER EXTREMITIES OF THE FEMUR DUE TO TUBERCULOSIS.

(London Hospital Medical College Museum.)

before abscess formation is made by pain and rigidity of the spine. Radiography is a great help in early diagnosis before the periosteum is reached.

Treatment of Tuberculous Inflammation of Bone.—The early treatment consists of the usual *general* treatment of tuberculosis, combined with rest to the inflamed bone. The lower extremity must be relieved of the weight of the body, and the neighbouring joints should be kept at rest. The further treatment, if any is necessary, depends on the bone affected and the extent of the disease. If possible, as in the case of the ribs or fibula, the whole of the diseased portion of the bone should be resected; but in the case of the long bones generally, the abscess should be opened, any sequestra removed, the diseased bone scraped, and an attempt made to secure healing by the first intention.

Later, with sinus formation and secondary infection, extensive removal of bone, with drainage, becomes necessary, or it may be advisable to amputate the limb.

Tubercular Dactylitis.—Tubercular dactylitis is a diffuse, tubercular periosteomyelitis of the phalanges, metacarpal or metatarsal bones. It is almost entirely limited to children, and is frequently multiple. The condition often terminates in suppuration, and the whole of the bone may separate as a sequestrum.

CLINICAL FEATURES.—There is a painless, spindle-shaped swelling of one or more of the bones of the hand or foot, which causes little inconvenience. The disease may terminate at this stage, and recovery occur with a slightly thickened and perhaps a shortened bone, but more commonly the condition terminates in abscess formation, pointing usually on one side of the finger. The diagnosis has to be made from syphilitic dactylitis by the usual methods.

TREATMENT.—The usual conservative treatment of tuberculosis is carried out, and the diseased digit kept at rest on a splint for a period of six months. If abscess formation result, the abscess should be incised, all diseased bone removed, and an attempt made to get union by the first intention. In the case of a toe, amputation can be substituted for this local treatment, but every effort should be made to preserve a finger.



FIG. 220.—TUBERCULOSIS OF A PHALANX (TUBERCULAR DACTYLITIS).

SYPHILIS OF BONES

Inflammation of the bone, due to infection with the *Spirochaeta pallida*, occurs during the secondary and tertiary periods of syphilis, and in both the acquired and inherited varieties of the disease. In the acquired disease, the inflammation occurs generally

in the shaft of the bone, and not at the epiphysial junction, so that involvement of the neighbouring joint is not common. This is probably because at the period of life when the acquired disease is common, growth has almost or entirely ceased at the epiphysial junction, and union of the epiphysis and diaphysis has occurred. In infants with inherited syphilis the soft spongy bone at the epiphysial junction is frequently attacked.

Secondary Stage.—1. Wandering pains in the bones (osteocopic) worse at night, are a common feature of early secondary syphilis, and are probably due to ovanoscent periostitis. The bones are usually slightly tender, but no other physical signs can be made out, and the condition disappears under antisyphilitic treatment.

2. Later in the secondary stage localized subacute periostitis is not uncommon. The affection is chiefly met with in the tibia, and is mostly symmetrical. An inflammatory exudation is present beneath the periosteum, raising it from the bone, and a swelling, termed a "node," is present. Under antisyphilitic treatment this node will disappear by absorption of the inflammatory exudates, but the periosteum may lay down new bone, at first soft and vascular, and later dense and hard, so that the node becomes permanent. Suppuration does not occur.

CLINICALLY, the diagnosis is made by finding a tender swelling on the bone which is the seat of a boring pain, worse at night, and associated with other evidences of secondary syphilis.

The TREATMENT is antisyphilitic.

Tertiary Period.—In the tertiary period the bones may be the seat of a chronic inflammation, ending in gumma formation or in sclerosis, and the disease may chiefly affect the bone under the periosteum or the medulla. The bones principally affected are the skull, nasal bones, palate bones, tibia, and femur.

1. *Syphilitic Periostitis ending in Sclerosis.*—In this form, which is common in the tibia, the inflamed

FIG. 221.—SYPHILITIC PERIOSTITIS OF TIBIA.

periosteum leads to the formation of new bone, so that the bone becomes larger and denser, and exostoses are frequently present.

There is a dull aching pain in the bone, which is relieved by antisyphilitic treatment.

2. *Syphilitic Periostitis ending in Multiple Small Gummata.*—

This condition is most frequently met with in the skull-bones, and may affect the pericranium or the dura mater, or both. It is frequently widely diffused over the whole of the skull. The inflammation may be associated with some new formation of bone, but the main feature is the gradual erosion of the bone due to the breaking down of the gummata. This erosion often occurs on a large part of the skull, giving it a curious worm-eaten appearance. Necrosis of large pieces of bone may occur, and the skull become perforated. Later, the gummata reach the surface, and the skin gives way. Infection by other organisms occurs, and there are numerous sinuses in the scalp discharging foul pus and leading down to carious bone.

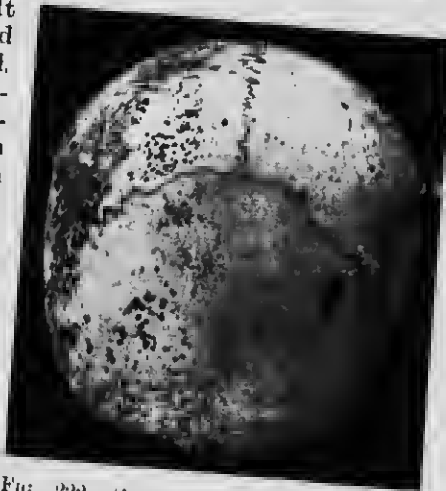


FIG. 222.—SYPHILITIC NECROSIS (WORM-EATEN) OF THE SKULL.
(London Hospital Medical College Museum.)

3. *Syphilitic Osteomyelitis ending in Sclerosis.*—This occurs in the long bones and in the bones of the skull, and is associated with severe aching pain. In the case of the skull, the bone becomes thicker and heavier, the diploë disappears, and the whole bone is of ivory density. The bloodvessels are obliterated and the veins are pressed upon; this accounts for the severe pain. Sclerosis may occur in one part of the bone at the same time that gumma formation is occurring in another.



FIG. 223.—SYPHILITIC NECROSIS OF THE SKULL.
(London Hospital Medical College Museum.)

4. *Syphilitic Osteomyelitis ending in Gumma Formation.*—Syphilitic inflammation of the medulla of bones ending in gumma formation occurs in the skull and long bones, and may be associated with the other forms of this disease.

There are frequently no signs of the disease until it affects the periosteum unless spontaneous fracture of the bone occurs. There is

usually a dull aching pain, and a radiogram may indicate rarefaction and sequestrum formation in the bone. When the periosteum is reached, a swelling forms on the bone, and later the skin becomes red and œdematous. If treatment is not carried out, the gumma bursts, and more or less extensive necrosis of the bone is found at the bottom of the sinus so formed, or an area of necrosed bone may be present in the floor of a large syphilitic ulcer. In the case of the skull-bones no involucrum is formed, and the separation of the sequestrum is very slow, taking months or years.

After the gumma has burst, secondary infection by pyogenic organisms is inevitable.

CLINICALLY, very few symptoms are present, and the patient may not seek medical advice until the gumma has burst.

Treatment of Syphilitic Inflammation of Bone.—In every case the antisyphilitic remedies, mercury or salvarsan and iodide of potassium, should be given, and frequently this is all that is necessary. In cases of sclerosis of bone with aching, boring pain, linear osteotomy may give relief, or in the case of the skull a piece of bone may be removed with a trephine. Necrosis of bone is treated on the usual lines of removal of the necrosed bone and antiseptic treatment of the wound. Mercury and iodides should continue to be given.

DISEASES OF THE BONES IN INHERITED SYPHILIS.—Inflammatory conditions of the bone, leading to osteosclerosis or gumma formation,

occur in the inherited or in the acquired disease, but special features may be present owing to the lesions occurring in growing and not in adult bones.



FIG. 224.—PARROTT'S NODES.
(London Hospital Medical College Museum.)

1. **Parrott's Nodes.**—These are bosses due to new bone formation following a periostitis of the bones round the anterior fontanelle—i.e., the two halves of the frontal bone and the parietal bones. Their presence causes a deformity of the skull known as the "hot cross-bun" or "natiform" skull. The newly formed bone is soft and spongy, and may be absorbed under antisyphilitic treatment; but if not it becomes hard and sclerosed.

and the deformity persists. The condition is not absolutely pathognomonic of syphilis. Other bones of the skull may show the same lesion.

2. **Mucoperiostitis of the Nasal Bones.**—A subacute inflammation of the nasal mucoperiosteum is a common disease in children with

inherited syphilis, and leads to a discharge from the nose and the symptom of "smuffles." If the inflammation continues, it leads to non-development or actual necrosis of the nasal bones, and the permanent deformity of "saddle-shaped nose."

3. **Syphilitic Osteochondritis.**—This lesion usually occurs during the first year of life, although it may appear later, and is a subacute inflammatory condition affecting the juxta-epiphysial bone, and spreading up the shaft under the periosteum. The inflammatory process may end in the formation of granulation tissue, and the epiphysis become spontaneously separated; or the bone may become infected with pyogenic organisms, and suppuration occur with discharge of the epiphysis as a sequestrum. The inflammation may end in sclerosis of the bone, leading to premature ossification of the epiphysial cartilage, and permanent shortening of the limb. If only part of the cartilage is affected, deformity may occur.

CLINICAL FEATURES.—The disease generally commences in the first six months of life, and the lesion is usually multiple and roughly symmetrical. The limbs are painful and tender, and as the child will not move them, they appear to be paretic (pseudo-paralysis). On examination, the bone at the epiphysial junction is found to be enlarged. The thickening extends for a variable distance up the shaft, the bone gradually becoming normal in size. If the epiphysis is loosened or suppuration occurs, the usual characteristic signs are present.

The **DIAGNOSIS** has to be made from rickets, and the principal diagnostic features are the age of the patient, the extension of the thickening along the shaft of the bone, and the presence of other symptoms of syphilis.

TREATMENT.—The treatment consists of giving the general anti-syphilitic remedies and careful splinting of the bones until the inflammation has subsided.



FIG. 225.—CRANIOTABES.

(London Hospital Medical College Museum.)

Craniotabes.—Craniotabes is a localized atrophy of the bone of the skull, which may continue until all the osseous tissue has been absorbed, and only the membrane of the bone is left. It is by no means pathognomonic of syphilis, but occurs in any wasting disease in children, and the localized patches of atrophy are in those places over which pressure occurs. The condition is therefore most common in the occipital and parietal bones. The diagnosis is made by finding a soft spot on the skull, which gives the sensation of crackling, like touching a stretched piece of parchment.

Curved Tibiæ.—This deformity generally becomes evident in syphilitic children about eight or nine years of age. It is due to an

inflammatory process leading to new formation of bone, so that the tibia increases in length. There is also new bone formation under the periosteum, and the new-formed soft bone tends to bend forward. The curve is antero-posterior, is most marked in the middle of the bone, and is partly due to bending and partly to the new bone formation.

Syphilitic Dactylitis.—This lesion affects the phalanges of the hand and foot and the metacarpal and metatarsal bones. Several

bones may be attacked about the same time, and the lesion is more common in inherited than acquired syphilis. The bone becomes swollen and painful, and the movements of the part are affected. The disease progresses slowly, but if untreated, a gumma forms, which may reach the skin and burst. Small fragments of bone will be discharged from the sinus. If treated early, complete recovery may result, but there may be permanent shortening of the finger.

The **DIAGNOSIS** from tubercular dactylitis is very difficult, but as a rule the disease is slower, and leads to more new formation of bone. The presence of a positive Wassermann reaction and the effect of anti-syphilitic treatment will make the diagnosis clear.

TREATMENT.—The treatment of all lesions of bone in inherited syphilis consists of giving general antisyphilitic treatment. If the bone affected is one of the bones of a limb, the limb should be put at rest on a splint.

Osteomyelitis Fibrosa.—

Osteomyelitis fibrosa is a chronic disease of bone, the cause of which is unknown.

It is most common in young subjects, and in the majority of cases is limited to one bone, but it may affect several.

PATHOLOGICAL ANATOMY.—The cancellous tissue of the bone is gradually absorbed, and its place taken by a vascular fibrous tissue.



FIG. 226.—CYST OF BONE.

in which cysts develop. These cysts have no endothelial lining, and giant cells are frequently found in their walls; these cells are probably associated with the absorption of the bone.

CLINICAL FEATURES.—The onset is painless, and frequently spontaneous fracture is the first symptom that attracts notice. In other cases there are vague pains, and the bone is found to be swollen or curved. The diagnosis can only be made by exploration or by radiography. In a radiogram clear areas are seen in the bone, instead of the usual appearance of the cancellous tissue.

TREATMENT.—The bone should be cut down upon, and all the diseased tissue removed with a sharp spoon, the cavity left being treated by one of the methods described on p. 489. In cases complicated by spontaneous fracture, amputation may be necessary. If the disease affects many bones, the only treatment consists of applying appropriate splints.

NEW GROWTHS OF BONE

The *Innocent* tumours of bone are osteoma, chondroma, and fibroma, and they have already been considered in the chapter on Tumours (p. 208).

The *Malignant* tumours of bone are divided into *primary* and *secondary*. Primary tumours are myeloma, sarcoma, and endothelioma, and the secondary are carcinoma and sarcoma.

Myeloma.—These tumours, sometimes called "myeloid sarcomata," are derived from the bone marrow, and their pathology has already been discussed in the chapter on Tumours (p. 208). The tumours grow most often from the medulla of the long bones near the ends, but occasionally they grow from the periosteum of the jawbones. The growth of the tumour leads to the absorption of the bone in the centre, and at the same time the periosteum lays down new bone, so that the bone becomes expanded. These tumours are very vascular and of a deep brown colour. On microscopical examination the tumour is found to consist of short spindle cells, and numerous giant cells containing many well-formed nuclei scattered through the cell. Spicules of new bone are sometimes found in the tumour, but bone destruction is the more prominent feature. In the more malignant tumours in which metastases are found, there are a large number of small round cells, and the condition is really one of sarcoma grafted on to a myeloma.

CLINICAL FEATURES.—The disease is most often met with between the ages of twenty and forty, and is most common in the upper end of the tibia, lower end of the femur, upper end of the humerus, and lower end of the radius. There is little pain in the early period of growth, and the first serious symptom of disease may be spontaneous fracture of the bone. In some cases the condition closely resembles tuberculosis of the neighbouring joint, and the differential diagnosis may only be made on X-ray examination, which shows absorption of the interior of the bone.

The first physical sign of the disease is expansion of the bone, and later the thin shell of bone that is left may crackle when pressed with the fingers (eggshell crackling).



FIG. 227.—MYELOMA OF THE LOWER END OF THE RADIUS.

These tumours as a rule do not form metastases.

TREATMENT.—In the early stages local removal is all that is necessary. The bone surrounding the tumour is divided, and the growth is then very thoroughly removed with a sharp spoon. Later, and especially if the bone is supported by a second bone, as in the case of the fibula and radius, the piece of the bone containing the tumour should be resected. Later still, when the tumour has burst through the periosteum, or spontaneous fracture has occurred, the limb should be amputated above the growth.

Myelomatosis (Myelopathic Albumosuria, Bruce Jones's Disease).—This condition is a pathological condition affecting several bones simultaneously. It

affects the red marrow of the vertebrae, ribs, and cranium, and brings about absorption of the cancellous and compact tissue of the bone. The new growth is soft and reddish in colour as a rule, but may be firm and greyish-yellow.

The disease usually occurs in middle life, and may last for years. Spontaneous fracture and distortion of the vertebral column frequently occur, but the condition remains limited to the skeleton, and there is no involvement of the lymphatic glands or spleen.

The bones are painful, and there is an intermittent pyrexia; the blood shows the changes of a profound anaemia, and at some period of the disease albumose is present in the urine (albumosuria).

Later the tumours in the bone may undergo sarcomatous degeneration, and secondary growth appear in the lymph glands and other organs. There is no treatment.

Sarcoma of Bone.—Sarcoma of bone may be of any type—round-celled, spindle-celled, or mixed-celled—but from the pathological

standpoint they can be divided into two groups: (1) Those in which the growth remains cellular; and (2) those in which adult tissues, bone, cartilage, and fibrous tissue appear in the ground substance of the tumour. The second class are named occurring in the adult tissue present, osteo-, chondro-, or fibro-sarcoma. As a rule the first group of cellular tumours are more vascular, more rapidly growing, and more malignant than the second. They invade the bone and destroy it, often without causing marked enlargement of it. In the second group it is in the older parts of the tumour that the secondary changes occur. In the case of bony change, the bone may appear as an irregular mass in the tumour or in spicules, or show a radiating fanlike arrangement. The last condition is most common in the periosteal sarcomata, the radiating arrangement of the spicules of bone being due to the ossification occurring round the bloodvessels that run from the periosteum to the bone.

Sarcoma of bone is chiefly found in the cancellous ends or under the periosteum of the long bones, especially the femur, tibia, radius, and humerus, or the "diploë" of the skull, in the pelvis, and in the jaw-bones. As a rule it is met with below the age of thirty, and is more common in males than females. In elderly people it frequently appears in bones which are affected with osteitis deformans.

These tumours are exceedingly malignant, especially the cellular periosteal growths. They rapidly cause metastases, usually in the lungs. Secondary growths in lymphatic glands are not uncommon.

CLINICAL FEATURES.—From the clinical standpoint sarcomata of the bone are divided into endosteal (central) sarcomata, periosteal sarcomata, and parosteal sarcomata.

Endosteal (Central) Sarcomata.—These tumours arise in the cancellous tissue of the bones, usually near the extremity, and gradually destroy the bone by replacing the osseous material with soft sarcomatous tissue. The periosteum is irritated by the growth as it



FIG. 228.—FRAMEWORK OF AN OSSIFYING SARCOMA OF THE FEMUR.
(London Hospital Medical College Museum.)

approaches it, and new bone being laid down, the bone appears to be expanded. The first symptom is usually pain in the bone, which is boring in character, and worse at night. It may, however, be entirely

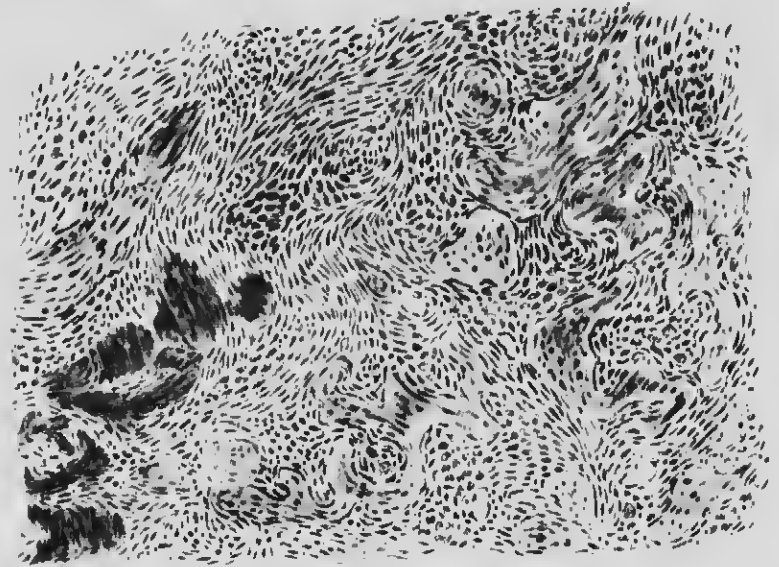


FIG. 229.—SECTION OF ENDOSTEAL SARCOMA.

absent, and spontaneous fracture or a swelling may be the first symptom noticed by the patient. In some cases the condition closely resembles tuberculous of the neighbouring joint.

As the bone is thinned by the central tumour, eggshell cracking may be present, and, later, when the tumour has burst through the periosteum, it becomes nodular. In the later stages it may not be possible to differentiate between endosteal and periosteal growths. Pulsation of the tumour is not uncommon. A bruit may be heard over it, and when the very vascular tumours penetrate the periosteum, there may be a sense of fluctuation. Very frequently the patient has a continuous increase of temperature, which may be as high as 102° F., and hectic in type.

An X-ray photograph will show the interior of the bone has been destroyed, and that it is more pervious to the rays than normal. On the whole, central sarcomata are less malignant than periosteal.

Periosteal Sarcomata.—These neoplasms grow from the osteogenic layer of the periosteum, and lie between the bone and that membrane which frequently forms a pseudo-capsule for them. They are more liable to secondary changes than the endosteal growths, but may be purely cellular, and are then exceedingly malignant. The more marked the secondary changes, the less malignant are the growths, and the more slowly growing.

Pain is an early symptom as a rule. The growth first shows itself as a spindle-shaped swelling surrounding the bone if it is in the middle of the shaft, or as a pyriform swelling if it is near the extremity. The swelling gradually shades off into the normal bone, and may be localized on one side of the bone only. Spontaneous fracture may occur after the bone is eroded, but is a late symptom of the periosteal growths. The skin over the tumour is usually very vascular, and there may be a well-marked local rise of temperature. A general rise of temperature may also be found with periosteal growths.

An X-ray photograph may show the outline of the tumour.



FIG. 230.—PERIOSTEAL SARCOMA OF FEMUR.

and if secondary bony changes are present, they may be seen, and give the photograph a characteristic appearance. In a soft vascular tumour fluctuation may be present. The diagnosis from inflammatory conditions may then only be possible on exploratory operation and microscopic examination of the tumour. Enlargement of the nearest set of lymphatic glands is not uncommon.

Treatment of Endosteal and Periosteal Sarcomata.—In considering the treatment of these sarcomata of bone, it must be remembered that whatever treatment is adopted, the prognosis is bad. This has led some surgeons in recent years to modify the orthodox treatment of

amputation at the earliest possible moment after the diagnosis has been made. This treatment, however, is still the one most generally accepted. The amputation should be performed through or above



FIG. 231. RADIOGRAM OF AN OSSIFYING SARCOMA.

the joint above the tumour, and it is usually best to remove the lymphatic glands at the same time. If the growth has already invaded the surrounding soft parts, they should be very freely removed. Metastases, especially in the lungs, are more common than local recurrence.

The proposed modifications of this treatment are—

1. That local resection only of the growth and bone should be done, as this is all that is necessary in the less malignant growths, and in the highly malignant growths recurrence is certain even if a high amputation is performed.
2. That an enucleation of the tumour should be performed, and then a three months' course of X-ray treatment given.
3. That Coley's fluid should first of all be given a three weeks' trial, and if the tumour gets smaller in this time, the injections should be continued. This method is advocated by Coley on the grounds that cures have followed the use of his fluid, and that these tumours are so fatal that the loss of three weeks of time would make no differ-

ence to the prognosis. If after a three weeks' course of injections there is no improvement, amputation is performed as a last resource.

In inoperable cases Coley's fluid should be given a trial.

Parosteal Sarcomata. These neoplasms arise from the fibrous layer of the periosteum and grow into the surrounding soft tissue and only invade the bone later. They are usually spindle celled in type



FIG. 232. SECONDARY CARCINOMA OF THE HUMERUS.

and are less malignant than either the endosteal or periosteal growths. They do not cause spontaneous fracture. They appear as solid nodular growths growing from one aspect of and firmly attached to the bone.

TREATMENT. In the early stages these tumours are readily detached from the bone, leaving an apparently healthy surface of

bone. If this treatment is carried out, however, recurrence is inevitable. The case should therefore be treated in the same manner as the other forms of sarcoma of bone, and high amputation carried out as soon as possible.

Secondary Sarcomata in bone are rarer than secondary carcinomata, but are not uncommon. They are usually central in position, and lead to spontaneous fracture, but are of little clinical importance, as no treatment can be carried out except under most exceptional circumstances.

Pulsating Hæmatoma of Bone (Osteo-Aneurysm).—Two distinct conditions have been included under these terms. In the first place, they have been used to describe plexiform angiomas which have invaded the bones.

These tumours are most common in the skull, and consist of a new formation of arteries and veins, which steadily increases, leading to erosion of the bone and eggshell crackling.

The only treatment is ligation of the supplying arteries, and is most unsatisfactory.

The terms have also been used to describe an entirely different condition of which the exact pathology is uncertain, but which is probably hæmorrhage occurring into a sarcoma or endothelioma of bone. The common situation of the tumour is the upper end of the tibia or the lower end of the femur. The clinical features are the appearance of a slowly growing cystic tumour of the bone, with pulsation and eggshell crackling, or the occurrence of a spontaneous fracture.

TREATMENT.—Amputation should be carried out as for other malignant tumours of bone.

Secondary Carcinoma of Bone.—Secondary carcinomatous growths are common in bones, especially after carcinoma of the breast in women, or of the prostate in men. The growths occur usually in the medulla of the bone, and lead to spontaneous fracture, so that in every case of spontaneous fracture occurring in an elderly person a search for a primary focus of carcinoma should be made. The condition presents itself in two forms—as a localized endosteal tumour with a certain amount of new bone formation from the periosteum, or as a diffuse carcinomatosis affecting several bones at the same time, causing multiple spontaneous fractures, or leading to bending of the bones. This condition has been termed "osteomalacia carcinomatosa." In cases of spontaneous fracture due to secondary carcinoma, union of the fracture may take place, but it never occurs in fracture due to primary sarcoma of the bone.

TREATMENT.—If the primary growth has been removed and has not recurred locally, and there is no evidence of metastases in any other part of the body, it may be justifiable to amputate a limb; but in the great majority of cases there is no treatment for carcinoma of bones.

Thyroid Carcinoma of Bones.—Secondary tumours of thyroid tissue are not uncommon in the bones of the skull. These tumours fre-

quently pulsate, and on microscopical examination, closely resemble normal thyroid tissue. The primary growth in the thyroid gland may be very small, and have all the clinical characteristics of a simple tumour.

Carcinoma of Bone due to Direct Extension.—The carcinomatous tumours most frequently invading the bone are the squamous-celled carcinomata of the mouth and nose. The tumour first becomes adherent to the bone, then invades it, causing necrosis of small pieces of bone. These malignant ulcers have usually a very foul and copious discharge.

TREATMENT.—In a few cases a radical extirpation may be tried, but the majority of cases are inoperable.

CYSTS OF BONE

Cysts occurring in bones are usually due to the breaking down of a neoplasm, such as a chondroma, sarcoma, or endothelioma, or to osteomyelitis fibrosa. The diagnosis and treatment of these conditions have already been described. The only other cysts to be considered are hydatid cysts.

Hydatid Cysts of Bone.—Hydatid cysts are rare in bones, and are most frequently seen in the medulla of the long bones. The type of the disease is exogenous cyst formation, so that there are multiple cysts in the bone without a mother enveloping cyst (*Echinococcus multilocularis*). The condition is usually first diagnosed on exploration after a spontaneous fracture has occurred, but it may be possible to make the diagnosis by radiography.

TREATMENT.—The cysts must either be extirpated or amputation performed.

GENERAL DISEASES ASSOCIATED WITH BONE LESIONS

Rickets.—Rickets is a general disease of malnutrition occurring in children, the exact cause of which is unknown. The following theories have been held as to the cause: (1) Fœtal in origin; (2) inherited weakness; (3) due to bad feeding, either too little fat or too little protein, or excess of carbohydrates; (4) due to overfeeding generally; (5) due to auto-intoxication from the alimentary canal; (6) due to want of exercise; (7) due to an infective organism; (8) defects in an internal secretion, probably that of the pituitary gland.

ETIOLOGY.—Rickets is most common between the ages of eighteen months and three years, although it may occur later. It is more common amongst the poor than the well-to-do, and more common in town children than country. The disease certainly is much more frequent in children who are artificially fed than in children who are suckled, although if suckling is prolonged for more than a year the disease is apt to occur. Amongst the artificially-fed the condition is more common in those children who are given patent foods and foods containing starch than those fed on properly modified cow's milk.

Next to improper food, bad hygienic surroundings, want of fresh

air and sunshine, and lack of exercise seem to be the most important predisposing causes.

Rickets may, however, occur in children who are apparently properly fed and live under excellent hygienic conditions.

CHANGES IN THE BONES IN RICKETS.—The pathological changes in the bones occurring in rickets may be summed up as follows: "There is an excessive preparation for the formation of bone and a



FIG. 233. — LOWER END OF THE FEMUR IN SECTION, SHOWING BROADENING AND IRREGULARITY OF THE EPHYSAL LINE DUE TO RICKETS.

defective fulfilment," and this occurs both at the epiphysal junction and under the periosteum. The normal narrow line of the epiphysal cartilage becomes broadened and irregular, and the zone of calcification is increased. The irruption of bloodvessels into the calcified cartilage is irregular and greater than normal, so that the part is excessively vascular and the Howship's lacunae are longer and more abundant than usual. The number of osteoblasts is diminished, ossification is therefore defective, and the bone laid down is soft and spongy. Similar variations from the normal occur in the bone laid down by the periosteum, which is therefore more vascular than in healthy bone, and as a consequence the whole bone is soft, spongy, and vascular, but is larger than normal, especially at the epiphysal junction. Later, when the active stage of the disease is over, the increased vascularity may lead to osteosclerosis, the bones of adults who have suffered from rickets being denser and harder than normal bone.

Defective development of the length of the bone may occur, so that the subjects of the disease are usually stunted in growth, or may even be dwarfs; but this is not constant, and a rickety patient may be abnormally tall.

As a result of the bones being soft and vascular, they bend under the weight of the body and the pull of the muscles, and various deformities occur, which are either exaggerations of the normal curves of the bones or due to some abnormal attitude adopted by the patient when sitting or standing (see Fig. 277).

CLINICAL FEATURES.—The child becomes irritable and restless, sweats profusely when asleep, especially about the head, and the bones appear to be tender. The appetite is lost, and the child suffers from constipation or diarrhoea and flatulency. It may lose weight, although many of the children remain fat, but the muscles are weak and flabby. Rickety children are subject to bronchitis and bronchopneumonia, and have little power of resistance against the infectious diseases.

On examination, the child is found to be anemic, with flabby muscles, disinclined to move, and crying when handled.

The abdomen is protuberant and hyper-resonant, and the liver and spleen are enlarged.

Head.—The head is large and square-shaped, with exaggeration of the frontal eminences. The fontanelles remain open longer and are larger than normal, and craniotabes may be present. The face appears small by contrast with the enlarged head; the eruption of the teeth is delayed, and they decay early.

Chest.—There is swelling due to excessive bone production at the costo-chondral junctions forming the *rickety rosary*, and if the child has suffered from broncho-pneumonia or some other cause for defective air entry into the lungs, characteristic deformities may be present. The most common of these is a pushing forward of the sternum and its cartilages, forming "pigeon breast," or the formation of a furrow running round the chest at the level of the attachment of the diaphragm (Harrison's sulcus).

Pelvis.—The pelvis may become contracted in all its diameters ("small round pelvis"), or it may be mainly contracted in its sagittal plane ("flat pelvis"); while in the more exaggerated cases, if the patient has been allowed to walk, the acetabula are pushed in and the symphysis pubes become prominent, forming a triradiate pelvis (see Fig. 238).

Spine.—If a child with rickets has been kept lying flat during the active period of the disease, the curves of the spine are less prominent than usual and the back is flat; but if he has been allowed to sit up, the normal dorsal curve becomes exaggerated and rickety kyphosis is present. This kyphosis, when excessive, becomes almost angular, and there may be considerable difficulty in differentiating it from the angular curve of Pott's disease. If the child has been allowed to sit on a seat that is not horizontal, as is the case when he is carried on one arm, scoliosis may develop; this may become exaggerated as he grows older and increases in weight.

Femur.—The common deformities in the femur are increase of the normal antero-posterior curve, coxa vara, and genu valgum (see Deformities, p. 269).

Tibia.—The usual deformity in the tibia is a curve inward, most marked in the upper third, producing the condition of "bow-legs"; but a curve almost equally common is an antero-posterior curve in the lower third, partly due to the backward pull of the tendo Achillis, and partly to the weight of the foot when the child is sat on a chair with feet projecting just beyond the edge of the seat.



FIG. 234.—TIBIA (SABRE SHAPE) FROM A CASE OF RICKETS. (London Hospital Medical College Museum.)

Feet.—The weakness of the musculature and the laxity of the ligaments leads to flat-foot if the child is allowed to walk during the active stage of rickets.

Upper Extremity.—The curves of the clavicle are exaggerated, and the increase in the size of the bone at the epiphysial junction is usually

well marked at the lower end of the radius; but deformity in the upper extremity is not common unless the child has been allowed to crawl during the active stage of the disease. In these cases there may be well-marked bowing of the humerus and the bones of the forearm, so that they somewhat resemble the forelegs of a hullo dog.

All the bones of the skeleton are liable to fracture from slight causes, and separation of the epiphysis is more common than in normal children.

PROGNOSIS.—If there are no complications, recovery always occurs, but is seldom complete before six months. The disease may last for years. To some extent the deformities tend to disappear, but they may become exaggerated as growth proceeds, especially genu valgum, scoliosis, and flat-foot.

TREATMENT.—The following directions should be given as to the general management of the patient: The child should sleep in a bed



FIG. 235.—SKELETON SHOWING THE DEFORMITIES ASSOCIATED WITH SEVERE RICKETS.

by itself, and the window of the room should be opened at the top. At least once a day—and better twice—the child should be taken out, and the more time it spends in the open air the better. The clothing should be made of flannel, and be light and warm so as to allow free use of

the limbs, and every care taken to prevent the chance of lung complications occurring. The child should always sleep for two or three hours in the middle of the day. The bowels should be carefully regulated, and the child bathed in warm water morning and evening.

Diet.—If the child is under eight months old, the best diet is its mother's milk, and if this cannot be given, cow's milk is the best substitute; it should be diluted with boiled water or barley water, and a small quantity of white sugar added. If the child has rickets, fresh cream should also be added to the milk. After eight months the diet should largely consist of cow's milk, to which should be added risks and nursery biscuits, a little stale bread with plenty of butter, dripping, or lard fat. When the child is a year old, the following may be added to the dietary: Plain milk pudding, lightly boiled eggs, meat gravy, or a little underdone scraped meat. The following articles of diet should *not* be given: Buns, biscuits, cakes, pastry, sweets, patent foods, or condensed milk. The meals should be given at regular times, and nothing should be eaten between meals. Tea and coffee are unnecessary and even harmful to children.

Drugs.—There is no specific drug treatment for rickets. Cod-liver oil should be given in drachm doses two or three times a day, but it owes its value to being an easily assimilated fat. Phosphorus and iron may also be given with advantage.

Prevention of Deformities—Lower Limbs.—The deformities that occur in the lower limbs are due entirely to the assumption of habitual postures and to the weight of the body when walking. A child with rickets should therefore, as far as possible, be kept lying down, and not allowed to sit with the legs folded. A useful method of treatment is to provide a shallow wickerwork tray, in which a firm mattress is placed, and to keep the child in this. The tray is easily carried in the open air, and the child is allowed freedom of the limbs without the injurious effect of the weight of the body. This method of treatment also prevents development of rachitic curves in the *spine* and deformities of the *pelvis*.

Upper Limbs.—The deformities in the upper limbs result from the child crawling, and this must be prevented.

Chest.—Deformities of the chest follow imperfect entry of air into the lungs, and any obstruction to respiration, such as adenoids, should receive appropriate treatment.

Head.—No treatment can prevent the development of deformities of the skull, but they are unimportant.

The treatment of the deformities associated with rickets are considered in the chapter on Deformities, p. 269.

Late Rickets.—Two conditions have been described under this term, one being a recrudescence of early rickets occurring at puberty, and the other the onset of this disease between the ages of ten and eighteen. The term should be reserved for the latter condition.

The disease occurs about the age of puberty in children who are living in bad hygienic surroundings and are subject to excessive strain,

mental or physical. Diet does not appear to be so important as in the rickets of early life.

The pathological changes that occur in the bones are precisely similar to those in early rickets, and are chiefly marked in the juxta-epiphysial bone, and the deformities resulting from the softened bones also resemble those met with in the infantile disease.

The general symptoms are headache, malaise, and anæmia; the patient complains of being easily tired and of aching pains in the regions of the joints.

On examination, the bones near the epiphysial cartilages are enlarged, and deformities are commencing to appear. The common deformities met with are in the lower extremity, such as coxa vara and genu valgum; but it is probable that the disease plays a large part in the production of the adolescent form of scoliosis.

PROGNOSIS.—The patient always recovers, but the deformities are persistent and often progressive; the course of the disease is slow.

TREATMENT.—The treatment consists of careful attention to the general health and the hygienic surroundings of the patient. As the deformities are chiefly found in the lower extremity, and are due to a disproportion between the weight of the body and the weight-bearing capacity of the limbs, the patient must be given periods of recumbency during the day, as well as a long night's rest. Splints and other apparatus may be necessary to correct deformity already present.

Later, osteotomies may be necessary.

Scurvy Rickets or Infantile Scurvy.—This condition is scurvy occurring in a child with rickets, and is met with chiefly in artificially-fed children, whose diet has been prepared with excessive care. The child has usually been fed on one of the better proprietary foods with the directions carefully carried out, or on milk that has been thoroughly sterilized.

SYMPTOMS.—The child, which has the ordinary symptoms of mild rickets, becomes anæmic, irritable, and wastes. The actual onset of the disease may appear to be sudden, and the patient becomes acutely ill with a temperature of 100° to 102° F. The limbs are found to be very tender, and there is often a pseudo-paresis. The gums bleed readily, and subcutaneous hæmorrhage, hæmaturia, blood-stained diarrhœa, or epistaxis may be present.

On examination, some of the bones—especially the lower end of the femur—are enlarged near the epiphysial cartilages, and the skin over them becomes œdematous and shiny; this is due to extravasation of blood between the periosteum and the bone. Later, the periosteum may lay down new bone, and the condition become evident on X-ray examination.

Spontaneous separation of one or more epiphyses may occur. The condition is most readily mistaken for tubercular disease of the joints, syphilitic osteochondritis, rickets, and Henoch's purpura.

TREATMENT.—The diet should at once be altered, the most important alteration being the giving of plenty of clean, fresh cow's milk, or providing a wet nurse for the child.

Three to six teaspoonfuls of orange or lemon juice should be given each day, and older children can be given potatoes and small quantities of green vegetables. Under this treatment the symptoms of scurvy will soon disappear, but the treatment for the rickets must be continued.

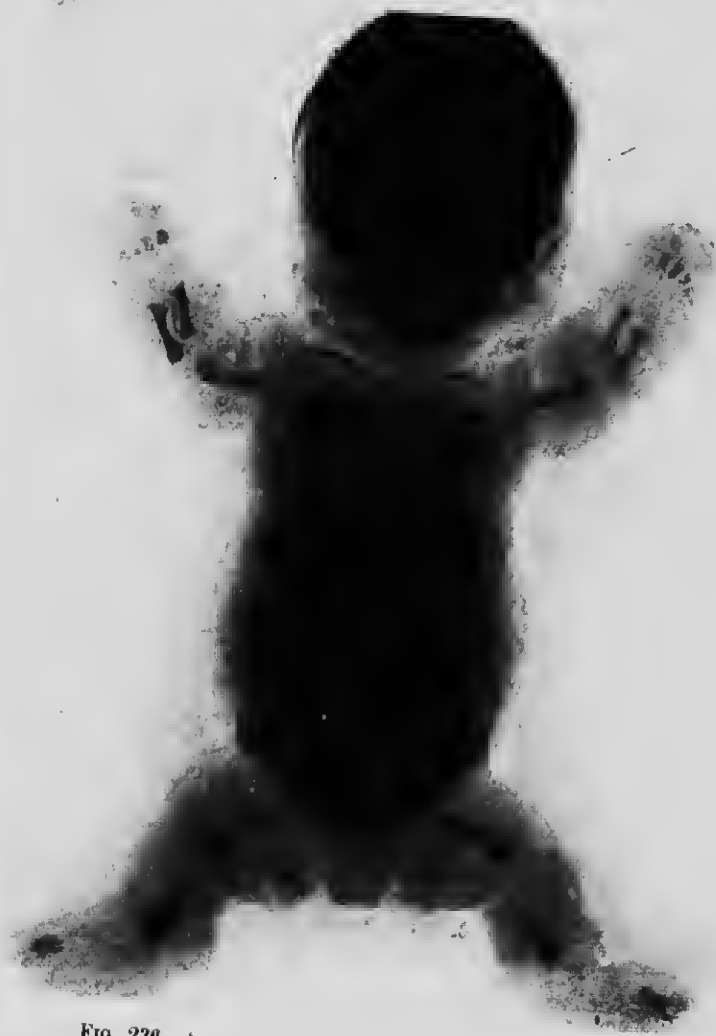


FIG. 236.—SKIAGRAM OF INFANT WITH ACHONDROPLASIA.

The child must be kept at rest, and the affected limbs should be wrapped in cotton-wool. If there is danger of separation of the epiphysis, or if this has actually occurred, the part should be carefully splinted.

Achondroplasia (Chondro-Dystrophia Foetalis—Foetal Rickets).—This is a congenital condition, the cause of which is unknown, and

results in a stunted form of growth, so that the patients, if they survive, form one of the varieties of dwarfs.

The condition is obvious at birth, the patient presenting the following characteristics: The skull appears to be large, overlapping the face, but on measurement is found to be of normal size. The apparent largeness is due to a shortening of the bones of the base of the skull due to premature synostosis of the basi-sphenoid and basi-occipital bones, so that there is a well-marked depression at the base of the nose. The trunk is normal in size, but the arms are short, so that instead of reaching down to the middle of the thigh they may not reach below the iliac crests. The lower extremities are also short, and this,

combined with the normal length of the trunk, causes the child to appear much shorter on standing than sitting. If the child survives, the intellectual and sexual powers appear to be normal, and the secondary sexual characteristics are assumed at puberty. The limb bones are also slightly deformed, but not markedly so; the chief deformity in adults beside the general dwarfing is lordosis.

The *pathological changes* in the bone are chiefly seen at the epiphysial lines. The cartilage is increased in size, and in some places is softened, whilst in others it is irregularly calcified; the columns of cartilage cells are defective or even absent, and the cells themselves small and irregularly arranged. Ossification is extremely irregular. There is no treatment.

Osteogenesis Imperfecta (Fragilitas Ossium or Congenital Osteopsathyrosis).—This is a congenital condition often occurring in families, the cause of which is unknown.

The skeleton in this condition is excessively brittle, so that prenatal and obstetrical fractures are common. After birth the tendency still continues, so that a patient may have sustained over a hundred fractures of the bones from slight causes.

On examination of the skeleton, it is found that ossification of the calcified cartilage at the epiphysial junction and under the periosteum is defective, and that the

FIG. 237. — SKELETON OF ACHONDROPLASIA.

(London Hospital Medical College Museum.)

amount of compact bone is diminished. The skull-bones also participate in the disease, and there may be large areas of the vault of the skull in which ossification has not occurred.

Union of the fractures usually occurs, but deformity is common owing to the number of fractures sustained.

TREATMENT.—There is nothing to be done except to protect the child from injury. The individual fractures are treated in the usual way.

Osteomalacia.—Osteomalacia is an acquired disease of unknown origin, chiefly affecting pregnant women, but occurring also in women who are not pregnant, and in men (8 per cent.).

The disease is most common in certain localities in Germany and Switzerland. Cases in England are very rare. According to some authorities, the disease is, like rickets, a general disease of malnutrition, differing only in that it develops when the patient has an adult skeleton. Other authorities consider it due to loss of secretion or hypersecretion of one of the ductless glands, particularly the ovary.



FIG. 238.—PELVIS OF A CASE OF OSTEOMALACIA.
(London Hospital Medical College Museum.)

PATHOLOGY.—The bones usually affected first in pregnant women are the pelvic bones and the lumbar vertebræ, and the disease may be limited to these bones or spread to the rest of the skeleton. In non-pregnant women and men the thorax and vertebræ are first attacked. The lime-salts in the bones are first absorbed, so that the organic framework only is left, and this absorption begins in the periphery of the bone and spreads to the centre. The bone marrow becomes excessively vascular, and hæmorrhages into it are common, and sometimes cysts filled with brownish fluid form. As a consequence of the loss of the bone-salts, the bones become soft, and bend readily under the weight of the body and the pull of the muscles. The pelvis becomes triradiate from the inward thrust of the femora, and lordosis and scoliosis are common deformities of the spine. Spontaneous fracture may also occur, and the bones may be so soft that after death they can be readily cut with a knife or squeezed like a sponge. The skull-bones may also be affected.

CLINICAL FEATURES.—The patient, who is usually pregnant or is lactating, complains first of shooting pains in the limbs, aching of the back, and inability to sit up without pain. The knee-jerks are commonly increased; an excess of lime-salts is present in the urine. The further development of the case is wasting of the patient, and the production of various deformities due to the softening of the bones.

PROGNOSIS.—Some cases rapidly recover, especially if the pregnancy is terminated, but it is liable to recur with successive pregnancies. In other cases the disease is steadily progressive, and this is



FIG. 239.—FEMUR FROM A CASE OF OSTEITIS DEFORMANS.



FIG. 240.—OSTEITIS DEFORMANS.

the usual course. Recovery is associated with fresh deposition of the lime-salts in the bone, but the deformities are permanent.

TREATMENT.—The patient, if suckling, should wean the child, and should be placed under good hygienic conditions with plenty of good food. The following drugs may be administered, but none are specific: Cod-liver oil, iron, arsenic, phosphorus, and lime. Morphia may be necessary on account of pain.

If the patient is pregnant, the pregnancy may be terminated both in hope of curing the disease and preventing the necessity for Cæsarian section later.

In some cases removal of both ovaries has cured the disease, and this can be recommended in non-pregnant women. If Cæsarian section is necessary for parturition, the ovaries may be removed at the same time.

Osteitis Deformans.—

The cause of this disease is unknown, but it is generally accepted as being a chronic inflammatory condition of all the bones of the skeleton.

PATHOLOGICAL ANATOMY.—In the early stages of the disease bone destruction is the most prominent feature, so that the bones become softer and more vascular, and bend under the weight of the body. The natural curves of the femora and tibiæ are exaggerated, and the dorsal curve of the spine becomes greater, so that the patient has well-marked kyphosis. Later in the disease this inflammatory condition ceases to cause destruction of the bone, and new formation of bone takes its place both under the periosteum and in the medulla. As a consequence, the bones become larger, denser, and roughened from new deposits under the periosteum. The skull-bones become thicker and denser, and the distinction between the tables and the diploë is lost. The curve in the bones becomes fixed as the bone gets denser, and there may be actual increase in the length of the individual bones. The patient, however, becomes shorter from the increased curving of the spine, and the degeneration of the intervertebral discs. The joints of the



FIG. 241.—OSTEITIS DEFORMANS, SHOWING LARGE SKULL AND KYPHOSIS.

spine and ribs become fixed, so that the thorax moves as a whole, and respiration is impeded.

CLINICAL FEATURES.—The patients are usually over fifty, and the disease is more common in men than women. The first symptoms may be dull aching pains in the bones, but not infrequently it is the steady increase in the size of the head, necessitating the wearing of larger and larger hats, that first attracts the patient's attention. When the disease is advanced the appearance is characteristic. The back is bowed forwards, and the large head carried pushed forward; the legs are curved forwards and outwards, and the arms have the appearance of being longer than normal, owing to the bent back. The chest moves badly,



FIG. 242.—ACROMEGALY.

the spine is stiff, and on examination it is found that the bones generally are enlarged. Wasting of the muscles occurs as the patient gets older, and the shape and size of the bones are plainly seen.

PROGNOSIS.—This disease interferes little with the general health, and the patient usually dies of some intercurrent disease. This is generally some inflammatory condition of the lungs, such as bronchitis or pneumonia, owing to the difficulty of expanding the chest. An undue proportion of the cases, however, develop sarcoma of bone.

TREATMENT.—There is no treatment.

Acromegaly.—Acromegaly is a general disease, with affection of some of the bones of the skeleton, believed to be due to some abnormality of the secretion of the pituitary body. In some cases the pituitary body has actually been the seat of tumour formation, such as endothelioma; in others, the gland has been enlarged and apparently hypersecretory; in others, again, no anatomical change has been found in the gland, but it is possible that the secretion may be increased or diminished without gross anatomical defects being present.

CLINICAL FEATURES.—The disease most frequently commences in young adults, and is slow in progress, the patient sometimes living over twenty years. The most obvious changes are—(1) Enlargement of the hands and feet, chiefly due to hypertrophy of the soft parts, but associated with increase in the size of the bones, and osteophytic outgrowths of their articular ends; the skin, nails, and hair are unaffected; (2) enlargement of the jawbones, both upper and lower, but especially the latter, which projects forward, and is coarse and heavy;

(3) increase in thickness of the nose, ears, eyelids, lower lip, and tip of the tongue. In some cases there is also general enlargement of the skeleton and body, and many so-called "giants" that are exhibited are examples of this disease. Besides these changes in the body, there is often evidence of a cerebral tumour. The patient becomes dull and apathetic, there is frequently persistent headache, and optic atrophy may occur from pressure of the pituitary tumour on the optic chiasma. In both sexes there is loss of sexual power, and females have amenorrhœa.

DIAGNOSIS.—This has to be made from myxœdema, astero-arthritis, and osteitis deformans.

PROGNOSIS.—The disease is fatal from a steadily increasing œdema, but the patient may live and follow his occupation for many years.

TREATMENT.—There is no medical treatment for this disease. Attempts at operation on the pituitary body have been made.

Hypertrophic Pulmonary Osteo-Arthropathy.—This condition in the majority of cases arises in connection with a chronic infective disease of the lung, such as empyema, bronchiectasis, and tuberculosis; but it may be due to other causes associated with chronic infective intoxication. The affection of the bones is a chronic periostitis chiefly of the phalanges and metatarsal and metacarpal bones, with a deposit of new bone along the shaft. The radius and ulna and other long bones may be affected, and there is a chronic effusion into the neighbouring joints. The condition is chiefly characterized by the appearance of the fingers and toes. The ends of the fingers become bulbous, partly due to an increase of the soft tissue, and partly to a deposit of new bone in the terminal phalanx. The nails are convex, and may be curved at their free ends towards the palm of the hand or sole of the foot.

TREATMENT.—The treatment is that of the cause which predisposes to the condition.



FIG. 243.—FEET OF A CASE OF ACROMEGALY.

CHAPTER XVI

INJURIES OF JOINTS—DISLOCATIONS

INJURIES OF JOINTS

Sprains.—A sprain is the result of sudden violence applied to a joint. Two factors go towards its production—(1) The joint surfaces are temporarily separated from each other; (2) the ligaments, tendons, muscles, and fasciæ round the joint are lacerated to a more or less degree, depending upon the severity of the sprain. The result is an attack of acute non-infective synovitis, with effusion of serum into the joint cavity, and an effusion of blood round and often into the joint. Repair takes place by the formation of fibrous tissue, which may cripple the movements of the joint by matting the surrounding tissues together, or by forming adhesions inside the joint itself. In the majority of cases a simple sprain will be completely recovered from; but in certain cases, especially in patients who have an inherited or an acquired tendency to joint diseases, as gout or rheumatism, a slight sprain may be followed by severe disability, and result in osteo-arthritis. Tubercular infection of the joint may also follow a sprain, particularly in children.

TREATMENT.—The treatment of a sprain is directed to limiting the amount of hæmorrhage and effusion, so that a minimum amount of damage shall be done, and to preventing the formation of an excess of fibrous tissue beyond that needed in the repair of the tissue. Directly the accident is sustained, the hæmorrhage is checked and effusion limited by the application of cold, either by means of an ice-bag or a cold-water handage. As soon as the part ceases to swell and the skin is dull and wrinkled, the maximum amount of benefit has been produced, and the joint should be firmly strapped in order to bring about the absorption of inflammatory exudates by pressure. The strapping should be removed daily, the limb massaged, and passive and active movements of the joint carried out. Later, if any stiffness results, adhesions may have to be broken down under anæsthesia, and the various forms of bath treatment may be tried.

Splints should only be used in the treatment of sprains if the ligaments of the joint are badly torn, and they should be dispensed with as soon as possible. Immovable splints of plaster of Paris, etc., should never be applied.

Wounds of Joints.—A wound of a joint is recognized by the escape of synovial fluid, which appears as drops of an oily fluid floating in

the blood. If the diagnosis is not obvious, no attempt should be made to discover if the synovial cavity has been penetrated until the surgeon's hands and the surrounding skin of the patient have been rendered aseptic, and the surgeon is prepared to do whatever is necessary for the treatment of the case.

1. **Punctured Wounds**, such as are caused by falling on a nail, should be treated expectantly. The joint is put at rest by means of the application of a splint in the best possible position for ankylosis, and, as the accident is always followed by an acute synovitis, the usual treatment of that condition should be carried out, and if there is much fluid the joint should be aspirated. The temperature and the local condition must be carefully watched, and at the first suspicion of suppuration the joint, after being explored with a needle, should be opened and drained if pus is present.

2. **Lacerated Wounds**.—The patient should be given an anæsthetic, and the surrounding skin rendered sterile. The wound should be cleaned from obvious dirt, and the extent of the laceration of the synovial membrane ascertained. If necessary, the opening into the joint should be enlarged, and the whole joint cavity washed out with a weak antiseptic solution, the limb being moved as this is done, so that all parts of the cavity are thoroughly cleaned. A drainage-tube should be introduced into as dependent a part as possible, and the wound in the capsule stitched up, unless it is much soiled, when it had better be left open and the wound plugged with gauze. The edges of the skin are approximated, and an aseptic dressing applied. The limb is placed at rest on a suitable splint. The tube is removed in forty-eight hours. As soon as healing has occurred and the stitches have been removed, massage and passive movements are commenced. Should suppuration follow, the case must be treated like other cases of suppurative arthritis.

3. **Lacerated Wounds, with Injury to Bones or Dislocation**.—In these cases the first question to decide is that of primary amputation. Amputation should be advised in all cases of compound fracture into a joint, if the patient is aged or broken down in health, and in all cases where there is much contusion and laceration, with comminution of the bones. In young, healthy subjects resection of the articular surfaces of the bones and careful aseptic treatment may save a limb which at first seems hopelessly injured, and amputation can always be done subsequently, if necessary. If it is decided to try to save the limb, all splinters of bone, etc., must be removed, and the case treated like a simple lacerated joint.

DISLOCATIONS

DEFINITIONS.—A dislocation is a permanent, abnormal, total, or partial displacement from each other of the articular portions of the bones entering into the formation of a joint. The following varieties of dislocations are recognized:

Compound Dislocations occur when a wound of the soft parts places the outer air in communication with the joint cavity.

Complicated Dislocations are dislocations in which there are also injuries to important nerves, bloodvessels, or integuments.

Complete Dislocation occurs if the joint surfaces are so displaced that they no longer touch each other, or touch only by their edges. If the displacement is less than this, it is called an *incomplete dislocation* or a *subluxation*. When a single bone, forming joints on both sides of the body, such as the lower jaw, suffers dislocation of both joints, the dislocation is said to be *double*, or *bilateral*.

Traumatic Dislocations are produced by external violence or muscular action, or both together, acting upon a healthy joint.

Congenital Dislocations are those in which the displacement occurs during intra-uterine life, presumably the result of defective development.

Obstetrical Dislocations are those produced during delivery, and are a variety of traumatic dislocations.

Spontaneous or Pathological Dislocations are produced gradually by the action of the muscles pulling on a joint that is altered by disease.

Recurrent or Habitual Dislocations are said to occur if the joint surfaces become frequently separated under the influence of some slight cause. They are secondary to ordinary traumatic dislocations, or due to paralysis of the muscles round the joint, or fracture of the bones.

Traumatic Dislocations.—Although no age is exempt, traumatic dislocations are most common in middle life. In children the violence more usually results in a separated epiphysis, and in elderly people fracture is more common than dislocation on account of the brittleness of the bones.

In the majority of cases the capsule of the joint is ruptured, and the bone escapes through the hole in it, but this is not invariable. The soft parts around are frequently badly torn, and portions of the bone may be torn off. Blood is freely extravasated into the cellular tissue round the joint.

The examination of a patient supposed to be suffering from a dislocation should be conducted systematically with the view of not merely ascertaining the presence or absence of a dislocation, but also learning if any complications are present which may affect the treatment, such as injuries to nerves or bloodvessels. It should be remembered that if these are overlooked at the time, their subsequent discovery may cause them to be attributed to the treatment by the patient. If swelling is marked, if the patient is fat, or the examination very painful, no opinion should be given until the patient is examined under anaesthesia, or a radiogram of the joint has been taken.

The history of the accident and the condition of the joint before its occurrence should be ascertained, so that old or pathological dislocations may not be taken for recent ones. In all cases the uninjured limb should be used for comparison.

The essential point in the examination is to ascertain the position

of the head of the bone in relation to the cavity from which it is supposed to be dislocated. The best evidence of dislocation is seeing or feeling the bone in its abnormal position and feeling it move when the lower part of the limb is rotated.

The **OBJECTIVE SIGNS** of Dislocation are—Deformity; difference in the length of the limbs; and loss of mobility.

Deformity is due to the presence of the head of the bone in its abnormal position, to extravasation of blood, inflammatory effusion, and alteration in the depth and position of the folds of the joint, and its normal depressions and prominences. The position of the long axis of the bone may also be altered. Deformity is also recognized in the radiogram.

Difference in Length of the Limb.—The limb may be either longer or shorter than its fellow, and lengthening may be present in one variety of dislocation of a joint, and shortening in others, while in a third no difference in measurement may be made out.

Loss of Mobility.—In almost every dislocation there is a characteristic position that the limb tends to assume and retain, and this position largely depends upon the tenseness of the ligaments and untorn fibres of the capsule and muscular spasm. Any attempt to move it out of this position is resisted by the ligaments and muscles, and the range of movement is limited.

Crepitus may be present, owing to the grating of the head of the one bone against the edge of the periosteum of the other, or against a fibrous band.

The **SUBJECTIVE SIGNS** are pain and loss of function.

Pain is due to the tearing of the surrounding parts, and the tenseness of those parts that have not yielded to the strain. It is usually markedly relieved by reduction, and may be associated with tingling and numbness, due to pressure on nerve trunks.

Loss of Function is usually complete, due partly to the pain and partly to the presence of the bone in an abnormal position. In some cases, however, it is curiously absent, and the patient is only aware of slight pain and some inconvenience in the use of the joint.

COMPLICATIONS.—These are—Fracture of one of the bones, and injury to neighbouring important bloodvessels and nerves.

Fracture of one of the bones forming the joint is frequently very difficult to diagnose, and fracture may be diagnosed as dislocation, and *vice versa*. In dislocations complicated by fracture of the articular surfaces or of the prominences to which muscles are attached, diagnosis of the fracture can often only be established by the X rays, but it should be suspected if the dislocation readily recurs after reduction.

Injuries to nerves and bloodvessels will be recognized by the characteristic symptoms to which they give rise, and these should always be examined for.

PROGNOSIS.—If the dislocation is promptly reduced, and no complications are present, the prognosis is good. The swelling and the pain subside, and the patient is able very shortly to use the limb.

which is soon as good and strong as ever it was. But in all cases the prognosis should be guarded, for in certain patients, and especially in those who are constitutionally prone to arthritic disease, chronic changes may be set up in the joint, the end of which it is impossible to foretell. In some cases progressive osteo-arthritis occurs, and the joint is permanently crippled, even although reduction was prompt and easy.

The inflammatory reaction may be severe and prolonged, and much periarticular thickening may follow; and in cases of people who have an inflammatory focus about the body, suppuration may occur, with total disorganization of the joint. This, however, is rare.

If the dislocation be compound, it may follow one of two courses. In the first case the wound heals promptly, and converts the condition into a simple dislocation; and in the second infection occurs and a suppurative arthritis is set up, totally destroying the joint or leading to inter-articular adhesions, which may greatly limit its function.

In complicated dislocations the prognosis is not so good. Fracture may be a great hindrance to reduction, and the callus formed may seriously cripple the joint. Rupture of the bloodvessels may lead to gangrene or traumatic aneurysm, whilst injury to nerves may be followed by permanent paralysis and wasting of muscles—a condition which predisposes to recurrent dislocation.

TREATMENT.—Reduction of a recent dislocation should be attempted at the earliest opportunity.

The method of reducing the dislocation is by scientific manipulation, causing the head of the bone to retrace the path by which it escaped, and to enter the joint again through the hole it tore in the capsule, the resistance of the muscles being overcome by anaesthesia or traction. Anaesthesia is not needed in all cases, and an attempt should usually be made to reduce the dislocation without its aid. Its use is not devoid of danger, and the collected cases of death under chloroform seem to show that its use is especially dangerous in reduction of dislocations. The advantage of anaesthesia is that it gets rid of muscular spasm, and the resistance of the patient provoked by the traumatism and the fear of pain; but it has been clearly shown that the resistance of the muscles is not nearly so important as the ligaments and torn capsule in preventing reduction.

In cases, however, that have resisted reduction, especially in muscular men, anaesthesia is very desirable, and reduction under its influence is often easy.

It is a great advantage to reduce the dislocation while the patient is still suffering from the shock of the accident, as muscular resistance is then lowered, and contraction of the muscles from the fear of pain can often be prevented by taking the patient unawares, or distracting his attention at the critical moment. Spasm of the muscles can also be overcome by gentle prolonged traction. Although manipulation ought always to be done, and the bone never forced back into its position by violence or the use of mechanical contrivances, yet a certain amount of force may be used, provided that the limb is in the

proper position. For example, in dislocation of the hip, force should never be used with the limb in a position of extension; but with the femur flexed on the abdomen, and the head of the bone opposite the hole in the capsule, some degree of force may be used to slip the bone over the rim of the acetabulum.

Occasionally a recent dislocation is irreducible, because of some exceptional position of the bones, or the intervention of soft parts between the joint surfaces. In these cases the joint should be cut down upon, and the dislocation reduced by the "open" method under aseptic precautions. This procedure is quite safe, and the dislocation is subsequently treated as a simple one. In cases complicated by fractures, the fragments of the bone should be secured in splints, and then reduction attempted by manipulation. If this fails, the joint must be cut down upon, the head of the bone reduced, and the opportunity taken of wiring or plating the fragments of the bone together, if they are near the joint and readily exposed.

Compound Dislocations must be treated by cleaning the wound, reducing the dislocation, and then carefully suturing the skin surface. Drainage should be employed if the part is much torn or is very dirty. Should healing by the first intention occur, the case is treated as one of simple dislocation; but if suppuration follow, the treatment is that of suppurative arthritis from other causes (see p. 550).

In cases where there is extreme laceration of the soft parts or fracture of the bones, the question of primary amputation should always be raised, especially in the aged and intemperate. Partial resection of the joint may be advisable if the bone is much splintered.

AFTER-TREATMENT.—After a dislocation has been reduced, a simple retentive bandage only is needed in most cases in order to confine the limb in an easy position. In some dislocations, however, for example, dislocations of the acromial end of the clavicle, the tendency to recurrence is so great that the bone must be fixed by a retentive apparatus.

The synovitis that follows reduction should be treated by the application of cold or heat, or by uniform gentle pressure, if it can be borne. Extravasation of blood is removed by massage, and adhesions are prevented from forming by passive and active movements. In making these movements those positions of the limb must be avoided in which the head of the bone presses against the torn part of the capsule, for in this case the sides of the rent would again be made to gape.

The limb can usually be used in from one to three weeks. If adhesions form in the joint, manipulation under anæsthesia, followed by massage and passive and active movements, must be carried out.

Unreduced Dislocations.—The changes that occur in unreduced dislocations are partly the effect of inflammation excited by the traumatism, and partly the effort of Nature to provide a new and serviceable joint. The changes consist in the formation of fibrous tissue about the end of the displaced bone, and in changes in the

shape of the bones at the new points of contact, partly produced by absorption, and partly by the formation of new bony outgrowth through irritation of the periosteum. A new joint is thus formed, with a new capsule of fibrous tissue, and a kind of synovial membrane may also be present. The surrounding muscles adapt themselves to the changed conditions; the old cavity is partly filled up with fibrous tissue, and partly obliterated by the absorption of bone. The bone adapts itself to the altered strains, and new lines of force appear in its internal arrangement. The bloodvessels and nerves also adapt themselves to the altered conditions, and in very many cases a useful limb and joint results. It is, therefore, obviously dangerous and futile to attempt the reduction of old-standing dislocations, for vessels may be



FIG. 244.—FORMATION OF A NEW JOINT IN AN UNREDUCED SUBCORACOID DISLOCATION OF THE SHOULDER.

ruptured, nerves torn, and extensive laceration of the tissues result; and even if the bone were replaced, there is no proper cavity for it to rest in and resume its original function.

At what period after a dislocation it is to be deemed unfit for reduction cannot be definitely stated. It varies with different joints and in different cases, and the condition of the arteries and bones must be considered. But it may be taken as a working rule that the reduction should not be attempted with the larger joints if the dislocation has been present for two months. To quote a case, however, Smith reduced a dorsal dislocation of the hip in a boy nine months after the injury.

The following accidents may occur during attempts to reduce old dislocations, whether successful or not: (1) Laceration of the skin. (2) Laceration of muscles. After such manipulations suppuration

may occur around the joint. (3) Laceration of veins. (4) Laceration of arteries. (5) Laceration of nerves. (6) Fracture of bones. (7) Avulsion of the limb. (8) Fat embolism.

In old-standing cases, if the limb is useless, if pain or paralysis is present from pressure on nerves, or congestion from pressure on the veins, excision of the head of the bone may give a movable and efficient joint.

SPECIAL DISLOCATIONS

Dislocation of the Lower Jaw

CAUSE.—Dislocation of the lower jaw is usually due to the muscular action of yawning, laughing, or attempting to take too large a bite. It may, however, be due to a blow on the jaw if the mouth is open, or to opening the mouth forcibly with a gag, as is sometimes done during anaesthesia. It is more common in women than men, and is usually bilateral.

The capsular ligament is stretched and only slightly torn, and the condyle of the jaw and the interarticular cartilage are carried forward over the eminentia articularis.

SYMPTOMS—1. *Bilateral.*—The mouth is open and the teeth cannot be made to meet; the chin is lengthened, and the lower teeth advanced $\frac{1}{2}$ inch beyond the upper. The cheeks are flattened, and there is a depression in front of the external meatus of the ear on each side. The saliva dribbles from the mouth, and there is difficulty in speaking and swallowing.

2. *Unilateral.*—The axis of the jaw is diverted to the opposite side, but otherwise the symptoms are similar to those of bilateral dislocation. The hollow in front of the meatus of the ear is only marked on the same side as the dislocation.

Reduction.—The surgeon stands in front of the seated patient, with his thumbs well guarded by a few turns of bandage, places them on the molar teeth, and the fingers of both hands under the jaw. The back of the jaw is depressed by pressure with the thumbs, and the chin is raised by the fingers. The bone slips into place with a snap. When unilateral, the efforts of reduction are applied to the dislocated side only. Reduction has been effected at the end of four months.

AFTER-TREATMENT.—A four-tailed bandage should be applied, as in cases of fractured jaw, and the patient must not be allowed to talk or to eat solid food for a week. The bandage should be worn for a month, and great care taken in opening the mouth for some months, as recurrent dislocation is common and intractable. Ankylosis does not occur.

RECURRENT DISLOCATION.—This condition is by no means uncommon, especially in women, and the patient may dislocate the jaw several times in a day. Reduction is very easy, and the patient frequently learns to do it herself.

Dislocation of the Sternal End of the Clavicle

CAUSE.—Dislocations of the sternal end of the clavicle are usually caused by violence applied to the acromial end, and the dislocation may be forwards, backwards, or upwards, the common variety being forwards.

DIAGNOSIS.—The diagnosis is generally obvious, the head of the bone being seen and felt in its new position. In dislocation backwards, difficulty in breathing and swallowing may be present, owing to pressure of the end of the bone on the trachea and the œsophagus.



FIG. 245.—DISLOCATION OF THE STERNAL END OF THE CLAVICLE.

Reduction.—The shoulder should be pulled outwards and backwards, whilst the elbow is carried in front of the mid-lateral line. Direct pressure on the bone should also be made.

AFTER-TREATMENT.—The shoulder should be braced backwards by strapping and bandages, applied as for fractured clavicle, and the elbow brought forwards and secured by a band of strapping passing round it and over the opposite shoulder. A pad of cotton-wool may be placed over the dislocated bone and secured in position by a band of

broad strapping. This apparatus should be used for three weeks, and the arm supported in a sling for another month.

If it is important to obtain a good result without deformity, rest in bed for two weeks, the patient lying on the back, shoulder and elbow joined, and then the arm kept fixed for another month. If reduction fail or recurrence take place, the head of the bone may be excised. Injections of alcohol into the tissues around the joint, with prolonged fixation, may prevent recurrence of the dislocation.

Dislocation of the Acromial End of the Clavicle

CAUSE.—This dislocation is usually caused by direct violence applied to the scapula, such as falls on the shoulder. Dislocation is upwards in nearly every case, and the diagnosis is obvious.

Reduction.—The shoulder is raised and carried backwards. The surgeon's fist is placed in the axilla, and the elbow brought to the side, the fist in the axilla acting as a fulcrum of a lever to force the shoulder outwards. Direct pressure upon the clavicle downwards may be made by an assistant at the same time.

AFTER-TREATMENT.—Reduction having been effected and the elbow flexed at a right angle, a broad piece of strapping is placed with its centre at the elbow, and its two ends are carried, one in front of the arm and one behind, up to the shoulder, where they cross over the dislocated ends of the bone, and are firmly fixed to the back and chest respectively. A second band of strapping secures the arm to the side of the chest, and the whole is covered with a bandage. The dressing should be worn for three weeks, and the arm kept in a sling for another two weeks. If recurrence takes place, there is usually very little functional disability.



FIG. 246.—APPARATUS FOR TREATING AN UPWARD DISLOCATION OF THE ACROMION

Dislocation of the Shoulder-Joint

CAUSES.—The usual cause is indirect violence, such as falls on the elbow and hand with the arm abducted; but it may also be due to muscular action, or possibly to direct violence to the shoulder. It is the most frequent of all the dislocations. There are five principal varieties—

1. Inwards and a little downwards beneath the coracoid process (subcoracoid).
2. Downwards and slightly inwards below the glenoid fossa (subglenoid).
3. Backwards and downwards below the spine of the scapula (subspinous).
4. Forwards and inwards beneath the clavicle (subclaviular).
5. Upwards and forwards (supracoracoid).

MORBID ANATOMY.—With the exception of the supracoracoid, which is complicated by fracture of the acromion or coracoid process, the capsular ligament is torn below, and the rent is inferior and anterior. The dislocation is first of all subglenoid, and the bone may stay in this position; but usually the dislocating force or the pull of muscles causes further displacement, and the head of the humerus is either carried forwards under the coracoid process or the clavicle, or backwards under the spine of the scapula, the surrounding muscles often being extensively torn.



FIG. 247.—SUBCORACOID DISLOCATION OF THE SHOULDER.

PHYSICAL SIGNS.—Eight signs are common to all varieties of dislocation of the shoulder—

1. Pain and other evidence of local trauma.
2. Rigidity and loss of function of the joint.
3. Flattening of the shoulder.
4. Presence of a hollow under the acromion.
5. Apparent projection of the acromion, with hollow tension of the deltoid muscle.
6. The presence of the head of the humerus in an abnormal position.
7. Inability to place the hand on the opposite shoulder when the elbow is made to touch the chest (generally present in recent dislocation, but not constant).
8. A ruler laid flat on the outer surface of the arm will touch the acromion and the external condyle.

In the subglenoid dislocation the arm is slightly lengthened, and in all the other varieties the arm is shortened. A measurement of the shoulder taken across the axilla is increased, and the axillary folds are not symmetrical on the two sides.

Radiography, especially if a stereoscopic radiogram is taken, renders the diagnosis certain.

Reduction.—The subglenoid, subclavicular, and subcoracoid dislocations may be reduced by—(1) Kocher's method; (2) outward

traction; (3) downward traction. In all three methods the scapula should be firmly fixed by an assistant.

Kocher's Method.—If no anæsthetic be given, the patient is placed sitting on a chair, and a broad towel is passed round the chest and over the scapula. The ends of the towel are firmly held by an assistant, so that the trunk and scapula are both fixed. The surgeon stands in front of the patient, flexes the forearm to a right angle, and then steadily approximates the elbow to the side. The arm is then rotated outwards to its utmost limit. The whole upper extremity is now brought forwards and slightly inwards, maintaining external rotation until the arm is almost horizontal. The manœuvre is completed by rotating the arm inwards, and bringing the hand to the opposite shoulder.

This method should always be tried first. It is most likely to fail in muscular subjects if no anæsthetic be given.

Outward Traction.—The patient is laid flat on the back on a low couch, and the surgeon sits beside him on a level with the shoulder. The forearm is bent to a right angle, and the arm grasped above the elbow and gently pulled until it is at right angles to the limb. An assistant fixes the trunk and scapula by means of a towel passed round the chest close up to the axilla. If no assistant is available, the surgeon fixes the scapula by placing his unbooted heel against it. Steady traction is made on the limb at right angles to the body until the dislocation is reduced. This may happen slowly, or suddenly with a snap. Reduction may be aided by manipulating the head of the bone in the axilla.

Downward Traction.—This is the easiest method of reduction, but the most dangerous. The patient lies flat on his back on a couch,



FIG. 248.—RADIOGRAM OF SUBCORACOID DISLOCATION OF THE SHOULDER.

and the surgeon sits on the couch on the side of the injury, facing him. The forearm is grasped, and the unbooted heel is placed in the axilla. Traction is made downwards and slightly outwards till the muscles are felt to give, and then the arm is carried across the surgeon's leg nearly to the middle line of the body, traction being maintained during the whole time.

The head of the bone is felt to slip into its normal position. All these methods are more likely to be successful if done under anaesthesia.

Subspinous Dislocation.—This dislocation may be reduced by downwards and forwards traction. Reduction is usually easy under anaesthesia.

AFTER-TREATMENT.—Immediately after reduction the arm is firmly bandaged to the side, evaporating lead lotion being applied to the shoulder. At the end of forty-eight hours the bandage is removed, the shoulder lightly massaged, and the joint gently moved, care being taken not to abduct the arm. The arm is then placed in a sling, which is worn during the day; but at night the bandage is replaced, fixing the arm to the chest. In hospital patients, or if care will not or cannot be exercised, the bandage should be retained day and night, but removed every day for massage and movement.

Active movements should be begun at the end of a week, and at the end of ten days a sling is all that is necessary day or night. The movement of abduction is the one that should be practised last.

The sling should be worn for a month, and six weeks should elapse before the arm is used freely. For methods of treating adhesions in the joint, see p. 555.

Unreduced Dislocations of the Shoulder-Joint.—When a dislocation remains unreduced, the traumatic inflammation in the capsule, the muscles and the surrounding tissue, ends in formation of fibrous tissue, and the bone is fixed in the abnormal position. Later, the muscles adaptably shorten or lengthen. The old articular cavity becomes filled with fibrous tissue and almost obliterated, whilst the displaced head of the bone forms for itself a new articular cavity by pressure and absorption at the same time as its own shape becomes modified by the same means. The fibrous tissue forms a false capsule for the new joint, and there is also a certain amount of formation of a synovial membrane. The muscles and nerves around which the head of the bone is displaced frequently become fixed to this new capsule by adhesions. In the case of the shoulder this formation of a new joint may give surprisingly good results, especially if massage and passive and active movements are persevered with for some months; but osteo-arthritic changes are common in these new joints.

TREATMENT.—No hard-and-fast rule can be laid down as to the time at which it is advisable to attempt reduction, and each case must be treated on its own merits. The age of the patient, the condition of his arteries, the amount of pain and disability, must all be taken into account; but it may be generally stated that reduction should not be

attempted after the humerus has been dislocated for six weeks. Attempts at reduction of old dislocations have been followed by the rupture of bloodvessels, injury to nerves, laceration of the skin, fractures of the bone, and the avulsion of the limb.

If there is little disability, the dislocation may be left, and an endeavour made by massage and passive movement to obtain a useful limb. In some instances, however, there is severe pain from pressure on the brachial plexus, or œdema from obstruction of the axillary vein. In these cases, or if the patient is young and wants a freely movable joint, the head of the humerus should be excised, and an excellent joint may result.

Recurrent Dislocation.—In a few cases after a dislocation of the shoulder has once occurred, the condition becomes habitual, and persistently recurs on the slightest provocation. This may either be due to some peculiarity of the dislocation—e.g., the muscles have been torn from the tuberosities, or the glenoid fossa has been fractured at the same time, or to incautious movements during the period of treatment, so that the dislocation is reproduced.

TREATMENT.—The patient may wear a shoulder-cap, which will prevent the dislocation, or an open operation can be performed. The capsule of the joint is exposed, and the condition found treated. If there is a large unhealed rent in the capsule, this should be closed, and if the capsule appears to be excessively loose, a portion of it should be excised. In some cases the best treatment is to excise the head of the humerus, and a remarkably good result may follow.

Dislocation of the Shoulder Complicated by Fracture of the Surgical Neck of the Humerus.—This is by no means an infrequent accident. The physical signs closely resemble those of an uncomplicated dislocation, but on rotating the lower end of the humerus, the tuberosities do not move, and crepitus may be obtained. Radiography will at once make the diagnosis certain.

TREATMENT.—The dislocation *must* be reduced before the fracture is treated, and the best method of procedure is to cut down on the fracture, reduce the dislocation by direct manipulation of the upper fragment, and then plate and screw the two fragments into position. Massage and passive movements can then be started early to prevent stiffness of the joint, without fear of causing displacement of the fragments.

Luxatio-Erecta.—This is a subglenoid dislocation produced while the arm is raised and abducted. The usual method of production is by catching hold of something during a fall, such as through a skylight, so that the weight of the body is suddenly thrown on to the shoulder-joint. The patient is unable to lower his arm until the dislocation is reduced; reduction is accomplished by downward traction.

Dislocations of the Elbow-Joint

1. **Dislocations of Both Bones.**—The radius and ulna may be dislocated backwards, forwards, or laterally, backwards dislocation being by far the most common, and the lateral dislocations usually being incomplete.

Backward Dislocation is commonly caused by falls on the palm of the outstretched hand, and is relatively frequent in early life owing to the small size of the coronoid process.

PHYSICAL SIGNS.—The olecranon process projects backwards, and the tendon of the triceps is stretched and tense whilst the forearm is held flexed and slightly pronated. Slight lateral deviation is frequently present with the dislocation. The relative positions of the



FIG. 249.—BACKWARD DISLOCATION OF THE RADIUS AND ULNA.

olecranon and the condyles of the humerus are altered, and the condyles do not move with the olecranon. This last sign is of importance in differentiating between a dislocation backwards and separation of the lower epiphysis of the humerus, or transverse fracture of the lower end. If the coronoid process of the ulna is fractured at the same time, the dislocation is easily reduced and readily recurs, but this complication is not common.

Reduction.—The surgeon stands in front of the patient, who is seated in a chair, and places his knee against the lower end of the humerus, the elbow being slightly flexed. The arm is grasped by one hand above the elbow to steady it, and the other hand grasps the wrist. Steady traction is made in the long axis of the limb until the muscles are tired, and then the elbow is flexed round the knee, traction being continued all the time. The bones slip into position with a snap, and movement is at once restored.

AFTER-TREATMENT.—If there be no fracture of the coronoid, there is no tendency for the dislocation to recur, but the amount of swelling

is usually great. The arm should be put in a sling, and cold, in the form of evaporating lead lotion, applied for two days. Careful massage should be begun at the end of twenty-four hours (see Sprains, p. 522). Passive movements are started five days after the injury, then active movements, and in three weeks the sling can be dispensed with altogether, and the patient resume the ordinary use of the joint.

Fracture of the Coronoid Process.—This is generally diagnosed by the ease with which displacement recurs, with crepitus, after reduction. If the coronoid process is not completely detached—and it seldom is—the elbow should be put up at once at a right angle, with the hand fully supinated. A posterior gutter splint is applied, with a largo pad in the angle of the splint, immediately behind the olecranon, so as to keep the forearm forward. At the end of ten days the splint is removed, the limb massaged, and then gentle passive movements begun, the olecranon being held forwards by the surgeon whilst extension is being carried out. Union usually occurs, with restoration of function, in six weeks, but a sling should be worn for two months. In cases of complete tearing off of the coronoid process it is probably wiser to wire it into position. (For the method of treatment, see Fractured Olecranon.)

Forward Dislocation without fracture of the olecranon is very rare. The diagnosis is easy as a rule.

Reduction.—The limb is forcibly flexed to less than a right angle, and then the upper ends of the bones are pulled back into place by a bandage passed round the front of the forearm close to the elbow.

The after-treatment is the same as for backward dislocation.

Lateral Dislocations of the radius and ulna are rarely complete, and dislocation outwards is much more common than dislocation inwards.

The diagnosis is made by a careful examination of the relative positions of the bony points round the elbow, and by radiography.

The TREATMENT is similar to that of backward dislocation.

UNREDUCED DISLOCATION OF THE ELBOW of more than six weeks' standing is best treated by excision of the joint.

2. **Dislocation of the Ulna alone.**—This accident is rare, and the bone is generally displaced backwards.

Reduction can be effected in the same way as for both bones, and the after-treatment is similar.

3. **Dislocation of the Radius alone.**—The radius may be dislocated forwards, backwards, or outwards, the dislocation forwards being by far the most common. It is frequently complicated by fracture of the ulna in the upper third, and the dislocation may be overlooked until the splint has been removed after treatment of the fracture.

Signs.—The forearm is flexed and semiprone; the elbow can only be flexed to a right angle; complete pronation is possible, but supination

is limited. The head of the bone can be felt in its abnormal position, and all movements are very painful.

Reduction.—This is often difficult on account of the orbicular ligament filling up the lesser sigmoid cavity, and recurrence is often impossible to prevent if the ligament is ruptured.

An anæsthetic should be given. The elbow is flexed to a right angle, traction is made on the forearm, and the head of the radius pressed into position. The surgeon should not be satisfied until pronation and supination are quite free, and there is no tendency to immediate recurrence. The arm should then be placed on a posterior gutter splint, the hand being fully supine. An anterior splint is applied with a pad over the head of the radius, and the whole fixed by strapping.

The splints are not removed for ten days. They are then taken off, the limb massaged, and, with the surgeon holding the head of the radius in position, gentle movements of rotation are performed, and the splint replaced. After the splints have been worn for three weeks, active movements are begun.

A sling is used for three weeks longer, and the arm then left free; but the patient should be cautioned against forcible movements for another three weeks. If reduction cannot be effected, the joint must be opened and the head of the radius replaced in the synovial cavity. The after-treatment is similar to the above.

Dislocations backwards and outwards are rare.

Subluxation of the Head of the Radius ("Pulled Arm").—This condition is due to a sudden wrench given to the elbow of a child by pulling it forcibly upwards by the forearm. The head of the radius is partially pulled through the orbicular ligament. Movements of the limb are painful. It is held motionless, with the elbow slightly flexed, and the hand midway between the pronation and supination. Supination is not free.

Reduction.—The forearm is smartly flexed and supinated, and the bone slips into position with a distinct click. The movements become free and painless.

A sling should be worn for two days. There are no after-effects.

Dislocations of the Wrist

Dislocation of the radio-carpal joint backwards is usually due to falls on the outstretched hand, an accident which also produces Colles's fracture, a more common result than dislocation. Dislocation forwards is much rarer than backwards, and lateral dislocation is practically unknown.

PHYSICAL SIGNS OF BACKWARD DISLOCATION.—The whole hand is displaced backwards, and the condition closely resembles Colles's fracture, but the styloid processes of the radius and ulna retain their normal relative positions.

Reduction.—The hand is grasped, and traction is made. Reduction is as a rule easy.

AFTER-TREATMENT.—An anterior splint projecting beyond the fingers is applied, and evaporating lead lotion used, as there is generally considerable effusion into the tendon sheaths and the joint.

Massage is started on the second day, and the splint is worn for ten days. Passive movement is then started, and pressure applied. A sling is worn in the intervals of massage. The sling is taken off at the end of the fourth week, and the result is usually satisfactory.

Dislocations of the Carpal Bones sometimes occur, the bones most frequently dislocated being the *os magnum*, the pisiform, and the semilunar. The diagnosis is made by radiography, and reduction is accomplished on common-sense lines. If the dislocation remains unreduced and limits the movements of the wrist, the dislocated bone should be excised.

Dislocation of the Metacarpo-Phalangeal Articulation.—This dislocation is most frequently met with in the thumb. The phalanx is dislocated backwards on the metacarpal bone. The diagnosis is obvious. The ruptured anterior or glenoid ligament is carried backwards with the phalanx, and forms the great obstacle to reduction by getting wedged in between the phalanx and the head of the metacarpal bone.

Reduction.—The hand is grasped and the metacarpal bone adducted into the palm with one hand. The other grasps the thumb, either unaided or by means of an instrument, and traction is made in the hyperextended position. Traction being maintained, the phalanx is flexed sharply, and reduction occurs.

In many cases, but by no means in all, difficulty is experienced in reducing the dislocation. Should reduction not be possible by manipulation, an incision is made over the front of the joint, exposing the head of the metacarpal bone. Reduction is then performed as above, forceps being used to pull the lower portion of the capsule out of the way. The capsule is then sewn, and the wound sutured.

AFTER-TREATMENT.—A moulded poroplastic splint is kept on for ten days. Massage and passive movement are then started, the splint being replaced in the intervals. The splint may be discarded in three weeks, and the hand freely used in another three weeks.

Similar dislocations occur, and similar treatment is required for the other metacarpo-phalangeal articulations.

Another method of treatment in unreduced dislocation is to divide the glenoid ligament with a tenotomy knife, introduced from behind. Reduction is then usually easy. The same after-treatment is necessary.

Dislocation of the Bones of the Pelvis

Fracture of the pelvis is much more common than dislocation, although dislocations of the pelvic bones do sometimes occur in prolonged and difficult labours with contracted pelvis, or from violent accidents.

The bones should be manipulated into position, and the after-treatment and complications are those of fractured pelvis.

Dislocations of the Hip-Joint

Dislocations of the hip are most commonly seen in adult males during the most active period of life, and, owing to the depth of the articulation and the strength of the ligaments, are much rarer than dislocations of the shoulder.

Dislocations of the hip-joint may be divided into **REGULAR** and **IRREGULAR**.—Regular dislocations occur when the ilio-femoral ligament of Bigelow remains intact, and the acetabulum is not fractured. They present certain constant features. In irregular dislocations the ligament is ruptured or the bone fractured, and dislocation may occur anywhere near the joint, and the head of the femur be found in almost any position.

Regular Dislocations are six in number, three being common and three uncommon. The three common dislocations are—

1. *Dorsal Dislocation*.—Dislocation backwards and upwards, the head of the femur lying above the tendon of the obturator internus (dislocation on to the dorsum ilii), or below that muscle (dislocation into the sciatic notch).
2. *Thyroid Dislocation*.—Dislocation downwards into the thyroid or obturator foramen.
3. *Pubic Dislocation*.—Dislocation upwards and forwards upon the pubic bone.

The three uncommon ones are—

1. *Anterior Oblique Dislocation*, in which the head of the bone lies below the anterior inferior iliac spine.
2. *Supraspinous Dislocation*.—The head of the bone lies above the anterior inferior spine.
3. *Dorsal Dislocation with Eversion of the Foot*.

An examination of the hip-joint will show that the joint is strongest anteriorly and superiorly, and its weakest part is below and internally. When the femur is forcibly abducted, the head of the bone comes into the shallowest part of the acetabulum, and against the weakest part of the capsule, and it is in this position that dislocation usually occurs. In the majority of all the regular dislocations of the hip, the head of the femur leaves the capsule through a rent in its lower and inner part, and then is driven into the place it is found to occupy by the direction of the dislocating force. It is, however, possible for the head of the femur to be driven through any part of the capsule, and in the irregular dislocations any part of the capsule may be ruptured.

Dorsal Dislocation—**PHYSICAL SIGNS**.—The limb is flexed, abducted, and rotated in, the hall of the great toe resting on the instep of the sound foot. There is marked shortening, and the great trochanter is above Nélaton's line. The head of the bone may be felt in its abnormal position. All the signs, including shortening, are less marked when the head of the bone is under the obturator internus tendon and lies in the sciatic notch.

Reduction.—This can be accomplished by two methods, manipulation and traction, of which the better is manipulation. An anæsthetic should always be given.

MANIPULATION.—The patient lies flat on the back on a couch, the surgeon stands on the affected side, and the pelvis is fixed by an assistant. The knee being flexed, the hip is fully flexed in adduction and slight internal rotation. Next the hip is internally rotated and circumducted outwards, finally being extended. The movements should be continuous.

TRACTION—Method A.—The patient lies as before on a very low couch, and the pelvis is fixed by an assistant. The hip is flexed at a right angle, and is slightly adducted and rotated in. Firm vertical traction is then made on the thigh, at first steadily, to tire the muscles, and then in a series of jerks, till the head of the femur enters the acetabulum.

Method B.—The patient is put lying face downwards on a table, with the thighs hanging over the end. The sound limb is supported in the line of the body by an assistant. The knee of the injured leg is flexed at a right angle, and the ankle supported by the surgeon. The weight of the limb now makes the necessary traction, and a slight rotating of the limb will cause the head of the bone to slip into place. The weight of the leg may be aided by placing a small sandbag on the calf.

This method will often succeed without anæsthesia (Stimson).

Thyroid Dislocation.—The limb is flexed, abducted, and rotated out. The prominence of the great trochanter has disappeared, and the leg is lengthened about 2 inches. The head of the femur can often be felt through the rectal wall.

Reduction—1. **MANIPULATION.**—The patient is put lying on his back, and the pelvis is fixed by an assistant. The hip is flexed in the abducted position as fully as possible. It is then adducted, internally rotated, circumducted, and brought down parallel to its fellow.

2. **TRACTION.**—The thigh is flexed to a right angle in abduction and external rotation. Traction is employed in the axis of the femur to bring the head of the bone near the acetabulum, and the limb is then rotated outward. The head slips into position with a snap. Reduction by this method will be aided by traction outwards. A jacketowel is passed round the thigh, and while the surgeon makes traction upwards, an assistant pulls upon the towel, so as to drag the head of the bone directly outwards.

Pubic Dislocation.—The limb is flexed, abducted, and rotated out. The hip is flattened, and the head of the bone is readily felt above Poupart's ligament to the outer side of the femoral vessels. Shortening to the extent of an inch is present.

Reduction—1. **MANIPULATION.**—Semiflex the thigh in abduction and rotate inwards. Maintaining internal rotation, circumduct inwards and extend.

2. TRACTION.—This is more usually successful than manipulation in this dislocation. Traction is made in the axis of the limb as it lies, and at the same time direct pressure is made on the head of the bone to prevent it from moving upwards during the next step in reduction. This is flexion, but it should not be carried quite to a right angle, and is succeeded by internal rotation, which carries the head into the acetabulum.

In all cases of reduction of the dislocation, care must be taken not to exercise too much force, otherwise the neck of the femur may be broken.

AFTER-TREATMENT.—There is very little tendency for the dislocation to recur after reduction of the regular dislocations, so, except in the case of children, there is no need to use a splint. The patient is put flat on his back in bed, with the lower extremities tied together, evaporating lead lotion being applied to the injured hip.

Massage should be started in two days, and at the end of five days passive movement, avoiding too great flexion and abduction. At the end of the week a band may be fixed to the end of the bed, and the patient allowed to raise himself to a sitting posture by its help, and then *quietly* lower himself again. This should be repeated several times a day, and the patient may turn about in bed. At the end of a fortnight he is allowed up on crutches, which are discarded as soon as experience has proved that the limb itself may be trusted. For some weeks care must be exercised in abduction and flexion.

Uncommon Regular Dislocations of the Hip.—In all the uncommon regular dislocations the head of the femur can be felt in its new position, especially if the patient is anesthetized. There is considerable shortening of the limb in the anterior oblique and supraspinous dislocations. The eversion of the foot seen in some dorsal dislocations (dorsal dislocation with eversion) is due to the direction of the dislocating force, which continues to act with the femur externally rotated, and causes rupture of some of the fibres of the ilio-femoral ligament. The condition is difficult to diagnose from fracture of the neck of the femur, but there is no crepitus, and the head of the bone may be detected in an abnormal position. Radiography will at once differentiate the two conditions.

The TREATMENT of these unusual dislocations is by the ordinary manipulative methods.

Irregular Dislocation of the Hip.—Irregular dislocation of the hip is mostly brought about by excessive violence, and the ilio-femoral (Y ligament of Bigelow) may be torn, or the acetabulum fractured. The head of the femur may be found in any position round the acetabulum, the limb assuming almost any posture. Diagnosis is easily made certain by radiography.

Reduction.—This is accomplished by traction in a downward and forward direction, the thigh being somewhat flexed. The femur is alternately rotated in and out, and abduction and adduction carried out till the head of the bone is felt to slip into place.

AFTER-TREATMENT.—If the ilio-femoral ligament has been torn, the patient should wear a long Liston splint for six weeks. It must, however, be removed once or twice a day for passive movement and massage. He should not be allowed to stand for eight weeks, and then care must be exercised, and walking gradually resumed.

If the rim of the acetabulum has been fractured, an extension apparatus is applied, and the limb secured to a long Liston splint. Extension should be maintained for eight weeks; but after the first fortnight careful passive movement should be started by the surgeon, extension being maintained during the movements, and the weight replaced at once afterwards.

Unreduced Dislocations.—A dislocation of the hip has been reduced at the end of nine months, but in most cases it is inadvisable to attempt reduction if the dislocation has been present for longer than eight weeks. If reduction be attempted, it should be remembered that skilful manipulation is much preferable to the old method of extension with pulleys, etc., and is as likely to be successful.

Reduction may be accomplished by the open method by replacing the head of the femur in the acetabulum, but in old-standing cases with marked disability the head of the bone should be excised.

After-treatment if Reduction has been accomplished by the Open Method in Old-Standing Cases.—The limb is fixed on a long Liston splint, and weight extension applied for the first three weeks. The stitches are removed as usual on the tenth day. At the end of the three weeks massage and passive movements are started. At the end of six weeks the patient may be allowed up on crutches, the limb being fixed in the intervals of massage on a Thomas's hip-splint. By the end of the third month the patient may begin to bear some weight on the limb, and the crutches should be discarded as soon as possible.

Dislocations of the Patella

Dislocation of the patella may be outwards, vertical, or inwards, and is usually due to muscular action or direct violence. Dislocation outwards is the most common, and, when due to muscular action, is generally associated with a lax condition of the ligaments of the knee or with genu valgum—either the genu valgum of puberty, or that occurring in old age due to osteo-arthritis changes in the joint.

Vertical displacement is due to direct violence, and is such that the outer border of the bone lies in the intercondyloid notch, and the inner border projects under the skin.

All the dislocations are more often incomplete than complete.

The **DIAGNOSIS** is obvious on careful examination and with radiography.

Reduction.—The knee is fully extended, the thigh flexed, and the bone manipulated into place with the fingers. Reduction is easy in the outward dislocation, but may be difficult in the vertical one, for which an anæsthetic is usually necessary.

AFTER-TREATMENT.—Cold should be applied for forty-eight hours by means of an icebag or Leiter's coils. If the effusion is excessive, it should be removed by aspiration. The further treatment is that of a severe sprain (see p. 522), but a splint should be worn in the intervals of passive movement, which should not be commenced for a week. The splint should be worn for three weeks, at the end of which time the patient may begin to walk with the knee well strapped, and later on, elastic supports should be used.

All apparatus can be discarded at the end of three months.

Recurrent Dislocation of the Patella.—This condition is associated with genu valgum, a lax condition of the ligaments, or paralysis of the quadriceps extensor. The condition may occur each time the patient fully flexes the knee.

TREATMENT.—If genu valgum is present, it should be corrected by an osteotomy. The condition is relieved, if the other two causes are present, by excision of a portion of the inner part of the capsule and part of the vastus internus muscle, with lengthening of the vastus externus if necessary.

Dislocation of the Knee

Dislocation of the knee is one of the rarer accidents, and, if complete, is due to very severe violence, as the ligaments of the knee are exceedingly strong. The tibia is displaced backwards, forwards, or laterally, and the dislocation may be complete or incomplete. The forward and backward dislocations are usually complete, whilst the lateral displacements are incomplete.

In complete dislocations there is extensive laceration of the soft parts with rupture of the crucial ligaments, so that after reduction the joint can be moved in almost any direction, and the extravasation of blood is excessive. The displaced tibia in backward dislocation and the femur in forward dislocation presses on the popliteal vessels, and if reduction is not speedily accomplished, gangrene of the foot may result. The diagnosis is obvious.

Reduction.—This is usually easily accomplished by traction and manipulation under anaesthesia.

AFTER-TREATMENT.—In complete dislocation the damage done to the ligaments is extensive, and rest is imperative. A straight posterior splint with a footpiece is applied, and an icebag or Leiter's coils placed over the knee. If there is much distension, the joint is aspirated.

Passive movement is begun at the end of two weeks, and often this has to be carried out under nitrous oxide anaesthesia. At the end of three weeks the patient is allowed up, with a moulded poroplastic or gutta-percha splint, the knee being carefully strapped; but massage and passive movement must be continued.

At the end of six months the splint may be discarded.

Dislocation of a Semilunar Cartilage (Internal Derangement of the Knee-Joint).—This accident occurs from sudden rotation of the body

when the knee is flexed and the foot firmly planted on the ground, so that the femur is rotated on the tibia. The accident commonly occurs whilst playing football or tennis, and the internal cartilage is more frequently displaced than the external.

PATHOLOGICAL ANATOMY.—One or more of the following conditions is present as well as the dislocation: The cartilage is torn away from the head of the tibia by rupture of the coronary ligament; the anterior or posterior fibrous horn, usually the anterior, attaching the cartilage to the interarticular surface of the tibia, is torn across; the cartilage is split transversely or longitudinally. If the cartilage is split, it becomes inflamed and swollen, and degenerative changes occur in it.

SYMPTOMS.—The patient is conscious of a violent wrench, and there is sickening pain in the knee. The knee is flexed, and cannot be straightened. The patient may be able to walk, but the knee is painful and stiff.

Reduction.—Reduction is often accomplished by the patient trying to move the joint either at once or suddenly during the next day or so, but if this has not happened, the surgeon should fully flex the knee, rotate inwards, and then suddenly extend. The accident is followed by an attack of acute traumatic synovitis.

AFTER-TREATMENT.—This is of great importance in order to prevent recurrence. The patient is kept from walking, and a back splint with a footpiece is applied to the knee. Cold is used to prevent effusion, and aspiration is performed if necessary. The splint should be worn until the effusion has subsided. The knee should then be carefully strapped, and a moulded poroplastic splint applied, reaching from the middle of the thigh to the middle of the calf.

Massage should be employed from the first, especially to the calf and thigh muscles, to prevent wasting; but passive movement should not be done for the first three weeks, and then only with great care.

The splint should be worn night and day for three months, and then on elastic knee-cap for another three months, so as to steady the joint and prevent overflexion.

Recurrent Dislocation.—Recurrence of this dislocation is very common after the cartilage has once been displaced, and it may become so frequent that the symptoms recur on the slightest muscular exertion (even on turning in bed), the patient becoming incapacitated for active life.

The pain and swelling in the recurrence are usually not so severe as in the primary dislocation, and the patient soon discovers the method of reducing the dislocation by himself.

On examination of the knee between the dislocations, there are usually no physical signs, except there may be a tender spot over the damaged cartilage which can sometimes be felt. On radiography the knee appears normal.

Although the symptoms of which the patient complains may be

typical of dislocation of the semilunar cartilage, this condition may not be present, as precisely similar symptoms may be due to a loose body in the joint or the presence of a hypertrophied synovial fringe, and, in the absence of physical signs or radiographic evidence, a differential diagnosis is impossible.

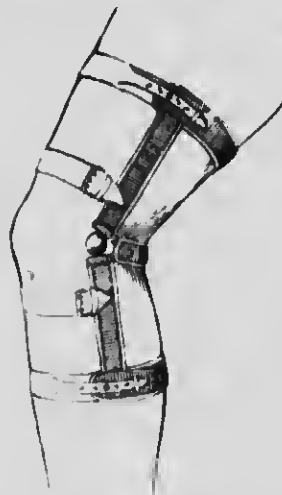


FIG. 250. MARSH'S BRACE FOR DISLOCATED SEMILUNAR CARTILAGE.

TREATMENT.—The patient must either wear some form of apparatus to prevent recurrence, or have the cartilage removed. One of the best forms of apparatus is Marsh's knee-clamp, which consists of two steel bars jointed at the knee with a pad which presses on the displaced cartilage.

If operation is decided upon, the knee-joint is opened by a curved incision over the cartilage, which is separated from its attachments and removed. The limb is then placed on a back splint with a footpiece, and kept at rest until the stitches are removed on the tenth day. The splint should then be discarded, the patient allowed to move the knee in bed, and passive movement and massage started. The patient is allowed up in three weeks with the knee strapped, and all apparatus and dressing are discarded at the end of six weeks. The results are excellent.

Dislocation of the Ankle

Dislocation of the foot on the tibia and fibula without fracture of the bone is only possible in the anterior and posterior directions, lateral dislocation always being a fracture dislocation. The bone most often fractured is the fibula.

Backward Dislocation of the foot is more common than the forward, and the tibia and fibula rest on the neck of the astragalus or on the scaphoid bone. The heel projects posteriorly, and the tendo Achillis is taut, the foot being in a position of plantar-flexion.

Forward Dislocation is uncommon; the projection of the heel is lost, the foot appears abnormally long, and is in a position of dorsiflexion.

Reduction.—This is made by traction on the foot, with extension or flexion of the foot, according to the nature of the displacement. In backward dislocation the foot is pulled forwards and downwards, then rapidly dorsiflexed; in forward dislocation it is pulled downwards and backwards, and then plantar-flexed.

AFTER-TREATMENT.—The foot is put at rest on a back splint with a footpiece, and treated as a severe sprain (see p. 522). There is no danger of recurrence.

Dislocation of the Foot Upwards.—Dislocation of the foot upwards between the tibia and fibula is commonly complicated by fracture of

the fibula (Dupuytren's fracture), but the dislocation may occur without fracture.

There is marked widening at the ankle, and the two malleoli project against the skin near the sole of the foot.

TREATMENT.—The foot is wrenched down into position, and the subsequent treatment is similar to that of a backward dislocation.

Dislocation of the Astragalus

This bone may be displaced in falls on the foot from a height, or in machinery accidents, and the most frequent displacement is forwards and outwards; backward displacements may also occur. The displacement may be either simple or compound, and in the latter case the diagnosis is obvious; but in the former the condition may be mistaken for a subastragaloid dislocation. The best guide to diagnosis of the injury, if a radiogram cannot be obtained, is the relative positions of the head of the astragalus and the two malleoli.

Reduction.—The patient is deeply anesthetized, and attempts made to push the bone into position, the knee being fully flexed in order to relax the calf muscles. Reduction is usually only possible in the incomplete dislocations, so that before the anesthetic is given permission for an open operation should be obtained. If reduction by manipulation fails, the astragalus should be exposed, and an attempt again made to put it into position; and if this fails, the bone should be removed.

An excellent functional foot is left after removal of the astragalus.

Subastragaloid Dislocation.

This accident is due to a violent wrench of the foot, so that all the bones of the carpus are displaced except the astragalus, which retains its normal relative position to the tibia and fibula.

The foot is most commonly displaced backwards and outwards, or inwards, but it may also be displaced forwards and inwards, or forwards and outwards; but these latter displacements are very rare. The dislocation is generally incomplete.

In the usual form of backwards displacement, the foot is plantar-flexed and everted, and there is a prominence on the instep in the neighbourhood of the scaphoid, due to the projection of the head of the astragalus. The tendo Achillis appears tense and prominent.

The condition must be carefully diagnosed from the more usual fracture dislocation of the ankle-joint, and a radiogram is invaluable.

Reduction.—This is often difficult. The patient should be anesthetized, and the knee fully flexed, counter-extension being made by an

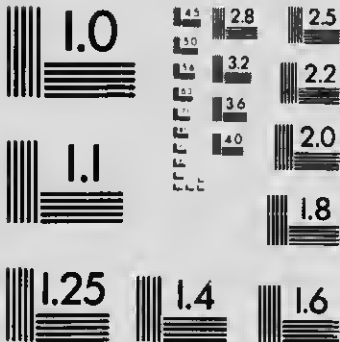


FIG. 251.—SUBASTRAGALOID DISLOCATION OF THE FOOT.



MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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assistant. The foot is then grasped, traction made in a downward direction, the toes being slightly plantar-flexed. When the muscles relax, the foot is smartly dorsiflexed by the hand behind the heel.



FIG. 252.—SUBASTRAGALOID DISLOCATION OF THE FOOT.

AFTER-TREATMENT.—This is the same as that for a severe sprain (see p. 522). If reduction cannot be accomplished, an open operation should be performed, and it may be necessary to excise the astragalus before the foot can be placed in position.

Dislocation of the Phalangeal Joints

Dislocation of these joints is similar to those of the phalangeal joints of the hand, but they are not so common. The same difficulty of reducing a backward dislocation of the first metatarsal-phalangeal articulation is met with as in the hand, and the same measures are taken to reduce the deformity.

PATHOLOGICAL DISLOCATION OF JOINTS

Pathological dislocation of a joint may be classified into—(1) Dislocation by destruction; (2) dislocation by distension; (3) dislocation by paralysis of muscles.

1. The majority of cases of pathological dislocations are due to destruction of the articular ends of the bones and the ligaments forming the joints, as occurs in tubercular disease and Charcot's disease. In many of the cases the actual exciting cause is a slight violence, such as muscular spasm, and the moment of dislocation can be definitely ascertained, but in others the dislocation can be definitely. Directly the dislocation is discovered, attempts should be made to reduce it, and the treatment of the disease of the joint upon which it depends is then carefully carried out.

2. Dislocation by distension occurs most commonly from an arthritis occurring in the course of such diseases as scarlet fever, typhoid, or septicæmia. The hip is most frequently affected. During the course of the illness there is a rapid effusion into the joint, associated with softening of the ligaments, and pathological dislocation may occur without suppuration. The condition is frequently not discovered until convalescence.

3. Dislocation from muscular paralysis: This is most often seen in the hip-joint and in association with infantile paralysis. The patient may be able to dislocate the joint at will. Reduction is very easy, but owing to the lax state of the muscles, reproduction of the dislocation readily occurs. The treatment usually consists of arthrodesis, and an attempt to secure bony ankylosis.

Many acrobats are able to produce certain dislocations at will.

Congenital Dislocations are described under Deformities.

CHAPTER XVII

DISEASES OF JOINTS

GENERAL CONSIDERATIONS.—The various bones of which the skeleton consists are connected at different parts of their surfaces, and such a connection is termed a "joint" or "articulation." In the movable joints the ends of the bones forming the articulation are expanded for greater convenience of mutual connection. They are covered with an articular cartilage, and firmly held together by dense fibrous bands termed the "ligaments," which form a capsule surrounding the ends of the bones. This capsule is lined by a membrane—the synovial membrane—which is itself lined by a smooth endothelium. This membrane secretes a fluid, the synovia, which lubricates the joint and makes movement easy.

The structures, therefore, which enter into the formation of a joint are bone, cartilage, ligaments, and synovial membrane; inflammation may start in any one of these structures. In children the bone entering into the formation of a joint consists of epiphysis and diaphysis, separated by a layer of epiphysial cartilage around which growth of the bone is most active, and the epiphysial cartilage may (as in the hip-joint) be inside the capsule of the joint.

It has been customary to divide inflammatory disease of joints into synovitis and arthritis, using the first term when the inflammatory process appears to affect mainly the synovial membrane, and the latter when the other structures of the joint are also involved; but the distinction is neither accurate nor useful.

Inflammatory conditions of joints will therefore be described under the term "arthritis," no matter what the cause may be, or to what extent the various structures which go to form a joint are involved.

Arthritis.—The CAUSES of inflammation of joints are non-bacterial and bacterial. Non-bacterial causes are traumatism, gout, and possibly rheumatism. Acute rheumatic arthritis (rheumatic fever) is almost certainly due to an organism, and is generally classified amongst the forms of bacterial or infective arthritis. The most common organisms that infect joints are the staphylococcus, streptococcus, gonococcus, pneumococcus, typhoid bacillus, tubercle, and the *Spirochæta pallida*. In many cases an injury predisposes to bacterial infection of a joint and this is especially true in the case of tubercle. The infecting organism may reach the joint by—(1) Direct infection, as in the case of penetrating wounds of the joints and compound dislocations; (2) by

the blood-stream, as in tubercle, syphilis, and pyæmic conditions; or (3) by direct extension from the neighbouring parts, particularly in infective diseases of the bone—*e.g.*, staphylococccic osteomyelitis.

SYMPTOMS AND PHYSICAL SIGNS.—As in other inflammatory conditions, these are divided into general and local. The *general* symptoms vary with the cause of the arthritis, and whether the condition is acute or chronic, and are those of the disease from which the patient is suffering, such as pyæmia, gonorrhœa, syphilis, tubercle, gout, or rheumatism. In traumatic arthritis the general symptoms are those of aseptic traumatic fever.

The *local* symptoms are redness, heat, pain, swelling, and loss of function, as in inflammation in other parts, and there is also loss of tone and wasting of the surrounding muscles.

Redness.—As the majority of the joints are deep-seated, redness of the skin over them is not a prominent feature, and is only present in the severer forms of acute arthritis. In some forms of chronic arthritis, when the joint is greatly swollen and the skin stretched over it, the blood may be squeezed out of the subcutaneous tissue, and the skin appear whiter than usual. This is most common in cases of tubercular arthritis, and accounts for the old name "tumor albus."

Heat.—Increase of the surface temperature occurs in acute arthritis. In chronic conditions, however, it may be cooler than normal.

Pain is due to stretching of the ligaments of the joint, and may be very severe in acute arthritis, but, on the other hand, it may be almost absent in the chronic condition. It is always increased by attempts to move the joint. If the articular cartilage is eroded, the pain becomes increased, especially at night. As a patient is dropping off to sleep, he wakes with a start, due to a sudden spasm of pain. This symptom is spoken of as "starting pains," and is due to relaxation of the muscles, allowing the joint surfaces to move on one another.

Swelling.—The swelling is partly due to effusion into the joint. This swelling gives a characteristic appearance to the various joints when they are inflamed, as it maps out the extent of the synovial cavity, and often allows the diagnosis to be made at a glance. The effusion may be serous, serofibrinous, or purulent, according to the severity of the inflammation and the cause. It is often only by bacteriological examination of the fluid removed from the joint that an exact diagnosis of the cause of the arthritis can be made.

Baker's Cysts.—If the effusion into the joint is chronic, and especially if it is present in large amount (hydrarthrosis or hydrops articuli), pouches of synovial membrane may be pushed out between the fibres of the capsule, and may form swellings around the joint. These hernial protrusions of the synovial membrane communicate at first with the joint cavity, but later they may become separated and appear as independent cysts lined by an endothelium at some distance from the affected joint.

Besides effusion into the joint cavity, the synovial membrane itself may become excessively thickened, causing swelling of the joint; or the synovial fringes may become enlarged, and deposits of fat occur in them, a condition spoken of as "lipoma arborescens" or "arthritis

lipomatosis." In other cases melon-seed bodies (see p. 357) are found in the joint.

Loss of Function.—When a joint is inflamed, it cannot be moved without pain, but becomes fixed in a certain position by spasm of the surrounding muscles. This position, which is characteristic for each joint, is the position of greatest comfort for the patient. As the joint cavity becomes distended with fluid, it assumes that position in which it has its greatest capacity, in order that tension and pain may be relieved. This can be demonstrated by distending the joint of a cadaver with fluid. The limb will assume the characteristic position of an inflamed joint during life. The recognition of this characteristic position is a great aid in the diagnosis of arthritis.

Loss of Tone and Wasting of Muscles.—The muscles surrounding and acting upon an inflamed joint lose their tone and waste. This wasting is partly accounted for by disuse of the muscles. This is not sufficient, however, to explain the loss of tone and rapid wasting, especially as attempts to move the joint cause the muscles to go into spasm. It has been suggested that the joint is a trophic nerve centre for the surrounding muscles. The loss of tone is most striking in cases of very chronic arthritis, such as tuberculous arthritis, and its recognition is a valuable aid to diagnosis.

TERMINATIONS OF ARTHRITIS—1. *Resolution.*—This termination is common in traumatic arthritis, but may occur also in arthritis due to bacterial infection. The fluid exuded into the joint cavity is absorbed, and there is a complete restoration to the normal, so that no trace of the previous inflammatory condition is left.

2. *Ankylosis.*—The term "ankylosis of a joint" is applied when the movements of a joint are restricted by union taking place between the two bones forming the joint surfaces. This union may be either fibrous or bony. The term *pseudo-ankylosis* is used when free movement of the joint is prevented by disease or deformity of the surrounding structures, the joint surfaces not being united. This pseudo-ankylosis is a frequent result of fibrosis of the ligaments and the muscles surrounding a joint consequent on inflammation.

Fibrous ankylosis is due to the formation of granulation tissue in the joint, which changes into fibrous tissue in the usual way. The fibres stretch between the joint surfaces and limit their movement. If the movements are forcible so that the fibres are stretched, pain is caused. The fibrosis may be dense and short (short fibrous ankylosis), or loose and long, depending on the extent of the inflammatory process. It is necessary to bear this distinction in mind when considering the treatment of the condition.

Bony Ankylosis is the fusion of the two bones forming the articular surfaces, and can only occur when the articular cartilage has been absorbed. This may occur either with or without suppuration, but is more common in the former case. After the cartilage has been absorbed, the bony surfaces become covered with granulation tissue and adherent to each other. This granulation tissue is invaded by osteoblasts, and new bone is laid down in it so that it may be

impossible to tell where the joint cavity was, the two bones being completely fused together.

Ankylosis, both fibrous and bony, may occur in any position of the joint; but in each joint there is a position in which the joint is most useful if ankylosis does occur. It is of the utmost importance that a joint should not be allowed to ankylose in any but the most favourable position for subsequent use. Pseudo-ankylosis is not uncommon after arthritis, being due to matting of the ligaments or tendons by fibrous tissue, and as the function of the joint may be entirely lost, it is equally important in this condition to see that the joint is fixed in a favourable position for use.



FIG. 253. — COMPLETE BONY ANKYLOSIS OF THE HIP-JOINT.

(London Hospital Medical College Museum.)

3. *Suppuration.*—This termination may be indicated by the increased severity of the general and local symptoms, but frequently its presence can only be determined by aspiration of the joint. The pus is at first confined inside the synovial membrane, but later bursts through the capsule and spreads into the surrounding tissue, the point of bursting and the method of spread being characteristic for each joint. After spreading through the surrounding tissue, the pus reaches the skin, escapes, and a sinus forms, leading down to the joint.

PATHOLOGICAL ANATOMY.—The synovial membrane is at first hyperæmic and swollen, but the surface endothelium rapidly breaks down, and the joint cavity becomes lined with granulation tissue, from which pus exudes. The ligaments become infiltrated with inflammatory exudates, and so softened that the joint surfaces are no longer kept in contact, and pathological dislocation of the joint occurs (see p. 548). The cartilages become eroded, and granulation tissue and pus forming

between them and the bone, they may become stripped from the bone, and form loose bodies in the joint.

The ends of the bones are acutely inflamed and change into granulation tissue, so that the bone is absorbed. In very acute inflammation pieces of bone may become necrosed, forming sequestra in the joint. In the case of children it is not uncommon for the whole of the epiphysis to die and become separated from the diaphysis at the epiphysal line as a sequestrum.

The periosteum, with which the ligaments of the joint are continuous, becomes inflamed, and destruction of the underlying bone occurs; but where the inflammation is not so severe as to end in necrosis of bone, new bone (osteophytes) is laid down by the periosteum, and this new bone may lead to locking of the joint surfaces (pseudo-ankylosis). The surrounding muscles become infiltrated with inflammatory exudates, and undergo fatty degeneration and fibrosis.

After the suppurative process is over and healing has occurred, one of four conditions is present: (1) In a few cases where the inflammation has been confined mainly to the synovial membrane, and where the pus has been evacuated early, almost complete resolution may occur, and there is little trace of the suppuration. (2) Bony or fibrous ankylosis may be present. (3) Pathological dislocation may occur. (4) The destruction of the tissues (especially the bones) may be so complete that the ends of the bone may become covered with fibrous tissue and a flail joint result.

Suppuration in a joint is dangerous to life, either from pyæmia, or if the suppuration is very prolonged, from lardaceous disease and exhaustion.

4. *Pathological Dislocation.*—This condition has already been described on p. 548.

TREATMENT—GENERAL.—The general treatment of arthritis consists of giving the specific treatment for the condition on which the arthritis depends—*e.g.*, gout, rheumatism, typhoid, or gonorrhœa, and in combating the effects of the absorption of bacterial toxins. In any but the mildest form the patient should be kept in bed, the diet should be light and nutritious, and suitable vaccine therapy should be carried out.

LOCAL.—The joint should be put at rest. If the condition is such that ankylosis is extremely unlikely to occur—*e.g.*, acute rheumatic arthritis or mild traumatic arthritis—the patient may be allowed to rest the joint in the most comfortable position. In all other cases the joint should be put at rest on a splint in the best possible position for ankylosis; otherwise ankylosis in a bad position or pathological dislocation may occur. The joint may be forcibly moved from the position of ease to the position of ankylosis either with or without anæsthetic, but in the majority of cases it is better to alter the position of the joint gradually by the use of extension, thus causing less pain

and discomfort to the patient. Extension is also useful after the position of ankylosis is reached, in order to separate slightly the joint surfaces, and so avoid interosseous pressure. The weight must not be too heavy, or the softened ligaments will stretch, and the danger of pathological dislocation be increased.

Cold.—In the very early stage of acute arthritis, and particularly of acute traumatic arthritis, cold in the form of an icebag, cold-water bandages, or evaporating lead lotion, may be applied in order to limit the amount of effusion, but after twenty-four hours it is useless, if not harmful.

Heat.—Heat is more often used in the treatment of chronic than acute arthritis. It is applied by means of fomentations, poultices, or the various forms of baths. It is chiefly of value in diminishing pain and aiding the absorption of inflammatory exudates when these are non-purulent.

Aspiration.—Removal of the fluid from an inflamed joint is carried out for the following reasons:

1. To prevent stretching of the ligaments when the fluid is excessive, and so reducing the danger of pathological dislocation.
2. In order to examine the nature of the exudate, whether serous or purulent.
3. For bacteriological or chemical examination of the fluid, in order to ascertain the cause of the arthritis.
4. For the purposes of treatment, the fluid being first removed, and then the joint washed out with some weak antiseptic lotion.

Drainage.—When acute suppuration has occurred in a joint, the joint cavity must be drained. Incisions are made into the joint, the cavity is washed out, and suitable drainage-tubes introduced.

Massage and Passive Movement.—If the arthritis is likely to end in fibrous ankylosis, and suppuration is not to be feared (as in traumatic or gonorrhœal arthritis), massage and passive movement should be carried out early and vigorously in order to prevent the formation of adhesions in the joint, and to maintain the tone of the muscles. If adhesions have already formed and movement of the joint is painful and limited, it will be necessary to give an anæsthetic in order to ascertain how far the want of movement is due to adhesions or to spasm of the muscles. If the adhesions are few in number, the joint should be forcibly moved under the anæsthetic, so as to break them down and restore free movement; but if the adhesions are short and dense, it is both useless and dangerous to attempt to regain movement. In many cases the bone will break before the adhesions, and even if the adhesions are torn through, they will rapidly re-form. If the case be considered suitable, and the adhesions have been broken down, massage and passive and active movements should be employed in order to prevent their re-formation.

When the chronic arthritis is likely to end in suppuration, as in the case of tubercular arthritis, massage, passive and active movements

are contra-indicated, and the joint must be kept at rest in the best possible position for ankylosis until the condition is considered to be cured. Cautious movement may then be begun, but no force should be used, or quiescent bacilli may become active again.

Pressure and Counter-Irritation.—These methods of treatment are very frequently combined, and are employed to bring about the absorption of the inflammatory exudation. The most usual method of carrying out this treatment is to cover the joint with strips of lint on which a thick layer of Scott's ointment is spread, and then to bind the joint over firmly with strips of lead plaster applied over the ointment. This dressing is removed as soon as it becomes slack.

Balncology.—Bath treatment is very largely used for the various chronic forms of arthritis which do not end in suppuration, such as gout, osteo arthritis, gonorrhoeal arthritis, etc. The baths are of many varieties, the most commonly used being—(1) Natural hot-water springs containing various substances in solution, such as sulphur, or similar baths prepared artificially; (2) tepid baths through which a current of electricity is passed; (3) hot, tepid, or cold water baths the hyperemic effect of which is increased by the method of their application, as by forcible douching or by needle baths; (4) hot mud or peat baths; (5) radiant-heat baths in which the joint is exposed to both heat and light produced by electricity, the most well-known being the Dowsing light bath; (6) dry non-radiant heat bath, in which the joint is exposed to hot, dry air of 300° or 400° F. by means of the Tymaner bath.

Bath treatment is largely carried out in towns where various natural springs are found, as at Bath, Harrogate, Buxton, etc., and is combined with medicinal treatment, drinking the natural spring water, dieting, massage, passive movement, exercises, and electrical treatment. The curative properties of the baths depend mainly upon the active hyperaemia produced by the heat, light, or friction.

Arthroctomy.—This operation is practically limited to cases of tubercular arthritis. It consists of removal of the diseased synovial membrane and the articular cartilages of the joint. The result aimed at is cure of the disease, with fibrosis or bony ankylosis of the joint.

Excision.—Excision of a joint consists of removal of the synovial membrane, and of a portion of one or both of the bones entering into the formation of the joint. The object of the operation is to remove all the diseased tissue and bring about bony ankylosis, or to secure a movable joint. In the lower limb, and for tubercular disease of the joints, bony ankylosis is usually desired; but in the upper limb, free movement is usually aimed at. Excision of joint is chiefly performed for tuberculous disease, and also for chronic suppurative arthritis due to other causes.

SPECIAL FORMS OF ARTHRITIS

Staphylococcic and Streptococcic Arthritis—1. *Direct Infection.*

Direct infection of a joint from these organisms occurs usually from a penetrating wound or a compound dislocation. The condition is

generally severe, ending in suppuration and disorganization of the joint. The ordinary signs of an acute arthritis are present, and there is a purulent discharge from the wound.

The **TREATMENT** consists of fixation of the joint in the best position for ankylosis and free drainage, but if the joint is severely lacerated,



FIG. 251.—SKIAGRAM SHOWING DESTRUCTION OF THE ARTICULAR SURFACES OF SHOULDER-JOINT IN A CASE OF SEPTICO-PYEMIA.
(Suppuration did not occur.)

the question of amputation should always be considered more especially in elderly subjects.

2. *Infection by the Blood-Stream.*—Acute arthritis is one of the common phenomena of septicopyemia. The clinical manifestations of the disease vary considerably. In some cases there are all the usual signs of an acute arthritis with effusion into the joint, and the condition may end in resolution, ankylosis, or suppuration. In other cases the clinical signs are so slight that the condition escapes notice until the joint is found to be distended with pus, or pathologically dislocated.

TREATMENT.—The joint affected should be put at rest in the best position for ankylosis, and the general treatment for septicopyemia

carried out. In many cases, owing to the serious nature of the patient's illness and to the delirium that is often present, it is exceedingly difficult, or even impossible, to immobilize the joints completely. It is not uncommon to find a patient who has recovered from septicaemia with one or more of the joints firmly ankylosed in a bad position, or pathologically dislocated, and the patient may become bed-ridden. Suppuration should be carefully watched for, and if aspiration shows that it has occurred, no time should be lost in opening and draining the joint. Many of these cases do exceedingly well if incision and drainage of the joint are carried out early. Almost complete resolution may ensue; but if drainage is delayed until destructive changes have occurred in the cartilage and bone, the result will usually be disorganization of the joint and pathological dislocation. In some cases excision of the joint or amputation may be necessary.

When the acute condition is over, massage, passive movement, baths, and exercises may be necessary to prevent stiffness of the joint.

3. *Infection from Surrounding Structures.*—Staphylococcal and streptococcal infection of a joint often follows infection of the juxta-epiphyseal bone by these organisms (staphylococci, streptococci, periosteomyelitis, or the acute arthritis of infants), and the bone lesion may be completely masked by the physical signs of the arthritis. These cases nearly always end in suppuration, necrosis of the articular ends of the bone, sinus formation, and disorganization of the joint. The condition is most common in the hip and knee.

TREATMENT.—If the infection of the bone is recognized, the periosteum should be incised, and the bone opened and freely drained. The joint should also be incised and drained, and placed in a splint in the best position for ankylosis; otherwise deformity or pathological dislocation is sure to occur. In cases of severe infection, when the condition has not been seen very early, amputation of the limb is probably the best treatment; or it may become necessary later when there is chronic suppuration with sinuses and lardaceous disease is present. Careful and prolonged treatment will usually result, however, in giving a useful limb, with bony or short, dense, fibrous ankylosis of the joint.

Typhoid Arthritis.—The common form of arthritis due to the typhoid bacilli occurs during the height of the disease (the third week), and most commonly affects the hip. There are usually few symptoms, and, owing to the gravity of the patient's general condition, the local inflammation is often not recognized until pathological dislocation has occurred. There is generally a large effusion into the joint, but suppuration is uncommon, and if pathological dislocation does not occur, the prognosis is good. The treatment consists of immobilizing the joint in the correct position.

In some cases the infection is mixed, or an infection with other organisms than the typhoid bacillus may occur, and then the condition usually ends in suppuration and destruction of the joint.

Pneumococcal Arthritis.—Pneumococcal arthritis may occur (1) as a complication of an attack of acute pneumonia (pneumococcal pul-

monitis); (2) as part of a general pneumococcal infection (peritonitis, meningitis, pericardium, etc.); (3) as an apparently primary infection.

The inflammation is most often acute, but it may be subacute, and there is nothing to differentiate it from other forms of acute arthritis. The DIAGNOSIS can only be fully established by aspiration of the fluid and discovery of the pneumococcus. The condition is more frequent in children than adults, and mostly ends in suppuration. The effusion, however, may be serous and become a sorbol. Several joints may be affected at the same time, and the knee is more frequently attacked than any other joint.

TREATMENT. The treatment is that of any other form of acute arthritis ending in suppuration. The prognosis is not good, owing to the general infection that is frequently present.

Scarlet Fever Arthritis. Two forms of arthritis are commonly met with in scarlet fever: (1) A mild form of arthritis occurring during the first ten days of the illness, chiefly in the upper extremity, and ending in resolution. This arthritis is probably due to the specific virus of scarlet fever. (2) An acute arthritis due to infection with staphylococcus and streptococcus, ending usually in suppuration. The source of the infection is probably the throat lesion usually met with in this disease.

The CLINICAL FEATURES of this arthritis and its TREATMENT are those of other forms of acute arthritis.

Acute arthritis is also met with during the course of the other specific fevers, as smallpox, measles, diphtheria, glanders, and anthraxæmia.

Gonorrhœal Arthritis.—Acute and subacute arthritis are common complications of gonorrhœal urethritis, vaginitis, or conjunctivitis, but are not necessarily due to the gonococcus. Bacteriological investigation of the fluid obtained from the joint may show—(1) the fluid to be sterile; if this is the case, the inflammation of the joint is probably due to toxins circulating in the blood; (2) a pure culture of gonococcus; (3) a mixed infection; (4) a culture of other organisms than the gonococcus, usually staphylococcus or streptococcus.

The arthritis may occur at any stage of the urethritis, and is most apt to attack those patients who have had other joint diseases. The knee-joint, ankle, and wrist are most frequently attacked, but any or every joint may be affected, such as the jaw, symphysis pubis, and the sacro-iliac joints.

The lesion shows no distinctive characteristic, but several clinical types may be differentiated.

1. *Arthralgic Form.*—The patient complains of wandering pain in the joints, but there are no physical signs.

2. *Monarticular Variety.*—The knee-joint is most frequently affected, and becomes filled with a serous or serofibrinous exudate. The condition is usually subacute, and can only be recognized from other forms of arthritis by the presence of the urethral discharge. The prognosis is good, and resolution is generally complete; but the

condition often relapses if there is a fresh attack of gonorrhœa, or the joint may remain chronically distended with fluid.

3. *Polyarticular Form.*—This affects chiefly the tendon sheaths on the back of the wrist and the carpal joints. It is characterized by the amount of periarticular thickening and the small quantity of fluid in the synovial cavity. The fingers and wrist become rigid, and if organization of the exudate occurs, severe crippling of the hand follows. This exudate is also met with in the joint and tendon sheaths of the carpus, and it may give rise to a rapidly developing flat-foot. The inflammation, both in the hand and foot, may rapidly resolve, but it tends to become chronic.

4. *Acute Periarticular Inflammation.* with effusion into the joint, may occur, and the condition end in suppuration. In these cases there is usually a mixed infection of the gonococcus and other pyogenic organisms. A pure infection of the gonococcus may however cause suppuration. The condition pursues the common course of a suppurative arthritis, with destruction of the articular cartilages, necrosis of bone, sinus formation, and finally fibrous or bony ankylosis.

5. *Pyæmic Form.*—This is a part of a general gonococcal infection, the serous membranes, such as the pleura, the pericardium, and endocardium, being also affected. The condition is rare.

TREATMENT.—The *Local* treatment is similar to that of arthritis due to other causes, but owing to the tendency to chronicity and the formation of inter- and peri-articular adhesions, immobilization of the joint must not be long continued. Passive movement, massage, and bath treatment should be carried out early. In some cases, in spite of the most careful treatment, fixation and crippling of the joint will occur. If the effusion becomes chronic, the joint may be washed out with a weak antiseptic fluid, and in the case of suppuration the usual incision and drainage must be carried out.

The *General* treatment consists of treating the urethritis, and, if necessary, giving injections of gonococcal vaccine. Iodide of potassium, which promotes the absorption of inflammatory exudate, mercury, and quinine may be given. Salicylates or aspirin may relieve the pain, but they have little effect on the course of the disease.

Acute Articular Rheumatism.—Though this variety of acute arthritis belongs to the realm of the physician, the surgeon must be able to recognize it from other causes of acute arthritis.

The **CAUSE** of the condition is unknown, but it is believed to be due to a diplococcus. Young people are most commonly attacked. It is a general disease with a tendency to localized inflammation of serous membranes, synovial membranes, and the endocardium, the inflammation ending as a rule in resolution or fibrosis. The arthritis is acute and multiple, and tends to disappear in one joint as it occurs in another. It is accompanied by a moderate or high pyrexia and copious acid sweats.

As a rule the joint condition ends in complete resolution, although fibrous ankylosis may sometimes occur. The diagnosis has to be made from other forms of arthritis and from acute periosteomyelitis.

TREATMENT.—The symptoms nearly always yield to large doses of salicylate of soda or aspirin, and they may be used as a method of diagnosis. As ankylosis is very rare, there is no need to immobilize the joints. For a further description of the disease and its treatment, the reader is referred to any standard book on medicine.

Tuberculous Arthritis

Tuberculous inflammation of joints is much more common in children than in adults, and occurs most frequently in the children of the poor living under bad hygienic surroundings. The onset of the disease can often be traced to a slight injury of the joint.

PATHOLOGICAL ANATOMY.—The disease originates either in the bones forming the joint, usually on the diaphyseal side of the epiphyseal line, or just under the articular cartilage, or in the synovial membrane. The relative frequency of the bony or synovial varieties varies with the age of the patient and the joint affected. As regards the age of the patient, it may be stated broadly that a primary bone lesion is more common in children. In adults the lesion begins with equal frequency in the bone and in the synovial membrane. In the case of the hip-joint the inflammation generally starts in the bone, and that of the knee-joint in the synovial membrane.

When the disease begins in the bone, the infection of the joint occurs by the extension of the tubercular granulation tissue to the synovial membrane at the periphery of the joint where the synovial membrane becomes continuous with the articular cartilage, or in the centre of the articular cartilage. In some cases a tubercular abscess in the bone actually bursts into the joint, and the disease then appears to commence as an acute or subacute arthritis.

Synovial Membrane.—In the usual chronic tubercular arthritis there is a diffuse thickening of the synovial membrane, due to the formation of granulation tissue in it. On microscopical examination, this granulation tissue is seen to be permeated with giant cell systems (see p. 111), which are most abundant and degenerative on the internal aspects of the membrane. The synovial fringes become prominent, and the thickened, pulpy, synovial membrane distends the joint cavity. Later, the granulation tissue breaks down into pus or undergoes fibrosis.

Articular Cartilage.—The tuberculous granulation tissue in the synovial membrane tends to spread over the surface of the articular



FIG. 255.—EARLY TUBERCULOSIS OF THE LOWER END OF THE FEMUR.

cartilage, and to bring about its destruction. In some cases it perforates the cartilage and spreads between it and the bone, so that the whole of the articular cartilage may become separated and form a foreign body in the joint. If the disease progresses, the articular cartilage is destroyed, and the raw surfaces of bone come into apposition.

Bone.—The bone becomes infiltrated with giant cell systems, and undergoes the changes already described under Tuberculosis of Bone. The destruction and absorption of the articular cartilage and the bone is most marked where the two bones entering into the formation of the joint are in contact, and prevention of this interosseous pressure is of great importance in the treatment of tubercular arthritis.

As a rule the destruction of the bone occurs in small particles (caries), but occasionally one large piece of bone may die and form a sequestrum in the joint (caries necrotica). Caries and necrosis are mostly accompanied by the formation of an abscess in or around the joint; but, exceptionally, a large amount of destruction of bone may occur without pus formation. This condition is termed "caries sicca."

Ligaments.—The ligaments holding the joint surfaces together become infiltrated and softened by the tuberculous granulation tissue, and, no longer performing their function efficiently, pathological dislocation of the joint is very apt to occur.

Effusion into the Joint.—The character of the effusion into the joint varies considerably in different instances and at different periods of the disease. In the majority of cases the joint cavity is distended with the pulpy, thickened, synovial membrane, and there is no true effusion into the joint. On the other hand—and especially if the disease is very chronic—the joint cavity may be distended with an abundant serous exudate (tubercular hydrops articulari), or may be filled with small masses of fibrin, which, under the influence of constant movement of the joint, become flattened and rounded (melon-seed bodies). It is exceptional for the joint to contain pus, but if it does so, the synovial membrane then assumes the character of the walls of a tubercular abscess.

Periarticular Abscess.—Abscesses round a tubercular joint are common, and arise in one of several ways:

1. They are due to direct extension of the tubercular process through the ligaments into the surrounding tissue.
2. Extension of the tubercular process to the tissues surrounding the joint, and the formation of abscess in them.
3. Secondary infection of the lymphatic glands near the joint, resulting in suppuration.

These abscesses spread between the muscles and along the tendon sheaths, and may reach the skin a considerable distance from the joint.

RESULTS.—If treatment is efficient in the early stage of the disease, resolution may occur and the joint be restored to its normal condition; but even in the most favourable cases there is usually a certain

amount of fibrosis of the synovial membrane, and some limitation of movement in the joint. Fibrosis is the most usual result of cure of the tubercular process, and firm fibrous or bony ankylosis may occur without any suppuration, the fibrous tissue forming between the joint surfaces and in the periarticular tissue.

In a large number of cases, unfortunately, the condition progresses to suppuration, destruction of the articular surface, and necrosis of the bone. Abscesses form round the joint and burst or are opened, and sinuses result. Other pyogenic organisms then infect the joint, and the destruction becomes more rapid, and pathological dislocation of the joint is a common sequel. Even after this has occurred, healing may follow with an excessive formation of fibrous tissue round the joint, and loss of part of the articular ends of the bones. The contraction of the fibrous tissue leads to the assumption of abnormal positions.

In many cases which are apparently cured the tubercle bacilli are not dead, but quiescent only, and recurrences of the inflammation may occur if the part is subjected to injury, such as a forcible attempt to obtain a movable joint by breaking down adhesions.

CLINICAL FEATURES.—The condition is essentially a chronic arthritis, and the onset is mostly insidious, although it may start with a subacute attack. The early symptoms are *pain*, particularly acute when the joint is jarred, and *rigidity*. In those cases, however, in which the disease originates in the synovial membrane, pain may be entirely absent. The joint assumes the characteristic position of greatest ease, and any attempt to move it is resisted. It is generally swollen and somewhat hot, but the skin is whiter than usual (tumor albus).

The swelling is most often due to pulpy thickening of the synovial membrane, no fluctuation being felt; but occasionally the joint cavity is distended with serous fluid (*hydrops articuli*). The surrounding muscles are wasted, the patient is easily tired, and shows the usual general symptoms of absorption of tubercular toxins.

As the disease progresses and the articular cartilages are eroded, there are "starting pains" at night, due to the movement of the inflamed bones on one another as the muscles relax their strain when the patient falls asleep. Abscesses form round the joint and burst; and if pyogenic infection occurs, there is a hectic temperature, with increase in all the general symptoms, and finally lardaceous disease, exhaustion, and death.

DIAGNOSIS.—The diagnosis has to be made first of all from other forms of chronic arthritis. This is done partly by clinical and partly by laboratory investigation. The age of the patient, the absence of other causes, the history of slight trauma, the insidiousness of the disease, and the thickening of the synovial membrane, are the clinical features in favour of tubercle. The laboratory methods consist of—
(1) Examination of the exudate for tubercle bacilli or other organisms, and a cytological examination as to the predominance of lymphocytes over other white cells; (2) the reaction of the patient to tuber-

culin; (3) the opsonic index of the patient to the tubercle bacillus. Radiography is of value in determining the amount of destruction of the bone, and also in diagnosing tubercular arthritis from other conditions which simulate it. One of the most important of these conditions is a central sarcoma of one of the bones forming the joint, which may very closely resemble tuberculous arthritis, and which is as a rule readily differentiated by radiography.

PROGNOSIS.—The prognosis of tubercular arthritis depends on the age of the patient, the joint affected, and the manner in which general and local treatment are carried out. It may be stated in general terms that the younger the patient, the more favourable the outlook, and that tubercular disease of the larger joints in adults is a most serious condition, frequently ending in amputation, or death. The larger joints, such as the sacro-iliac and the hip-joint, have a much worse prognosis than the smaller ones, and the time occupied in their cure is much longer. Efficient treatment, both general and local, has a most important bearing on the prognosis. In the children of well-to-do parents, the diagnosis being made early and treatment well carried out, tubercular arthritis is usually arrested in the early stages of the disease. In these cases recovery with only slight impairment of movement is common. Among poor children, compelled to live in bad hygienic surroundings, suppuration with destruction of the joint and sinus formation is almost the rule.

TREATMENT—General.—General treatment is of great importance. The patient should be put under the best hygienic conditions, with plenty of fresh air and sunshine. The diet should be generous and easily assimilated, and some form of cod-liver oil should be given. Injections of tuberculin may be of value.

Local.—The first step in the local treatment is to move the joint from the position of greatest ease to the one most useful for the patient if ankylosis should follow. This can be done in several ways:

1. In very early cases, if the patient is put at rest in bed, the spasm of the muscles will disappear, and the joint can be placed in any position. It is important to realize this in the diagnosis of the disease, as after a week's rest in bed all the physical signs of arthritis may disappear, only to reappear if the patient is allowed to move the joint freely.
2. An anæsthetic may be given and the joint moved into position and placed in a splint. The disadvantage of this method is that the spasm of the muscles returns on recovering from the anæsthetic, the two bones being forced together, and interosseous pressure and pain increased.
3. The limb may be placed in a plaster of Paris case in the abnormal position so that it gets complete rest. This case is removed in about three weeks, the position of the limb partially corrected, and a fresh case applied. This is continued until the limb is placed in the desired position.

4. An extension apparatus is placed on the limb, and extension is made in the abnormal position—*i.e.*, in the case of the knee the joint is supported in the flexed position, and extension made in the line of the tibia (see Fig. 277). The amount of weight used should be sufficient to check "starting" pain, but should never cause pain. As the muscles become stretched, the position of the joint can be gradually altered, extension being maintained until the desired position is reached.

After the limb has been placed in the corrected position, the two great indications for treatment are **rest** and the **avoidance of interosseous pressure**.

Rest.—In the case of young children with tuberculosis of one of the joints of the lower extremity, complete recumbency during the whole period of treatment is advisable. In older children and adults complete rest in bed should be carried out for the first few months. The limb should be placed on a suitable splint to maintain the corrected position, and it is advisable that extension should be maintained, so that the joint surfaces are kept slightly separated from each other. If this is done, absorption of the articular cartilage and bone will not be so rapid, and pathological dislocation will be prevented. It is desirable to allow older children and adults up after the first few months in bed. In the case of tuberculosis of the upper extremity, rest in bed is unnecessary.

The joint should be carefully fixed on a splint, so that movement is impossible, and in the case of the lower extremity the weight of the body should be taken off the joint by the patient wearing a patten on the sound limb and using crutches. Many of the splints in use allow of extension being carried out whilst the patient is getting about. The splint must be worn constantly day and night, and only removed for purposes of washing. The period during which absolute rest must be maintained varies with the joint affected and the progress of the disease. It is usually from one to five years and patients should be definitely informed of this directly the treatment is begun.

Bier's Method of Hyperæmia.—This has been largely used in the treatment of tubercular arthritis, and should be given a trial if it does not interfere with rest and the general treatment.

Injection of Antiseptics.—Iodoform is most frequently tried as an injection. The skin over the joint is cleaned as for an operation, and 1 to 2 drachms (according to the age of the patient) of a 10 per cent. solution of sterilized iodoform in glycerin is injected. This injection is repeated every two to four weeks so long as good is thought to result from it, and may be continued even when sinuses have formed round the joint.

TREATMENT OF ABSCESSSES.—The following methods of treating an abscess in connection with tubercular arthritis are used:

THE PRACTICE OF SURGERY

1. Conservative treatment is continued with the hope that the abscess will be absorbed. If it increases in size, it is aspirated, and the cavity filled with iodoform emulsion. Aspiration may be performed several times.

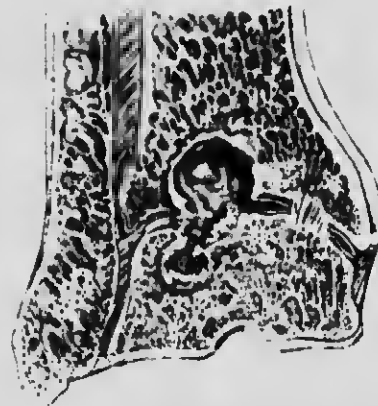


FIG. 256.—TUBERCULAR ABSCESS IN THE TIBIA AND ASTRAGALUS (TUBERCULOSIS OF THE ANKLE-JOINT). (London Hospital Medical College Museum.)

2. The abscess is freely opened, all the pus evacuated, and the walls scraped with a sharp spoon. If any necrosed bone is found at the bottom of the abscess, it is removed. The abscess cavity is then carefully sponged till it is dry, and the wound closed. A large dressing is applied, with considerable pressure, and the wound allowed to heal by the first intention.

3. When a secondary infection has occurred or the ab-

scuss is pointing, it must be opened and drained, but this should always be avoided if possible.

TREATMENT OF SINUSES.—Even after sinus formation has occurred, conservative treatment should be persevered with. In many cases, however, operation is necessary. An X-ray photograph of the joint should be taken in order to estimate the extent of the destruction of the bone and to determine the presence of any sequestra. Before taking the photograph the sinuses may be filled with bisnuth paste, so that their extent and direction can be clearly ascertained. The sinuses are then laid open, any necrosed bone removed, and their walls carefully scraped; they must then be made to granulate from the bottom. Careful splinting is necessary during the whole period of the healing of the sinuses.

OPERATIVE TREATMENT.—The modern method of treatment of tubercular arthritis is conservative by rest and the avoidance of interosseous pressure, but operative measures are necessary in some cases. Operation should be performed earlier in adults than in children, as recovery under conservative treatment is not so common and relapses are more frequent. There is not the same danger of interference with growth by damage to the epiphysial cartilage in adults as there is in children. The prolonged period of rest necessary for conservative treatment is also not so easily obtained in adults, and operative measures may considerably shorten the time of cure.

Operative treatment should be carried out earlier in some joints

than in others. In tuberculous arthritis of the sacro-iliac joint, for example, operation should be performed early, as the prognosis for conservative treatment is bad. In joints such as the elbow, where a large portion of bone can be removed, and a movable joint is of the utmost importance, operative treatment should be carried out earlier than in the case of the hip, where the results of operation are exceedingly poor. Operation will also be indicated when radiography shows the presence of large sequestra, and when secondary infected sinuses are present and show no signs of healing.

The classical operations that are performed are **arthrectomy** and **excision** of the joint; but in the majority of cases in which conservative treatment has first been thoroughly tried, the modern operation partakes of the nature of both these operations. The joint is well exposed, and all the diseased tissue is removed with scalpel, scissors, bone forceps, and gouges. The operation resembles somewhat that undertaken for a new growth, all the diseased tissue being removed, and, as far as possible, the sound tissue preserved. Antiseptics are freely used during the operation, and the wounds closed with drainage.

After these operations, rest and splint treatment must be continued until the joint is soundly healed.

The treatment of the deformities following tubercular arthritis will be considered under the treatment of the disease in the various joints.

Amputation.—Amputation for tuberculous disease of joints is becoming steadily rarer, but it is still indicated if conservative and operative treatment have failed and the patient is losing flesh and strength, or lardaceous disease is present. Amputation is relatively more often necessary in adults than in children.

Syphilitic Arthritis

1. **SECONDARY ACQUIRED SYPHILIS.**—In the early stages of secondary acquired syphilis the patient may complain of wandering pains in the joints, which are usually worse at night. There are no physical signs, and the condition yields to antisiphilitic treatment. The term "arthralgia" is used for this condition.

Later, in the secondary period, the patient may suffer from a subacute arthritis with effusion into the joint. The condition is frequently multiple and symmetrical, and the effusion may be considerable, forming one of the varieties of hydroys articuli. Pain is not a prominent symptom, and the patient may be getting about with both knee-joints distended with fluid. The condition usually yields rapidly to antisiphilitic treatment, but pathological dislocation from distension may occur.

2. **TERTIARY ACQUIRED SYPHILIS**—(1) *Periarticular Gummata.*—This condition most frequently affects the knee-joint, and consists of the formation of multiple gummata in the periarticular tissues. There is some effusion into the joint, but only slight functional disability. The diagnosis is made by the history and the finding of several nodules round the joint, which will tend to become softer in the centre. If

the condition is neglected, the gummata spread to the skin and burst, but even then healing is usually sound under antisyphilitic treatment, and the joint is little interfered with.

(2) *Interarticular Gummata*.—In these cases the syphilitic granulation tissue invades the synovial membrane and the articular cartilage, interfering considerably with the function of the joint and leading to great impairment of movement. The condition closely resembles tuberculous arthritis, from which it is distinguished by the history, the nodular nature of the synovial thickening, and the presence of Wassermann's reaction in the blood-serum. The effects of treatment are very important in arriving at a differential diagnosis. If this form of syphilitic arthritis is not promptly treated, considerable functional disability will occur.

(3) *Syphilitic Osteo-Arthritis*.—This affection resembles osteoarthritis from other causes. The articular cartilages become eroded, and the bone is exposed, and the synovial membrane may become thickened. Periarticular gummata may form and burst, so that sinuses leading down to the joint result. Pain is not a marked feature of this disease, and there is absence of lifting of the bone.

3. **INHERITED SYPHILIS**.—(1) Syphilitic osteochondritis (syphilitic epiphysitis), occurring during the first few months of life, is not infrequently associated with effusion into the joints, and in rare instances secondary infection and suppuration may follow.

(2) About the age of puberty the patient may suffer from a painless symmetrical arthritis, usually of the knees, with effusion into the joint cavity. The condition is chronic, and may resist treatment for months. It is characterized by the rapid fluctuations in the amount of fluid in the joints. Antisyphilitic treatment usually brings about complete recovery.

(3) Periarticular gummata and interarticular gummata may occur in the inherited or in the acquired disease.

TREATMENT.—The *General* treatment of syphilitic arthritis consists of the giving of mercury or salvarsan, combined, in the tertiary period, with iodide of potassium. The *local* treatment is similar to that of other forms of subacute and chronic arthritis, but prolonged immobilization is unnecessary.

Operative treatment is only necessary in neglected cases in which disorganization of the joint has been allowed to occur.

Gout.—Gout is a general disease of metabolism, among the manifestations of which are acute and chronic inflammation of the joints. The inflammatory condition is associated with the deposit of crystals of urate of soda in the substance of the articular cartilage and sometimes in the bone and synovial membrane, where it appears as white plaques. Certain joints, such as the metatarsal-phalangeal joint of the great toe, are much more prone to be attacked than others. The condition may be monarticular or polyarticular.

SYMPTOMS.—In acute gouty arthritis the onset of the symptoms is sudden and severe, occurring usually in the early morning. There is intense throbbing pain, the joint becomes swollen, and the skin

over it is red and shiny. The slightest movement or jarring causes intense agony, and the patient is completely incapacitated. The condition may subside in a few days, or continue for weeks and pass into a chronic condition. In the interval between the attacks the patient may be quite free from joint symptoms, but after frequent attacks, symptoms and physical signs resembling osteo-arthritis are present, and the patient may become completely crippled.

For further considerations of this disease and its treatment, the reader is referred to textbooks of medicine.

Osteo-Arthritis (Arthritis Deformans, Rheumatoid Arthritis, Rheumatic Gout).—Osteo-arthritis is a subacute or chronic inflammatory condition of joints, leading to degeneration of the various structures that form the joint, this degeneration being associated with a certain amount of hypertrophy. The condition is not a pathological entity, but it is convenient to include several different joint affections under this term, as the pathological anatomy of the diseased joint and the clinical features of the disease are similar in nature.

In connection with this chronic degeneration of joints, the following etiological factors may be considered, but in many cases two or more of them combine to bring about the diseased condition:

Trauma.—Osteo-arthritis may follow a definite injury, which may have only produced at first a slight traumatic arthritis or may have been severe enough to cause dislocation of the joint. This sequel to an injury of the joint is more likely to occur in patients who are already the subjects of chronic joint affections, such as chronic rheumatism or gout, or in elderly people. In some cases it is probable that the injury calls attention to a joint that is already the seat of osteo-arthritis from other causes.

Abnormal and Excessive Strain.—After fractures in which the fragments of bone have not been placed in accurate apposition, an abnormal strain is frequently thrown upon the neighbouring joints, and they tend to develop osteo-arthritis, especially at the places where the strain is excessive. A similar condition is seen in joints subjected to abnormal strain from the presence of a deformity, such as the knee-joint in genu valgum, and the metatarsal-phalangeal joint of the great toe in flat-foot. Excessive strain from certain occupations or repeated slight injuries of a joint arising from an occupation, may bring about the development of this condition, to which the term "trade arthritis" has also been given.

Cold and Damp.—Osteo-arthritis is most common in those districts which are cold and damp and have a clay soil. It is particularly prevalent in agricultural labourers whose occupation exposes them to the effects of cold and damp. Whether cold and damp are exciting or predisposing causes to the condition is uncertain.

Auto-Intoxication.—The formation of toxins by abnormal metabolism of the body or in the intestinal canal and their absorption are believed by some to be the cause of the joint condition. Arbuthnot Lane believes chronic constipation with copremia to be a most important etiological factor. Others ascribe the condition to the ab-

normal formation of lactic acid either in the stomach or in the general metabolic processes.

Infection.—In many cases of osteo-arthritis some focus of chronic infection can be found, such as oral sepsis, a urethral or vaginal discharge, or suppuration in one of the accessory sinuses of the nose. The absorption of the toxins of the various bacilli causing the condition is believed to bring about the joint changes.

Other observers have believed in the presence of a specific bacillus causing the inflammation of the joints, absorption of its toxins accounting for the general symptoms from which the patient may suffer.

Presence of Foreign Bodies.—Osteo-arthritis may follow the repeated attacks of arthritis due to the slipping of a loose semilunar cartilage or the presence of a foreign body in the joint. The effusion of blood into the joint that occurs in some cases of hæmophilia may also be followed by osteo-arthritic changes.

Senility.—Elderly people, in whom none of the above factors are present, may suffer from osteo-arthritic changes, and the condition may be looked upon as senile degeneration of the joint.

PATHOLOGICAL ANATOMY.—Although the pathological changes are always those of degeneration, the superficial appearance of the joint varies considerably in different cases.

Synovial Membrane.—As a rule the synovial membrane is vascular and thickened and the synovial villi hypertrophied, so that they hang like shaggy fringes into the joint cavity, sometimes being large enough to be felt on clinical examination. In some cases there is a large increase in the subsynovial fat, which develops in the villi, giving the condition known as "lipoma aborescens." Chondrification, and finally ossification of the synovial fringes at the edge of the articular cartilage, may occur, and the fringes may then break off and form foreign bodies in the joint. Occasionally this thickening of the synovial membrane is absent, and it undergoes degeneration into fibrous tissue, which contracts.

Effusion into the Joint.—The amount of effusion into the joint is generally moderate, but in those instances in which the hypertrophy of the villi is marked, the joint may be enormously distended, forming one of the varieties of hydrops articuli. On the other hand, with cicatricial contraction of the synovial membrane, the fluid in the joint may be less than normal and much thinner than synovia (arthritis sicca).

Articular Cartilage.—The cells of the cartilage first become increased in number and degenerated; this is followed by fibrillation of the cartilage, its surface becoming roughened and the cartilage softer than normal. At those places where the interosseous pressure is marked, this softened cartilage becomes worn away and the underlying bone exposed; but at the edges of the joint, away from the pressure, the cartilage becomes proliferated, and grows into the synovial villi and ligaments, projecting into the joint as irregular overgrowths (eccbondroses), which finally may become ossified (osteophytes). The edges of the joint surfaces therefore become irregular and thickened.

a condition spoken of as "lipping" of the bones. This irregular growth of bone may be so excessive that the joint surfaces become locked and pseudo-ankylosis of the joint occur; but bony ankylosis, except in the case of osteoarthritis of the spine (spondylitis deформиans), is rare.

Bones.—The articular ends of the bones also undergo degeneration and soften, the bone wearing away, except on the surface, where interosseous pressure is marked. Here the superficial layer of the bone becomes hard and polished (oburnated), and may be grooved where the two bony surfaces work on one another. At the edges of the joint hypertrophy of the bone occurs, causing the lipping described above.

Ligaments.—The ligaments share in the general degeneration of the joint tissue and become softened. If there is much fluid in the joint cavity, the ligaments may be stretched, and there may be hypermobility of the joint; but more commonly, however, chondrification and ossification of the ligaments occur, and this, combined with the presence of the osteophytes, causes extreme limitation of the movements of the joint.

Muscles.—The muscles surrounding the joint lose their tone and undergo fatty degeneration. There is frequently loss of elasticity, and pigmentation of the skin of the limb.

CLINICAL FEATURES—1. *Polyarticular Variety occurring in Children (Still's Disease).*—This variety more frequently affects girls than boys, and is seen in the first ten years of life. Many joints are implicated, but the disease chiefly affects the synovial membrane, and marked bony and cartilaginous changes are absent. The neighbouring lymphatic glands are enlarged, and there is also enlargement of the spleen. Serous membranes, such as the pericardium and pleura, may be affected, and adhesions form between their surfaces.



FIG. 257.—OSTEO-ARTHRITIS OF THE KNEE-JOINT.
(London Hospital Medical College Museum.)

2. *Subacute Polyarticular Variety*.—This form of the disease mostly attacks young adults, especially anemic girls, and often follows one of the infective fevers. The condition occurs as attacks of subacute arthritis, each attack leaving the joint more crippled than it was before. The disease tends to start in the smaller joints of the hands and feet. It is mainly symmetrical, and finally all the joints of the body may be affected. The articular attacks are associated with rise of temperature, tachycardia, sweating of the hands and feet, and pigmentation of the skin. The attacks of arthritis may continue for years, and the patient finally left completely crippled. The attacks may then cease, the general symptoms disappear, and the patient be without pain and in comfort, except for the crippling of the limbs. Treatment may be of great value in arresting the progress of the disease.



FIG. 958.—OSTEO-ARTHRITIS OF THE HEAD OF THE FEMUR, SHOWING EBURNATION OF BONE.
(London Hospital Medical College Museum.)

3. *Chronic Polyarticular Variety*.—This is most frequently seen in late adult life, and is also more common in females than in males. The joints first affected are the small joints of the hands and feet. The condition is characterized by the appearance of small bony out-growths at the bases of the phalanges, termed "Heberden's nodules." The disease tends to spread to the large joints, but its progress is very slow, and it may take many years to produce any serious crippling. It is the chronic rheumatism or rheumatic gout commonly met with amongst the poor, hard-working female population. Many cases of it can be seen in any workhouse infirmary.

4. *Monarticular Variety*.—This is the form most usually seen by the surgeon, for it either develops after an injury, or becomes apparent

because of some slight injury. The disease appears to be limited to the injured joint when a trauma was the directly exciting cause; but sometimes slight evidences of the trouble can be found in the other joints of the body. The condition is most often seen in elderly people, but it may occur in quite young subjects who have an inherited tendency to joint inflammations (arthritic diathesis).

PHYSICAL SIGNS IN THE JOINT.—The patient will complain of pain in the joint, which is worse when he is warm in bed at night, and is increased by movement. He will also complain of stiffness in the joint, which is worse after resting, and becomes less as the limb is moved. On examination of the joint, there may not be any increase in the amount of fluid, according to the type of disease present; but if the joint is moved, there is felt a creaking, which, as the condition progresses, becomes a true bony crepitus. The ends of the bones may be enlarged, and the characteristic pipping may be felt at the edges of the articulation. In some cases the hypertrophied and chondrified synovial fringes may be felt as foreign bodies in the joint. Distension with fluid of the bursa in connection with the joint is not uncommon, and Morsant Baker cysts may form. Radiography may show the alterations in the bony surfaces of the joint.

As the disease advances, the patient becomes more crippled, and characteristic deformities frequently appear. For example, in the hip-joint the neck of the femur becomes absorbed, and coxa vara is present. In the knee an exaggerated condition of genu valgum frequently develops. The deformity in the hands is often characteristic, the small joints being swollen with nodular thickenings at the bases of the phalanges, and the whole hand and fingers are deflected to the ulnar side. In the shoulder the bicipital groove often becomes roughened, and the tendon of the biceps may become so frayed that it ruptures on very slight violence (see p. 350).

PROGNOSIS.—The prognosis is very uncertain. In some cases, although nothing can restore the joint to its former condition, the progress of the disease is arrested, and the patient is left with slight crippling in one joint. This is liable to be increased in damp weather, and from slight traumatism. In other patients, in spite of the most careful treatment, the disease steadily progresses until every joint in the body may be crippled. Even then the disease is not incompatible with long life, and the patient may die of some intercurrent disease, frequently pneumonia.

TREATMENT—General.—The patient should, if possible, live in a dry climate and on a gravel or sandy soil. Wet and exposure of all kinds are to be avoided. The diet should be generous, but opiates are divided as to the value of abstinence from carbohydrates or proteid diet. Drugs are of little value, the most commonly used being iodide of potassium, guaiacum, arsenic, and the natural mineral waters of Bath, Buxton, Harrogate, and the various Continental spas.

Careful attention and treatment should be given to any source of toxic absorption, such as carious teeth, antrum suppuration, gleet,

or chronic vaginitis. Chronic constipation should be relieved by appropriate treatment.

Local.—Only during the acute exacerbations of the disease should the joint be kept at rest. Every effort should be made to increase and maintain the mobility of the joints without strain or violence. Massage, passive movements, and exercises, are all necessary, and should be persevered with. The various forms of bath treatment (see p. 556) are all valuable, and each and every one of them may be tried with benefit to the patient.

The joints should always be kept wrapped in flannel. Stimulating liniments to increase the hyperæmia are of some value.

OPERATIVE TREATMENT.—In a few cases in which the disease is limited to one joint, and has so advanced that the patient is seriously crippled, excision of the joint may be performed with benefit. This operation is most useful in the case of the knee, elbow, and jaw; but suitable cases for its performance are most uncommon.

Joint Affections in Hæmophilia.—Hæmorrhage into one or other of the larger joints is by no means uncommon in hæmophilia, and the usual signs and symptoms of a hæmarthros are present. The joint is swollen and painful, and held in the position of greatest ease, and the patient suffers from a rise of temperature and general malaise. In the course of a few days the characteristic staining of the skin associated with deep-seated hæmorrhage is apparent. The blood is slowly absorbed, and the joint returns to a normal condition in the course of a few weeks. If the hæmorrhage is repeated several times into a joint, the blood does not become absorbed, but remains in the joint as a foreign body. Gradually degenerative changes appear precisely similar to those seen in cases of osteo-arthritis, and the patient suffers from the usual symptoms of this condition.

TREATMENT.—While the joint is acutely distended with blood it should be kept absolutely at rest in the position of greatest ease, but as the blood becomes absorbed, very gentle massage and passive movements should be used to prevent stiffness. Under no circumstances must the joint be vigorously manipulated, or the hæmorrhage will return. If the joint cannot be readily moved, gradual extension by weight and pulley should be tried. When the osteo-arthritic change becomes evident, the usual treatment should be carried out, but the utmost care to prevent injury must be taken throughout the whole of the treatment.

Loose Bodies in Joints.—Loose bodies present in joints fall into three distinct pathological and clinical groups:

1. *Fibrinous Loose Foreign Bodies (Melon-Seed Bodies)*—These foreign bodies are small and multiple, and it is not uncommon to find several hundreds in a joint. They are composed of fibrin arising from inflammatory exudates into the joint, or from altered blood-clot. At first they are irregular in shape, but by the constant movement and friction of the joint they become rounded and flattened, somewhat resembling small melon-seeds. They are usually associated

with tubercular disease of the joint, but may be present in osteo-arthritis, Charcot's disease, and hæmophilic joints. When they are present, there is usually excess of fluid in the joint, and they may be diagnosed by the curious creaking sensation they give when the joint is moved. They more frequently occur in tendon sheaths and hursæ than in joints.

CLINICALLY, they do not give rise to any characteristic symptoms, and are frequently only discovered when the joint is explored.

TREATMENT.—The treatment is that of the primary joint disease.

2. *Multiple Loose Bodies associated with Obvious Joint Disease.*—

This variety of loose body in joints is usually associated with osteo-arthritis, and the loose bodies are hypertrophied and frequently chondrified or ossified synovial fringes, which have become pedunculated or actually detached, and free in the joint cavity. These loose bodies may grow after they are detached, and become as large as a walnut. They vary in number from half a dozen to several hundreds.

CLINICALLY, the signs of osteo-arthritis are usually obvious, and there is excessive creaking in the joint. In some cases loose bodies can readily be felt, or can easily be seen in a radiogram. As a rule the only symptoms are those of osteo-arthritis, but as an exception they may give rise to the symptoms about to be described of a solitary loose body.

TREATMENT.—The treatment is that of osteo-arthritis, but if the loose bodies are giving rise to definite symptoms, they must be removed.

3. *Solitary Foreign Body in an Otherwise Healthy Joint.*—These are portions of articular or intra-articular cartilage which are broken off by mechanical violence, synovial fringes which have become chondrified from osteogenic cartilage cells, or portions of articular cartilage which have become detached from the underlying bone by "quiet necrosis" or osteochondritis dessicans. These foreign bodies may be quite free or attached by a pedicle. They are usually smooth and rounded, about the size of a horse-bean, and give rise to characteristic clinical symptoms. They are almost always found in the knee-joint.

CLINICAL FEATURES.—The patient who is not conscious of any joint trouble is suddenly seized with violent pain in the joint, which becomes locked. The pain is often agonizing, and followed by an acute attack of arthritis, in which the joint cavity is distended with fluid. When this subsides, the function of the joint is usually completely restored until another attack similar to the first occurs.

After a time the patient will frequently become aware of the movement that causes the locking, and also how the loose body can be disengaged. He may also be able to produce and locate the loose body. A curious feature about this condition in many cases is the way in which a loose body will slip away and disappear, and may not again be evident for months.

The loose body will be seen in a radiogram if it contains hene. If

the condition remain untreated, and the attacks of synovitis are repeated, the chronic degenerative changes of osteo-arthritis supervene.

TREATMENT.—If possible, the loose body should be isolated and fixed before the anæsthetic is given, then the capsule incised over the place, and the loose body slipped out. If this is not done, there is often considerable difficulty in finding the piece of cartilage, but it can usually be discovered by directing a strong stream of water into the joint. The joint capsule should be closed without drainage.

It will be noted that the symptoms are precisely similar to those of loose internal semilunar cartilage in the knee, which is one of the varieties of loose bodies in that joint.

DISEASES OF JOINTS SECONDARY TO DISEASES OF THE NERVOUS SYSTEM

Neuro-Arthropathy—Charcot's Disease

Arthropathy of Tabes Dorsalis.—Lesions of the joints in tabes dorsalis most commonly occur in the ataxic stage of the disease, but they may occur earlier, and precede any of the other symptoms. The onset of the affection frequently follows some slight injury, and the progress is often extraordinarily rapid. The joints most affected are those of the lower extremity, especially the hip and knee; the disease may be bilateral.

PATHOLOGICAL ANATOMY.—Two types are distinguished—the *atrophic* and the *hypertrophic*. In both the pathological changes met with in the joint closely resemble those of osteo-arthritis. In the atrophic variety there is extensive destruction of the articular cartilage and the articular ends of the bones; the ligaments are softer and stretched, and there is considerable effusion into the joint, which becomes weak and flail-like. The hypertrophic form resembles a severe degree of osteo-arthritis, with extensive formation of new bone, which may lead to locking of the joint in the later stages; but in this, as in the first variety, the main characteristic is hypermobility. Loose bodies may be present in considerable numbers.

CLINICAL FEATURES.—The disease is quite painless, and the patient only complains of the swelling and instability of the joint. On examination, the joint is usually much swollen, with a considerable amount of fluid in the capsule; but in the hypertrophic variety the swelling is chiefly due to new bone formation. Movements of the joint are painless, and there is usually hypermobility in all directions, and pathological dislocation may occur. On moving the bones on one another, there is frequently marked grating, and the presence of a number of loose bodies may make the joint feel like a bag of bones. The amount of functional disability varies with the disorganization of the joint, but the absence of pain allows the joint to be used with greater freedom than appears possible on examination.

A radiogram will show the extensive changes in the bones. The course of the disease varies considerably. In one case the

joint may be disorganized and useless in a few weeks, whilst in another there may be retrogression of the symptoms, with considerable improvement in the function.

The **DIAGNOSIS** is made by the physical signs in the joint, the absence of pain, and the presence of other symptoms of tabes dorsalis.

TREATMENT.—The treatment of the joint lesion consists of supporting the joint with splints and other apparatus, and in cases of disease of the lower extremity the patient must use crutches. If the amount of fluid is excessive, it should be removed by aspiration. In some cases of Charcot's disease of the knee-joint, in which the symptoms



FIG. 259.—CHARCOT'S DISEASE OF THE KNEE: ATROPHIC FORM.
(London Hospital Medical College Museum.)

of the nervous disease are not advanced, and the patient is a suitable subject for operation, excision of the joint, with an attempt to secure bony ankylosis, may be successful; but the cases must be very carefully selected. Amputation is sometimes advisable when the limb is useless.

Arthropathy in Syringomyelia.—The joint lesions in this disease closely resemble those in tabes dorsalis, but the joint affected is most frequently the shoulder.

The condition is entirely painless, and even with extensive destruction of the joint, the patient may have a useful arm. Suppuration may follow infection from the trophic ulcers that are apt to develop in this disease.

The **TREATMENT** is similar to that of tabetic joints.

Arthropathy following Lesions of the Peripheral Nerves.—The trophic lesions following division of the main nerve trunks in the hands and feet have already been described. Among other lesions, there is an arthropathy of the joints—especially the terminal—of the fingers and toes.

The joints become swollen and painful, and in a few cases bony ankylosis results.

The treatment is to restore the physiological continuity of the nerve trunks.

In other lesions of the nervous system, such as homiplegia, paraplegia, infantile paralysis, spina bifida, etc., joint lesions may occur, but they are rare.

Functional Disease of Joints (Hysterical Joint, Neuromimesis).—

The condition is most frequently seen in young girls about the age of puberty, but sometimes also in quite young children and in men.

The condition is becoming more common in male adults since the introduction of the Workmen's Compensation Act, owing to the litigation which often takes place. The condition frequently arises after a slight accident, pain and rigidity being the symptoms chiefly complained of. The pain is generally of an exaggerated character and increased by touching the joint; but if the patient's attention is distracted, deep pressure may be borne without complaint. The rigidity is also exaggerated, no movement being possible if ordinary force is used, and the muscles controlling the joint are seen to be in rigid spasm directly any attempts to move the joint are made. The joint is often held in an abnormal position, which may be quite different from that assumed by an inflamed joint, and there is neither heat nor swelling. In some cases in which the joint has been disused for some time there may be an apparent swelling of the joint owing to the wasting of the surrounding muscles; but careful measurement will show it to be the same size as the opposite one. The joint may be kept contracted and unused for years, secondary changes then appearing in the ligaments and joint surfaces, making free use of the joint impossible.

DIAGNOSIS.—The diagnosis has to be made on a knowledge of the nervous condition of the patient, the exaggeration of the symptoms, especially that of pain, and the absence of the characteristic symptoms of organic disease, but the diagnosis of hysterical joint should not be made until every other affection of the joint has been excluded. Radiography will show the absence of bony defects, and examination under an anæsthetic will demonstrate the free mobility of the joint.

TREATMENT.—The treatment is that of other hysterical conditions, and consists mainly of discipline and suggestion. The absence of organic mischief should be explained and, if possible, demonstrated to the friends of the patient, so that they may help intelligently in the treatment; and if they cannot be convinced, the patient should be secluded from them. Splints and all forms of apparatus should be avoided, but massage, passive movement, and electricity may be useful.

The general health should be improved in every way. The question of litigation arising after slight injury is considered under Traumatic Neurasthenia (see p. 373).

NEW GROWTHS OF JOINTS

New growths arising from the synovial membranes or articular surfaces of a joint are exceedingly rare, and only two need be mentioned—chondroma and sarcoma.

Chondroma of Joints.—Multiple cartilaginous tumours, projecting into the joints as loose bodies, may arise from the synovial membranes of joints, and give the symptoms of loose bodies. The tumours are composed of pure hyaline cartilage, and may be so numerous that the joint cavity is full of them.

The TREATMENT is removal.

Sarcoma of Joints.—A sarcoma may secondarily invade a joint from the cancellous tissue of the bone forming the articulation, but primary sarcomata sometimes arise from the synovial membrane. The growth appears as a nodular swelling at one part of the joint, but this physical sign is often obscured by a blood-stained effusion into the joint. The diagnosis is only to be made by exclusion of other conditions and exploration of the joint.

The TREATMENT is amputation of the limb.

DISEASES OF THE VARIOUS JOINTS

Temporo-Maxillary Articulation

Inflammation of this joint is shown by redness over its outer aspect in front of the ear, and inability to open the mouth. The mouth is held slightly open, and there is spasmodic contraction of the masseter and pterygoid muscles. If ankylosis results, the mouth is generally closed. Should suppuration occur, the pus points externally on the face or into the external auditory meatus.

Gonorrhœal Arthritis.—This is frequently bilateral and subacute. Under treatment resolution is the rule, but ankylosis of the joint may follow.

Pyogenic Arthritis.—Pyogenic infection of the temporo-maxillary joint may follow pyogenic infection of either the upper or lower jaw, and is usually associated with carious teeth, suppuration in the mastoid antrum, or suppurative parotitis. It may be pyæmic in origin. The condition usually ends in ankylosis.

Tubercular Arthritis.—This is rare, and, as a rule, secondary to tubercular disease of the temporal bone or lower jaw. The treatment consists of thorough eradication of the disease by operation.

Osteo-Arthritis is the commonest affection of the temporo-maxillary joint, and generally ends in destruction of the interarticular cartilage and locking of the jaw by osteophytic outgrowths. The mouth is held slightly open, and the condition is usually bilateral.

The TREATMENT is that of osteo-arthritis in general.

Ankylosis of the Jaw.—Two varieties of ankylosis of the jaw are described, extra- and intra-articular.

Extra-articular ankylosis is due to cicatricial contraction occurring in the soft tissue round the joint. It follows such conditions as cancerum oris, suppurative tonsillitis, necrosis of the lower jaw, suppurative parotitis, etc.

Intra-articular ankylosis is due to inflammatory conditions in the joint itself, leading to adhesions. It may be fibrous or bony.

TREATMENT.—The necessity for treatment depends on the amount of movement present in the joint, and the amount of interference with mastication and speech. In mild cases with fibrous ankylosis, passive and active movements may be all that is necessary.

OPERATIVE TREATMENT.—The operative treatment depends on the variety of the ankylosis, whether intra- or extra-articular. With intra-articular ankylosis, excision of the condyle and as much bone as is necessary to give free movement is the operation of election. It should be carried out through an incision along the lower border of the zygoma. If possible, the interarticular fibro-cartilage should be left.

For extra-articular ankylosis, and in some cases in which the above operation fails, a false joint should be established by removing a wedge-shaped piece of bone from the lower jaw in front of all the cicatricial tissue, and if necessary the operation should be done on both sides. The wedge should be sufficiently large, with the base downwards and backwards.

After both these operations, early passive and active movements are necessary to prevent recurrence of the ankylosis, movements under anaesthesia being often necessary at first.

Sterno-clavicular Articulation

Inflammation of this joint shows itself as redness and swelling over the front of the joint, and inability to move the arm freely and without pain. Acute arthritis of the joint may be due to the gonococcus, but more commonly it is infected with pyogenic organisms in the course of septico-pyæmia. Should suppuration occur, the joint should be opened from the front.

Tubercular Arthritis of this articulation is rare, and presents the usual symptoms and physical signs of a chronic arthritis.

The **TREATMENT** consists of immobilization of the shoulder by Sayre's method of strapping, but if the disease progresses, excision of the joint should be performed early, and an attempt made to secure bony ankylosis. Should this be successful, the movements of the shoulder are but little impaired.

Osteo-Arthritis frequently affects the sterno-clavicular joint in the polyarticular form of the disease, and requires the usual treatment.

Shoulder-Joint

In inflammation of the shoulder-joint the swelling is generally first present in front in the sheath of the tendon of the biceps muscle, which communicates with the cavity of the joint. Later there is fulness in the axilla. Occasionally the subdeltoid bursa communicates with the joint, and becomes distended with fluid, causing the shoulder to appear more rounded than usual. With acute inflammation the characteristic position assumed is for the arm to be hanging by the side, with slight abduction and internal rotation, but later the head of the humerus is adducted and drawn upwards towards the coracoid process. The most useful position for *ankylosis* is slight abduction, but there is never any need for extension, as the weight of the limb, combined with a pad in the axilla, is all that is necessary to give the required position. Ankylosis of the shoulder-joint is not a serious condition, as the absence of movement of the shoulder can be largely compensated for by hypermobility of the scapula. The joint should be *aspirated* from the front, and if drainage is necessary, it should be opened from the front between the deltoid and pectoralis major, and a counter-opening made posteriorly along the posterior edge of the deltoid.

Excision of the head of the humerus is performed through an anterior incision between the deltoid and pectoralis major, the skin incision running downwards and outwards from $\frac{1}{2}$ inch below the tip of the coracoid process.

Pathological Dislocation takes place forward under the coracoid process.

Tubercular Arthritis.—Tubercular arthritis of the shoulder is met with in young adults, the disease generally starting in the head of the humerus, and affecting, secondarily, the synovial membrane. It is very insidious in its onset, and frequently there is no effusion into the joint, the pathological change mainly consisting of a dry caries of the head of the humerus and glenoid cavity (*caries sicca*). In other cases there is effusion into the joint, which is generally first noticed along the course of the biceps tendon.

SYMPTOMS.—The symptoms are pain and loss of movement in the shoulder, with wasting of the surrounding muscles, so that the acromion process and the tuberosities of the humerus become unduly prominent. Radiography will show the destruction of the bones. The head of the humerus may become loose in the joint as a sequestrum. The diagnosis from osteo-arthritis is often difficult on account of the slow progress of the disease and the absence of suppuration.

PROGNOSIS.—Although the disease may last for years, the ultimate prognosis is good, but fibrous ankylosis and considerable loss of movement of the joint will result.

TREATMENT.—The joint should be put at rest in the following manner: The wrist is supported in a sling fastened round the neck, a cotton-wool pad placed in the axilla to abduct the arm slightly, and the arm is then strapped to the side, the strapping going quite round the

chest. A light plaster of Paris case can with advantage replace the strapping. The patient's clothes must go on over the arm, as in no other way can continuous rest be given.

Eric'sen's shoulder-cap may also be used. It consists of a poroplastic or leather cap accurately moulded to the shoulder, and held in position by straps; the wrist is suspended in a sling. The apparatus,



FIG. 260.—CARIES SICCA OF THE SHOULDER-JOINT.

however, does not give the same amount of rest as the above-mentioned method of fixation. The shoulder must be kept at rest for at least six months after all symptoms have disappeared, and return to use must be very gradual.

Excision of the joint should be done early if the arthritis does not yield to conservative treatment, and the results of operation are excellent, a very movable and useful joint being the result.

Osteo-Arthritis.—Osteo-arthritis is common in the shoulder-joints of elderly working men, and may be associated with extensive effusion into the surrounding bursæ. In some cases the tendon of the biceps becomes frayed as it passes through the bicipital groove, and rupture from slight violence is not uncommon.

The usual treatment of osteo-arthritis should be carried out.

Neuro-Arthropathy of the shoulder is generally met with in association with syringomyelia.

Elbow

The swelling in inflammation of the elbow-joint is first seen on the outer side of the head of the radius, and on either side of the triceps tendon. The characteristic attitude of inflammation is flexion at an

angle of 140 degrees, with the forearm held midway between pronation and supination. Although the synovial membrane of the superior radio-ulnar articulation is always continuous with that of the elbow-joint, in chronic inflammation, extension and flexion are generally limited before pronation and supination.

The most useful position for *ankylosis* is flexion to slightly beyond a right angle, with the hand semiprone, and the joint should be fixed in a splint in this position.

Aspiration should be performed from the outer and posterior aspect, and the joint *incised and drained* by an incision parallel with the outer edge of the triceps. In cases of disorganization of the joint a counter-opening should be made on the inner side, care being taken to avoid the ulnar nerve.

Excision of the joint is performed through a median posterior incision, and the bone removed consists of the lower end of the humerus and the upper ends of the radius and ulna. Free movement being aimed at, passive and active movements should be begun as soon as the wound has healed.

Tubercular Arthritis.—Tubercular arthritis is the most common of the inflammatory diseases of the elbow, and occurs chiefly in young subjects. The synovial membrane is usually the first site of the disease, which is often painless in the early stages, the joint merely becoming swollen and the movements restricted; even swelling is absent in some cases, and the only physical sign is the limitation of movement. Abscess formation occurs later, and the abscess usually points on the inner or outer side of the triceps tendon. Wasting of the muscles is marked in the later stages of the arthritis.

TREATMENT.—The joint should be placed in a plaster of Paris case in the position of inflammation, and after a month's rest it should be flexed to the limit of pain and again fixed. This manipulation should be repeated until the joint is in the most useful position for ankylosis—*i.e.*, flexed at slightly less than a right angle, and semiprone. It may be fixed in moulded poroplastic or leather splints secured by huckles, but a plaster of Paris case answers admirably for the elbow, the arm being kept in a sling. The plaster should extend from the axilla to the wrist, and be changed every six weeks or so after the proper position has been secured.

Conservative treatment should be persevered with in children even after sinuses have formed, but in adults excision of the elbow offers a better prospect of cure than waiting. The operation should be a very thorough one, all the diseased bone being carefully removed. A freely movable joint is the ideal to be aimed at.

Osteo-Arthritis, Neuro-Arthropathy, and other diseases of the elbow, follow the lines of these diseases in other joints, and there is nothing special to add about them.

Wrist-Joint

In disease the wrist-joint includes the lower articulation between the radius and ulna, the articulation between the radius and the first row of carpal bones, all the articulations of the carpus and the carpo-metacarpal articulations.

The wrist-joint when inflamed assumes a position of flexion from 120 to 140 degrees, and the fingers are dropped downwards. If pathological dislocation occurs, the carpus slips forwards on the forearm.

The arthritis may be secondary to inflammation of the tendons round the wrist, and fixity of the fingers is common. The most useful position for *ankylosis* is slight dorsal flexion (extension), as in this position the grip of the hand is firm and strong. Ankylosis of the wrist causes little disability as long as the movements of the fingers and elbow are free. The *swelling* in arthritis of the wrist occurs all round the joint, obliterating the bony prominences, being especially seen on the anterior and posterior aspects, and giving the wrist a characteristic rounded appearance. *Aspiration* is rarely necessary, and should be done from behind, and *incision*, if necessary, should also be done from the dorsal aspect.

Excision.—There are several methods of excising the wrist, but all of them are performed through dorsal incisions, and in a classical excision the following bones are removed: The lower ends of the radius and ulna, all the carpal bones, and the bases of all the metacarpal bones. In practice the following bones should be saved unless diseased: The pisiform, the hook of the ulna, the trapezium, and the base of the metacarpal bone of the thumb. The ideal aimed at is a firm movable joint between the forearm and the hand, and flexible fingers, and care must be taken that the index-finger and the thumb do not become approximated. Movements of the fingers should be started forty-eight hours after the operation, and movement of the wrist in two weeks. In some cases, however, it is better to allow bony ankylosis to occur between the forearm and the hand, and endeavour to get free movement of the fingers only. There is a persistent tendency for adhesions to form in the tendon sheaths round the joint, and movements must be persevered with, under anaesthesia if necessary, until this tendency ceases.

Tubercular Arthritis.—This condition may be primary in the synovial membranes or in the carpal bones, or it may be secondary to tubercular teno-synovitis. The prognosis is not good, and even when it is synovial in onset, it usually spreads to all the carpal bones. The symptoms are stiffness and swelling round the carpus, the joint assuming the characteristic position of inflammation. There is as a rule little pain until the articular cartilages covering the bones have been destroyed, and then the usual typical starting pains at night will be present. Abscesses generally form and point on the dorsal aspect. Radiography will show which bones are affected, and to what extent they are diseased, and is exceedingly useful in deciding on the necessity for operation.

TREATMENT.—Fixation of the wrist is best obtained by means of a plaster case applied over a thick layer of cotton-wool, and the mal-position should be gradually corrected. If anterior and posterior wooden or poroplastic splints are used, they should reach as far as the tips of the fingers. Fixation should be continued for six months after all symptoms have disappeared.

OPERATIVE TREATMENT.—If in spite of careful conservative treatment the disease progresses, limited operations should be performed. Incisions should be made over areas of softening, and the tubercular granulation tissue removed with a sharp spoon. Radiography will show which bones are affected, and, if necessary, they may be removed. Attempts should be made to get all the wounds to heal by the first intention. If these limited operations fail, excision must be performed; and if septic sinuses are present, amputation may be necessary to save the patient a large amount of suffering.

Gonorrhœal Periarthritis, leading to a pseudo-ankylosis, is very liable to attack the wrist-joint. The usual treatment should be carried out, massage and passive movements being employed early; if ankylosis occurs, care must be taken that it is in the most useful position.

Sacro-Iliac Joint

With inflammation of the sacro-iliac joint the position of the lower limb often remains unaltered; but it may be abducted and somewhat everted at the hip-joint, giving apparent lengthening. The condition therefore simulates arthritis of the hip-joint, from which it has to be diagnosed. The position assumed by the patient when standing is rather characteristic; the weight of the trunk is thrown on the sound limb, whilst the other hangs down, and there is a lateral curve of the spine, with scoliosis. This position is also assumed by patients with sciatica. *Ankylosis*, if it occur, is of little importance, and is associated with hardly any functional disability of the lower limb. *Swelling* may be detected in two places—posteriorly by the side of the posterior superior spine, and anteriorly by the finger placed in the rectum. Fluctuation may be felt with the finger in the rectum and the finger over the joint. The joint should be *aspirated* from behind over the swelling, and *incision* may also be done posteriorly.

Excision of the sacro-iliac joint is performed through a posterior curved incision, and the ilium trephined, so that the joint is freely opened. The wound should be closed without drainage in order that healing may occur by the first intention, and the patient kept at rest for eight weeks to secure firm bony ankylosis.

Tubercular Arthritis.—Tubercular disease of this joint has the peculiarity of occurring more often in young adults (fifteen to thirty-five) than in children, and, like all cases of tubercular arthritis in adults, shows little tendency to spontaneous healing, usually going on to abscess formation and destruction of the joint.

CLINICAL FEATURES.—The early symptoms are indefinite. The patient complains of pain, weakness, and a sense of fatigue in the lower

part of the back, and it is only on careful examination and radiography that a diagnosis can be made. Pain is usually elicited by jarring the pelvis, or by strongly pressing the iliac crests together, and rectal examination should never be omitted. Abscess formation generally occurs early, and the pus points posteriorly as a rule, but it may appear at the lower border of the gluteus maximus, near the great trochanter, or burst into the rectum or cæcum.

The **PROGNOSIS** is bad, and in many cases radical operative treatment is the only hope of cure.

TREATMENT.—The patient must be kept lying flat in bed in a box-splint or with a long Liston splint applied to the diseased side for six months. Extension should be used if there is much pain. If the symptoms are relieved at the end of the six months, he should be allowed up with a well-fitting poroplastic or leather splint surrounding the pelvis. A patten should be placed on the sound limb, and the patient allowed to walk with crutches. Treatment should be continued for one year after all symptoms have disappeared, and the crutches and splints left off gradually.

If the disease progresses in spite of conservative treatment, no tin or must be lost before radical excision of the joint is carried out. All the diseased tissue should be removed with chisels and flushing gouges, and the wound closed to secure union by the first intention. If sinuses form, further operations should be done early until healing is secured; otherwise the sinus will remain open for years, or until the patient dies of exhaustion with lardaceous disease. After excision, the joint should be kept at rest for months.

Pyæmia.—The sacro-iliac joint is sometimes affected in a general pyæmia, and the symptoms and treatment follow the usual lines.

Hip-Joint

An inflamed hip-joint assumes a position of flexion, abduction, and eversion, so that the strong ilio-femoral ligament (Y-shaped ligament) is relaxed. Later, when suppuration occurs and the ligaments are softened and disintegrated, the position changes to one of flexion, adduction, and inversion. In the first case the limb, owing to the fixed position of abduction, appears to be longer than its fellow (apparent lengthening). In the second, owing to the fixed adduction, it appears shorter (apparent shortening). As the disease progresses, the femur on the diseased side becomes actually shorter by the absorption of the head and neck of the bone (real shortening).

If the destruction continue, the head of the bone may be pathologically dislocated on to the dorsum ilii, and the position of flexion, adduction, and inversion results, with a large amount of real and apparent shortening. The most useful position for a hip-joint to become ankylosed in, if there be—and there usually is—real shortening, is slight abduction and slight flexion. To bring the leg into this position, extension is used.

The *swelling* in arthritis of the hip generally shows itself in front by

a fulness in Scarpa's triangle. In rare cases the ilio-psoas bursa communicates with the joint, and becomes distended with fluid.

Aspiration of the Joint.—The joint should be aspirated from the anterior and external aspect in the line of the incision for excision of the joint, the needle being thrust backwards and inwards.

Arthrotomy.—This operation is done chiefly for septic arthritis, usually due to pyæmia, or to acute osteomyelitis of the femur, and in these cases the incision must be made at the earliest possible moment. The incision is the same as that for excision of the hip by the anterior method, starting $\frac{1}{2}$ inch below the anterior superior spinous process of the ilium, running downwards and a little inwards for 3 inches. It should pass between the tensor fasciæ femoris and the gluteal muscles on the outside, and sartorius and rectus femoris on the inside. The capsule of the joint is opened in the same line. If the incision has been done early, a drainage-tube is inserted into the joint, and in many cases an excellent result is obtained; but if the case is seen late and much disorganization has occurred, a posterior counter-opening may be made, and the joint drained from behind, any dead bone being removed. In all cases the patient should be fixed in a box splint with weight extension, and rest on pillows should never be trusted alone.

A Thomas's splint should be worn later if necessary.

Tubercular Arthritis of the Hip.—Tuberculosis is more common in the hip than in any other articulation, and is most frequently seen in the children of the poorer classes, although it does occur in adults. The starting-point is much more commonly in the bones than in the synovial membrane, and it generally attacks the neck of the femur on the diaphysial side of the epiphysial line. The epiphysial line of the upper end of the femur lies entirely inside the capsule of the hip-joint, so that lesions of the juxta-epiphysial bone can extend directly to the synovial membrane and infect the joint. In some instances the disease starts in the head of the femur immediately beneath the articular cartilage, or in the rapidly growing bone at the junction of the three bones that unite to form the acetabulum.

From whatever focus it starts, the whole joint is usually involved, but the focus of disease may spread outwardly, leaving the synovial membrane intact. It is possible to determine these latter cases at the present time by radiography, and, by removing the focus of disease, prevent infection of the joint cavity.

As the disease progresses, the articular cartilages are destroyed by invasion by the tuberculous granulation tissue, and the head and neck of the femur become carious, and gradually disappear. In some cases necrosis of the bone is more rapid, and large sequestra are formed. The most typical of these consists of the entire head of the femur, which becomes separated by the spread of the tubercular granulation tissue across the neck of the femur at the level of the epiphysial line. It may be seen in a radiogram lying loosely in the joint. The acetabulum also becomes carious, and may be perforated, so that the granulation tissue spreads into the pelvis, in which an abscess may be formed.

More usually the upper and back part of the acetabular rim becomes absorbed owing to the pressure of the head of the femur at this part, so that the acetabular cavity is steadily enlarged upwards and backwards. A new rim of bone is formed by the periosteum above the head of the femur, and this is again attacked by the tubercular process



FIG. 261.—WANDERING ACETABULUM.
(London Hospital Medical College Museum.)

and absorbed. Another rim then forms higher on the dorsum illi, and this process continues until the head of the femur may lie 1 or 2 inches above its normal position, and yet no true pathological dislocation has occurred. This condition is spoken of as "wandering acetabulum." In a few instances true pathological dislocation may occur; or when the ligaments are softened by the disease, a slight violence may produce a traumatic dislocation.

CLINICAL FEATURES.—

The patient is usually a child, and the mother will frequently give a history of some slight accident, and complain that since

then the child has been unwell, has slept badly, taken little food, and walked with a limp, the limp being more pronounced on slight fatigue. The child will complain of pain either in the hip or more commonly, on the inner side of the thigh or in the knee. This latter pain is accounted for by the same nerves, anterior crural, obturator and sciatic, supplying the hip-joint, the knee-joint, and the skin on the inner side of the thigh. This pain is frequently worse at night, the child waking with a start (starting pains).

EXAMINATION.—On being stripped, it will be noticed that the child stands with the diseased limb slightly advanced, and the weight of the body thrown on the sound limb. The pelvis, as shown by the position of the anterior superior spines, is tilted downwards on the diseased side, and there is a slight lateral curve of the spine.

The patient walks with a limp, and tends to keep the heel on the diseased side off the ground, walking on the ball of the foot, and dragging the limb.

He should then be placed lying on his back on a firm couch without a pillow, with both legs extended and parallel. The following points will then be noticed:

1. *Wasting and Loss of Tone of the Muscles.*—This can be often better appreciated by the eye and by palpation than by measurement.

2. *Lordosis of the Lumbar Spine.*—This position of the lumbar spine is due to the flexion of the hip. The hip is held by spasm of the muscles in the flexed position, and when the child is made to lie with the limbs extended, instead of extending the diseased hip-joint, the pelvis is moved by curving the lumbar spine. If the diseased limb is gently flexed, the lordosis disappears, and the amount of flexion necessary to cause its disappearance shows the extent of flexion of the hip. It can also be ascertained by strongly flexing the *sound* limb, when the lordosis will disappear and the flexion of the diseased joint become apparent.

3. *The Diseased Limb will appear Longer than the Sound Limb.*—This phenomenon is due to *abduction* of the hip. When the joint is held rigidly in the position of abduction, both legs being placed parallel to one another, the patient tilts the pelvis down on the diseased side, or adducts the sound limb to the diseased one, in either case producing an *apparent lengthening* of the limb. Measurement of the two limbs will show them to be equal in length.

4. The limb is held in a position of external rotation, and if internal rotation is attempted, the pelvis, and not the hip-joint moves.

5. *Movements.*—All movements, both active and passive, of the diseased joint are restricted. When the movements of flexion or abduction are attempted beyond a certain small limit, it will be seen that the patient moves the pelvis instead of the hip-joint, the movement taking place in the lumbar spine. If the movements are carried out gently, there is no pain. The movements first restricted are rotatory movements, then abduction and adduction, and finally flexion and extension. In the early stages of the disease a week's rest may result in disappearance of all these phenomena, but they will reappear on active use of the joint.

6. There is a *fulness in Scarpa's Triangle*, and on deep palpation above Poupart's ligament, the external iliac glands may be felt to be enlarged. The child is then placed lying on his face, and it will be noted that there is general wasting and loss of tone of the muscles. This is most readily seen in the buttock, which is flattened and flabby. The *gluteal fold* is less marked than usual, or absent, owing partly to the flexion of the hip, and partly to the loss of tone of the muscles.

In this position the lumbar spine should be examined, as Pott's disease with psoas spasm may simulate hip disease very closely.

A *radiogram* taken at this stage of the disease may show some blurring of the outlines of the joint surfaces, or a focus of disease in

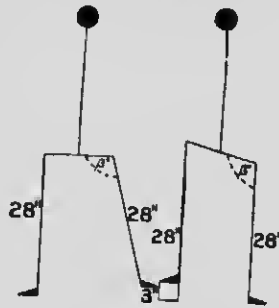


FIG. 262.—DIAGRAM SHOWING APPARENT LENGTHENING.

the head of the femur; but, on the other hand, there may be no evidence of disease.

LATER SYMPTOMS AND PHYSICAL SIGNS.—As the disease progresses, the *general* symptoms become more marked, the patient is anæmic and wastes, and there are constant slight rises of temperature. If abscesses and sinuses form, infection by the pyogenic organisms occurs, and the toxic condition is increased, until finally lardaceous disease supervenes. The patient may die from exhaustion consequent on prolonged suppuration and lardaceous disease, or from generalized tuberculosis.

With further destruction of the bones and ligaments, the position of flexion, abduction, and external rotation changes to one of flexion, adduction, and internal rotation. The exact cause of this change is doubtful, but it is probably due to an attempt of the muscles to separate the two inflamed joint surfaces, there being no tension of fluid in the joint maintaining the position of greatest capacity, as the ligaments have softened and given way. In exceptional cases the joint from the first may be in the flexed, adducted, and internally rotated position.

If the patient is now examined as before, the lordosis of the lumbar spine will still be present, and probably increased; but the *apparent lengthening* will have given way to *apparent shortening*, as in the attempt to bring both legs parallel, the pelvis is tilted up on the diseased side, making the diseased limb appear shorter than its fellow.

Still later in the disease the flexion and adduction deformity may be so marked that the patient cannot bring the legs parallel, and he lies with the diseased limb flexed and adducted across the body, causing a deep groove to be formed in the groin and a marked prominence behind, due to the great trochanter.

On measurement of the two limbs, it will be found that the diseased limb is really shorter (*real shortening*) than the sound limb, owing to absorption of the head and neck of the femur and of the acetabulum. That the shortening has occurred in the upper end of the femur and in the acetabulum is proved by finding that the great



FIG. 263.—OLD-STANDING TUBERCULOSIS OF THE HIP-JOINT, WITH SINUS FORMATION, ADDUCTION AND INTERNAL ROTATION, AND REAL SHORTENING.

trochanter lies above Nélaton's line, and that the vertical limb of Bryant's triangle is shortened (see p. 455).

The rigidity of the limb is more marked than in the early stages, and no movement may be possible at the hip-joint. A radiogram taken at this stage of the disease will show the destruction of the head and neck of the femur, and perhaps the formation of sequestra

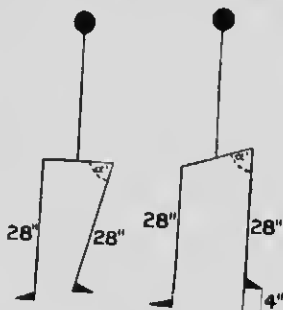


FIG. 264.—DIAGRAM SHOWING APPARENT SHORTENING.

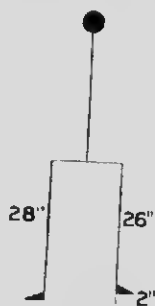


FIG. 265.—DIAGRAM SHOWING REAL SHORTENING.

and also the altered position of the femur on the pelvis, owing to the absorption of the upper and posterior lip of the acetabulum (wandering acetabulum).

ABSCESS FORMATION.—Abscess formation may occur at any period of the disease, and may be the first marked symptom that brings the patient to the surgeon, or it may occur after the joint condition has been apparently cured (residual abscess). The following are the common situations:

1. An anterior and external abscess coming to the surface a little in front and internal to the great trochanter, close to the origin of the tensor fasciæ femeris.
2. A posterior abscess developing in the gluteal region, and pointing at the lower border of the gluteus maximus.
3. An internal abscess pointing on the inner side of the femoral vessels below Poupart's ligament.
4. A psoas abscess, the pus first infecting the ilio-psoas bursa, and then passing into the muscles, so that an abscess is formed partly in the thigh, and partly in the iliac fossa above Poupart's ligament.
5. A pelvic abscess, due to perforation of the acetabulum, with tubercular granulation tissue. This abscess may point in the bladder or rectum, through the great sacro-sciatic notch, or into the ischio-rectal fossa.

These abscesses have the usual physical signs of tubercular abscesses in any part of the body, and may burrow long distances from the original focus of the disease.

PATHOLOGICAL DISLOCATION, at one time thought to be common, is a rare complication of tubercular arthritis; but it is of great im-

portance to recognize it early. It occurs in the later stages of the disease, and is due to destruction of ligaments of the joint, combined with a slight degree of violence, a sudden contraction of the muscles being sufficient to cause it. The dislocation is upwards on to the dorsum ilii, and the flexion, adduction, internal rotation, and shortening, are all increased, whilst the great trochanter is found to be well above Nélaton's line. A radiogram makes the diagnosis certain. If the dislocation is recognized early, it should be reduced by the usual method of reducing a traumatic dislocation; but later this is impossible, and the deformity will be permanent.

DIAGNOSIS.—The diagnosis of tubercular arthritis of the hip has to be made from the following conditions: Other inflammatory conditions of the hip-joint; congenital dislocation of the hip; coxa vara; psoas abscess, with Pett's disease; inflammation of the ilio-psoas muscle from appendicitis, inflamed glands, etc.; tubercular disease of the sacro-iliac joint; sciatica; tuberculosis of the knee; and neoplasms in the head of the femur and pelvic bones. A well-taken radiogram is of the utmost value in distinguishing tuberculosis of the hip-joint from all these conditions.

PROGNOSIS.—The prognosis of tubercular arthritis of the hip in children is good, although there is nearly always some deformity and limitation of movement left. In adults the outlook is grave, and a majority of the cases end fatally. As long as sinus formation does not occur, ultimate recovery is to be hoped for, although the process of cure takes years of careful treatment; but when sinuses form and become infected with other organisms, the prognosis is unfavourable, and death may occur from toxic absorption, exhaustion, and lardaceous disease. General infection or infection of other joints or the spine by tubercle may occur at any stage of the disease.

RESULTS.—Complete resolution is rare, there nearly always being some fibrosis, with limitation of movement and real shortening from absorption of bone. When the articular cartilages are absorbed, a dense fibrous or bony ankylosis is usually present, and there is a constant tendency for the scar tissue to contract and deformity to develop. Even with bony ankylosis the joint in the course of time may become flexed, adducted, and rotated in, if means are not taken to prevent this contraction.

In some cases the raw ends of the bone become covered by scar tissue, which forms a periosteum for them, and as there is no union between the femur and the acetabulum, a flail joint results.

In cases of apparent cure the tubercle bacillus may be only quiescent, and years after all symptoms have disappeared an abscess may develop (residual abscess), or the disease may light up again after a slight injury.

TREATMENT.—The treatment in principle is the same as for all tuberculous joints, and should always in the first instance be conservative.

The joint is moved from the position of deformity into the most useful position for ankylosis—*i.e.*, slight abduction and very slight flexion. This is done by one of the following methods:

1. *Extension.*—The extension apparatus consists of two broad bands of strapping connected by a piece of wood which is broader than the sole of the foot. In the centre of this piece of wood a hole is bored. The two bands lie on each side of the limb, reaching well above the knee, and the wood is about 3 inches from the sole of the foot, and at right angles to it. The bands are fastened to the limb by strips of lead plaster evenly applied to the leg from below upwards, each strip overlapping by about two-thirds the one below, and crossing on the front of the leg. A layer of Gangee tissue should protect the bony prominences of the malleoli from being cut by the strapping. A cord with a weight attached passes through the hole in the piece of wood, and runs over a pulley fixed to the end of the bed. It is of great importance that the pull of the weight should be in the line of the limb, which, it must be remembered, is fixed by spasm of muscle in a flexed and abducted position. One of the objects of the extension is to relieve interosseous pressure, and if the pull of the weight be not



FIG. 266.—EXTENSION APPLIED TO THE HIP.

in the line of the limb, the powerful ilio-psoas muscle will act as the fulcrum of a lever, and the head of the femur will be pressed more closely against the acetabulum.

The patient is placed in bed with a fracture-board under the mattress, making it even and firm, and a long external splint (modified Listen), reaching from the axilla to below the foot, is bandaged on to the *sound* limb and round the chest. If the patient be a child, a chest-band should also be used to maintain the recumbent position. The real position of the diseased limb is now found by gently flexing the limb with the knee extended until all lordosis is removed, the lumbar spine lying in contact with the bed. The limb is then moved outwards until the anterior superior spines are level, thus giving the position of abduction. Of course, if adduction be present, the limb must be moved inward across the other till the spines are level.

The limb must be supported on an inclined plane in whatever position it has been placed, the pulley being adjusted in the line of the long axis of the limb, so that extension is made exactly in this line. The amount of weight used varies with the age of the patient. In children under ten it should be from 3 to 5 pounds, but in all cases

it must be varied according to the symptoms present. One of the first effects of weight extension noticed is the diminution of the starting pains at night; sufficient weight must therefore be used to prevent these pains. On the other hand, too great a weight will cause continuous pain by stretching the ligaments of the part. With a properly adjusted weight a child with tubercular disease of the hip should have no pain. With adults, of course, heavier weights must be used. The weights, after once being adjusted, should not be removed for any cause.

As the spasm of the muscles is overcome, the limb can be gradually brought into the corrected position. Every three or four days the limb is grasped and extension maintained on it while the weights are removed, the inclined plane slowly lowered, and the limb abducted till movement of the pelvis begins. The limb is then adjusted in the improved position, the position of the pulley being altered. Similar alterations are made from time to time till—usually in about ten to fourteen days in early cases—the limb will have regained its natural position and lie flat on the bed parallel with its fellow. In old-standing cases this may take weeks or months.

This method of extension removes flexion more readily than abduction or adduction, and with the limb in proper position as regards flexion, the pelvis may still be tilted, indicating adduction or abduction. As a slight degree of abduction is beneficial, making up by its apparent

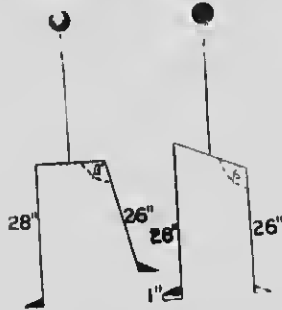


FIG. 267.—DIAGRAM SHOWING APPARENT LENGTHENING COMPENSATING FOR REAL SHORTENING.

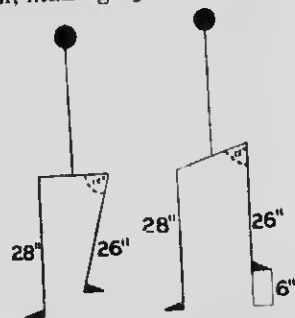


FIG. 268.—DIAGRAM SHOWING REAL AND APPARENT SHORTENING.

lengthening for the real shortening of the limb, this may be disregarded; but adduction is of more importance, for by its apparent shortening it increases the real shortening, apparent shortening, from its effects on the patient's mode of walking, being practically the same as real shortening.

Adduction can be treated by lateral traction combined with the extension. A broad band of strapping is passed in the form of a loop round the thigh about midway between the knee and the groin, and a cord attached to it passes over a pulley at the side of the bed. The weight of the lateral traction should be about half the weight of the extension.

2. *Immediate Reduction of Deformity.*—An anæsthetic is given, and the pelvis is fixed by an assistant; then with great care, using extension rather than leverage, the limb is placed in its proper position, and it is then secured in a box splint with extension, a Thomas's splint, or in a plaster of Paris case.

The disadvantage of this method is that damage may be done if force is used. In some cases when the tissues round the hip are much contracted, it may be combined with subcutaneous division of the muscles about the anterior superior spine and the adductor region.

If the deformity is associated with abscess or sinuses, this treatment should not be employed. In cases in which there is much dense fibrous tissue, especially if subluxation is present, the deformity may be disregarded until the disease is cured, when it is overcome by osteotomy of the femur.

Rest.—Having by one of these methods brought the hip-joint into the most useful position for ankylosis (should it occur), it must be secured by rest in this position for a prolonged period.

Confinement to bed, with careful splinting and extension, give the best results in the case of children, as they can be kept in bed for one or two years without their general health suffering, and they readily adapt themselves to the necessary recumbent position. A very suitable splint for the treatment of tubercular arthritis of the hip in young children is the box splint.

The **box splint** consists of two long, straight, external splints, reaching from the axillæ to below the feet, and joined together at the foot by a crossbar. The best form has a hinge on the diseased side opposite the hip-joint, and the crossbar is continued beyond the splint on that side, so that the limb may be placed in any position of abduction required. The side splints are carefully padded, and at the top, just below the axillæ, are hooks for securing the upper bandage. A broad flannel bandage is fastened to the hook on one side, passed over the splint on the opposite side, and is fastened again to the hooks, thus holding the patient in a kind of sling. A few turns are then taken round the chest and splint, fastening every turn by the hooks. The sound limb is firmly bandaged to the side splint, the bandage coming well past the middle of the thigh, care being taken to support the foot in the right-angled position so as to prevent talipes decubitus. The diseased limb, which has an extension apparatus applied to it, is lightly bandaged to the side splint, and from the crossbar of the extension a cord runs through a hole in the bottom bar of the splint over a pulley, and supports a weight.

The patient is usually anæsthetized to adjust the splint, but this form of splint is best used after the limb has been brought into a good position by gradual extension.

In children the upper part of the bandages should be covered with mackintosh to prevent their getting soiled with urine.

Patients, especially children, may be left in these splints for weeks and months if necessary.

When sinuses exist, an interruption is made in the splint opposite

the hip, so that dressing may be carried out without the splint being removed.

Bryant's splint is an elaborate form of box splint, the traction being applied by means of india-rubber bands.

AMBULATORY TREATMENT.—In cases of tubercular arthritis in older children and adults, some form of splint should be applied which will allow the patient to get about so that he may have the benefit of fresh air and exercise whilst keeping the diseased joint at rest, and avoiding interosseous pressure. This is termed the "ambulatory method of treatment," and Thomas's hip splint is one of the most satisfactory of the numerous splints devised for carrying it out.

Thomas's Hip Splint.—This splint consists of a flat piece of malleable iron, $\frac{3}{4}$ inch wide, and long enough to extend from the lower angle of the scapula to the middle of the calf. The bar should pass in a perpendicular line downwards over the lumbar region across the pelvis, slightly external to the posterior spinous process of the ilium, along the course of the sciatic nerve, to a point slightly internal to the calf of the leg. There is a slight twist in the long axis in the lumbar portion at the junction of the upper and middle third, so that the anterior surface of the lower section may look somewhat outwards. The upright is moulded to the curves of the body, and is fitted with chest, thigh, and leg hands. The chest-hand is riveted to the upper end of the upright, so that one-third is on the diseased side and two-thirds on the sound side. The thigh-piece is fitted 1 to 2 inches below the buttock, and the calf-piece is riveted to the lower extremity of the splint. Of the last two pieces the outer bar should be slightly larger than the inner. The splint should be padded with felt and covered with leather. The chest-hand is closed by a strap and buckle, and suspended on the shoulder by straps fastening in front. In some splints the lower hands are also provided with straps and buckles, but these should not be trusted to alone, but the limb firmly handaged to the splint as high as the upper third of the thigh. It is best to secure the upper part of the splint round the chest with a broad flannel handage.



FIG. 269.—THOMAS'S HIP-SPLINT.

A useful modification of Thomas's splint is to continue the upright down hollow the foot, and fit on a footpiece at right angles to the upright, handaging the foot to it. This prevents and corrects the rotation of the foot outwards, which is not done by the usual form of Thomas's splint. It also prevents the occurrence of talipes decubitus.

Thomas's splint can be used in two ways—(1) As a means of re-

ducing the deformity; (2) as a means of maintaining the corrected position after deformity has been removed by weight extension.

1. **THE REDUCTION OF DEFORMITY BY THOMAS'S METHOD.**—The splint is adjusted to the angle of the deformed position of the limb, no attempt being made to correct the deformity, and the patient is kept in bed on a soft mattress, so that the splint can sink into it. As the muscular spasm relaxes with rest, the splint is straightened slightly from time to time by bending it at a point opposite to the hip-joint until the correct position is obtained. During this stage of the treatment the patient must be kept in bed, and the splint should not be moved except by the surgeon, who is particularly careful not to move the limb during the active stage of the disease.

2. When deformity is corrected by extension and the active symptoms have subsided, the patient is allowed to go about wearing the splint. A patten, at least 4 inches in length, is placed on the foot of the sound limb, and the patient uses crutches.

Double Thomas's Splint.—A double Thomas's splint is made by joining two single splints. These are riveted to the chest-band above, and are connected at the lower ends by a crossbar, unless the splint is to be used for the correction of a deformity.

In the treatment of tubercular arthritis of the hip in young children a double Thomas's splint is better than a single, as it more readily stays in position (a single Thomas's splint is very apt to slip round to the side and become useless), the patient can easily be moved about in it, and he does not suffer from the confinement. If used to reduce deformity, the sound limb is first bandaged to the splint in the extended position, the upright on the diseased side being carefully adjusted to the deformity, and gradually straightened in the same way as a single splint.

A child having once been placed in a Thomas's splint, should be taken out as seldom as possible, and great care must be taken that the hip is not moved when it is necessary to remove the splint.

In some cases, however, where constant attention can be given, it is a good plan to remove the splint at night in the early stages of treatment, and fix on an extension with a weight.

Removal of Thomas's Splint.—It must be remembered that the removal of any splint in the treatment of tuberculosis of a joint is of the nature of an experiment, and each case must be considered on its own merits, there being no absolute means of telling when the disease is arrested.

In the case of tubercular arthritis of the hip, the following may be taken as a working rule: The splint should be worn for twelve months after all pain has ceased, provided no abscess has formed. At the end of that time the splint should be removed at night; at the end of another month it may be left off for four hours a day, and at the end of the third month it may be left off altogether, great care being taken to guard against overuse and injury. If at any time the symptoms return, especially if pain is felt at night, the splint should be put on again for a period of six months.

American surgeons have modified Thomas's splint considerably especially in the way of combining extension with it, and in the use of convalescent splints; but the simple Thomas's splint described is the most satisfactory in hospital treatment, and leaves little to be desired in private practice, if strict attention to details is given. Thomas advised that after the splint is removed the patient should still continue to use a patten and crutches for some months, and he also used at times a convalescent splint, which only extended to the lower part of the thigh, permitting motion at the knee, but restricting the movement of the hip. The average time of treatment of a case of tuberculosis of the hip-joint is about two years.

Another method of obtaining rest in tubercular arthritis of the hip is by means of the **plaster of Paris bandage**. The first plaster bandage is applied under anaesthesia, and extends from the nipple line down the limb to include the foot. The limb is fixed in a position of slight flexion and slight abduction. As the bandage is applied, a strip of malleable steel, long enough to reach from the lumbar region to the lower third of the thigh, should be incorporated in the plaster. The strip of steel should be in the line in which the bar of a Thomas's splint runs. Another piece of steel is incorporated in the plaster behind the knee-joint. These steel slips give support to the plaster in places where it is likely to break. A well-applied plaster may be left on for two or three months, and if the deformity is not corrected at the first application, it will usually be found easy to correct it at the second, the spasm of the muscle having entirely disappeared. This method of treatment is particularly useful in out-patient practice, and is to be recommended as a preliminary means of treatment before a Thomas's splint is applied. The foot should always be included in the plaster, otherwise oedema will result. The plaster under the foot also transmits the weight of the body to the plaster case, and thus relieves the hip-joint from pressure. When well applied, the fixation is perfect.

If abscesses form, they should be treated according to the methods already given (p. 118), and pathological dislocation as stated above should be treated by immediate reduction and fixation.

OPERATIVE TREATMENT.—In the modern method of treatment of tuberculosis of the hip-joint, conservative methods are invariably tried first, and even with abscess and sinus formation the majority of surgeons prefer to continue the treatment of rest rather than employ operative measures, or, if they are compelled to operate, limit the interference to opening and draining abscesses and scraping sinuses. The classical operation of excision of the hip is rarely performed at the present time, but in advanced cases the joint may be exposed from the posterior or anterior aspects, and all the diseased tissue removed. Even in these cases the operation should be as conservative as possible, and all tissue not invaded by tubercular granulations should be spared. On the other hand, if this treatment is adopted, the surgeon must not hesitate to follow the track of the tubercular process, and, if necessary, remove diseased tissue from inside the pelvis,

following it through the hole in the acetabulum. After the operation the remains of the head of the femur are placed in the acetabulum, and the limb is fixed in a position of abduction, in order to compensate by apparent lengthening for the real shortening that will be present. Fixation by splints is necessary, until all the sinuses are soundly healed, and even then some form of apparatus must be worn to prevent contraction deformities.

In deciding whether operation is necessary, radiography is often of great help.

If it is seen that the bone is extensively destroyed and septic sinuses are present, and the general health of the patient has seriously suffered, amputation is preferable to the extensive operation that would be necessary.

The limb is best removed by the anterior racket incision, and it may be necessary to cut away a large part of the pelvic bone in order to remove all the diseased tissue. The wound should be drained, and if sinuses persist, they should be scraped from time to time until healing is sound.

Deformity resulting from Old Tubercular Arthritis.—In a large number of cases of cured tubercular arthritis of the hip, the joint is left in a position of flexion, adduction, and internal rotation, owing to ineffective treatment. This position is partly caused by contraction of the soft tissues—i.e., muscles and tendons round the joint, and partly by fibrous or bony ankylosis of the joint itself. As a consequence of this position of the hip, secondary deformities appear in the spine. In order to overcome the flexion and place the feet on the ground, the patient has to increase the curve of the lumbar spine, and lordosis results, and in order to place both legs parallel, so that the patient can walk, the pelvis has to be lifted upwards on the affected side. As a consequence of this, there is marked apparent shortening, and scoliosis of the spine follows owing to the oblique pelvis. The patient is unable to compensate for the internal rotation in any way.

TREATMENT.—In severe cases the deformity may be removed by tenotomy of the contracted muscles and extension. The extension is made at first in the position of deformity, but as the fibrous tissue and muscles stretch, the limb is gradually brought into a position of abduction with very slight flexion. This position is maintained by splinting, plaster of Paris being the best material, until all tendency to contraction has disappeared.

In those cases in which the main deformity is adduction, the wearing of a high boot may be all that is necessary.

In the measurement for a high boot it is of the utmost importance to distinguish between real and apparent shortening. Real shortening



FIG. 270.—O'CONNOR EXTENSION BOOT.

is due to absorption of the head and neck of the femur and the acetabulum, to want of growth in the diseased bone due to damage of the epiphysial line, and to pathological dislocation. It cannot be made less by any treatment, but it may increase with growth of the rest of the body. Apparent shortening includes the real shortening due to the above causes with the shortening due to the tilting of the pelvis

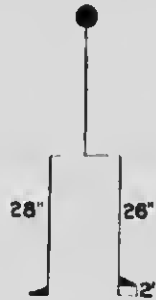


FIG. 271.—DIAGRAM SHOWING REAL SHORTENING.

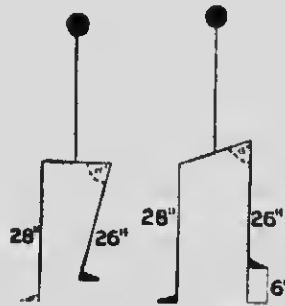


FIG. 272.—DIAGRAM SHOWING REAL AND APPARENT SHORTENING.



FIG. 273.—METHOD OF MEASURING APPARENT SHORTENING FOR ORDERING A HIGH BOOT.

upwards on the adducted side. This tilting is necessary in order to bring the two legs parallel, so that the patient can walk. If the limb is abducted, the sound side of the pelvis is tilted up to bring the limbs parallel, and there is apparent lengthening, which may completely compensate for the real shortening. Real shortening is discovered by measuring from the anterior superior spine to the internal malleolus, on both sides, with the legs held in a similar position. It can also be ascertained by measuring from the umbilicus to the internal malleolus.

Apparent shortening is measured by standing the patient up with the sound limb straight and the diseased limb parallel to it, and finding

the distance the sole of the foot is from the ground. This is most conveniently done by putting graduated blocks of wood under the foot until the patient stands on both soles with the knees straight.

In marked cases of deformity adduction, flexion, and internal rotation can all be relieved by a subtrochanteric osteotomy (**Gant's operation**). The femur is divided below the level of the trochanters, and the limb put up in a position of abduction and extension, rotation being corrected at the same time. The effect of this operation is to somewhat increase the real shortening, and to get rid of the apparent shortening, by changing it into apparent lengthening. The removal of the flexion deformity also does away with the compensating lordosis of the lumbar spine.

Pyæmic Arthritis.—Acute arthritis of the hip may follow infection of the blood-stream by staphylococcus or streptococcus (septic pyæmia), gonococcus, pneumococcus, etc.

CLINICAL FEATURES.—All the signs of an acute arthritis may be well marked, but in some cases an accurate diagnosis is exceedingly difficult, and the condition may be overlooked until suppuration occurs, or until the joint is found to be ankylosed, usually in a bad position, or pathologically dislocated after recovery from the acute illness. If the condition is suspected during an acute illness, aspiration of the joint with an exploring syringe will establish the diagnosis.

TREATMENT.—The usual treatment of acute arthritis should be carried out, and the limb kept in the best position for ankylosis by means of weight extension and splinting. If there is any suspicion of suppuration, the joint should be explored with an aspirating syringe, and if pus is found, the joint must be opened and drained through an anterior incision. If this is done early, and the patient recovers from his general disease, restoration of the function of the joint may be complete.

Should the condition not be discovered until pathological dislocation has occurred, an attempt should be made to reduce this dislocation under anaesthesia, tenotomy of the muscles being performed if necessary.

If the attempt be successful, the limb should be splinted and treated in the same way as a traumatic dislocation. If reduction is not successful, the question of replacement of the head of the femur in the acetabulum by an open operation should be considered.

Osteo-Arthritis of the Hip (Morbus Coxæ Senilis).—Osteo-arthritis of the hip may be part of a polyarticular osteo-arthritis, or the disease may be almost entirely confined to one hip.

The usual degenerative changes characteristic of osteo-arthritis are present, and considerable deformity may result. The head of the femur is enlarged and flattened, and may come to occupy a position on a lower level than the great trochanter, owing to absorption of the neck of the bone, and a deformity resembling coxa vara results. The acetabulum becomes enlarged, and tends to "wander" upwards and backwards on the dorsum ilii, and there is usually extreme lipping. As a consequence the limb is adducted and shortened, and the movements of

the hip are considerably impaired. The great trochanter lies above Nélaton's line, and the vertical line of Bryant's triangle is shortened. Bony crepitus is usually easily obtained, and if the patient is examined after an injury, this sign may lead to an erroneous diagnosis of fracture of the neck of the femur.

The **CLINICAL FEATURES** of the disease are characteristic of those of osteo-arthritis, and the diagnosis has to be made from tubercular arthritis and coxa vara. Radiography is of great value in establishing an exact diagnosis.

TREATMENT.—The treatment is that of osteo-arthritis, and presents no unusual features. In a few menarticular cases occurring in young subjects excision of the joint may be advised if the condition prevents walking on account of the deformity.

Neuro-Arthropathy.—Charcot's disease of the hip-joint presents no unusual features.

Knee

In arthritis of the knee the joint is first held in a position of flexion, but as the ligaments become softened, the tibia begins to be displaced backwards and outwards on the femur, and the bones of the leg rotate on their long axis, so that the feet is everted. In pathological dislocation, therefore, the position is one of flexion with displacement backwards and outwards, and rotation outwards of the tibia and fibula. The head of the femur becomes abnormally prominent on the outer side of the popliteal space, and the biceps muscle is contracted. As a consequence the patient cannot place the foot on the ground, and it is useless for progression.

The most useful position for ankylosis of the knee is one of slight flexion, so that the patella is just over the instep when the patient stands erect.

Swelling in the knee-joint is seen on either side and above the patella. It marks out the extent of the synovial membrane of the joint, which usually communicates with the large suberureus bursa, which extends 2 inches above the patella. In one in ten cases, however, the suberureus bursa does not communicate with the joint, and the swelling is then limited to the sides of the patella.

Aspiration is performed by plunging the aspirating needle into the synovial cavity on the side of the patella.

Drainage.—On account of the important structures in the popliteal space, it is not possible to drain the joint in the most dependent position unless the degree of destruction is advanced. The joint is drained in the following manner: An incision is made directly above the patella in the middle line, and the joint opened. A director is then thrust down on each side of the joint, lateral openings made as low as possible, and drainage-tubes inserted.

Excision of the joint is performed through an anterior curved incision, the joint being opened by dividing the ligamentum patellæ. In the classical operation about three-quarters of the condyle of the femur are removed, and the whole of the articular surface of the upper

end of the tibia, together with the articular surface of the patella. The limb is then put up on a Howse's splint in the extended position, and firm, bony ankylosis is usually the result to be desired.



FIG. 274.—HOWSE'S SPLINT FOR EXCISION OF THE KNEE.

Tuberculous Arthritis.—The disease may originate in the synovial membrane or in the bone, and is usually very insidious and painless in its onset. When the synovial membrane is primarily affected, the joint cavity becomes filled with tubercular granulation tissue which invades all the synovial pouches, and spreads over the surfaces of the articular cartilages. As a rule there is little fluid in the joint, and the swelling feels doughy on examination, but, exceptionally, there may be a large amount of fluid in the joint (hydrepseri articuli), which may be serous fluid with melon-seed bodies, or tubercular pus.

If the bone is primarily affected, the disease starts more often in the femur than the tibia, and appears first under the articular cartilage or at the epiphysial junction. As the epiphysial junctions of the tibia and femur are completely outside the capsule of the knee-joint, the inflammatory process may find its way towards the skin without invading the synovial membrane. These cases should be regarded as tuberculosis of the bone and not of the joint, and operative treatment can be carried out without opening the joint cavity.

Sequestra are present in the tibia and femur in a large number of cases of tuberculosis of the knee-joint, and the greater the destruction of the joint the more likely are sequestra to be found, recovery being impossible until they have been removed.

SYMPTOMS.—The patient complains of some pain in the knee-joint and a feeling of insecurity. He is unable to extend the joint completely, and is easily fatigued. Later in the disease, with destruction of the articular cartilage, the pain may be severe, especially at night. On examination, the knee is found to be flexed, and cannot be extended, and there is a pulpy "white" swelling of the joint. Later, abscesses and sinuses form round the knee, and if treatment is neglected, the joint becoming pathologically dislocated backwards and outwards, with external rotation.

TREATMENT.—The usual hygienic measures should be carried out, and the knee is especially suitable for treatment by Bier's method of passive hyperæmia.

Local.—The joint must first be placed in the most useful position for ankylosis, and this can be done by the following methods:



FIG. 275.—TUBERCULOSIS OF THE RIGHT KNEE.



FIG. 276.—PATHOLOGICAL DISLOCATION OF THE KNEE, WITH BONY ANKYLOSIS.

1. *Extension.*—A similar extension apparatus to that used for the hip should be applied to the leg, but should not reach higher than the tubercle of the tibia. The extension must be made in the line of the leg, so the limb should be supported with the thigh resting on an inclined plane, and the leg on a horizontal plane in the position of deformity. The weight should pass over a pulley at the end of the bed, and about 3 to 10 pounds should be used, according to the age of the patient. Counter-extension may be made by passing a broad band of strapping or a troughlike splint of poroplastic felt round the thigh, and connecting it with a weight passing over a pulley at the head of the bed, care being taken that there is not too much pressure on the back of the thigh, causing œdema. Every three or four days the inclined plane should be lowered a little, the limb at the same time being carefully supported so that sudden movement does not occur at the joint. In many cases the limb will be straightened in about fourteen days, and a splint may be applied.

2. *Reduction by Plaster of Paris Case.*—The limb is gently extended, under anæsthesia if necessary, and a plaster case put on, reaching from the upper part of the thigh to the toes. This is left on for six weeks, and when removed, the limb is extended still farther and a fresh case put on, and this is repeated till the limb is quite straight. This method has the usual advantages and disadvantages of plaster cases.



FIG. 277.—EXTENSION APPLIED TO THE KNEE.

After reduction of the deformity, the joint should be kept at rest for nine months after all the symptoms have disappeared. In the case of young children the patient should be kept in bed with extension applied to the joint; but in older children and adults the ambulatory form of treatment should be used, and this is best carried out by the use of Thomas's knee splint.

Thomas's Knee Splint.—This can be used to reduce deformity with the patient in bed, but is best adapted for the ambulatory method of treatment of tubercular arthritis when the limb is in the corrected position. It consists of a well-padded iron ring, set obliquely and covered with leather, from which an iron rod extends downwards on each side of the leg, terminating in a second smaller ring at the lower end. A strip of leather runs nearly the whole length of the splint, and is fastened to the lateral bars. The splint must be of such a height as to extend from 3 to 4 inches beyond the foot, and when applied the upper ring should rest internally against the tuber ischii, and externally against the anterior superior spine above the great trochanter.

The method of applying it is as follows: A knee extension apparatus is fixed to the leg, and the limb is then passed through the upper ring of the splint till the tuber ischii is resting on the splint. The cord of the extension apparatus is then fixed to the bottom of the splint, so that the limb is held straight and slight traction is exerted. Broad bands of strapping are now fastened round the splint and the limb, one round the thigh and the other round the calf, whilst gentle pressure is made on the knees with a flannel bandage. Finally, a bandage is carried from the ankle to the groin over the limb and splint.

If used for the ambulatory form of treatment, a 4-inch patten must be fixed to the foot of the sound limb, and the patient given crutches. Care must be taken that he cannot reach the ground with the toe, as he will often try to walk



FIG. 278. — THOMAS'S KNEE-SPLINT.
WITH PATTEN.

in a position of equinus. A broad hand may be carried from the splint over the opposite shoulder, but this is not absolutely necessary if the limb is well fixed to the splint.

Counter-irritation or Bier's method of passive congestion may be carried out while the limb is in the Thomas's splint, which must be constantly worn. If the strapping is well applied, there is no need to remove it for weeks at a time, but the limb should be re-handaged daily.

Forcible straightening of the knee-joint under an anæsthetic is inferior to gradual extension, but it may be done in mild cases where the force necessary to reduce the deformity is not great. The limb should be immediately fixed in the position of extension on a splint.

After removal of a Thomas's knee splint, it is well to keep the knee (especially if the patient is a child) for a year in a moulded leather or poroplastic splint, which is fastened with straps and buckles or laces.

After ankylosis in a good position has occurred, there is a constant tendency for flexion to occur until growth is complete, and cases discharged as cured with fibrous or even complete bony ankylosis in a good position will return in the course of a year with marked flexion. It is therefore advisable to keep the patient under observation for years, and to correct at once any tendency to flexion by the use of a splint. If the case has been treated early and a good movable joint is obtained, the tendency to flexion is not present.

OPERATIVE TREATMENT.—Conservative methods should always be first tried in cases of tubercular arthritis of the knee, but operative measures should not be delayed for too long.

In children, with their greater recuperative powers, conservative methods will usually effect a cure, and operation in them is a more

serious matter than in adults on account of the damage that may be done to the epiphysial cartilage and subsequent interference with growth. For these reasons operation should be delayed in children, and if it becomes necessary on account of progression of the disease, in spite of conservative treatment, arthrotoomy, rather than excision, should be performed. The joint should be laid well open, all the synovial membrane removed, and any part of the bone or articular cartilage that is affected carefully scraped away. The wound is then closed, the limb carefully splinted, and kept at rest until firm fibrous ankylosis has resulted. Complete excision of the knee may, however, be necessary in children if sinuses are present or if treatment has been neglected, and there is marked deformity or pathological dislocation. Adults do not respond so readily to conservative treatment, and the prognosis is not good as in children, and as growth is complete, damage to the epiphysial cartilage is not to be feared; in adults, therefore, operation should not be delayed if the disease is progressing, but complete excision, with removal of all the diseased tissue, should be carried out. It is the more important to do this if the general health of the patient is suffering from the pain and confinement.

Amputation is necessary, if in spite of conservative and operative treatment, the disease progresses and the general health of the patient is being seriously affected.

If recovery occurs with ankylosis in a bad position, tenotomy of the hamstring muscles and prolonged extension may overcome the deformity in slight cases, but with dense fibrous or bony ankylosis operation is necessary. The joint should be exposed as for excision, and a sufficiency of the bone removed to allow the limb to be easily straightened. The limb is then fixed in the extended position on splints for months or even years, as there is a great tendency for the flexion deformity to reappear, even if bony ankylosis is obtained, until growth is complete.

The other forms of arthritis of the knee and Charcot's disease call for no special description.

Ankle-Joint

The position assumed by the ankle when acutely inflamed is that of plantar-flexion and eversion, and in chronic inflammation, if the treatment is inefficient, the position of equino-valgus results. The most useful position for ankylosis is with the sole of the foot flat or very slightly inverted, with the foot at right angles to the leg. The swelling is most marked on either side of the tendo Achillis, and the joint should be aspirated by passing a needle in from the outer side of that tendon. Incision of the ankle-joint is rarely required, and is perhaps best done from the outer side just in front of the external malleolus. Drainage is difficult; in fact, drainage of the ankle-joint cannot be effectual unless the astragalus is removed.

Excision of the ankle is an operation of doubtful benefit; excision of the astragalus and erosion of the joint is the operation that is usually performed for tubercular disease if operative measures become necessary.

INFLAMMATION OF JOINTS

Joint.	Position assumed when inflamed.	Most Useful for Ankylosis.	Positions of Swelling.	Place for Aspiration.	Incision for Drainage.	Incision for Excision.	Pathological Dislocation.
JAW ..	Mouth slightly opened	Mouth slightly opened	External	External	External	Over condyle or at angle	—
SHOULDER	Abduction; later adduction	Slight abduction	Anteriorly and in axilla	In front	Anterior, with counter-opening behind	Anterior	Subacromoid.
ELBOW	Flexed and semi-prone	Flexed at less than right angle and semiprone	Each side of triceps	Postero - external	Postero - external	Posterior - median	Backwards.
WRIST ..	Flexion	Slight extension	Anterior and posterior	Posterior	Posterior	Posterior	Forwards.
HIP ..	(1) Flexion, abduction and external rotation (2) Flexion, adduction and internal rotation	Abduction and slight flexion	Fulness in Scarpa's triangle	Antero - external	Antero - external	Antero - external or posterior	Upwards and outwards. —
KNEE ..	Flexion	Slight flexion	Above and each side of patella	Laterally	Two lateral incisions	Anterior	Backwards outwards, and externally rotated.
ANKLE	Plantar - flexion and eversion	Slight inversion and foot at right angle to leg	Each side of tendo Achillis	Postero - external or anteriorly	Excision of astragalus	—	—

Tubercular Arthritis.—Tubercular disease of the ankle occurs at all ages, and this joint is the one most frequently affected in tubercular arthritis in adults. The disease starts in the synovial membrane or in the bones, but destruction of bone is not a marked feature. The astragalus is more affected than the tibia or fibula.

CLINICAL FEATURES.—The foot is somewhat painful and is held in a position of equino-valgus, so that the patient walks on the toes. The calf muscles are wasted, and there is a pulpy swelling on either side of the tendo Achillis. Radiography will show to what extent the bones are affected. The tendon sheaths in the neighbourhood are very likely to be secondarily affected, and abscesses form on the posterior aspect of the joint.

TREATMENT.—Correction of the deformity is effected by the application of light plaster cases from the toes well up to the calf. These are first put on in the deformed position and changed once a month, the position being gradually changed to that of slight varus with the foot at right angles to the leg. If valgus is present when the disease is cured, the patient runs a great risk of developing progressive flat-foot. After the most useful position is reached, the foot should be kept at rest for at least six months. Interosseous pressure can be removed from the articulation by the following methods:

1. The application of Thomas's knee splint, and the use of patten and crutches.
2. The knee is flexed at a right angle and a peg leg is fitted, so that the patient walks about with the ankle off the ground.

When the disease resists conservative treatment, a radiogram should be taken to show the extent of the disease in the bone, and erosion of the joint should be carried out. In the majority of cases it is best to remove the astragalus completely and then scrape away any diseased tissue in the tibia and fibula. A very useful foot results. *Amputation* is necessary in progressive cases in adults which have resisted the other methods of treatment.



FIG. 279.—ANKYLOSIS OF THE OS CALCIS AND ASTRAGALUS, FOLLOWING TUBERCULAR DISEASE OF THE TARSUS. (London Hospital Medical College Museum.)

CHAPTER XVIII

ABDOMINAL SURGERY: INJURIES AND DISEASES OF THE ABDOMINAL WALL, PERITONEUM, OMENTUM, AND MESENTERY—OVARIAN TUMOURS—ABDOMINAL FIBROIDS OF THE UTERUS—ECTOPIC GESTATION

INJURIES AND DISEASES OF THE ABDOMINAL WALL

Contusions of the Abdominal Wall.—Contusions of the abdominal wall owe their importance to the likelihood of their being complicated by injury of the viscera in the abdominal cavity. In addition to the severity of the blow, the factors most to be taken into consideration are the preparedness of the patient for the blow and the strength of the abdominal muscles. When a patient is prepared, even for a second, for a blow on the abdomen, the lumbar spine is flexed, withdrawing the abdomen from the blow, and the abdominal muscles are rigidly contracted. Under these circumstances the force of the blow falls on the abdominal muscles, causing usually severe contusion of them with great pain, and later the appearance of bruising; but the viscera escape. On the other hand, if the muscles are totally unprepared, bruising of them may be slight or absent, but one of the intra-abdominal viscera may be ruptured.

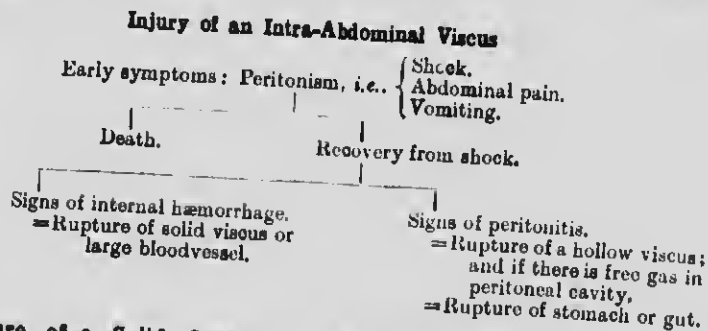
CLINICAL FEATURES.—After a severe blow on the abdomen, the patient suffers from shock (see p. 199), and the severity of the shock depends more on the contusion of the abdominal wall and the circumstances under which the blow was received than on the occurrence of an intra-abdominal lesion. For example, a child run over the abdomen will often be in a condition of severe shock from the fright of the accident, and in twenty-four hours will be completely recovered, while an adult, with a ruptured spleen or ileum, may show few signs of shock. Besides shock, there is abdominal pain and often vomiting.

A careful examination should be made of the patient, and if no evidence is found of an acute abdominal lesion, the case should be treated as one of contusion of the abdominal wall; but if there is any doubt as to whether a severe intra-abdominal lesion is present and the patient is under favourable conditions for surgical interference, it is safer to perform an exploratory laparotomy than to wait for a mere definite occurrence of grave symptoms.

TREATMENT.—The patient should be kept in bed, with the abdominal muscles relaxed by supporting the head and shoulders, and the thighs flexed over a pillow. In severe contusions cold, by means of an icebag, or evaporating lead lotion, or heat in the form of fomentations, may be applied to the abdomen.

Contusions of the Abdomen associated with Injuries to the Abdominal Viscera.—The abdominal viscera are most likely to be injured if there is a sudden severe localized blow such as a kick from a horse, and a hollow viscus, such as the stomach or bladder, is more liable to rupture if it is distended than if it is empty. Disease of the solid viscera, for example, enlargement of the spleen due to malaria, may favour rupture from very slight causes. The order of frequency of rupture of the abdominal viscera from external violence is—Liver, spleen, kidney, stomach, intestines. Rare injuries are—Rupture of the bladder or ureter, laceration of the vessels in the mesentery, or tearing of the aorta or vena cava.

CLINICAL FEATURES.—Directly after the accident the patient is found in a condition of shock more or less severe (as explained above) and suffering from abdominal pain and vomiting. These three symptoms—shock, abdominal pain, and vomiting—have been termed “peritonism,” and are found in all sudden severe lesions of the abdomen. If the lesion is a very severe one, the patient may die from shock in a few minutes, but in less degrees of injury the shock is gradually recovered from and a period of relief of symptoms may occur. This period is rapidly followed by the symptoms of internal hæmorrhage if a solid organ has been ruptured or a large bloodvessel torn, or peritonitis with free gas in the peritoneal cavity if some part of the alimentary tract has been ruptured. The above may be stated graphically thus:



Rupture of a Solid Organ or Large Bloodvessel.—The patient becomes unconscious and pale, with rapid pulso, sighing respiration, and restlessness. The abdominal wall is usually flaccid, and on percussion there is shifting dullness in the peritoneal cavity. Localized tenderness may be present over the liver or spleen, and in the case of rupture of the kidney, blood may be present in the urine.

Rupture of a Part of the Alimentary Canal.—After the initial “peritonism,” there is usually an interval, during which the patient

apparently recovers; but in a few hours the symptoms of peritonitis supervene. The abdomen becomes rigid and distended, the temperature and pulse-rate rise, the breathing is thoracic, and the knees are drawn up. Free gas is present in the peritoneal cavity, as is shown by disappearance of the liver dulness. Vomiting is often incessant, and there is complete constipation.

Rupture of the Urinary Bladder is not usually attended by any marked symptoms, and it should therefore be part of a routine examination to pass a catheter in order to ascertain the condition of the urine and bladder.

Rupture of the Gall-Bladder is also unattended by characteristic symptoms, and bile may remain for days in the peritoneal cavity without causing more than a slight inflammatory reaction.

Partial Rupture of Part of the Alimentary Canal.—In some cases the rupture of intestine may be incomplete, one or more of the coats remaining intact. Beyond peritonism there may be no symptom of the condition; but in the course of a few days infective processes may lead to complete perforation and the onset of symptoms of peritonitis, either localized or diffuse.

WOUNDS OF THE ABDOMINAL WALL

Wounds of the abdominal wall without penetration of the peritoneal cavity have the usual features of wounds elsewhere, and demand the usual treatment. If the muscles are divided, they should be separately sutured with catgut, and the skin wound should be closed in the usual way with silkworm gut, chainage being provided for if necessary.

Penetrating Wounds.—In every case of a wound of the abdominal wall careful search should be made to ascertain if the peritoneum is opened.

These penetrating wounds may be divided into two groups—

1. Penetrating wounds, with protrusion of viscera. The viscera most usually presenting through an abdominal wound are the small intestine and the omentum, and the diagnosis is usually obvious. In one case seen by the author a piece of gut protruded through the muscular coat, but did not appear at the small skin wound. Penetration was not suspected, and the piece of gut became strangulated, with a fatal result.
2. Penetrating wounds, with injury of viscera. In these cases blood, intestinal contents, urine, or bile, may escape from the wound, or be retained within the abdominal cavity. The symptoms which supervene will either be those of internal hæmorrhage or acute general peritonitis.

Gunshot Wounds are examples of penetrating wounds, and are usually associated with injury of the viscera, especially the small intestine. The wounds in the intestine are usually multiple; as many

as five wounds in one piece of gut have been caused by the passage of one bullet. The wound in the skin is usually small, but the muscles are much more extensively lacerated, and there is often prolapse of the intestine through them. A bullet wound of the liver or spleen is associated with internal hæmorrhage, while one of the alimentary canal is followed by acute peritonitis, with free gas in the peritoneal cavity.

TREATMENT.—Every wound of the abdominal wall should be carefully explored, and if the peritoneum is divided, it should be further opened if necessary, so that the viscera can be examined methodically, and every lesion treated. When a viscus is prolapsed through a wound, the patient should be prepared for operation, and when under the anæsthetic, the viscus should be further drawn out and washed with warm saline solution, and if uninjured, returned to the abdominal cavity. Any lesion of it must, of course, be treated before it is replaced.

With gunshot wounds the peritoneal cavity must be freely opened, and a careful search made for any injury, it being remembered that lesions are frequently multiple, and the finding of one gross lesion must not hinder search for others. The intestine should be sutured if possible, but resection may be needed.

The experience of military surgeons has shown that gunshot wounds of the abdomen *received in a battle* are best treated under the usual conditions of military surgery by giving morphia and feeding by the rectum, and avoiding operation unless there is severe intra-abdominal hæmorrhage. Spontaneous recovery after perforation of the gut frequently occurs, especially if the patient was fasting before the injury was received.

Rupture of the Abdominal Muscles.—Rupture of the abdominal muscles, especially the rectus, sometimes occurs as a result of violent muscular efforts, usually in lifting heavy weights; or it may be due to blows on the abdomen; or it may occur during the violent spasms of tetanus. The rupture nearly always occurs below the umbilicus.

SYMPTOMS.—The symptoms are those of rupture of any muscle—viz., a sharp pain like that of a blow at the moment of rupture, followed by pain and swelling in the muscle, and later by bruising of the skin.

TREATMENT.—Slight rupture should be treated by rest in bed, but if the muscle is badly torn, the two ends should be sutured together.

Phantom Tumours of the Abdominal Wall.—Phantom tumours are due to localized contractions of a segment of one of the abdominal muscles—usually the upper part of the rectus. The skin over the contracted muscle is often hyperæsthetic.

This condition chiefly occurs in neurotic females, and may be purely a nervous lesion; but it is more common for the spasm of the muscle to be associated with disease of the underlying viscera, such as carcinoma of the stomach or inflammation of the gall-bladder. Under an anæsthetic the "phantom" tumour disappears, and then it is often possible to make out a deep-seated swelling. In some cases

phantom tumours resembling pregnancy (spurious pregnancy) are produced by distension of the intestines with gas and contraction of the recti muscles. Such a spurious pregnancy may even go to spurious labour.

NEW GROWTHS OF THE ABDOMINAL WALL

Innocent

Lipoma.—Lipomata, both circumscribed and diffuse, are not infrequent in the abdominal wall, and have the usual features of lipomata elsewhere. They have to be diagnosed from protrusions of the subperitoneal fat through the abdominal parietes (fatty hernia; see p. 741), which are most common in the middle line above the umbilicus and at the hernial orifices.

TREATMENT.—The treatment of lipomata is removal.

Fibroma.—Fibromata of the abdominal wall are more common in women than in men, and grow principally from the sheath of the rectus and in the region of the iliac crest. They grow slowly, but may reach a large size (14 pounds), and then resemble intra-abdominal tumours.

SYMPTOMS.—The patient complains of a lump, which is found to move with the abdominal wall, and does not disappear when the abdominal muscles are contracted.

TREATMENT.—The tumour should be removed, and it is often necessary at the same time to remove a piece of the parietal peritoneum to which it is attached. The gap in the abdominal wall must be carefully closed to prevent the development of a ventral hernia.

Malignant

Sarcoma.—Sarcomata of the abdominal wall often grow very slowly, and are only locally malignant (the recurrent fibroid of Paget). The diagnosis is the same as for fibromata, and the treatment is very free removal. Microscopic examination is generally necessary in order to discriminate between the fibromata and the sarcomata.

Carcinoma.—Carcinoma of the abdominal wall is usually secondary to carcinoma of the abdominal organs, especially the stomach. The growths are most usually seen near the umbilicus, the tumour cells spreading along the lymphatic vessels of the round ligament. They are of chief importance for diagnosis, and may determine the nature of an obscure abdominal disease.

CYSTS

Urachal Cysts.—The urachus represents the normally obliterated portion of the allantois, and forms the superior true ligament of the bladder, running from the summit of that organ to the umbilicus. Complete obliteration may not occur, and a cyst may form in the course of the ligament.

These cysts may grow to a considerable size (many pints), and may

be mistaken for ovarian and mesenteric cysts. When large they may become attached to the abdominal viscera.

CLINICAL FEATURES.—The patient complains of a swelling situated in the middle line below the umbilicus. This swelling is cystic, and lies behind the abdominal muscles, and is very slowly growing. When it is cut down upon, the anterior surface is uncovered by peritoneum. Urachal cysts are most common in young male adults.

TREATMENT.—The best treatment is excision, but if the cyst is large and runs down to the floor of the pelvis, this may not be possible, and the cyst should be incised and drained.

DISEASES OF THE UMBILICUS

Urachal Fistula.—If the urachus remains entirely unobliterated, a fistula at the umbilicus communicating with the bladder will be found after separation of the umbilical cord, and urine may be discharged through it if there is any obstruction in the urethra. Urinary calculi have also been found in such fistulae. In other cases there is prolapse of the mucous membrane, and a little red swelling is found at the umbilicus.

In a few cases of old-standing cystitis, with obstruction to the urethra, an acquired urinary fistula may appear at the umbilicus.

TREATMENT.—After seeing that the passage through the urethra is quite free, the fistula should be dissected out and the opening in the bladder closed.

Lesions in Connection with the Vitelline Duct.—The vitelline (omphalo-mesenteric) duct runs from the small intestine, within 3 feet of the ileo-cæcal valve, through the umbilicus to the yolk sac. All traces of this duct should normally disappear, but it not infrequently persists (2 per cent.) in some form. The commonest form is a blind sac communicating with the intestine (Meckel's diverticulum), but in other cases there is a fibrous cord between the intestine and the umbilicus, or there may be an open channel between the gut and the navel, forming an **umbilical fistula**, which discharges mucus or faecal matter.

In some cases, again, the canal only persists at its umbilical end, and there is a **blind fistula**. The mucous membrane becomes everted, and a soft red polypus appears at the umbilicus, which can be identified as a remnant of the duct by finding intestinal mucosa on microscopic examination.

Lastly, both ends of the duct may be closed and a cyst form by distension of the intervening portion with mucus.

TREATMENT.—Fistulae communicating with the gut should be dissected out, and the opening in the ileum closed by suture.

Blind fistulae can be treated by destroying their mucous membrane with Paquelin's cautery, or by dissection.

A polypus should be removed after ligature of the base. A cyst should be removed by dissection.

Acquired Fistula in Infants.—A faecal fistula at the umbilicus of an infant is not always due to remains of the vitelline duct, but may be due to inclusion of a small portion of ileum in the ligature which ties the umbilical cord.

Umbilical Granulomata.—A mass of granulation tissue may form at the umbilicus after separation of the umbilical cord, and persist as a small red tumour at the umbilicus, which discharges serum and blood.

TREATMENT.—Ligature and removal. Microscopic section will differentiate it from a remnant of the vitelline duct or the urachus.

Eczema, Inflammation, and Ulceration not infrequently occur at the umbilicus of an infant when it is not kept properly clean, and demand the usual treatment of this condition elsewhere.

Acquired Fistula—Acquired fistulae at the umbilicus are met in connection with the stomach, gall-bladder, and intestines. They are secondary to inflammatory conditions of these organs, or, in the case of the stomach and intestines, the strangulation of these structures in an umbilical hernia. Umbilical herniae are described in the chapter on Hernia (p. 739).

DISEASES OF THE PERITONEUM

Inflammatory Conditions

ACUTE PERITONITIS may be either infective or non-infective, and each of these may be general or localized.

INFECTIVE PERITONITIS may be due to a primary infection of the peritoneum; or be secondary to an inflammatory condition of one or other of the organs covered by the peritoneum; or follow a traumatic or pathological rupture of some part of the alimentary canal into the peritoneal cavity.

Acute Infective General Peritonitis.—The *Causes* of this condition are—

1. Direct infection of the peritoneum through penetrating wounds of the abdominal wall and after operations on the abdominal organs.
2. Traumatic rupture or penetrating wounds of some part of the alimentary canal.
3. Acute perforation by ulcers through the walls of the alimentary canal—*e.g.*, gastric ulcer, duodenal ulcer, and stercoral ulcer.
4. Inflammatory conditions of the various abdominal organs, extending to the membrane over them—*e.g.*, acute appendicitis, acute pancreatitis, and acute cholecystitis.
5. Rupture of abscess—*e.g.*, pyosalpinx or liver abscess, into the peritoneal cavity.
6. Infection through the blood-stream by the organisms of the various infective fevers, including the pneumococcus, the gonococcus, and the glanders bacillus.

The organism most frequently found in connection with infective conditions of the peritoneum is one of the coli group. It is not necessarily the causative agent, but often a secondary infection. Other organisms frequently found are the *Streptococcus pyogenes*, the *Staphylococcus pyogenes*, and the *Bacillus pyocyaneus*.

MORBID ANATOMY.—On post-mortem examination, the intestines—especially the small intestines—are found to be distended, and the various coils stuck together on their opposing surfaces by lymph. The contents are usually foul-smelling liquid faeces and gas. The stomach is distended, and contains a thin brownish-coloured fluid in large quantities. The peritoneum is congested and has lost its lustre, the subperitoneal tissue is often oedematous, and the omentum is thickened and oedematous.

Exudate.—The amount and character of the exudate depend on the cause of the condition and the length of time the patient has lived since the onset of the illness. In some severe cases, when the patient has only lived for about twenty-four hours, there is little more than a slight fibrinous exudate, which just sticks the coils of intestines together. The amount of fibrin is sometimes excessive, and it can be peeled off the coils of intestines and the abdominal viscera in large flakes (fibrinous peritonitis). In other cases, again, the exudate is mainly serous, and there is no attempt at localization of the fluid (serous peritonitis). Lastly, the exudate may be purulent. Pus may be found all over the peritoneal cavity, but it tends to collect in the various natural fossæ, such as the pelvis and the kidney pouches, and between the coils of intestine which are glued together by a fibrinous exudate. Free gas may also be found in the peritoneal cavity, due to the presence of gas-forming organisms, or associated with perforation of some part of the alimentary canal.

SYMPTOMS.—The onset is usually sudden, with acute pain in the abdomen, and vomiting. The pain is at first referred to the umbilicus, but later becomes general, and is described by the patient as "bursting" or "burning."

The temperature is raised (100° to 104° F.), and in the rectum may be considerably higher. The pulse-rate is markedly increased (120 to 160), the pulse being small and often described as "wiry." The respiration is quickened, shallow, and thoracic, the abdomen taking no part in the respiratory movements.

Constipation is usual, owing to paralysis of the muscles of the intestines (ileus paralyticus), and this is generally a prominent feature of the condition; but in over 25 per cent. of cases there is diarrhoea, especially if the pelvic peritoneum is chiefly affected.

The urine is diminished in quantity, high-coloured, and frequently contains albumin. In a case of pelvic peritonitis there may be pain on micturition, and difficulty, amounting sometimes to complete retention.

The tongue is furred and dry, the patient complaining of great thirst.

Vomiting is generally a well-marked symptom from the first, and is often accompanied by continuous hiccough. The vomit consists at first of the contents of the stomach and duodenum, but later is a dull brown fluid containing altered blood; and this will be vomited even if the patient is taking nothing but milk and water. The vomiting is usually effortless, the patient gulping up small quantities, but it may be so continuous as to desiccate him. This symptom accounts partly for the excessive thirst.

The patient lies in bed in the dorsal position, the knees well flexed, and frequently the arms raised above the head. He is restless and distressed, usually speaking in a whisper; the face is drawn and anxious, the eyes sunken, and the nose often blue and cold (Hippocratic facies); the mental condition is generally clear to the last.

On examination of the abdomen, it is found to be rigid and, in the early stages of the disease, contracted owing to spasm of the muscles; but as the illness advances, and the intestines become distended with gas, the abdomen is correspondingly distended and tympanitic on percussion. The skin is hyperæsthetic, and the patient complains of great pain when touched lightly, but deep pressure is better borne. As the exudate collects in the peritoneal cavity, there may be shifting dulness, showing the presence of free fluid. This fluid may be felt collected in the pelvis on rectal or vaginal examination.

ANOMALOUS SYMPTOMS.—It will, of course, be understood that the symptoms of acute general peritonitis vary considerably in character and degree, according to the severity and the cause of the condition, and the following atypical cases should be recognized:

1. A type of case in which general symptoms of infection are largely absent and the chief complaints are abdominal distension and absolute constipation. This type is often seen in general peritonitis, secondary to a perforation of the large bowel by an abscess or malignant growth, or from the bursting of a diverticulum of the pelvic colon. The condition is usually diagnosed as acute intestinal obstruction, but the true diagnosis is discovered on operation. There are frequently free fæces in the peritoneal cavity. These cases are almost invariably fatal.
2. After an operation on the abdominal viscera, followed by acute general peritonitis, there is usually little or no rise of temperature. The patient does not complain of pain, and the abdomen may remain flaccid, although it is somewhat distended; there is often persistent, slight vomiting and hiccough; but the bowel may react to enemata. The pulse gets much more rapid, the extremities cold, and the patient generally dies within forty-eight hours of the operation. Reopening the abdomen and draining is of little value.

3. The patient, usually a child, is a little restless and flushed, the eyes are bright, and he talks and may even play with his toys. The abdomen is not distended, but it is slightly rigid. Vomiting may not occur. The pulse is very rapid and weak. It is extremely difficult to make the parents realize the gravity of these cases, and they may refuse to believe that the child is seriously ill until within a few hours of his death.

TREATMENT.—In all cases of infective general peritonitis, the abdomen should be opened as soon as possible, so as to deal with the cause of the condition, and establish drainage. Directly the diagnosis of peritonitis is made, preparations for operation should be begun, and the patient should be placed in the Fowler position—*i.e.*, the head of the bed is tilted so that the patient lies at about an angle of 35 degrees with the horizontal. In this position the inflammatory exudates gravitate down to the pelvis, where they are not so dangerous, and can be readily removed.

Use of Morphia in Acute Abdominal Conditions.—Morphia should never be given in acute abdominal conditions until a diagnosis has been made, and the course of treatment decided upon. It must never be given if a second opinion is being sought. Morphia relieves the pain and mental anxiety, relaxes the rigid abdominal muscles, improves the pulse, and alters the entire clinical picture, so that a false impression of the condition is given, and the necessity for urgent operation is not realized. When the decision for operation has been made, a small dose of morphia may be given to tide over the period of necessary delay, especially if the patient has to be moved before operating.

In every case it is of importance to diagnose, if possible, the exciting cause, as the position of the incision depends on this; but if no exact diagnosis can be reached, a small incision should be made over the appendix, as this is by far the commonest cause of an unexplained general peritonitis.

After the cause has been treated—*e.g.*, suture of a perforated gastric ulcer, removal of a suppurating Fallopian tube, or gangrenous appendix—drainage of the peritoneal cavity must be carried out. In the majority of cases this can be efficiently done by inserting a large tube containing a wick of gauze (cigarette drain) down to the bottom of Douglas's pouch, either through the original incision or through a median opening made just above the symphysis pubis. When the patient is returned to bed, he is placed in the Fowler position, and kept in this position for four or five days.

Removal of the inflammatory exudate is effected by mopping out the peritoneal cavity with gauze swabs or sponges, but adherent lymph must not be removed. Irrigation of the peritoneal cavity is unnecessary, but, in cases of general peritonitis without adhesions, is harmless if done carefully. When localized adhesions exist, irrigation may do harm by breaking down the adhesions and spreading the infection.

In those cases in which operation has been delayed until a large

amount of pus has collected in the peritoneal cavity, and is being shut off into loculi by adhesions between the coils of intestines and omentum, it is also necessary to drain both kidney pouches as



FIG. 286.—DIAGRAM SHOWING THE PERITONEAL POUCHES, WITH THE PATIENT IN THE FOWLER POSITION.

well as the pouch of Douglas. These operations should always be performed as rapidly as possible, and a minimum of anæsthetic given, or intraspinal anæsthesia should be used.

AFTER-TREATMENT.—The patient should be kept very quietly in bed, but the use of morphia is to be avoided if possible, as it increases the tendency to flatulent distension of the abdomen and ileus paralyticus, which is the chief danger following peritonitis. If the patient has lost much fluid from vomiting or exudation, saline fluid should be given by the rectum (proctolysis), subcutaneously, or intravenously. Vomiting should be treated by discontinuing any fluid by the mouth and washing out the stomach, or by giving large doses of hot water, so that the patient washes out the stomach naturally by vomiting.

The bowels should be opened by enemata or by aperients, the most largely used being calomel in 2-grain doses every two hours, magnesium and sodium sulphate in drachm doses, and castor oil. A difference of opinion exists as to the time for giving the aperients, some surgeons believing that they should be given as early as possible (twelve hours after the operation), others preferring to wait for two or three days.

McCosh advises the injection of magnesium sulphate into the duodenum during the time of operation.

Again, in cases of severe paralysis of the intestines, some surgeons attempt to force peristalsis by enemata, purgatives, strychnine, and eserine; others think it better to give the paralyzed muscles time to recover and order no aperient, but prescribe morphia in order to give the intestines rest. The author deprecates the excessive use of aperients and enemata in these cases, as they are unnecessary with slight distension, and are of doubtful value in severe paralysis of the intestines, being often followed by diarrhœa, which tends to exhaust the patient.

If the condition of ileus continues, the abdomen may be reopened and the intestine punctured; or a Paul's tube may be introduced into one of the distended coils.

Recovery may follow this procedure, but in the majority of instances severe ileus paralyticus is fatal. It is impossible to predict when recovery will take place.

The wound should be frequently dressed to remove all the discharges, and the drainage-tube replaced as soon as possible by a gauze drain. No rule can be laid down as to when the drainage-tube should be removed, but in the case of perforated gastric ulcer it is seldom necessary to leave it in for more than forty-eight hours. As there will always be some suppuration in the wound, the scar will be weaker than that of a wound which heals by the first intention; it is therefore advisable for the patient to wear a belt for some months after the operation, to avoid the risk of ventral hernia.

Acute Infective Localized Peritonitis.—This is due to the same causes as general peritonitis, but the infection is not so acute and widespread. Adhesions have time to form between the coils of intestine, the omentum, and the parietal peritoneum, and so localize the inflammation to one part of the peritoneal cavity. The inflammatory exudate may be absorbed, and a few adhesions left to mark the site of the inflammation; or a localized abscess may form, which steadily enlarges, and may burst—

1. Externally.
2. Into the general peritoneal cavity, causing general peritonitis.
3. Into the intestines or bladder.
4. Into the subperitoneal tissue and burrow any distance.
5. Through the diaphragm into the pleura or lungs.

SYMPTOMS.—The symptoms are similar to those of acute general peritonitis, but are milder in degree, and the abdominal signs of rigidity and tenderness are most marked over the site of the inflammation. In the course of twenty-four or forty-eight hours a distinct swelling can be felt, which is tense, and either dull or resonant on percussion, according as it is deep-seated or the reverse. This swelling is due to matted intestine and omentum. When it forms, the general symptoms abate, as toxic absorption is diminished by the walling-in of the exudate.

This swelling will disappear if the inflammation resolves, but if an abscess forms, it slowly increases in size. If it invades the abdominal

wall, the skin becomes red and œdematous, till finally the abscess points and bursts. The pus is generally very foul, and the abscess frequently contains gas, the organism present being usually the *Bacillus coli*. A discharge of pus from the rectum or urethra will indicate that the abscess has burst into the alimentary canal, or into the urinary passages; while the formation of an empyema or expectoration of the pus will indicate perforation into the pleura or the lungs.

TREATMENT.—As soon as an acute infective localized peritonitis is diagnosed, the abdomen should be opened over the site of the inflammation, and the condition causing the peritonitis—such as an inflamed appendix or gall-bladder—dealt with, and local drainage established if necessary.

The exceptions to this rule are very few, and concern principally neglected cases of appendicitis and salpingitis.

If the patient has had several previous attacks of these conditions, and the present attack is not severe, the surgeon may delay operation until resolution has occurred, or until a localized abscess forms which requires drainage.

A further consideration of the treatment of localized peritonitis will be found under Appendicitis (p. 705), which is one of the most frequent causes of this condition.

The following varieties of localized infective peritonitis—viz., pelvic abscess and subdiaphragmatic abscess, require special mention.

Pelvic Abscess.—The formation of an abscess in the pelvic peritoneal cavity is usually secondary to inflammation of a pelvic appendix, or to inflammation of the Fallopian tubes or uterus.

Since the introduction of the Fowler position, pelvic abscess due to inefficient drainage of Douglas's pouch has become less frequent.

The abscess as a rule is situated between the rectum and bladder, or in the female between the rectum and the uterus and vagina. An abscess may also form between the uterus and the bladder. The sides of the abscess are formed by the pelvic wall, and the roof by the intestines and omentum, which are matted together by inflammatory adhesions.

SYMPTOMS.—The early symptoms are those common to all forms of peritonitis; but owing to the less rapid absorption that occurs through the pelvic peritoneum than in other parts of the peritoneal cavity, the general symptoms are not so well marked. The muscles in the lower abdomen are rigid, but this symptom also is less marked than when there is inflammation in other parts of the abdomen. Diarrhœa frequently takes the place of the more common condition of constipation.

With the formation of a localized abscess in the pelvis, the general symptoms become still less marked; and if a rectal or vaginal examination is not made, the abscess may pass undetected until it forms a well-marked swelling in the lower abdomen, and contains a pint or more of pus, or until it bursts through the rectal wall. The diagnosis is made by feeling a tender cystic swelling in the front of the rectum in addition to the general symptoms of mild infection.

TREATMENT.—If the abscess is actually pointing in the rectum or in the posterior fornix of the vagina, it may be opened in these situations. In other cases—and especially if the peritoneal cavity has already been opened—the abscess should be reached from above, either through the original wound or through a second one just above the symphysis pubis. A large drainage-tube should be introduced.

Subdiaphragmatic Abscess.—A subdiaphragmatic or subphrenic abscess is an abscess situated in the upper part of the abdomen in more or less proximity to the diaphragm. In many cases, however, the abscess is subhepatic.

VARIETIES.—Subdiaphragmatic abscesses may be (1) intra- or (2) extra-peritoneal.

Intra-peritoneal.—The reflexions of the peritoneum which form the falciform and coronary ligaments of the liver divide the upper

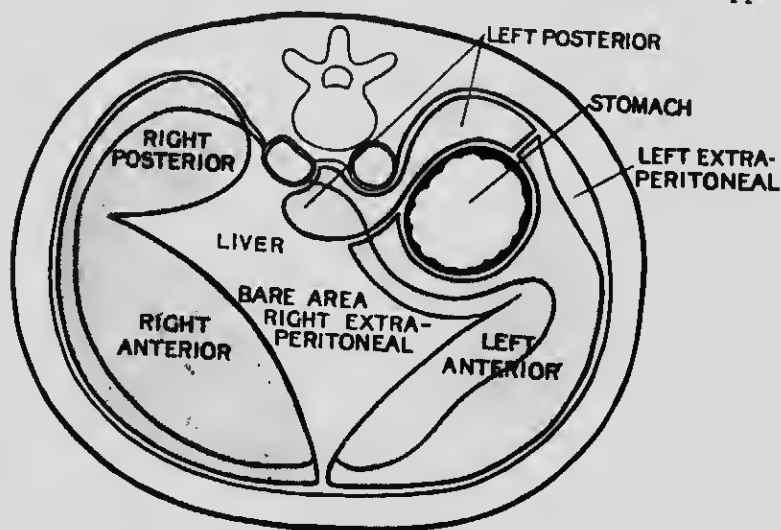


FIG. 281.—DIAGRAM SHOWING THE SITUATIONS OF SUBDIAPHRAGMATIC ABSCESSSES, (AFTER BARNABD).

part of the peritoneal cavity into four more or less distinct compartments:

1. A right anterior, lying between the right lobe of the liver and the anterior abdominal wall.
2. A right posterior, lying behind the right lobe of the liver, between it and the diaphragm.
3. A left anterior, between the left lobe of the liver and the anterior abdominal wall.
4. A left posterior, forming the lesser sac of the peritoneum, lying behind the liver and the stomach, and between them and the posterior abdominal wall.

Pus may collect in any one of these compartments, and form a correspondingly named subdiaphragmatic abscess.

Extraperitoneal.—

1. Right extraperitoneal. The reflexions of the peritoneum, forming the falciform ligament, separate on the posterior aspect of the right lobe of the liver, leaving a surface uncovered by peritoneum. Pus may collect in this space, and separate still further the layers of the falciform ligament, the abscess being wholly extraperitoneal.
2. Left extraperitoneal. The pus forms in the loose cellular tissue round the upper part of the left kidney, and ascends behind the peritoneum, lifting the membrane off the left roof of the diaphragm.

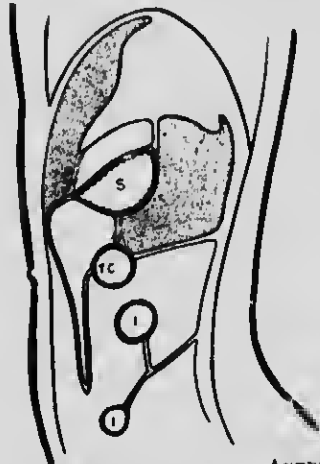


FIG. 282.—DIAGRAM OF ANTERIOR AND POSTERIOR SUBDIAPHRAGMATIC ABSCESSES (AFTER BARNARD).

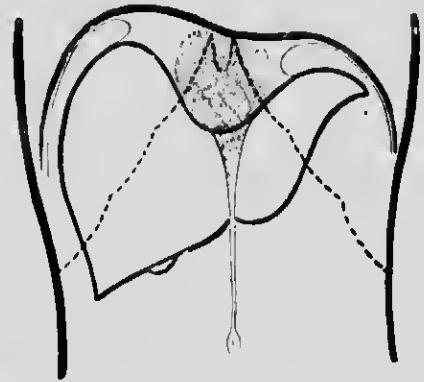


FIG. 283.—SUBDIAPHRAGMATIC ABSCESS BETWEEN THE REFLECTIONS OF THE CORONARY LIGAMENT (AFTER BARNARD).

CAUSES.—The abscess may be due to—

1. Direct drainage of the pus into one of the peritoneal fossae in cases of suppurative peritonitis, due to such causes as acute appendicitis, diverticulitis, acute perforation by a gastric ulcer, or suppurative salpingitis. Subdiaphragmatic abscess from this cause is much less common since the adoption of the Fowler position in the treatment of peritonitis.
2. Extension of suppuration from an abscess in its neighbourhood, such as liver abscess, empyema, abscess in the kidney, or an abscess in connection with a rib.
3. Chronic perforation by a gastric, duodenal, or intestinal ulcer after the formation of adhesions. For example, an ulcer in the anterior wall of the stomach may be associated with

a left anterior subdiaphragmatic abscess; while an ulcer in the posterior wall, with closure of the foramen of Winslow by adhesions, may rupture into the lesser sac of the peritoneum, and cause a left posterior subdiaphragmatic abscess.

4. Extension of the suppuration by the lymphatics in the retro-peritoneal tissue. This accounts for many extraperitoneal abscesses, such as left extraperitoneal abscess following perforation of the posterior aspect of the iliac colon.

The most common cause of subdiaphragmatic abscess is chronic perforation of a gastric or intestinal ulcer. Other common causes are acute appendicitis, tropical abscess of the liver, and empyema.

The pus generally contains the *Bacillus coli*, and is foul-smelling. Gas is frequently present in the abscess, due to perforation of a hollow viscus or to the presence of gas-forming organisms.

CLINICAL FEATURES.—The abscess may develop soon after an obvious cause, such as an attack of acute appendicitis, for which the abdomen has been opened and drained; or it may develop slowly without the primary cause—such as a duodenal or gastric ulcer—being suspected.

The *General Symptoms* are those of any infective condition, and vary with the acuteness of the disease. In acute cases the general symptoms are marked, and rigors often occur. In chronic cases there may be merely a feeling of general malaise with evening rises of temperature.

The *Local Symptoms* vary somewhat with the site of the abscess. Pain is always an early and prominent feature, and is referred to the situation of the pus. In right-sided abscesses the liver dulness is usually increased upwards, and the edge of the liver becomes depressed below the costal margin. In left-sided abscesses—which generally contain gas—the left lobe of the liver is displaced downwards and the heart upwards. In two-thirds of the cases of both left- and right-sided abscesses there is an abdominal swelling, which does not move on respiration. The base of the corresponding lung is usually compressed, with corresponding physical signs. It is often a matter of the greatest difficulty to determine whether the pus lies below or above the diaphragm; and, of course, in some cases it lies on both sides of that muscle.

The X rays are exceedingly valuable in the diagnosis of subdiaphragmatic abscess. In a radiogram the situation of the abscess may be shown by the presence of a dark shadow; and if the fluorescent screen be used, it will be seen that the corresponding half of the diaphragm does not move on respiration.

The **DIAGNOSIS** of subdiaphragmatic abscess is confirmed by aspiration of the pus; but this should not be done unless the surgeon is ready to complete the operation if suppuration be found. Under anaesthesia the needle attached to a good aspirating syringe is inserted through the pleura into the pouch indicated by the physical signs.

Two or three punctures are often necessary, and care should be taken that the needle penetrates the diaphragm—a fact indicated by the needle rising and falling with the respiration.

RESULTS.—The patient may die of septicæmia, or the abscess may burst into the pleural cavity, the lungs, pericardium, stomach, general peritoneal cavity, or externally.

The **PROGNOSIS** is not good, owing to late diagnosis, the difficulty of establishing efficient drainage, and the seriousness of the condition that gives rise to the abscess.

TREATMENT.—The abscess must be opened and drained. In most instances this is best accomplished through the pleura. The abscess should first be located by the use of the exploratory syringe. The pleura is opened after resecting portions of one or two ribs, and the diaphragm is then stitched to the intercostal muscles. An opening is then made in the diaphragm, the pus evacuated, and a large tube placed in the abscess cavity. It will be necessary to drain the pleura at the same time if an empyema is present. It is generally impossible to deal with the cause—*e.g.*, a perforated gastric or duodenal ulcer—at the time of opening the abscess.

When the abscess is pointing in the abdomen, it may be best to open it from the abdominal aspect; or, in the case of a right posterior abscess, it may be opened by an incision below the twelfth rib.

The opening of a suspected subdiaphragmatic abscess should be deferred until the evidence of a definite localized collection of pus is fully established.

Pneumococcal Peritonitis.—Peritonitis, due to infection of the peritoneum with the pneumococcus, is most common in female children. It is usually secondary to pneumococcal infection of the lungs, the organism reaching the peritoneum by the blood-stream, or by extending along the lymphatics, passing through the diaphragm. In other cases it is part of a general pneumococcal infection of the serous membranes, or a primary infection of the peritoneum, the organisms finding their way through the mucous membrane of the intestine or along the Fallopian tubes.

CLINICAL FEATURES.—Two varieties may be distinguished—*viz.*, acute and chronic.

Acute.—The symptoms and physical signs are similar to those of general peritonitis due to the pyogenic organisms, but diarrhoea is frequently present instead of constipation, and the general symptoms are not so severe. The diagnosis is often decided by the history of a recent pneumonia.

Chronic.—The chronic cases originate generally with a subacute attack of peritonitis with diarrhoea, and as the subacute symptoms subside there is a slow formation of fluid in the lower part of the abdomen, or there may be some localized collection of fluid below the umbilicus. The patient wastes, and the general signs of chronic infection are present. The pus may point near the umbilicus, and spontaneous cure may follow.

The pus is usually greenish in colour, non-odorous, and a large

quantity of fibrin is generally present; but there is nothing pathognomonic about the pus, and the diagnosis is only absolutely established by finding the pneumococcus on bacterial examination. A mixed infection may be present.

TREATMENT.—In acute cases, which will often be mistaken for infective peritonitis following appendicitis, the abdomen should be opened and drained, and the patient placed in the Fowler position.

In chronic cases the collections of pus should also be opened and drained, and two or more incisions may be necessary.

The **PROGNOSIS** is not good in acute cases.

Gonococcal Peritonitis.—Gonococcal peritonitis is most common in women, and is due to direct extension of the gonococcus through the walls of the uterus or Fallopian tubes, or along the mucous membrane of the Fallopian tubes to the peritoneum.

In men it is said to be due to direct extension through the walls of the vesiculæ seminales.

CLINICAL FEATURES.—The condition generally originates with an acute attack. The inflammation may be limited to the pelvis (pelvic peritonitis), or be general. In other cases the symptoms are similar to those of other varieties of localized or general infective peritonitis; and the diagnosis is only suggested by finding a gonococcal discharge from the vagina or urethra, or evidence, on examination of the female genitalia, of swollen and distended tubes. The absolute diagnosis can only be made by finding the gonococcus in the exudate into the peritoneal cavity.

RESULTS.—The patient may die as a result of toxæmia and exhaustion, or the local inflammation may subside, leaving adhesions. Pelvic abscess may follow.

TREATMENT.—The patient should be placed in the Fowler position, and the question of urgent operation decided. In the majority of acute cases it is better to open the abdomen, remove the infected tubes if necessary, and drain Douglas's pouch; but it cannot be denied that many cases will get better without operation, and if an abscess forms inside the tubes (pyosalpinx) or in the peritoneal cavity, it can be dealt with safely after all the acute symptoms have subsided.

If operation be decided against, the patient should be left in the Fowler position. Vaginal douches must be given, and fomentations applied to the abdomen. The diet should be light and nutritious, the bowels kept open, and drugs given to relieve the pain, if necessary. With evidence of the formation of pus, the abdomen should be opened and the abscess drained, the tubes and ovaries being removed at the same time if necessary.

Tuberculous Peritonitis.—Tuberculous inflammation of the peritoneum is most common in children, and is, as a rule, secondary to tuberculous of the intestines, mesenteric glands, the Fallopian tubes, or the epididymis. Other cases are associated with tuberculous of the lungs, bronchial glands, bones, and joints.

The inflammation may be acute or chronic.

Acute Miliary Tuberculosis.—Acute miliary tuberculosis is most commonly associated with a general infection of the body by the tubercle bacillus, and is fatal in a few weeks or months. The peritoneal symptoms may be very prominent, and the case is then frequently mistaken for one of typhoid fever; or the chief symptoms may be referred to the lungs or meninges, and the peritoneal symptoms escape notice. There is no surgical treatment.

In other instances acute tuberculous peritonitis is due to the bursting of a tuberculous mesenteric gland or Fallopian tube into the general peritoneal cavity. The symptoms then closely resemble those of peritonitis due to infection by other organisms, and the case is frequently mistaken for one of acute appendicitis or salpingitis. The diagnosis is only made on opening the abdomen and discovering the source of the infection, or finding the bacillus on bacteriological examination.

Chronic Tuberculosis.—Four pathological and clinical types may be distinguished: Serous, purulent, ulcerative, and fibrous.

Serous Form.—This is the most common variety, and is distinguished by a copious, serous exudate into the peritoneal cavity. The patient—most often a child—wastes, loses his appetite, becomes feverish, and the abdomen increases steadily in size.

On examination, free fluid is found in the abdominal cavity by the usual physical signs, and it is often possible to distinguish lumps in the abdomen, which may be—

1. Enlarged mesenteric glands.
2. A rolled-up and tuberculous omentum.
3. Matted intestines, with fluid between the coils.
4. Masses of impacted feces.

In boys it is common to find a hydrocele, the excess of fluid distending the processus vaginalis. As the abdomen becomes more and more distended, the umbilicus is everted, and the skin becomes shiny, with large prominent veins over it. The diagnosis has to be made from ascites due to other causes, such as cirrhosis of the liver.

PROGNOSIS.—The prognosis of this type is fairly good.

TREATMENT.—The usual general treatment of tubercle should be carried out, and a course of X-ray treatment to the abdomen may prove beneficial.

If the fluid steadily increases in amount, the abdomen should be opened below the umbilicus, and the fluid allowed to escape. The visceral and parietal peritoneum will be found to be covered with small tuberculous nodules, and the mesenteric glands to be enlarged. If the Fallopian tubes are tuberculous, they should be removed, and caseous mesenteric glands must be scraped out thoroughly. The abdomen is then closed without drainage, and the general treatment of tuberculosis continued. The effects of this operation are sometimes striking, but if the fluid reaccumulates, it may be necessary to remove it by aspiration; but this procedure should not be used as a substitute for the primary operation.

Purulent Form.—This form is most common in female children. It resembles the serous variety, but the general symptoms are more marked, and the condition of the patient more serious. The pus may be encysted in loculi between the intestines, or may be free in the peritoneal cavity. The physical signs are those of ascites, either general or localized. Spontaneous evacuation may follow pointing and rupture at the umbilicus.

TREATMENT.—The abdomen should be opened, and the pus, which may be found in large quantities, should be evacuated. The intestines generally lie matted together and covered by a gelatinous exudate at the back of the abdomen. The wound may be closed entirely, or the peritoneal cavity drained for a few days.

The *PROGNOSIS* is not so good as in the serous variety, but improvement or recovery may follow the operation.

Ulcerative Form.—The abdomen is only slightly distended, or it may be retracted. The patient wastes rapidly, and shows the usual symptoms of a hectic fever. If the abdomen be opened, the whole of the intestines are found matted together in one fibro-casrous mass with collections of green or brown pus between the coils. Fistulae between the coils of intestines are not uncommon. The intestines are frequently adherent to the abdominal peritoneum, and a faecal fistula may form.

The *PROGNOSIS* is hopeless, and laparotomy is useless.

Fibrous Form.—The onset of this variety is, as a rule, very insidious, and the general symptoms are not marked. The patient generally suffers from constipation, alternating with attacks of diarrhoea. The abdomen is only moderately distended, and feels doughy; but hard, irregular masses may be felt, which are rolled-up omentum or localized collections of fluid. The intestines are usually distended with gas, and attacks of subacute intestinal obstruction are common. On opening the abdomen, the intestines may be seen matted together with fibrous tissue, and the omentum rolled up into a sausage-shaped mass in the epigastric region. Tubercles are found scattered over the intestines and the omentum.

The *PROGNOSIS* of this variety is not good, owing to the frequency of such complications as intestinal obstruction, the formation of abscesses between the coils of intestine, and faecal fistulae.

TREATMENT.—The usual general treatment of tuberculosis is carried out, including a course of X rays; but if there is no improvement, laparotomy may be proposed. It may not, perhaps, be beneficial, but it is a harmless procedure. Intestinal obstruction must be treated by laparotomy, but it will often be necessary to establish a faecal fistula.

It must, of course, be understood that these types frequently become mixed. For example, the main type may be fibrous, but in one part of the abdominal cavity the tubercle may have undergone caseation, and ulceration be present; or a large collection of serous fluid may occur between the coils of intestine matted together by fibrous tissue.

Non-Infective Peritonitis.—Non-infective peritonitis may be—
(1) General, or (2) localized.

Generalized non-infective peritonitis follows the extravasation of aseptic bile, urine, blood or fluid from rupture of the pancreatic, hydatid, or ovarian cysts into the peritoneal cavity.

The inflammation of the peritoneum results in a serofibrinous exudate, which may become infected—usually by the *Bacillus coli*—absorbed, or may result in the formation of peritoneal adhesions.

The SYMPTOMS are those of mild infective peritonitis, with a copious exudate.

TREATMENT.—In the majority of cases it is necessary to open the abdomen in order to deal with the condition causing the peritonitis, such as the removal of an ovarian cyst or the suture of a ruptured bladder.

On the other hand, if the condition follows operation, or a slight extravasation of blood, no treatment beyond rest in bed is necessary.

Localized Non-Infective Peritonitis.—This condition most commonly follows the leaving of a sterile foreign body—such as a swab or a pair of forceps—in the abdomen. The foreign body becomes encapsuled with fibrous tissue, and may remain undiscovered for years, or it may gradually force its way into the alimentary canal, and be discharged through the anus. At any time infection may occur, and an abscess form round the foreign body.

Other forms of chronic non-infective peritonitis, associated with mediastinitis, pericarditis, etc., are of medical rather than surgical interest.

TREATMENT.—A foreign body left in the peritoneal cavity should be removed as soon as its presence is diagnosed.

NEW GROWTHS OF THE PERITONEUM

Endothelioma.—The only *primary* new growth of the peritoneum of any importance is an endothelioma. This form of neoplasm is very rare. It occurs in the form of numerous small nodules, or of large sheets of new growth. It is generally accompanied by a serous or blood-stained effusion into the peritoneal cavity. The condition is often mistaken for a chronic inflammation. There is no treatment.

Secondary New Growths of the peritoneum are usually carcinomata, due to carcinoma of the ovary, stomach, or intestines. In many cases there is a general carcinomatosis, a condition which on abdominal exploration may closely resemble a tuberculous peritonitis, or large masses may be found all over the abdomen. There is always a serous or blood-stained exudate. The abdominal tumours may not be felt until the fluid has been removed.

CLINICALLY, the condition may come on insidiously, the patient not coming for treatment until the disease is extraordinarily advanced. The only SYMPTOM may be wasting, with some enlargement of the abdomen.

There is no treatment.

Papillomata (Warts).—When a papillomatous cyst of the ovary bursts into the peritoneal cavity, papillomata may be grafted all over the peritoneum, and when the abdomen is opened the peritoneum is found to be studded with warts.

These papillomatous growths may disappear after removal of the primary lesion in the ovary.

CLINICALLY, they cause hydroperitoneum. The reason for the presence of the fluid is not usually recognized until the abdomen is



FIG. 264.—PAPILLOMATOUS CYST OF THE OVARY (TURNED INSIDE OUT.)
(London Hospital Pathological Institute.)

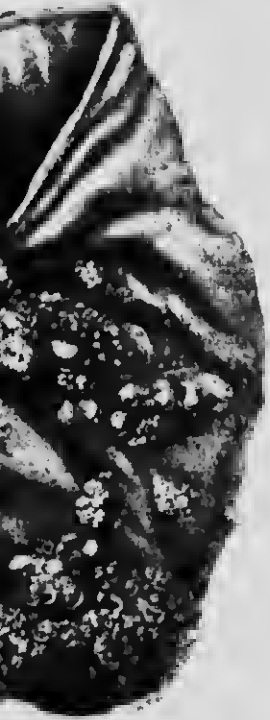
opened, except in cases when the patient has been known to be suffering from ovarian tumour.

The **TREATMENT** is the removal of the parent cyst in the ovary.

RETROPERITONEAL NEW GROWTHS

Lipomata.—Retroperitoneal lipomata are generally formed in the fatty tissue in the posterior wall of the abdomen pushing the stomach and intestines forwards. They frequently originate near and round the kidney, and grow into the root of the mesentery. These tumours may grow to an enormous size, one weighing 63 pounds having been removed.

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GROWTHS

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CLINICAL FEATURES.—If the tumour is large, the patient complains of vague abdominal symptoms and an increase in the size of the abdomen, while other parts of the body are wasting. The abdomen on examination gives a sense of being filled with fluid, but there is no shifting dulness. In thin patients the lobulation of the tumour may be made out, and the intestines are found to be lying in front of the swelling. Small lipomata give no symptoms, and are only discovered on abdominal exploration.

TREATMENT.—Removal of these tumours may be a matter of considerable difficulty if they are large and adherent. In the majority of cases they do not affect the patient's health, and therefore should only be removed if an examination shows that this may be effected without much difficulty.

According to Adams, these tumours are usually fatal, as they tend to undergo sarcomatous degeneration.

Sarcomata.—Sarcoma of the retroperitoneal tissue is most common in middle-aged men.

The onset of the disease is insidious, and, according to some authorities, may start as an innocent growth. The tumour, in most cases, situated in the posterior part of the abdomen, usually behind the colon, which it pushes forwards. There is progressive loss of flesh throughout the illness, and in the later stages ascites is present.

TREATMENT.—These tumours are mostly inoperable when first seen, and the only treatment consists of making an artificial anus if there are symptoms of intestinal obstruction.

Carcinomata.—Retroperitoneal carcinomata are generally secondary growths in the lymph glands, the primary focus being in the intestine, ovary, or testis.

Attempts at removal are only permissible when the tumour is very small and the primary growth can also be removed.

Cysts.—Retroperitoneal cysts are usually either—(1) Hydatid cysts, or (2) pseudo-cysts of the pancreas.

The former have the usual character of hydatids, and require the customary treatment.

The latter will be considered under Diseases of the Pancreas (p. 783).

DISEASES OF THE OMENTUM

NEW GROWTHS

Sarcoma.—Sarcomata of the omentum are mostly met with in adults over the age of forty-five. Like other malignant growths in the abdomen which do not affect vital structures, there are no characteristic symptoms in the early stages. The patient complains of loss of weight and strength, combined with symptoms of dyspepsia.

On examination, a hard, nodular, movable swelling is felt in the front of the abdomen, usually near the umbilicus. There is free fluid in the abdomen, and the anterior surface of the tumour (which is best examined in the knee-elbow position) is flattened.

The TREATMENT of this tumour is disc

Carcinoma of the omentum is a general carcinoma

Cysts.—Hydatid cysts in this situation are usually ovarian cysts that are free of its attachment to the pedicle. On operation, the characters of an ovarian cyst are

The TREATMENT

Torsion of the Omentum is exceptionally common in hernia. When the omentum is unusually congested with general peritonitis

CLINICAL FEATURES.—In a hernia associated with a large omentum, the hernia is present as a tender mass, and is suggested if the patient is asked to cough. The hernia is

TREATMENT.—The omentum should be removed at the same time as the

AF

Embolism and Thrombosis of the mesenteric vessels is most common in the omentum. It is suggested by a sudden onset of symptoms, and is most common in patients with constipation, the symptoms are generally severe, and

CLINICAL FEATURES.—The symptoms are a sudden onset of symptoms, mostly in patients with constipation, the symptoms are generally severe, and

If the abdomen is black, and often a large amount of fluid is found in the peritoneal cavity, or only a small amount is affected, or only a small amount is affected, or only a small amount is affected.

TREATMENT.—If the diagnosis is certain, this may be resected, and the wound will be closed later, and the intestines is

AFFECTIONS OF THE MESENTERIC GLANDS

The mesenteric glands may be affected in the following ways:

1. Part of a general enlargement of lymphatic glands, as in Hodgkin's disease or leukaemia.
2. Carcinomatous enlargement, secondary to carcinoma of the intestines, or occasionally of the breast.
3. Infection from ulceration of the intestine, which may occur in typhoid fever or ulcerative colitis. In this case suppuration occasionally follows, and the abscess has to be diagnosed and treated in the usual way. Infection may also follow tuberculous ulceration.

Tuberculous Adenitis of the Mesenteric Glands.—Infection of the mesenteric glands by the tubercle bacillus is most common in children, generally following an intestinal lesion, though this may not be clinically apparent. The pathology of the condition is the same as that of tubercle in other glands. Fibrosis, suppuration, and calcification may follow. The glands most commonly affected are those of the ileo-caecal region.

CLINICAL FEATURES.—Clinically, the condition is met with—

1. An obscure swelling may be found in the abdomen of a child suffering from general malaise and vague abdominal symptoms. On laparotomy, this swelling is found to be a mass of tubercular glands, breaking down into a tubercular abscess.
2. A gland may burst and infect the peritoneum, the symptoms then being those of acute or chronic tuberculous peritonitis. If the abdomen is opened for this condition, the broken-down gland should be removed.
3. The gland may become secondarily infected, and attacks of peritonitis, resembling appendicitis, may occur, with the presence of a lump in the ileo-caecal region. The true condition is often only recognized when the abdomen is opened.
4. The inflammation of the glands may result in the formation of adhesions between the coils of intestine, causing intestinal obstruction. The partial character of the obstruction and the presence of a tumour frequently in children, leads to the diagnosis of intussusception, the true cause being found on laparotomy.
5. The condition may cause no symptoms, being only discovered on X-ray examination of the abdomen. Calcified mesenteric glands give a good shadow, which may be mistaken for stone in the kidney, uræter, or bladder.

TREATMENT.—When the abdomen has been opened and tuberculous mesenteric glands discovered, the glands most enlarged—especially if they are breaking down—should be removed.

Excellent results have followed this operation. If a tuberculous abscess is found, it must be opened, the pus evacuated, and the gap in the mesentery closed to avoid drainage, if possible.

NEW GROWTHS OF THE MESENTERY

Tumours of the mesentery are nearly always retroperitoneal **lipomata** or **sarcomata** (see p. 631) which have grown into and between the layers of the mesentery.

CLINICALLY, they have the usual symptoms of an intra-abdominal growth, and on examination, a central, somewhat movable, solid tumour is found, having a band or bands of resonance running across it.

TREATMENT.—Sarcomata are generally inoperable. If the growth is recent, however, or if it is a lipoma, an attempt should be made to shell the tumour out, care being taken to avoid excessive injury to the bloodvessels of the intestines; otherwise gangrene will ensue. In some instances it is necessary to resect a portion of the intestine at the same time.

MESENTERIC CYSTS

Cysts of the mesentery may be—

1. **Chylous or Serous Cysts**, due to dilatation of the lymphatic channels in the mesentery.
2. **Blood Cysts**, following injury, hæmorrhage into a solid tumour, or degeneration of an angioma.
3. **Hydatid Cysts**.
4. **Dermoid Cysts**.

The nature of the cyst cannot be determined till after removal and microscopic examination. The origin of many cysts remains obscure. Calcification of the cyst wall is not unusual.

CLINICALLY, the patient complains of vague abdominal symptoms, and on examination, a freely movable, cystic swelling is felt in the middle of the abdomen, with a band of resonance crossing it. If the wall is calcified, a shadow will be seen in a radiogram. Symptoms of intestinal obstruction may occur.

TREATMENT.—The cyst should be excised with or without a portion of the intestines. Incision and drainage should be avoided if possible, as a fistula may result.

OVARIAN TUMOURS

Ovarian tumours may be either cystic or solid, the former being by far the more common. They may arise either in the ovary itself or in certain congenital remnants that are found near the ovary, and represent the earliest genito-urinary apparatus—*i.e.*, the pronephros and the mesonephros, or Wolffian body.

1. CYSTS ARISING IN THE OVARY

1. **Simple Cysts.**—These cysts are probably due to distension of one of the Graafian follicles with fluid. They are rarely of large size, and are lined with a cuboidal epithelium like that of the *membrana granulosa*. They contain a serous fluid which has a specific gravity between 1005 and 1020. These cysts probably never become malignant, but hemorrhage may occur into them, forming blood-cysts. A large cyst (cricket-ball size) is usually surrounded by a number of smaller ones. In some cases there are a large number of small cysts in both ovaries, forming tumours which can be readily felt on vaginal examination. This variety of tumour is called after the gynaecologist who first described it, **Rokitansky's tumour**. It is a very rare condition.

2. **Multilocular Adenomatous Cysts.**—Cysto-adenomata arise in connection with the ovary, and may grow to a very large size. They occur at any age, but are most common after thirty. The smaller loculi are lined by a columnar epithelium, but in the larger it becomes flattened, and may finally disappear. The cysts contain mucin, which is often brown from extravasation of blood into it, or it may contain cholesterol. Calcification of the walls may be present, and when the cyst grows to a large size, it usually becomes adherent to the intestines, omentum, and bladder. Rupture into the peritoneal cavity does not cause severe peritonitis. Carcinomatous degeneration of these cysts is uncommon, but not infrequently intracystic papillomatous growths are found.

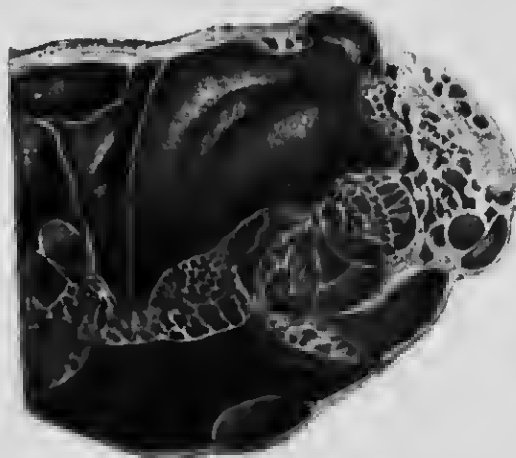


FIG. 285.—PART OF A MULTILOCULAR CYSTO-ADENOMA OF THE OVARY.

(London Hospital Medical College Museum.)

3. **Lutein Cysts.**—Lutein cysts arise in connection with the corpus luteum of pregnancy, and do not grow to a large size. They are rare, and only to be distinguished from simple cysts by careful examination of the wall. They may be associated with hydatidiform mole or chorion epithelioma.

4. **Teratomata (Ovarian Dermoids, Embryomata).**—Teratomata are cysts of the ovaries, which are believed to arise from an asexual development of an ovum, may be divided into two groups—the unilocular and the multilocular.

Unilocular teratomatous cysts occur at any age, and are the most common variety of ovarian cyst met with in children. They consist of a single cyst, into which projects at one place the embryonic rudiment which is covered with a squamous-celled epithelium from which grow coarse hairs. This stratified epithelium also contains sebaceous glands, and the cyst is usually filled with their secretion. Bones, teeth, and mammae may also be found in the cyst as well as structures, resembling muscle, special sense organs, and nervous tissue.

Multilocular teratomatous cysts are rare, and consist of a solid growth, in which cavities of various sizes are found. The cavities may contain sebaceous matter, hair, and other structures found in the body, or mucin similar to that found in the cysto-adenomata.

Teratomatous cysts, especially the multilocular variety, may undergo malignant change, and the form of growth may be squamous-celled carcinoma, columnar-celled carcinoma, sarcoma, or chorion epithelioma.

These teratomatous cysts are very apt to become inflamed and suppurate. When they become inflamed they become adherent to the bladder and intestines, and if suppuration occurs, the cyst contents may be discharged by the rectum or the urethra. They may also discharge externally, causing a fistula, or burst into the peritoneal cavity, causing a diffuse general peritonitis.

2. CYSTS ARISING IN EMBRYONIC REMNANTS (CYSTS OF THE PAROÖPHORON)

These cysts are probably derived from the mesonephros (Wolffian body), and are either unilocular or multilocular. Although any of the cysts of the ovary may develop papillomatous intracystic growths, they are most common in this variety of cyst, which are therefore sometimes termed **papillomatous cysts**. The small cysts are lined with a columnar ciliated epithelium, and they contain a thin serous fluid of low specific gravity. The intracystic growths are villous papillomata, which bleed readily, and are apt to become malignant. The papillomata may spread through the cyst wall and grow on the peritoneal aspect of the cyst, or they may grow on the other ovary. If the cyst bursts, the papillomata may become grafted on the peritoneum, and this membrane may become studded with small growths, which cause a rapid effusion into the peritoneal cavity. The papillomata usually continue to form on the peritoneum, and lead to the death of the patient, but occasionally they disappear spontaneously (see Fig. 284).

On microscopical examination, the innocent papillomatous growths present a central core of loose connective tissue and bloodvessels covered by a single layer of columnar-celled epithelium; but when they are malignant, there is proliferation of the epithelium which passes through the basement membrane into the stroma.

3. BROAD LIGAMENT CYSTS

These cysts may arise from the parovarium, from accessory Fallopian tubes, or may be inflammatory in origin (lymphatic cysts). They are usually unilocular, and burrow between the layers of the broad ligament. The Fallopian tube lies stretched across them, and the ovary is separated from the cyst unless it is of very large size. The contents consist of a clear, straw-coloured fluid of low specific gravity, which does not contain albumin. Rupture into the peritoneal cavity is not infrequently followed by disappearance of the cysts. Occasionally they contain intracystic growths.

4. TUBO-OVARIAN CYSTS

A tubo-ovarian cyst is a cyst of the ovary, the cavity of which communicates with a dilated Fallopian tube. In the majority of cases they arise from inflammation occurring in the Fallopian tube, the ovary becoming secondarily adherent and cystic; but it is possible that in some cases a cystic ovary becomes adherent to the tube, and an opening forms from pressure atrophy. These cysts frequently become inflamed and suppurate.

CLINICAL FEATURES OF OVARIAN CYSTS.—Ovarian cysts are met with at all ages, but are most frequently diagnosed after puberty. They may grow to an enormous size, but their rate of growth varies considerably. Ovarian cysts may grow for a long time without causing symptoms, and the patient may apply for treatment on account of the increasing size of the abdomen. In other cases there are disorders of the menstrual function—viz., pain, diminished menstrual flow, or menorrhagia. A very large cyst may cause embarrassment of the action of the heart or the diaphragm, or it may press on the vena cava, causing ascites and œdema of the legs.

In a large number of cases the onset of COMPLICATIONS first brings the patient under observation. These are—

1. *Impaction in the Pelvis.*—This will cause pressure on the bladder, with frequent micturition or retention of urine; pressure on the rectum, causing constipation; and very occasionally pressure on the ureter, followed by hydronephrosis.

2. *Torsion.*—Torsion of the pedicle of an ovarian cyst may be due to emptying a pregnant uterus, or muscular exertion, or no cause may be apparent. The twisting of the pedicle causes intense engorgement of the cyst, and hæmorrhage into its cavity. The cyst may become gangrenous, and peritonitis follow from infection of the *Bacillus coli*. The symptoms are sudden onset of acute abdominal pain, with shock and vomiting (peritonism). On examination, the patient is found to have a rounded, tender swelling rising out of the pelvis. Later, there are the usual symptoms of peritonitis.

3. *Inflammation and Suppuration.*—Inflammation and suppuration are due to infection of the cyst with micro-organisms, usually the *Bacillus coli communis*. It is rare in simple and multilocular adenomatous cysts, and is most common in teratomata. The symp-

toms are the general signs of an infective disease and the presence of a tender, painful lump in the pelvis.

4. *Rupture*.—Rupture may be either spontaneous or due to violence, and the symptoms may be vague or well marked. In some cases there is sudden acute abdominal pain and shock, followed by general peritonitis, while in other cases rupture is only recognized by the appearance of free fluid in the abdomen. This fluid may be absorbed, and spontaneous cure follow, or the cyst may re-form.

PHYSICAL SIGNS OF AN OVARIAN CYST—Abdominal Examination.—On inspection, there is a swelling in the lower abdomen projecting antero-posteriorly, and the umbilicus is flattened or bulging. The swelling feels cystic or may fluctuate, and localized cysts may be felt on its surface. It moves with respiration. It is dull on percussion, while the flanks are resonant, showing the absence of free fluid in the peritoneal cavity. Auscultation gives no diagnostic sign of an ovarian cyst, but this method may be used in the differential diagnosis from pregnancy.

Vaginal Examination.—The uterus is somewhat fixed and displaced, but the sound passes the usual distance. The cervix is not softened. If the cyst is entirely in the pelvis, it will be felt as a painless cystic swelling lying behind or to one side of the uterus. This swelling is usually freely movable, but may be attached to the uterus.

When the cyst lies in the abdomen, it may not be possible to feel it on vaginal examination, but in other cases the swelling can be felt bimanually, or direct continuity between the pelvic and the abdominal swelling made out.

The **DIAGNOSIS** has to be made from a distended bladder, pregnancy, ascites, phantom tumours, encysted inflammatory fluid in the peritoneum, fibromyomata, and other tumours of the uterus, hæmato-metra, mesenteric cysts, etc.

TREATMENT.—An ovarian cyst should be removed through an abdominal incision as soon as it is diagnosed. The abdomen is opened just to one side of the middle line, the cyst exposed, and all adhesions to surrounding structures should be carefully separated. The question of diminishing the size of the cyst by tapping will then arise. Unilocular simple cysts may be tapped, and can then be removed through a much smaller opening, but it is better to remove all the other varieties of cysts without tapping. The contents of the cyst are irritating to the peritoneum, or they may contain organisms (especially the teratomata) or transplantable tumour cells (papillomatous cysts). The pedicle of the cyst is crushed and tied in sections to minimize the risk of slipping of the ligatures, and after division a cuff of peritoneum is drawn over the raw surface by means of a purse-string suture. This helps to prevent the formation of adhesions which later might cause intestinal obstruction. Broad ligaments often have no pedicle, and must be excised from their peritoneal investment. In the majority of cases this is easily stripped off, but it may be closely adherent, so that part of the cyst only can be removed, the remainder being brought up to the abdominal wall and drained. After a broad ligament cyst

has been enucleated, the gap in the peritoneum should be closed with absorbable sutures.

If an ovarian cyst is very closely adherent to the intestines and omentum, it may be dangerous to separate it, and it is sometimes advisable to empty the cyst and close the opening. As soon as the fluid reaccumulates, it is removed by aspiration. It is very seldom that this method of treatment is indicated.

If the patient is so old that the ovaries are functionless, it is advisable to remove both ovaries at the operation, even if the second one shows no sign of disease, as it may subsequently become the seat of cyst formation, necessitating a second operation.

In all cases of ovariectomy, even if the patient is young, it is advisable to obtain consent for removal of both ovaries, as multilocular and papillomatous cysts are frequently bilateral.

TREATMENT OF COMPLICATIONS—1. *Torsion*.—Torsion of the pedicle of an ovarian cyst is treated by immediate operation, as life may be threatened by internal hæmorrhage, peritonitis, or exhaustion from suppuration. The removal is similar to that of an uncomplicated cyst, but drainage of the peritoneal cavity may be advisable.

2. *Hæmorrhage* into the cyst from other causes besides torsion should be treated by ovariectomy.

3. *Rupture* of a cyst, inflammation, and suppuration are all indications for immediate ovariectomy.

4. *Ovarian Cyst and Pregnancy*.—The treatment of election is ovariectomy, as the pregnancy only very slightly increases the danger of the operation. If the cyst is firmly adherent in the pelvis, or the patient is not in a suitable condition for operation, and relief is needed, the cyst may be tapped, but this method of treatment should seldom be used. If the cyst is not discovered until the later months of pregnancy, operation should be postponed until the child is viable (thirty-fourth to thirty-sixth week), as premature labour may be induced by the operation.

Termination of the pregnancy may be brought about in cases of malignant cysts, so as to check the rate of growth of the tumour.

5. *Ovarian Cyst and Parturition*.—If the confinement is proceeding normally, it should be completed, and the cyst may be removed at the termination of the third stage, or later when the uterus has involuted. If complications are present at the confinement, the abdomen should be opened and the cyst removed, and in cases of closely adherent cysts it may be advisable to perform Cæsarian section at the same time.

SOLID OVARIAN TUMOURS

Solid ovarian tumours compose about 2 per cent. of the tumours of the ovary. They are divided into innocent and malignant.

Innocent

Fibromata.—These are rare, slowly growing tumours, arising (1) as a diffuse growth of the ovarian stroma; (2) an encapsuled localized growth; (3) a pedunculated growth. They occur in adults, most fre-

quently between the ages of thirty and fifty, and cannot be diagnosed clinically from other forms of solid ovarian tumours or pedunculated fibroids of the uterus. Ascites is an occasional complication; it disappears after removal of the tumour.

Adenomata.—Solid adenomata of the ovary have been described, but are very rare. They are sometimes associated with ascites and pressure effects, but clinical diagnosis is not possible.

Papillomata may arise on the surface of the ovary, and cause secondary growths on the peritoneum and ascites. The secondary growths sometimes disappear after removal of the ovary.

Malignant

Sarcoma.—Sarcomata are found at all ages, and in young subjects are frequently bilateral. All varieties of cells are met with, but the most common growth is the round-celled sarcoma. The prognosis is very grave.

Carcinoma.—Primary solid carcinomata of the ovary are either adeno-carcinoma or a diffuse growth of epithelial cells spreading through the whole ovary.

Secondary carcinoma of the ovary is more common than primary, and is usually associated with a primary growth in the stomach or intestines.

Cystic carcinomata may arise in a papillomatous cyst or a multilocular adenomatous cyst. In a large number of cases the diagnosis can only be made on microscopical examination.

Endothelioma.—Endotheliomata may occur in the ovary, and are highly malignant. They can only be distinguished from the carcinomata and sarcomata by microscopical examination in the early stages.

CLINICAL FEATURES OF MALIGNANT OVARIAN TUMOURS.—The patient complains of enlargement of the abdomen and loss of flesh and strength. Amenorrhœa is often an early symptom, and later there is pain from pressure on the pelvic nerves, and the onset of peritonitis. Ascites is an early feature, and later there is œdema of the legs from pressure and anæmia.

On examination, a hard fixed nodular tumour is felt in the pelvis, rising up into the abdomen.

Death occurs from cachexia, peritonitis, or pulmonary embolism.

TREATMENT.—The diagnosis often has to be settled by exploratory laparotomy, and if no secondary growths are found and the tumour is not adherent, an attempt to remove it should be made. As the condition is frequently bilateral, the other ovary should always be removed at the same time; and to make the operation complete, it is advisable to remove the uterus and its appendages.



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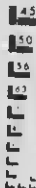
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MYOMATA (FIBROIDS) OF THE UTERUS CAUSING AN ABDOMINAL TUMOUR

Myomata of the uterus are the commonest solid abdominal tumours in women. They are rare before the age of thirty, and probably never arise after the menopause, but they may not cause symptoms until after this event. They are much more common in single and sterile women than in those who have borne children.

Histologically a fibroid consists of whorls of unstriated muscle fibres joined together by connective tissue. The tumour itself contains few bloodvessels, but it is surrounded by a vascular capsule formed from the uterine wall.

Myomata tend to undergo various forms of degeneration, the most important being—

1. *Fibrosis*, the tumour becoming dense and hard, and the muscular fibres disappearing.

2. *Calcification*.—This usually occurs in old age, and the tumour becomes stony hard and ceases to grow.

3. *Myxomatous Degeneration* starts in the centre of the tumour, transforming it into a yellow-green, semifluid substance.

FIG. 286.—SUB-PERITONEAL FIBROIDS OF THE UTERUS.
(London Hospital Medical College Museum.)

4. *Cystic Degeneration*.—The centre of the tumour is transformed into a cyst with ragged walls. It is probably a further advance of myxomatous degeneration.

5. *Malignant Degeneration*.—This is an uncommon change, only about 2 per cent. of myomata becoming sarcomata.

CLINICAL FEATURES.—The fibroid tumours which are of interest to the general surgeon are those growing under the peritoneal covering of the uterus. These are termed "subserous fibroids." Subserous fibroids may exist for years without causing symptoms, or they may be associated with disorders of menstruation.

PHYSICAL SIGNS.—On palpation of the lower abdomen there is felt a firm, hard mass rising out of the pelvis. The tumour is smooth.

non-sensitive except just before the menstrual period, and is more or less mobile. Small globular swellings can usually be felt on the main tumour, and the lump has been compared to a mass of potatoes. On percussion, the tumour is dull. On listening with the stethoscope, a uterine souffle synchronous with the heart's beat may be heard over the tumour.

Bimannual abdominal and vaginal examination will show that the uterus is enlarged and the tumour lies in close connection with it. The uterus is often drawn upwards, so that it is difficult to reach the cervix, which presents none of the softening characteristic of pregnancy. Many of the subserous fibroids are only connected with the uterus by a pedicle, and in these cases it is almost impossible to differentiate the tumour from an ovarian cyst or a solid tumour of the ovary.

A uterine fibroid may grow so big as to produce great discomfort from its size, causing œdema of the legs from pressure on the vena cava and embarrassment of the respiration from distension of the abdomen. The complications are—

1. *Torsion*.—A pedunculated subperitoneal fibroid may undergo axial rotation, causing sudden acute abdominal symptoms. The patient complains of violent abdominal pain with vomiting, and there is a sudden enlargement of the tumour. Torsion is followed by local peritonitis, and the tumour becomes adherent to surrounding structures. In some cases torsion may lead to degeneration of the tumour, or it may become detached altogether from the uterus.

2. *Suppuration*.—Infection of a uterine fibroid is rare, and the infecting agent is usually the *Bacillus coli*. The tumour undergoes rapid enlargement, and there are the usual general symptoms of infection.

3. *Incarceration in the Pelvis*.—If a fibroid tumour becomes fixed in the pelvis, it causes pressure symptoms on the pelvic organs.

The pressure on the bladder usually causes irritability and frequency of micturition, but if the urethra is pressed upon, there is retention of urine. Pressure on the rectum causes painful defæcation and hæmorrhage, and has even caused sufficient obstruction to warrant a colostomy. Pressure on the sacral plexus of nerves causes neuralgic pain and paræsthesia along their course.

TREATMENT.—The only treatment of subperitoneal myomata of the uterus is removal, but this operation is not always necessary. The following cases may be considered:

1. *Small tumours not causing symptoms*. The tumours can be left, and the patient may live for many years without them in any way interfering with her health or comfort.

2. *Large Fibroids*.—Very large fibroids should be removed, as they may cause serious pressure effects by their size.

3. *Fibroids which become incarcerated in the Pelvis* should be pushed up above the sacral promontory, an anæsthetic being given if necessary. It is then usually advisable to remove the fibroid, as recurrence of the condition is probable.

4. The occurrence of *torsion* or *suppuration* should lead to removal of the fibroid.

Two operations are performed for subperitoneal fibroids of the uterus—viz., **myomectomy** and **hysterectomy**. The operation of election is hysterectomy, which may either be an amputation of the body of the uterus, the cervix being left, or a total hysterectomy.

Myomectomy is to be preferred to hysterectomy in the following conditions:

1. In cases of a solitary pedunculated myoma; a wedge-shaped portion of the uterine wall from which the tumour is growing should be removed with the pedicle.
2. If the patient is of such an age that pregnancy is possible, an attempt to preserve the uterus is justifiable.

For a detailed description of myomectomy and hysterectomy the reader is referred to a textbook on gynecology.

ECTOPIC GESTATION

Intraperitoneal Rupture of a Tubal Gestation

By the term "tubal gestation" is indicated the development of a foetus in the wall of one of the Fallopian tubes instead of in the uterus. Rupture of the tube gives rise to one of the grave acute abdominal lesions, and may come under the treatment of the general surgeon.

The CAUSES of tubal gestation are past attacks of salpingitis leading to desquamation of the lining epithelium of the tubes, and attacks of peritonitis leading to peritoneal adhesions, which distort the tubes and partly obstruct the lumen.

Rupture of a tubal gestation may occur—

- (1) Into the peritoneal cavity, and bleeding be so severe that the patient dies in two or three hours;
- (2) between the layers of the broad ligament;
- (3) into the lumen of the tube. In this case, if the abdominal ostium is closed, a hæmo-salpinx forms, but if the ostium is open, the blood escapes into the peritoneal cavity, and the ovum may be extruded (tubal abortion)
- (4) into the uterus; this is rare, and only follows when the tubal pregnancy occurs in that part of the tube passing through the uterine wall (interstitial gestation).



FIG. 287.—RUPTURED TUBAL GESTATION (SEMI-DIAGRAMMATIC).

CLINICAL FEATURES OF ACUTE INTRAPERITONEAL RUPTURE.—Tubal gestation usually occurs in women who have been sterile for

some years. The patient gives a history of amenorrhœa and morning sickness, and will often state she had believed herself to be pregnant. Rupture usually occurs before the end of the second month of the pregnancy, but in cases of interstitial pregnancy may be delayed until the third month.

The patient is suddenly seized with violent abdominal pain and vomiting, and in a short time exhibits all the signs of internal hæmorrhage. She becomes steadily paler, the skin is cold, the pulse rapid, the respiration sighing, and there is great restlessness.

On examination, the abdomen is generally tender and a little rigid, and percussion may show that there is free fluid in the flanks. Vaginal examination is usually negative unless the blood is clotted; an indefinite swelling may then be felt in Douglas's pouch.

TREATMENT.—The abdomen should be opened to one side of the middle line below the umbilicus, and the damaged tube pulled into the wound, ligatured, and removed.

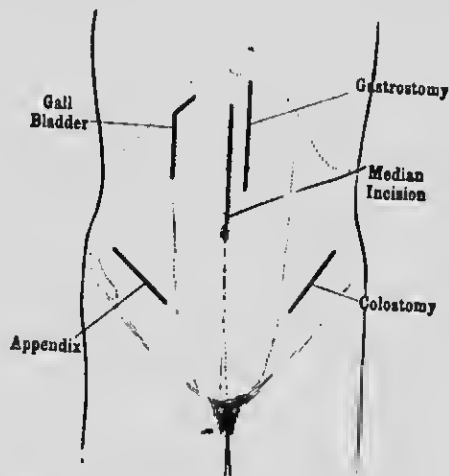


FIG. 288.—INCISIONS IN ABDOMINAL OPERATIONS.

The blood in the peritoneal cavity should be removed with sponges, and the abdomen closed. If the gestation is interstitial, the tube should be excised and the uterus repaired by sutures.

CHAPTER XIX

INJURIES AND DISEASES OF THE STOMACH AND DUODENUM

INJURIES AND DISEASES OF THE STOMACH

Rupture of the Stomach.—The stomach is most commonly ruptured by a localized blow on the abdomen, such as a kick from a horse when the stomach is distended after a meal.

CLINICAL FEATURES.—The patient at first suffers from peritonism—*i.e.*, shock, abdominal pain, and vomiting, the vomit consisting of blood or food mixed with blood. In a short time the symptoms of peritonitis supervene with the physical signs of free gas and free fluid in the peritoneal cavity.

In cases of incomplete rupture there may be at first vomiting of a little blood and no further symptoms, but if the part of the stomach which is damaged becomes gangrenous, symptoms of peritonitis will supervene in a few days.

TREATMENT.—The abdomen should be opened at once, and the rent in the stomach sutured. As in all cases of suture of the stomach and intestine, the mucous membrane should be first united with a continuous layer of chromicized catgut, and then the peritoneum united by a continuous or an interrupted row of sutures of fine silk. This second row of sutures should pierce the peritoneum and the muscular coat, and be arranged as shown in Diagram 304.

After suture of the stomach, the peritoneum should be cleaned with sponges, a small opening made above the symphysis pubis, and a large drainage-tube, with a gauze wick, passed into Douglas's pouch. The upper wound is completely closed by layers of sutures uniting the peritoneum, the muscular aponeurosis, and the skin. The patient is nursed in the Fowler position, and the after-treatment is similar to that of perforated gastric ulcer (see p. 657).

Wounds of the Stomach.—These are produced from without by stabs or bullet wounds, or from within by the unskilful use of the stomach-tube, gastroscope, or by foreign bodies.

CLINICAL FEATURES.—There is usually very little bleeding, internally or externally, with wounds of the stomach, and in the case of external wounds there is rarely escape of stomach contents. The symptoms—which should never be waited for—are those of peritonitis, with free gas and free fluid in the peritoneal cavity. The diagnosis in external wounds is usually easy, but with internal wounds

the condition will probably not be recognized until symptoms of peritonitis occur.

TREATMENT.—The abdomen should be opened at once, the existing wound being enlarged or a fresh opening made just to one side of the middle line. The wound in the stomach should be sutured, and especially in the case of gunshot wounds search should be made on the posterior wall of the stomach for a wound of exit, which must also be sutured. The peritoneal cavity is cleaned, and drainage of Douglas's pouch carried out in the usual way.

Burns of the Stomach.—Burns of the stomach are produced by swallowing corrosive acids or alkalies, and are associated with burns of the œsophagus. The part most severely burnt is the region of the pylorus and the lesser curvature.

SYMPTOMS.—The symptoms are intense burning pain along the œsophagus and in the abdomen, with increasing vomiting of dark, blood-stained fluid, and pieces of burnt mucous membrane. The patient may die rapidly of shock, or in a few days from exhaustion or peritonitis due to gangrene of the stomach wall. Recovery may occur with stenosis of the pylorus or hour-glass constriction of the stomach. Stenosis of the œsophagus is usually present as well.

TREATMENT.—The surgical treatment of this condition is immediate gastrotomy and cleaning out the stomach. A gastro-jejuno-stomy is then performed so as to keep the stomach empty and to obviate the stricture of the pylorus, which will probably follow.

Foreign Bodies in the Stomach.—Foreign bodies in the stomach include coins, fruit-stones, tooth-plates, pieces of pipe and whistles, which have been swallowed inadvertently, usually by children, or deliberately by lunatics or criminals.

The foreign body usually passes *per anum* in from three to fourteen days, and it is often astonishing how some of these bodies manage to pass the pylorus and the ileo-cæcal valve. The foreign bodies that most usually lodge in the stomach are those that have sharp edges like tooth-plates, or long, narrow articles like lead pencils.

SYMPTOMS.—At first the foreign body causes no symptoms, and its position can only be ascertained by the X rays; but if it remains in the stomach, it causes dyspepsia, and by its presence may cause ulceration of the gastric mucous membrane with the symptoms of gastric ulcer. Perforation of the stomach with peritonitis will sometimes follow.

TREATMENT.—The patient should be fed on such articles of diet as porridge, mashed potatoes, and suet puddings, and aperients of all kinds should be avoided. The passage of the foreign body may be followed with the X rays, and the stools should be carefully examined until it has passed. If it is retained in the stomach, or if it is of such a nature that it is unlikely to pass, it should be removed by gastrotomy.

Hair-Balls.—These are collections of hair in the stomach, which may in time form an exact cast of the interior of that organ, so that

it is difficult to understand how the patient takes food. They occur in neurotic women and lunatics who develop the habit of eating their own hair.

The symptoms are gastric pain, vomiting, and wasting, but generally no history of hair-swallowing can be obtained. A freely move-

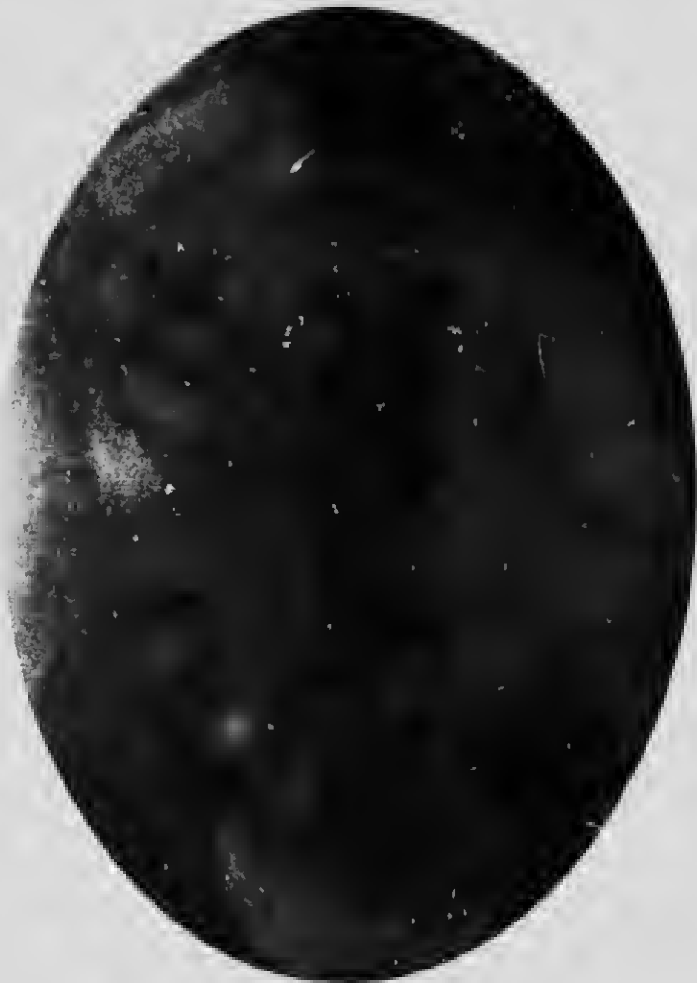


FIG. 289.—SAFETY-PIN IN THE DUODENUM.

able tumour resembling the stomach in outline may be felt in the epigastric region.

TREATMENT.—The hair-ball should be removed by gastrotomy.

The diagnosis will probably only be made on opening the stomach.

Acute Phlegmonous Gastritis.—This is an acute infective inflammation of the submucous tissue of the stomach, generally ending in

PLATE III.



Mass removed from the Stomach of a Lunatic, consisting of human hair, horse hair and strips of cloth. The horse hair and strips of cloth were from the patient's mattress.

London Hospital Medical College Museum



suppuration, which may be primary or secondary to ulceration of the stomach, or to one of the specific infectious fevers. Males are more frequently affected than females, and it may occur at any time from childhood to old age. Two varieties are described— a diffuse and a circumscribed.

CLINICAL FEATURES—*Diffuse Form.*—There are the usual general symptoms of an acute infective disease with epigastric pain and tenderness, vomiting, and intense thirst. Later the classical symptoms of peritonitis supervene. There is no pus in the vomit, and the condition cannot be diagnosed.

Circumscribed Form. The initial symptoms are the same as in the diffuse form, but are not so severe. If the patient survives, a localized abscess forms in the submucous tissue of the stomach, which may give rise to a palpable tumour. The abscess may burst into the stomach, when the patient will vomit a large quantity of pus, or into the abdominal cavity, causing acute general peritonitis.

TREATMENT.—The condition is so rarely met with and so much more rarely diagnosed that no line of treatment can be laid down. The diffuse form would probably always be fatal, but a localized abscess might be opened and drained with success.

Gastric Ulcer

Gastric ulceration may be due to the presence of foreign bodies in the stomach, burns of the mucosa from acids or alkalis, syphilis, tubercle, and typhoid fever; but by the term "gastric ulcer" is usually understood an acute or chronic ulcer of the stomach, the exact cause of which is unknown.

ETIOLOGY. Although simple ulcer of the stomach may occur at almost any age after puberty, two types of patients who commonly suffer from this disease can be differentiated. The first are young anæmic girls of the servant class, who suffer from acute ulcer, and the second, elderly men and women of the working class, who tend to develop chronic ulcers. Both classes of patients usually eat their meals rapidly and irregularly and have decayed teeth and oral sepsis.

The best-known theories accounting for the formation of a gastric ulcer are—

1. The condition is due to infection of the wall of the stomach from oral sepsis.
2. The condition complicates a chronic gastritis or a neurosis of the stomach, which is associated with excessive secretion of hydrochloric acid (hyperchlorhydria), which damages the mucous membrane of the stomach.
3. The ulcer results from auto-digestion of a portion of the stomach wall from which the blood-supply has been cut off by a minute embolus lodging in an artery.
4. That the ulcer is dependent upon an altered nerve-supply of the stomach—*i.e.*, it is analogous to acute bedsores and perforating ulcers of the foot.

None of these theories is entirely satisfactory.

PATHOLOGICAL ANATOMY.—*Acute* gastric ulcer is frequently multiple (50 per cent. of the cases) and may involve all the coats of the stomach down to the peritoneum. When this gives way, the ulcer is said to perforate. The ulcer is roughly round in outline with clean-cut edges.

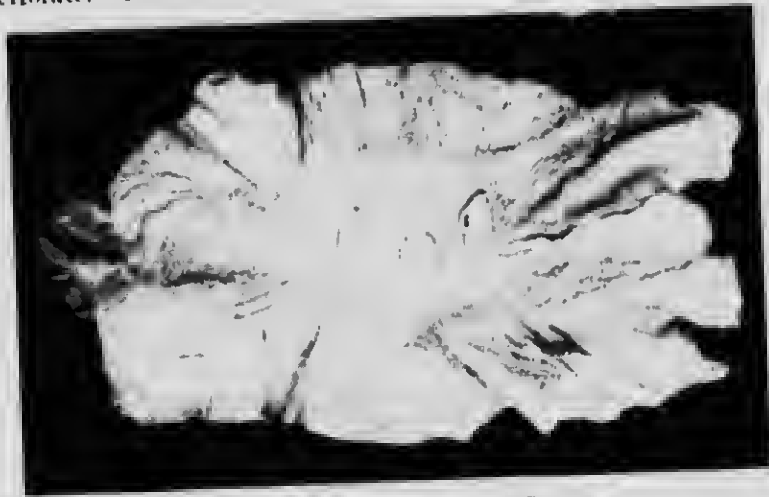


FIG. 290.—SIMPLE ULCERS OF THE STOMACH.
(London Hospital Medical College Museum.)

and is situated almost indifferently in any part of the stomach, but most commonly on the anterior wall. It frequently erodes vessels and causes profuse hæmorrhage; acute perforation is common.

Chronic gastric ulcer is usually single, although it may be formed by the coalescence of two or more ulcers. It has an irregular shape and thickened edges. It is most frequently found near the pylorus on the posterior wall of the stomach and at the lesser curve. The base of the ulcer is thickened and becomes adherent to the surrounding structures, so that the floor of the ulcer may be formed by the pancreas or the abdominal parietes. The amount of fibrous tissue may be so great that a tumour is formed in the stomach, which may be palpable before laparotomy, but is usually discovered on opening the abdomen. This tumour may resemble a mass of carcinoma, and a differential diagnosis may only be possible on microscopic examination.

These ulcers may perforate or cause severe hæmorrhage, but more commonly they cause trouble by contraction of the fibrous tissue surrounding them. The most usual complications are stenosis of the pylorus, hour-glass stomach, perigastric adhesions, perigastric abscess, and disease of the pancreas. Carcinoma of the stomach supervenes on chronic gastric ulcer in an appreciable number of cases (10 to 50 per cent., according to various authors).

A healed gastric ulcer, unless it is very superficial, leads to puckering of the stomach wall from cicatricial contraction, and a white opacity of the peritoneum is seen over its site, enabling the

surgeon to recognize old ulceration on examining the outside of a stomach.

CLINICAL FEATURES.—The symptoms are very similar in the acute and chronic varieties. The patient complains of the symptoms of indigestion, and chiefly of pain in the epigastrium, coming on about one or two hours after food, and often relieved by the next meal or by vomiting. This pain is believed to be due to spasm of the muscles of the stomach. The vomiting occurs at irregular intervals, and may contain semi-digested food (coffee-ground vomit) or large quantities (pints) of bright red blood. Later, with stenosis of the pylorus, the vomit will be characteristic of dilated stomach (see p. 666). The patient is usually constipated,

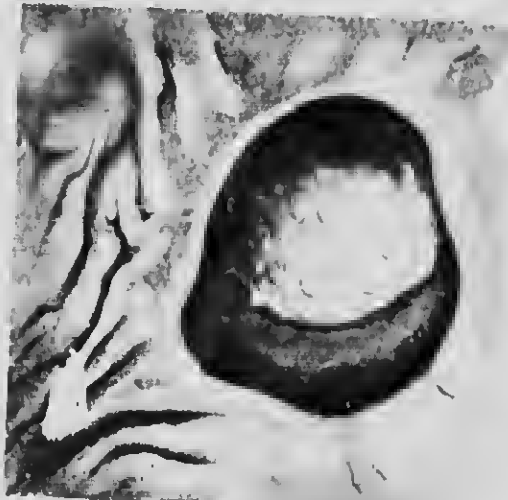


FIG. 201. CHRONIC ULCER OF THE STOMACH, WITH THE HEAD OF THE PANCREAS FORMING THE FLOOR. (London Hospital Medical College Museum.)

and the stools may be black from semi-digested blood (melena), especially after an attack of hæmatemesis.

On examination, the patient may be wasted, and is nearly always found to be suffering from a secondary anemia, which in very chronic cases may be so profound as to suggest pernicious anemia. The teeth are usually carious. The abdomen is tender in the epigastrium, and a woman may complain that she has to loosen her corsets after a meal on account of this tenderness. The upper part of the rectus muscle is contracted, and this contraction may be so marked as to form a "phantom tumour"; more rarely a swelling may be felt behind the upper part of the right rectus in the region of the pylorus.

If a test meal is given and withdrawn, the amount of free hydrochloric acid present in the gastric fluid is usually above normal. It may, however, be normal in amount, and in old-standing cases is often diminished or even absent, especially if there is dilatation of the stomach.

Gastroscopy may show the presence of a gastric ulcer, but the gastroscope is still in the experimental stage, and is not yet of much value.

DIAGNOSIS.—If all these symptoms and physical signs are present, the diagnosis of gastric ulcer is easy; but in many cases in which an ulcer has perforated or has eroded a vessel and caused profuse hæma-

temesis, the patient will give a history of only slight indigestion. On the other hand, most of the symptoms may be present without a gastric ulcer. The conditions which are most readily mistaken for gastric ulcer are duodenal ulcer, gall-stones, chronic appendicitis, and movable kidney. Sometimes the differential diagnosis can only be made on opening the abdomen. Gastric and duodenal ulcers are frequently associated with chronic appendicitis, and this organ should usually be removed when the abdomen is opened.

TREATMENT.—The treatment of gastric ulcer is medical, and consists of rest in bed, careful dieting, and the use of sedative drugs. It is often very successful, but surgical interference is indicated under the following conditions:

1. If the symptoms persist after medical treatment has been given a reasonable trial, or if frequent relapses occur after apparent cure by medical means.
2. If hour-glass stomach, stenosis of the cardiac orifice, or pyloric stenosis follows, or gastric dilatation from any cause.
3. For persistent pain due to the presence of perigastric adhesions.
4. For acute perforation with general peritonitis, or chronic perforation with perigastric abscess formation.
5. If profuse hæmatemesis occurs.
6. If carcinoma supervenes.

1. **Medical Treatment fails to relieve in a Reasonable Time, or Frequent Relapses occur.**—It is stated by Leube that if there is no relief of symptoms after thorough treatment for four or five weeks, medical treatment alone is insufficient to bring about a cure, and surgical aid should be sought.

The surgical treatment of gastric ulcer consists of performing gastro-jejunostomy with or without excision or sequestration of the ulcer. Before this operation is undertaken, the patient should have had efficient medical treatment, including attention to the teeth, false ones being obtained if necessary. He should be fed on sterilized food for two or three days before the operation, and if there is any dilatation of the stomach, it should be washed out one hour before the operation is commenced.

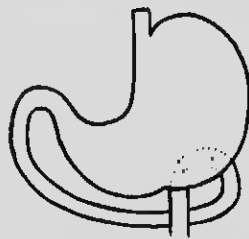


FIG. 292.—POSTERIOR GASTRO-JEJUNOSTOMY.

Gastro-Jejunostomy.—The abdomen should be opened above the umbilicus by an incision a little to the left of the middle line, the rectus muscle being retracted in order to incise the posterior part of the sheath and the peritoneum. The stomach is pulled out of the wound, and the situation of the ulcer demonstrated by the appearance of the peritoneum and by touch. If it can easily be done, the ulcer may be excised or sequestered by a purse-string suture, but this is

not necessary to bring about a cure, and should not be attempted if the ulcer is large or awkwardly situated. The commencement of the jejunum is then identified, a hole made in the transverse mesocolon, and the stomach passed through it. The jejunum, as near as possible to the duodeno-jejunal flexure, is then brought into apposition with the posterior wall of the stomach at the junction of the fundus and the antrum pylori, and near the greater curvature. After securing the stomach and intestine in clamps, from $2\frac{1}{2}$ to 3 inches of the two viscera are joined by a continuous silk suture passing through the peritoneal and muscular coats. Incisions are then made into the

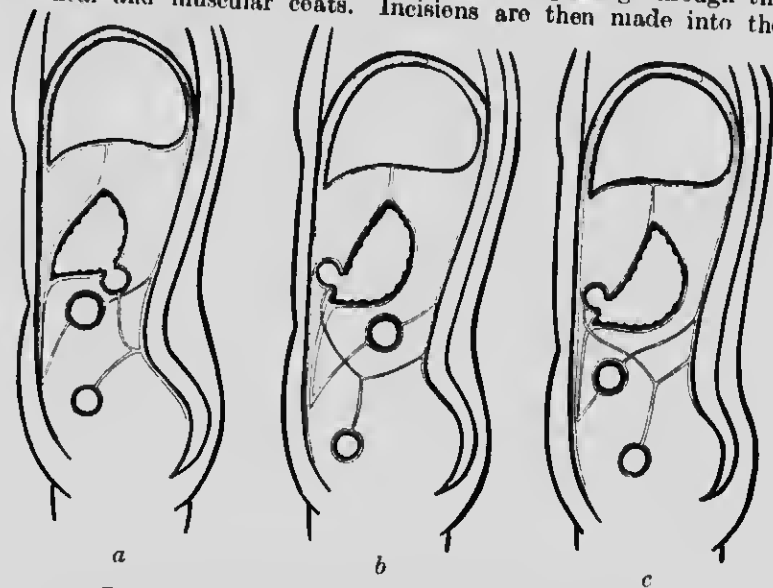


FIG. 293.—DIAGRAMS SHOWING GASTRO-JEJUNOSTOMY.

(a) Posterior gastro-jejunostomy; (b) anterior gastro-jejunostomy below the transverse colon; (c) anterior gastro-jejunostomy above the transverse colon.

stomach and jejunum, parallel with the row of sutures and the mucous membranes sewn together with catgut sutures. This line of suture is then covered with a second continuous suture involving the peritoneal and muscular coats only, and being continuous with the first line of suture. The stomach and intestine are then replaced in the abdomen, and the wound closed. If the stomach is so bound down that the posterior surface cannot be reached, the anastomosis should be made with the anterior wall, the small intestine passing through the transverse mesocolon and the great omentum to the front of the stomach, or being brought round in front of the transverse colon.

In all cases the appendix should be removed if it can be reached readily.

The patient is nursed in the sitting position, and for the first few days the diet consists of sterilized milk, albumin water, and water. Rectal feeding may also be utilized.

RESULTS OF THE OPERATION.—The operation of gastro-jejunostomy must not be looked upon as a cure of gastric ulcer, but careful dieting with thorough mastication of the food is as necessary after operation as in the medical treatment before operation. The uses of the operation are considered to be—(1) To empty the stomach rapidly so as to prevent stasis of food in it, (2) to divert food from the pylorus and so prevent spasm of the pyloric sphincter, (3) to permit reflux of the alkaline fluids in the duodenum to the stomach, and so neutralize the hyperacid gastric juice.

The results of the operation are generally excellent, and may be divided into—(1) Patients who experience complete relief of symptoms and gain weight rapidly, (2) patients in whom an error of diet causes a return of the symptoms, but are otherwise relieved, (3) patients requiring the most rigid care and dieting to prevent return of symptoms, (4) patients (a small minority) who experience no relief beyond that due to the necessary rest in bed and careful dieting.

In a few cases, either shortly after the operation or much later, the patient may develop an ulcer (peptic ulcer) on the intestinal side of the gastro-jejunostomy opening, which may lead to fatal hæmorrhage. A carcinoma has been known to develop at the site of the anastomosis.

RECURRENT VOMITING.—In a few cases—and especially if the anastomosis has been made too far from the duodeno-jejunal flexure, persistent vomiting of bile and the contents of the duodenum may follow this operation. The patient should be sat up, and the stomach carefully washed out, but if the vomiting persists, the abdomen must be reopened, and an anastomosis performed between the afferent and efferent loops of intestine.

2. (a) **Stenosis of the Cardiac Orifice** is an uncommon result of gastric ulcer. The symptoms are those of stricture of the lower end of the œsophagus, and the stenosed orifice should be kept open by the passage of bougies. Failing this, gastrostomy should be performed.

(b) **Hour-Glass Stomach.**—In this condition the stomach is divided into two pouches communicating with each other by a small orifice. The causes of hour-glass stomach are—(a) Congenital. It has been stated that this is the most frequent cause, but recent observations throw doubt on this opinion, and it is believed that the majority of alleged congenital cases are really due to contraction of a healed gastric ulcer. (b) Perigastric adhesions, chiefly running from the liver to the anterior surface of the stomach. (c) Cicatricial contraction of a healed gastric ulcer. (d) Annular carcinoma of the body of the stomach. The condition is often complicated by stenosis of the pylorus due to cicatricial contraction of a second ulcer.

CLINICAL FEATURES.—The symptoms are similar to those of dilated stomach due to pyloric stenosis (see p. 666), and the condition is often only recognized on operative interference. The points of diagnosis are—(1) Fluid introduced into the stomach may apparently disappear by passing into the second sac. (2) After washing out the

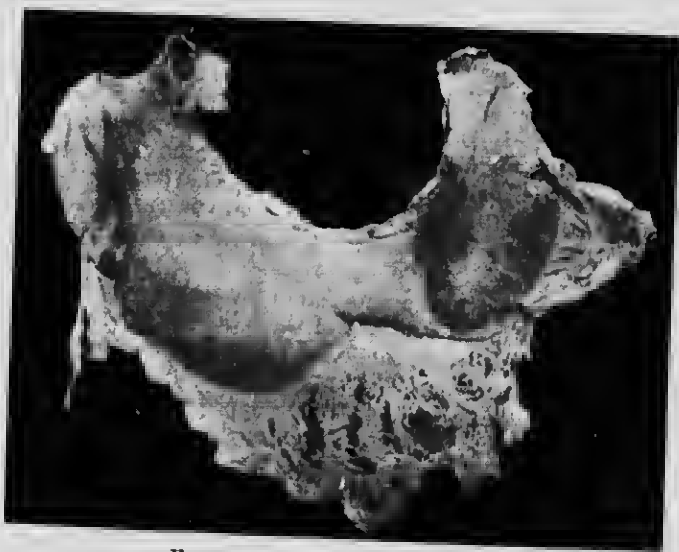


FIG. 294.—*Hour-glass Stomach.*
(London Hospital Medical College Museum.)



FIG. 295.—*Hour-glass Stomach.*
(Skiagram taken after bismuth meal.)

proximal sac until the fluid returns, clear manipulation of the stomach may cause a flow of turbid fluid, which was contained in the distal sac. (3) After inflating the stomach with CO₂ gas, a distinct sulcus between the two portions may be seen. (4) The patient is given a meal containing bismuth, and an X-ray photo is then taken of the stomach, and the division of the stomach into two sacs may be easily apparent.

TREATMENT.—A careful examination of the stomach should be made after opening the abdomen, and one of the following operations should be performed, according to the condition found: (a) Gastro-gastrostomy—*i.e.*, uniting the two sacs by an artificial opening; (b) gastro-jejunosotomy, the proximal sac of the stomach—or, better, both sacs—being united with the jejunum. This is the operation most commonly indicated. (c) Partial gastrectomy. This operation is chiefly indicated when the constriction is carcinomatous.

(c) **Pyloric Stenosis.**—This condition is considered later (p. 665).

3. Persistent Pain with Perigastric Adhesions.—The adhesions that cause most pain and discomfort are those between the pylorus and the liver, which are frequently associated with some dilatation of the stomach owing to pyloric obstruction. The pain and discomfort are often sufficient to make the patient a chronic invalid. The adhesions are discovered on opening the abdomen for the persistent pain and dyspepsia.

TREATMENT.—The adhesions are carefully separated, and as far as possible covered by peritoneum by careful suturing and plastic operation on the peritoneum. If necessary, a posterior gastro-jejunosotomy is performed. When dense adhesions are being dealt with, it must be recognized that their separation may open the stomach at the site of an old ulcer, and if this occurs, suture of the opening and gastro-jejunosotomy are imperative.

4. Acute Perforation of a Gastric Ulcer.—Acute perforation may occur in both acute and chronic ulcers. It is most commonly met with in the acute ulcers of young women, although it is by no means uncommon in elderly men. The ulcer is usually situated on the anterior surface of the stomach. Opinions differ as to whether perforation is more common at the cardiac or the pyloric end. In the cases under the care of the author, pyloric perforation has been slightly the more frequent. The opening into the stomach may be only as large as a pin's head, or it may admit a finger. As seen from the peritoneal surface, the opening is round with clear-cut edges, and a surrounding thickened area of scar tissue or oedema. Fluid or actual food is seen to escape through the opening. It has been stated that in 20 per cent. of the cases two perforations exist, but the records of the London Hospital do not confirm this statement.

SYMPTOMS.—The patient who gives a history of recent indigestion or has the typical symptoms of gastric ulcer is suddenly seized with violent abdominal pain, vomits and becomes collapsed, with a sub-normal temperature and a rapid, feeble pulse (peritonism). These

symptoms are most evident if there is a large perforation on the anterior wall of the stomach. If the perforation is small or on the posterior wall, so that the contents of the stomach pass into the lesser sac, the condition of peritonism is not so well marked. As a rule, in an hour or so, the condition of shock passes off, and the patient's general condition improves, especially if morphia has been given; and it may be difficult to persuade the patient and his friends that urgent operation is necessary, although he still complains of abdominal pain.

On examination the abdomen is rigid and immobile, and there is evidence of free gas and free fluid in the peritoneal cavity. If the patient is treated expectantly, he will show in a few hours the characteristic signs and symptoms of acute general peritonitis (see p. 617), except that vomiting occurs in less than half the cases. Death occurs in the majority of untreated cases within three days, but it is possible that in a few cases spontaneous recovery has occurred.

TREATMENT.—As soon as the condition of perforated gastric ulcer is suspected, the abdomen should be explored by a small opening just above the symphysis pubis. The subperitoneal tissue will be found to be œdematous, and when the peritoneal cavity is opened, gas will escape, and a turbid yellow fluid with a sour smell wells up through a tube pushed into Douglas's pouch. Particles of food and flakes of lymph may also be seen, and if, as is often the case, the patient has been given brandy during the period of collapse, it may be recognized by its smell. A second incision is then made in the upper part of the abdomen just on one side of the middle line, the perforated ulcer. It can often be recognized by the escape of gas and fluid from it during the respiratory movements. The opening in the ulcer should be at once closed by a stitch passing through all the coats of the stomach, one on each side of the ulcer, and then further closed by a purse-string suture. In some cases it may be advisable to excise the ulcer before suturing, or if the perforation is large, it may have to be closed by suturing omentum over the gap.

After closing the perforation, some surgeons proceed to perform gastro-jejunostomy if the condition of the patient allows, but this operation is certainly not essential for recovery, and in other opinions should only be performed if there is well-marked pyloric stenosis. If necessary, gastro-jejunostomy can be performed at a later operation.

The peritoneum is cleaned by sponging out all the pouches, and a large drainage-tube is passed into Douglas's pouch through the suprapubic incision, and the upper wound completely closed. The patient is nursed in the Fowler position.

After the operation, saline is administered either by the rectum or subcutaneously, and feeding with small quantities of albumin water, milk and water, or meat extracts, is begun as soon as the anæsthetic vomiting has ceased.

The drainage-tube is removed at the end of forty-eight hours.

The usual complications of acute general peritonitis may follow, the most common being broncho-pneumonia, empyema, or sub-diaphragmatic abscess.

When operating on a case of perforated gastric ulcer, the possibility of the ulcer being malignant should not be overlooked, and if the appearance is suspicious, a small portion of the wall should be removed for microscopic examination. Closure of a carcinomatous ulcer may be performed in the same way as a simple ulcer, and the patient may recover from the perforation, although, of course, the prognosis is not good.

Chronic Perforation.—An ulcer, especially when situated on the posterior wall, may gradually erode the wall of the stomach so that the pancreas or liver will form the floor of the ulcer, and such an ulcer is sometimes spoken of as a *penetrating ulcer*. By chronic perforation is understood a perforation of the ulcer into an area shut off from the general peritoneal cavity by adhesions, so that a perigastric abscess results.

The majority of these abscesses are varieties of subdiaphragmatic abscess (see p. 623), the most common being—(1) Perforation of an ulcer on the anterior wall at the cardiac end, forming a left anterior abscess; (2) perforation on the posterior wall forming an abscess in the lesser sac; and (3) the formation of a left extraperitoneal abscess.

CLINICAL SYMPTOMS.—The patient may give a history of indigestion or of the more characteristic symptoms of gastric ulcer, followed by the symptoms and physical signs of deep-seated pus in the upper part of the abdomen. The swelling due to the formation of the abscess most commonly appears in the left hypochondrium or left loin.

TREATMENT.—The abscess must be opened and drained in the usual way, though this is sometimes followed by the formation of a gastric fistula. In some cases this fistula is unimportant, and will close spontaneously, but in others nearly all the contents of the stomach may escape, and the patient emaciates rapidly. If a fistula does form, the patient should be fed *per rectum* to see if spontaneous healing will occur, but if it persists, the abdomen must be opened, and an attempt made to close the opening in the stomach after separation of the adhesions. If possible, a gastro-jejuno-stomy should be performed at the same time.

FISTULÆ may also form between the stomach and the transverse colon, and the patient may pass undigested food in the stools, or may vomit solid fæces. The abdomen should be opened, the two viscera dissected apart, and the openings closed. In one case seen by the author, in which this was not possible, a colostomy was established on the proximal side of the opening, and the patient had complete relief from the vomiting of fæcal matter, being perfectly well a year after the operation.

5. Profuse Hæmatemesis (Gastrorrhagia).—Death from excessive or frequently repeated hæmorrhages is one of the dangers of gastric

ulcer, but it is not very common. The bleeding may prove rapidly fatal, or the patient may be drained by successive hæmorrhages spread over three or four days. The hæmorrhage may be venous, capillary, or arterial. At the present time it is not possible to differentiate those cases of gastric hæmorrhage which will prove fatal from those cases that will recover, so no absolute rule for the treatment of these patients can be formulated. Certain general rules only can be laid down, and each case must be treated on its own merits.

TREATMENT.—(1) Medical treatment should always be tried first in cases of hæmatemesis from acute gastric ulcer, as 95 to 97 per cent. of the cases recover under medical treatment. Medical treatment consists of absolute rest, the hypodermic administration of morphia, the giving of adrenalin by the mouth, and placing an icebag on the epigastrium. After the hæmorrhage is arrested, rectal feeding should be carried out for a few days.

(2) If the bleeding is not arrested in a few hours, and if the surroundings of the patient are suitable for surgical interference, the hæmorrhage should be arrested by surgical means, especially if the ulcer is believed to be chronic.

(3) If profuse hæmorrhage recurs in a day or so after being treated medically, surgical interference should be contemplated, and the operation performed, if possible, between the attacks of bleeding.

(4) If the patient is blanched when first seen, and actual bleeding is not occurring, he has greater chance of recovery by medical means than by surgical interference.

Surgical Treatment.—The surgical treatment of hæmorrhage from a gastric ulcer is the rapid performance of the operation of posterior gastro-jejunostomy. At the same time it is advisable to excise or sequester the ulcer, but in the case of large chronic ulcers this is not possible. After the abdomen has been opened, a careful search should be made for the ulcer, the stomach being opened if necessary. The further treatment depends on the condition found. Ligature of the bleeding-point is difficult on account of the friability of the tissues (it is to be remembered that these are cases of secondary hæmorrhage), but ligature of a mass of tissue containing the bleeding vessel may be tried. As ligature of the gastric vessels in continuity does not lead to gangrene of the stomach, this may be tried, but it is uncertain in its effects, and should always be combined with gastro-jejunostomy. Opening the stomach and cauterization of the ulcer is another method that has been advocated. It is useful in capillary oozing, but gastro-jejunostomy should always be performed at the same time.

6. Carcinoma supervening on Gastric Ulcer.—Carcinoma may be suspected in a case of old-standing gastric ulcer if the symptoms are progressive and the patient wastes, or if a tumour develops in the epigastrium. The abdomen should be opened at once, as the only chance of radical cure is immediate excision of the carcinoma. In the majority of cases the question of carcinoma supervening on chronic ulcer will arise on the operating-table, when the abdomen has been

opened for an exploratory laparotomy or to perform gastro-jejunostomy for a chronic ulcer. The presence of a hard mass in the stomach may at once arouse the suspicion of carcinoma, but it is often impossible to decide between this and chronic inflammation without a microscopic examination. If the mass is at the pylorus, it is probably safer to perform pylorotomy and gastro-jejunostomy, but in any other situation a piece should be removed for microscopical examination, and the abdomen closed. The result of the examination will determine the further procedure.

Gastric Erosions.—A gastric erosion is a slight loss of the mucous membrane of the stomach—*i.e.*, it is a very small superficial ulcer. Erosions are very frequently found post mortem in people who have died from accidents, as well as from almost any disease, and it is probable that the majority of them heal without symptoms, although if some peculiar condition is present in the stomach, an erosion may become a gastric ulcer.

In a few cases erosions lead to profuse hæmatemesis, but this is uncommon, and they are almost entirely of post-mortem interest.

If the abdomen is opened after a diagnosis of gastric ulcer or one of its complications has been made, and no ulcer is found, gastro-jejunostomy should never be performed unless some good and sufficient reason for the operation is present. The appendix region should always be examined, and as this organ is always a constant source of danger, it should be removed irrespective of the presence or absence of disease.

NEW GROWTHS

New growths of the stomach other than carcinoma are **adenoma**, **fibroma**, **lipoma**, and **sarcoma**. They are all rare and of little clinical interest, and may be classed as pathological curiosities.

Carcinoma of the Stomach.—Carcinoma of the stomach may be either columnar or spheroidal celled, or in cases spreading from the cardiac orifice of the œsophagus, squamous-celled. The growth may contain a large amount of fibrous tissue (scirrhous type), or be of the soft medullary type. Either type may undergo colloid degeneration.

PATHOLOGICAL ANATOMY.—The growth may affect the cardia, the body of the stomach, or the pylorus, 60 per cent. of the cases being found in the last situation.

The following types may be distinguished:

1. A large massive growth from the wall of the stomach projecting into the interior, and forming a readily palpable tumour.
2. A hard constricting growth usually found near the pylorus, causing pyloric obstruction or hour-glass stomach.
3. A diffuse infiltration of the whole stomach wall, causing the stomach to become thickened, firm, and immobile. "leather-bottle stomach."
4. A carcinomatous ulcer, with papillomatous growths at the edges, rapidly infiltrating the stomach wall.

The growth usually spreads widely in the submucosa toward the cardia, and chiefly affects the lesser curvature; extension to the duodenum may occur, but is uncommon. The glands affected lie along



FIG. 296.—CARCINOMA OF THE PYLORUS CAUSING STENOSIS.
(London Hospital Medical College Museum.)



FIG. 297.—DIFFUSE CARCINOMATOSIS OF THE STOMACH (LEATHER-BOTTLE STOMACH).
(London Hospital Medical College Museum.)

the lesser and greater curvatures and behind the pylorus, between it and the head of the pancreas; but enlargement of the glands does not necessarily mean cancerous infiltration, as there is always septic

absorption from the surface of the growth. Later, secondary growths appear in the liver, or the whole of the peritoneum may become carcinomatous.

As the growth progresses the stomach becomes adherent to the liver, the pancreas, and the transverse colon. The establishment of a gastro-colic fistula is not very uncommon.

CLINICAL FEATURES.—Carcinoma of the stomach is slightly more common in men than women, for in men the stomach is the commonest situation of cancer. The average age is between forty and sixty, though many cases younger than forty are seen.

The earliest symptoms of the condition are loss of weight, general malaise, anæmia, and loss of energy, combined with symptoms of dyspepsia. They come on without any cause, and are unrelieved by treatment. The appetite may be unimpaired at first, but later it is lost, and there may be absolute distaste for food. These symptoms usually appear in a middle-aged man without any previous history of digestive trouble, but in a proportion of cases (10 to 50 per cent.) there is a previous history pointing to gastric ulcer.

Pain may be present in the gastric area, or be referred to other parts of the abdomen, and is usually increased, although in the early stages it may be relieved, by the taking of food. The amount of pain varies considerably, and is rarely very severe.

Vomiting is an almost constant symptom (86 per cent.), the vomiting consisting of the food taken, often mixed with a small quantity of semi-digested blood (coffee-grounds vomit). In a few cases the hæmorrhage is profuse, and in others particles of the growth may be found in the vomit. Traces of blood may also be found in the stools.

Tumour.—In the majority of cases of gastric carcinoma an epigastric swelling, which is hard and nodular and moves on respiration, is felt at some period of the disease; but if the growth is at the cardiac end, or the liver is enlarged or depressed, the tumour may only be found on post-mortem examination, or during an exploratory laparotomy. The appearance of a tumour should not be waited for in a case of suspected carcinoma of the stomach, as it may be taken as a rule, though not an absolute one, that the clinical appearance of a tumour means that the growth is not capable of being completely removed.

Temperature.—In a fair proportion of the cases there is an irregular pyrexia, and in some rigors may occur during the course of the illness.

Test Meal.—A test meal will show that there is delay in emptying the stomach, and on chemical examination the normal amount of free hydrochloric acid (2 per cent.) is diminished or absent, and abnormal acids, as butyric or lactic acid, appear.

Bacteriological examination of the vomit or the result of a test meal may show the presence of the Oppler-Beas bacillus and the *Bacillus filiformis*, while microscopical examination may show the presence of fragments of growth.

Later Symptoms are a profound secondary anaemia, simulating pernicious anaemia, ascites, enlargement of the supraclavicular glands on the left side, nodular enlargement of the liver due to secondary growth, and nodules in the peritoneum or abdominal wall owing to a general carcinomatosis.

SYMPTOMS DUE TO THE SITUATION OF THE CARCINOMA.—*Carcinoma of the Cardia* frequently obstructs the orifice, and the symptoms are similar to those of carcinoma of the lower end of the oesophagus, the chief being dysphagia and regurgitant vomiting. The stomach in these cases may become small and atrophic.

Carcinoma of the Body of the stomach shows the symptoms given above.

Carcinoma of the Pylorus causes pyloric obstruction, and the symptoms of dilatation of the stomach (see p. 666) are added, and often overshadow those of growth.

TREATMENT—*Carcinoma of the Cardia*.—Usually the only treatment for this condition is gastrostomy, when the patient is no longer able to swallow a liquid diet. This operation may lead to prolongation of the life for some months.

Carcinoma of the Body.—If this is diagnosed early, and it can usually only be done by exploratory laparotomy, the affected segment of the stomach should be freely removed. This really amounts to a complete **gastrectomy** in the majority of cases, with removal of the lymph glands along the greater and lesser curvatures, and those lying behind the pylorus, for local recurrence is the rule in these cases which have survived resection of part of the stomach. The mortality of partial and complete resection of the stomach is at least 30 per cent. If removal of the stomach is not indicated on account of the general condition of the patient, extent of the growth, secondaries in the liver and peritoneum, or from other causes, no operation should be performed, as gastro-jejunostomy is not likely to give much relief. The patient should be made as comfortable as possible by careful dieting and the free administration of morphia.

Carcinoma of the Pylorus.—The operation of election is a **pylorectomy**, with removal of all the lesser curvature of the stomach and the glands in the neighbourhood. The cut end of the duodenum and the stomach may then be closed, and an anastomosis made between the remainder of the stomach and the jejunum; or this operation may be done first, and the pylorus removed at a later operation. In other cases the cut ends of the duodenum and the stomach may be joined by end-to-end suture. Local recurrence is the rule, though cure is not unknown.

In cases in which pylorectomy is not possible or contraindicated

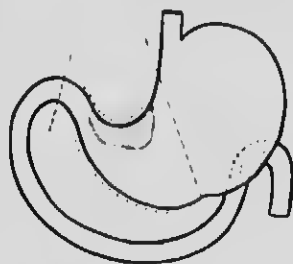


FIG. 298.—PARTIAL EXCISION OF THE STOMACH FOR CARCINOMA, WITH GASTRO-JEJUNOSTOMY.

by the presence of secondary growths, and a dilated stomach due to pyloric obstruction is present, a gastro-jejunostomy may be performed as a palliative measure. In the majority of cases the relief given by this operation is striking. There is a rapid disappearance of all the symptoms, and the patient may gain weight in an astonishing manner, to put on 1 or 2 stones in a few months being by no means uncommon. This disappearance of symptoms and the gain in weight often convince the patient that he is cured, but unfortunately the symptoms inevitably recur, and it is seldom that he lives twelve months. In the cases that have been apparently cured by this operation, the diagnosis has been probably incorrect, and the thickening round a chronic ulcer mistaken for a carcinoma.



FIG. 299. —PART OF THE LUMEN AND WALL OF THE STOMACH, SHOWING COLLOID DEGENERATION.

In the few instances in which a gastro-jejunostomy is impossible owing to widespread infiltration of the stomach, and the patient is desirous of living for a little longer at any sacrifice, the upper part of the jejunum may be fixed to the skin and opened—**jejunostomy**—and the patient fed as after a gastrostomy.

Perforation of a Carcinomatous Ulcer.—A carcinomatous ulcer of the stomach may perforate in the same way as a simple ulcer, the perforation being acute or chronic.

An acute perforation will cause the onset of symptoms of general peritonitis, and it will only be possible to diagnose the condition as perforation of a malignant ulcer on opening the abdomen.

Suture of a carcinomatous ulcer and drainage of the peritoneum may be successful for the time.

Chronic perforation leads to the formation of a perigastric abscess, and when this is opened, to a gastric fistula, which continues to discharge until the death of the patient.

PYLORIC OBSTRUCTION AND DILATATION OF THE STOMACH

Pyloric obstruction, with secondary dilatation of the stomach, is due to—(1) Congenital causes, either congenital hypertrophic stenosis of the pylorus, or congenital stenosis; (2) simple obstruction, due to cicatrization of an ulcer, or to the formation of inflammatory bands and adhesions; (3) obstruction due to a pyloric carcinoma, usually of the contracting scirrhus type.

Congenital Hypertrophic Stenosis of the Pylorus.—This condition is a hypertrophy of the circular muscle fibres forming the pyloric ring combined with muscular spasm. The cause is unknown.

CLINICAL FEATURES.—The affection is most common in male infants who are apparently normal at birth, the symptoms usually appearing about the third week of life. The child, who up till then has been thriving normally, begins to vomit his meals. The vomiting appears without retching, but is preceded by a period of discomfort, and the food is violently expelled from the stomach (forcible vomiting) about a quarter of an hour after it has been given. (Owing to the loss of the food the child wastes rapidly and is constipated.

The physical signs are a dilated stomach, with waves of peristalsis passing over it from left to right, and a tumour felt in the pyloric region; this tumour is not always palpable.

TREATMENT.—The patient should be very carefully dieted with small quantities of modified milk given at frequent intervals. The milk has often to be changed before one is found that suits the child. The stomach is washed out at regular intervals, and injections of saline

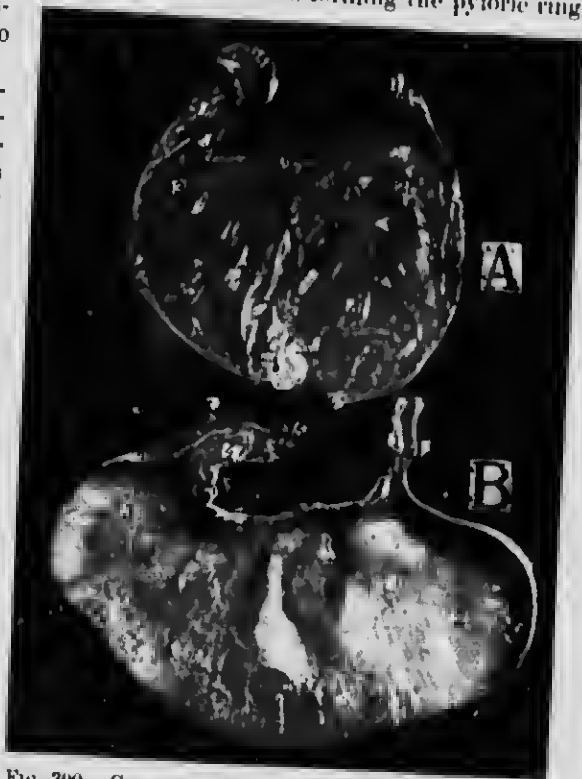


FIG. 300.—CONGENITAL HYPERTROPHIC STENOSIS OF THE STOMACH (b) CONTRASTED WITH A NORMAL INFANT STOMACH (a).

(London Hospital Medical College Museum.)

fluid are made into the bowel. In the majority of cases this treatment is successful, but in a minority surgical treatment is necessary, and should be carried out before the patient is emaciated. Unfortunately it is not yet possible to differentiate those that will be cured by medical means and those that require surgical interference.

The surgical treatment consists of stretching the pylorus or performing gastro-jejunostomy. The mortality of the latter operation has been high, but this has been due to late interference.

Congenital Stenosis.—A condition of dilated stomach is sometimes met with in young adults who have never had any symptoms of gastric ulcer, and on examination a constricted pylorus is found, which is believed to be a congenital stenosis. The patient, with careful dieting, may lead a fairly comfortable life, but gastro-duodenostomy (Finney's operation) or gastro-jejunostomy may completely relieve all the symptoms.

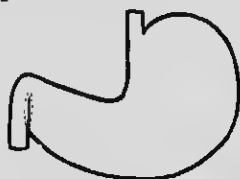


FIG. 301.—FINNEY'S OPERATION.

Acquired Stenosis, Simple or Malignant.—Stenosis of the pylorus, either simple or malignant, leads to dilatation of the stomach, the symptoms of which are—The patient vomits large quantities of semi-digested food and gastric juice at almost regular intervals; the vomit is usually sour-smelling, and fermentation processes are often going on in it, making it frothy. On examination, it contains sarcinae, numerous bacteria, butyric and lactic acids.

It is found that a test meal does not pass out of the stomach in the usual time, and if a meal containing bismuth is given and a radiogram of the stomach taken, the outline of the stomach and the position of the greater curve can be made out. If a series of radiograms is obtained, the time taken for the food to pass through the pylorus can be estimated.

PHYSICAL EXAMINATION.—The stomach may definitely stand out in the epigastrium, and waves of peristalsis may be seen passing from left to right across it, and a lump may be felt at the pylorus.

The stomach may be made more prominent by giving the patient



FIG. 302.—FIBROUS PYLORIC STENOSIS, WITH DILATATION OF THE STOMACH.

(London Hospital Medical College Museum.)

a solution of bicarbonate of soda to drink, followed by some tartaric acid, so that CO_2 is manufactured, and distends the stomach. On listening with the stethoscope, the effervescence can be heard over a wide area. Percussion may shew increase of the normal stomach resonance, and when the stomach contains fluid, a splashing sound is heard on manipulation.

The cause of the obstruction has to be determined by the history and the concomitant signs of gastric carcinoma, gastric ulcer, inflammation of the gall-bladder, etc.; but in many cases this is only possible on opening the abdomen, and even then it may be extremely difficult to decide between fibrous thickening and scirrhus carcinoma.

TREATMENT.—If the pyloric obstruction is carcinomatous, the ideal operation is a free pylorectomy, with an anastomosis between the remainder of the stomach and the jejunum. If this is not advisable, owing to the presence of secondary growths, life may be prolonged, and the patient made more comfortable for a time by gastro-jejunostomy.

For simple stenosis the best treatment is a large posterior gastro-jejunostomy, which in many cases will completely relieve all the symptoms as long as the patient is reasonably careful in his diet. If the patient is averse to surgical treatment, the stomach should be washed out daily and the diet very carefully arranged.

Tetany.—In cases of dilated stomach, with fermentation of the gastric contents, tetany may occur. The patient suffers from carpo-metacarpal and tarso-metatarsal spasms, with hypersensibility of the nerve trunks. (For further symptoms the reader is referred to textbooks on medicine.) The onset of this condition is a strong indication for gastro-jejunostomy.

Gastroptosis.—Displacement of the stomach downwards is generally associated with some dilatation, and often combined with general visceroptosis (Glenard's disease). The patient is usually a woman, and has a lax abdominal wall, owing to repeated pregnancies.

CLINICAL FEATURES.—The patient complains of vague abdominal pains, dyspepsia, vomiting, flatulency, constipation, and general discomfort. The skin is generally lax, the complexion sallow, and symptoms of neurasthenia are nearly always present.

On examination, the abdominal wall is flaccid, and evidence of

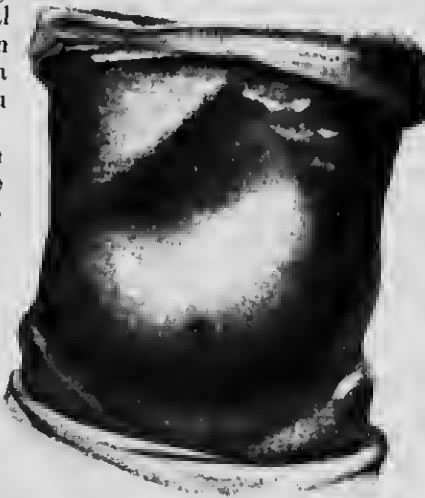


FIG. 303.—DILATATION OF THE STOMACH.

dilated stomach can usually be obtained by inspection, palpation, and auscultation. The pancreas can often be felt lying across the aorta above the lesser curve of the stomach.

The patient should be given a test meal, and the motor activity of the stomach estimated. A bismuth meal should also be given, and a series of X rays taken, so as to define accurately the position and size of the stomach, and to find out the time taken for the stomach to empty itself.

TREATMENT.—A large number of the cases lose most of their symptoms with careful dieting, attention to the teeth, and the wearing of a well-fitting abdominal belt, and this is the proper line of treatment for all cases with neurasthenia and where there is no undue delay in the food passing the pylorus. If the food is habitually retained for a long time in a stomach which is considerably dilated, gastro-jejunostomy may be performed after medical treatment has failed to relieve the symptoms; but both surgeon and patient must be prepared for failure to obtain marked improvement.

Gastropexy, which is carried out by shortening the gastrohepatic omentum, and attaching the upper surface of the liver to the diaphragm and anterior abdominal wall, has also been advocated, as well as *gastroplication*—*i.e.*, diminishing the size of the stomach by folding. These operations often appear successful, as the patient is enforced to have three weeks' rest in bed with careful dieting, but they are not likely to be permanently successful, and certainly will not cure the neurasthenia.

Acute Dilatation of the Stomach.—Acute dilatation of the stomach—a condition that is usually fatal—occurs (1) after abdominal operation and injuries; (2) after operation on other parts of the body; (3) during the course of a debilitating illness; (4) from entirely unknown causes in patients who are not seriously ill.

The dilatation of the stomach is enormous, and the duodenum may or may not be involved. In those cases in which the dilatation involves the duodenum, the cause of the condition has been ascribed to pressure of the superior mesenteric artery on the duodenum. It may be generally stated, however, that the cause of the condition is unknown. The majority of writers on the subject state that it is due to a toxic paralysis of the muscular tissue of the stomach.

CLINICAL FEATURES.—The onset of the condition is sudden, and the patient complains of violent epigastric pain, which soon becomes general over the whole abdomen. Vomiting is constant, and toward the end the vomit is brown in colour and offensive. If a stomach-tube is passed, large quantities (pints) of fluid may be removed, with temporary relief; but the stomach immediately begins to refill. On examination, the abdomen is found to be distended, and the outline of the stomach may sometimes be seen. Peristalsis is not present. The stomach on percussion is hyper-resonant, owing to the large amount of gas it contains, and a splash may be brought out by manipulation. The general condition of the patient is similar to that seen in

acute intestinal obstruction, but diarrhoea has been observed. Death usually occurs in three or four days.

TREATMENT.—Directly the condition is suspected the stomach should be washed out, and if it fills again rapidly, the tube should be left in for several hours, and the patient placed in the prone position, with the pelvis raised. If this does not bring relief, the abdomen should be opened and a gastrostomy or a gastro-jejunostomy performed.

AFFECTIONS OF THE DUODENUM

Duodenal Ulcer.—An ulcer in the duodenum is nearly always situated within 2 inches of the pylorus—*i.e.*, in that part of the duodenum lying above the entrance of the alkaline bile and pancreatic juice into the intestine. The cause of duodenal ulcer is believed to be the same as that of gastric ulcer (see p. 649). It appears to be almost an accident on which side of the pyloric ring the ulcer forms. The condition is much more common in men than in women, and most usually occurs between the ages of thirty and forty-five. The relative frequency of gastric and duodenal ulcer is a matter of dispute, but according to Mayo, 60 per cent. of all gastric and duodenal ulcers are situated in the duodenum.

PATHOLOGICAL ANATOMY.—The ulcer is generally situated on the right anterior wall of the duodenum, and is indicated on the peritoneal surface by a white thickening and puckering of the intestine. It is mostly chronic, with indurated edge and an excavated floor, and perforation into the peritoneal cavity or into a large vessel is common.

In a few rare cases seen after burns the condition seems to have arisen from inflammation and suppuration in Brunner's glands.

CLINICAL FEATURES.—As in the majority of cases the diagnosis of duodenal ulcer depends entirely on the history of the case, very careful attention must be given to this. The chief complaint is of "hunger pain." Pain in the abdomen when the patient is hungry may occur in cases of dyspepsia without duodenal ulcer; therefore "hunger pain" which is diagnostic of duodenal ulcer, must be defined. It is a *severe* pain in the epigastrium, coming on four or five hours after a meal, and therefore usually occurring at night. The pain is sufficient to wake the patient up, and may be so severe that he cannot rest in bed. It is, however, generally relieved by taking a little food, and the patient forms the habit of having a glass of milk or a biscuit by the bedside in order to get relief from the pain if it occurs. The pain may recur night after night in succession, and then quite suddenly intermit, so that the patient is free from pain for weeks; but a further attack is almost inevitable. Between the attacks of pain the patient may be comfortable or suffer from the usual symptoms of chronic dyspepsia due to any cause. The appetite may remain good, and the kind of food taken seems to have little influence on the attacks of pain. On examination, there may be a little tenderness to palpation behind the upper right rectus, which may be in spasm, especially

during an attack of pain. A test meal shows that hydrochloric acid is present in the gastric juice—perhaps in excess. There is often delay in the food leaving the stomach. Hæmatemesis is not a common symptom, but may occasionally be so severe that the patient may die before the blood appears in the stools. Faint traces of blood (occult blood) may be found by means of chemical tests in stools that appear normal, but the patient must have been fed on a hæmoglobin-free diet for at least a week before this test is of value, and it then only shows that hæmorrhage is occurring somewhere in the intestinal tract.

The **DIAGNOSIS** has to be made from biliary colic due to the presence of gall-stones, movable kidney with Dietl's crises, and chronic appendicitis. This can often only be done after the abdomen has been opened. Another condition which may be mistaken for duodenal ulcer is lead colic, but a careful examination of the patient and his symptoms should obviate this error.

TREATMENT.—Although it is certain that cure of a duodenal ulcer may follow careful dieting and drug treatment, the condition is so dangerous and cure so uncertain that surgical methods should be employed as soon as the diagnosis is made or even suspected.

The surgical treatment consists of performing a posterior gastro-jejunostomy, with, if it can readily be done, excision or sequestration of the ulcer.

The appendix should be removed at the same operation.

As in the case of gastric ulcer, this operation is not a cure in itself, but must be supplemented by rest, careful dieting, removal of decayed teeth, and the wearing of artificial ones if necessary. If this after-treatment is not carried out, relapse is probable.

COMPLICATIONS—Acute Perforation.—In latent cases this may be the first symptom of a duodenal ulcer, but usually a history of dyspepsia and "bunger pain" is given. The symptoms are precisely similar to those of perforated gastric ulcer—*i.e.*, peritonism, followed by acute general peritonitis, with free gas and free fluid in the peritoneal cavity. As the contents of the duodenum are guided by the ascending mesocolon down into the right iliac fossa, the case may resemble one of gangrenous appendicitis; but a differential diagnosis is as a rule readily made.

TREATMENT.—The abdomen should be opened above the symphysis pubis by a small incision, and gas and fluid, which may be bile-stained, will escape. A second incision is then made in the epigastrium, and the ulcer located and sutured. This suturing is often more difficult on account of the position of the duodenum than in perforated gastric ulcer.

If the suturing is imperfect or the duodenum is constricted by the suturing, a posterior gastro-jejunostomy should be performed at the same time, the rules for taking this step being the same as those given under the Treatment of Perforated Gastric Ulcer (see p. 657). The upper wound should be closed, and drainage of the peritoneum carried out as in perforated gastric ulcer, through a tube carried into Douglas's pouch through the suprapubic incision.

The patient is nursed in the Fowler position, and the after-treatment is the same as for perforated gastric ulcer.

Chronic Perforation.—This may be intra- or extra-peritoneal. In intraperitoneal perforation an abscess forms in the right anterior or posterior subdiaphragmatic area, and in extra-peritoneal perforation the abscess is in the retroperitoneal tissue on the right side of the abdomen. The symptoms and complications are those of subdiaphragmatic abscess (see p. 623), and the treatment consists of opening and draining the abscess, without any attempt at dealing with the duodenal ulcer. If, however, the patient recovers and a fistula persists, an attempt to close this may be made after it has become chronic, the first step in the operation being the performance of a gastro-jejunostomy.

Hæmorrhage.—The bleeding is usually severe, and generally comes from the superior pancreatico-duodenal artery. It may appear as hæmatemesis, but more usually as melæna.

The patient during an attack of indigestion becomes faint and anæmic, and after some hours the blood appears in the stools. The hæmorrhage may be so severe as to cause death, but it generally ceases after a time, though recurrence is common.

TREATMENT.—The rules given under the treatment of hæmorrhage from a gastric ulcer apply equally, although more urgently, to duodenal ulcers. If operation is carried out, no pains must be spared to close the mouth of the opened vessel efficiently, and ligature of the main artery in continuity should not be relied upon.

Stenosis of the Pylorus, with dilatation of the stomach, may follow cicatrization of a duodenal ulcer, and the condition cannot be distinguished from that following gastric ulcer.

The diagnosis is that of dilated stomach from simple stricture of the pylorus, and the treatment consists of performing gastro-jejunostomy.

NEW GROWTHS

Carcinoma of the Duodenum.—Carcinoma of the duodenum rarely supervenes on a chronic duodenal ulcer, nor is extension of carcinoma of the stomach to the duodenum common.

The most usual situation is near the entrance of the common bile and the pancreatic ducts, and the presence of the growth here causes jaundice and the symptoms of pancreatic disease.

The diagnosis is made on exploratory laparotomy, and if the growth cannot be removed, a cholecystenterostomy will relieve the jaundice; a gastro-jejunostomy may be necessary to relieve the obstruction of the duodenum.

CHAPTER XX

INJURIES AND DISEASES OF THE INTESTINES

Contusions of the Intestine.—Contusions of the intestines occur from kicks and blows on the abdomen or "run-over" accidents. The condition cannot be diagnosed with certainty, but only assumed after injuries of the abdomen, without evidence of perforation of the alimentary canal or rupture of a solid organ. If the condition is seen post mortem, a bruise on the intestinal wall is present, but clinically the only evidence of the injury is more or less paresis of the intestinal movements.

The condition, for which there is no treatment, usually ends in complete recovery; but two serious consequences may follow. The first is ulceration of the mucous membrane at the site of injury, with subsequent cicatricial contraction of the lumen of the bowel during healing, causing chronic intestinal obstruction; and the second, gangrene and perforation of the intestine. This second condition is most common if the mesentery has been injured at the same time as the bowel, so that there is interference with the blood-supply.

The SYMPTOMS, if perforation occurs, are those of a severe abdominal injury (see p. 611), followed in two or three days by symptoms of general peritonitis, with free gas in the peritoneal cavity. In some cases adhesions have time to form, and the peritonitis is localized, and an intraperitoneal abscess develops.

The TREATMENT, if perforation occurs, is that of ruptured intestine.

Rupture of the Intestine.—Rupture of the intestine is due to kicks and blows on the abdomen and "run-over" accidents, the bowel being torn across against the posterior bony wall of the abdomen and not burst. It is, in fact, the further development of a contused intestine. Rupture is much more common in the small intestine than in the large (25 to 1), and the most common sites of rupture are the duodenum and the lower three feet of the ileum.

CLINICAL FEATURES—Intraperitoneal Rupture.—Immediately after the accident the patient is in a condition of peritonism—i.e., shock, abdominal pain, and vomiting. Patients with rupture of the intestine have been known to walk up to hospital. These initial symptoms are usually followed after a short interval by those of acute general peritonitis, with free fluid and free gas in the peritoneal cavity. In a few cases in which the intestines have been empty at the time of the

accident and the rupture small, local peritonitis with adhesions and abscess formation have followed. Blood rarely appears in the stools.

Extraperitoneal Rupture may occur in the duodenum and in the ascending and descending colons. The initial symptoms of peritonism are followed by emphysema of the posterior abdominal wall, and the gradual onset of the local and general symptoms of cellulitis and abscess formation. The abscess may point externally, and a faecal fistula result.

TREATMENT.—The first treatment will be that of shock, but as soon as rupture of the intestine is diagnosed or even suspected, the abdomen should be opened so that an accurate diagnosis can be made, and the condition dealt with at the earliest possible moment.

Small ruptures are treated by careful suture of the rent; but large or complete ruptures, which invariably have badly contused edges, should be treated by resection of a portion of the gut, or, if the patient's

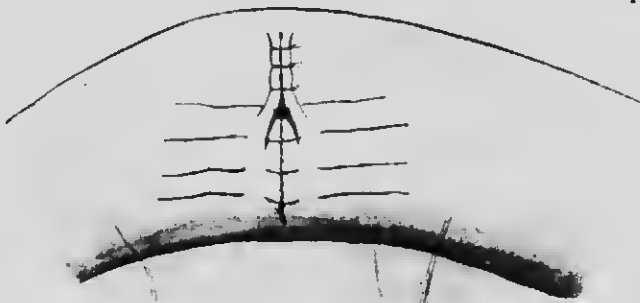


FIG. 304.—CZERNY-LEMBERT'S SUTURE.

condition is desperate, by insertion of a tube into each end of the ruptured intestine. The peritoneum must be cleaned by sponging, and drainage of Douglas's pouch is carried out, the patient being nursed in the Fowler position.

If a retroperitoneal rupture is not diagnosed until an abscess has formed, it should be opened and drained in the usual way, and closure of the faecal fistula should follow later if it does not close spontaneously.

Gunshot Wounds of the Intestine usually cause multiple lesions and lead to general peritonitis. The condition has been described under Gunshot Wounds of the Abdomen (p. 612).

CONGENITAL MALFORMATIONS

Congenital Stenosis may appear at any part of the intestine, but in the small intestine is most common in the region of the vitelline duct, and in the large intestine at the lower end (imporporate anus). Except for the last variety the condition is very rare.

If the stenosis is complete, death occurs in a few days after birth, unless an artificial anus is established. Incomplete stenosis may only be discovered on the post-mortem table. If any symptoms are present, they are those of chronic intestinal obstruction, but acute symptoms may develop at any time, owing to congestion of the mucous membrane, blocking of the opening with feces, or the stenosed portion of the gut forming the apex of an intussusception.

TREATMENT.—The treatment is that of intestinal obstruction.

Congenital Idiopathic Dilatation of the Colon (Hirschsprung's Disease).—This condition is an enormous dilatation of the colon with hypertrophy of its walls affecting all or part of the large gut, and

having no discoverable cause. The parts of the colon most often dilated are the descending, iliac and pelvic colons.

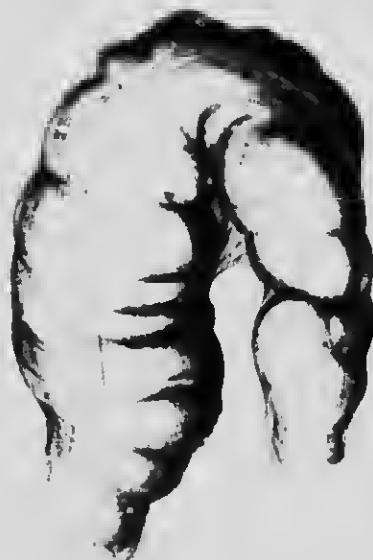


FIG. 305. — CONGENITAL IDIOPATHIC DILATATION OF THE COLON (HIRSCHSPRUNG'S DISEASE).

(London Hospital Medical College Museum.)

PATHOLOGICAL ANATOMY.—The muscular coat of the intestines is thickened, and the mucous membrane is also thick and vascular. When faecal accumulation has persisted for some time in the distended gut, stereocoral ulcers of the mucous membrane may be present.

CLINICAL FEATURES.—The patient suffers from constipation. This may have been present from birth, and increases in severity as he grows older. Constipation extending over two or three weeks is not uncommon, and is accompanied by little general disturbance. If the bowels are left confined, vomiting and other symptoms of obstruction supervene, and masses of feces difficult to dislodge, accumulate in the colon.

The condition of the abdomen varies according to the amount of faecal accumulation. If the examination is conducted when the colon is empty, little distension is found; the lower abdomen feels full, however, and the abdominal walls are flabby. If the bowels have not been opened for a week or more before the examination is made, the abdomen is distended, and visible waves of peristalsis may be seen. Tumours consisting of masses of feces may be present in the lower abdomen, and can be indented with the finger. Rectal examination gives no information beyond the fact that a hard mass of feces can be felt.

If the condition is left untreated, wasting and general physical degeneration may occur from toxic absorption of the contents of the

colon, or the condition may terminate in acute obstruction. In the case of a patient aged sixty-three seen by the author, the condition was unsuspected, and only discovered on post-mortem examination.

On opening the abdomen, the dilated and hypertrophied colon may hide the whole of the small intestines.

TREATMENT—Medical.—The bowels may be kept acting with enemata, and massage of the colon carried out daily. This treatment, combined with care in the diet, may make the patient's life tolerable.

Surgical.—The whole of the dilated portion of the colon may be excised, or the lower end of the ileum may be anastomosed with the lower end of the colon (ileo-colostomy), the former being the more satisfactory operation, but also the more dangerous. If operation is delayed until marked faecal accumulation is present, an artificial anus should be established before excision or anastomosis is performed.

INFLAMMATION OF THE INTESTINES

Enteritis or inflammation of the mucous membrane of the small intestine will be found described in textbooks on medicine.

Colitis.—Inflammation of the mucous membrane of the large intestine is also usually treated by the physician, unless ulceration is present, when surgical treatment may be necessary.

ULCERATIVE COLITIS.—Ulceration of the colon may be due to tubercle, typhoid, the presence of the amœbæ dysenteriae, syphilis, malignant tumours, etc., or it may be a terminal affection of chronic disease such as chronic interstitial nephritis. The variety usually described as ulcerative colitis is a clinical, if not a pathological, entity.

Simple Ulcerative Colitis.—This affection is most common in adults, and very often no predisposing or exciting cause can be found. The onset is insidious, the patient suffering from diarrhoea with a steadily increasing number of stools *per diem*. The stools are loose and offensive, containing pus, blood, and shreds of mucous membrane. The general health suffers, and the patient wastes steadily until death takes place from inanition and exhaustion. Occasionally perforation of the intestine or severe hæmorrhage may occur.

On examination, the abdomen is flaccid and slightly tender. Examination of the rectum with the sigmoidoscope may show the ulceration in the colon and rectum.

SURGICAL TREATMENT.—The surgical treatment consists of irrigation of the colon through the appendix after suturing it to the skin (*appendicostomy*), or through the cæcum (*cæcostomy*). Appendicostomy has the advantage of being much simpler, and the opening can be readily closed, but the results are unsatisfactory. It is therefore probably best to make an opening in the cæcum in order that the colon may be efficiently irrigated and the flow of fæces over the ulcerated

surface prevented. The fluid used for irrigation should be mildly antiseptic and non-irritating. The opening into the caecum is closed when the ulcers in the colon are considered to be healed.



FIG. 306.—ULCERATION OF THE COLON.

Tuberculosis of the Intestines.—Two main varieties of tuberculosis of the intestine are seen: (1) The ulcerative, (2) the hyperplastic.

1. *Tubercular Ulceration.*—Tuberculous ulcers of the intestine are usually multiple, and are found either in the small or large intestine, or both. The ulcers tend to spread round the intestinal wall, following the course of the bloodvessels, and little nodules of tubercle are usually to be seen on the peritoneal surface of the gut.

SYMPTOMS.—The early symptom is diarrhoea, and the cases at first generally come under the care of the physician. Surgical interference is only necessary for the complications, which are—(1) Chronic intestinal obstruction due to gradual stenosis of the lumen of the gut as the ulcer heals, or to matting of the intestines together; (2) acute obstruction due to kinking of the gut after adhesions have formed; (3) abscess formation following chronic perforation or suppuration in the mesenteric glands; (4) fistula formation after an abscess has burst.

TREATMENT.—The treatment necessarily depends on the condition present, but in the majority of cases the results of treatment are unsatisfactory.

2. *Hyperplastic Tuberculosis.*—This lesion usually occurs between the ages of twenty and forty, and is equally distributed between the sexes. The most frequent site of the disease is the caecum and first part of the ascending colon. It may, however, be found in other parts of the large intestine, or the lesions may be multiple and nearly the whole of the colon may be affected.

PATHOLOGICAL ANATOMY.—The disease originates as a submucous infiltration, and even when advanced there may be no ulceration of the mucous membrane. The wall of the gut is greatly thickened with fibrous tissue, in which caseous nodules may be seen, and the lumen becomes progressively contracted. Adhesions are usually found round the inflammatory mass, and tuberculosis of the mesenteric glands

may be present. On macroscopic examination, it often closely resembles carcinoma, and a differential diagnosis may only be possible on microscopic examination when the mass is found to be inflammatory and not neoplastic. It is difficult to find the tubercle bacillus in the mass.

CLINICAL FEATURES.—The symptoms are those of chronic intestinal obstruction, and a hard nodular mass may be felt in the course of the large intestine, usually at the ileo-caecal junction. There may be a mucopurulent discharge from the rectum, but tubercle bacilli are not found in it.

The **DIAGNOSIS** from carcinoma is suggested by the age of the patient, the length of time the disease has been present, the presence of tuberculous lesions in other parts of the body, and the absence of blood in the stools. In many cases a differential diagnosis is impossible until the abdomen has been opened, and even then only on microscopic examination of the thickened colon. It is possible that many cases of alleged cure of carcinoma of the colon following excision, colostomy, or anastomosis, have been cases of hyperplastic tuberculosis, and it is essential to submit to microscopic examination all cases of suspected new growth of the colon.

TREATMENT.—The mass should be excised and the divided ends of the colon joined, or the ileum anastomosed with the transverse colon. The amount of gut removed need not be so large as in cases of carcinoma, and extensive removal of glands is unnecessary.

If obstruction is present before the operation, and the gut above cannot be emptied, a preliminary artificial anus should be formed. The immediate mortality of excision has been about 25 per cent., but if the patient survives the operation, the prognosis is good.

If excision is not feasible, the portion of the gut affected should be short-circuited, in order that the chronic obstruction may be overcome. This may be followed by healing of the tuberculous lesion.

Typhoid Ulceration.—Perforation of a typhoid ulcer generally occurs in the second or third week of the disease, but in the "ambulatory" form it may be the first serious symptom of the condition. The perforation mostly occurs in one of the ulcers in the lower end of the ileum, and is more common in men than in women. Multiple perforations may be present.

SYMPTOMS.—During the course of typhoid fever the patient suddenly complains of acute abdominal pain, and becomes collapsed, with a fall in the temperature. The symptoms of general peritonitis then supervene, with evidence of free gas in the peritoneal cavity. In many cases, owing to the general condition of the patient, the symptoms of peritonitis are not well marked, and the diagnosis is extremely difficult. Exploratory laparotomy should be performed if there is grave suspicion of perforation, as the only chance of recovery is immediate suture of the intestine.

TREATMENT.—An incision is made through the abdominal wall in the right iliac region, and the ileum brought into the wound and the perforation identified. It is closed in the usual way with Lembert's sutures, and the peritoneal cavity drained, the patient being placed

in the Fowler position. Examination of the ileum for other perforations should be made. In some cases suture is not possible, and the section of gut must be excised, and the two ends joined, or an artificial anus must be established at the site of the perforation.

Cicatricial Stricture of the Intestine.—Cicatricial stenosis of the intestine is most commonly met with in young adults, and is due to healing of an intestinal ulcer (tubercle, syphilis, ulcerative colitis, following strangulated hernia, etc.), or to contraction of mesenteric or peritoneal scar tissue. It is more common in the small than in the large intestine.

CLINICAL FEATURES.—The usual symptoms are those of slowly increasing chronic intestinal obstruction (see p. 700), with hypertrophy and increased peristalsis of the intestine above the stricture. In a few cases the first serious symptoms are those of acute obstruction. The diagnosis, apart from the history, is seldom possible before laparotomy.

TREATMENT.—After the abdomen has been opened and the site of the obstruction identified, one of the following operations may be performed:

1. Resection of the stenosed piece of gut.
2. Lateral anastomosis with short-circuiting of the affected coil.
3. Enteroplasty. The stricture is divided by a longitudinal incision, and the cut sewn up transversely.

If the condition has not been diagnosed until acute obstruction is present, or a large amount of faecal matter is retained behind the stricture, an artificial anus should be established at a preliminary operation. If this is necessary in the small intestine, the final operation should be performed in a few days, as the escape of the contents of the small intestine may lead to emaciation and inflammation of the skin round the artificial anus.

Acquired Diverticula of the Intestine.—Acquired diverticula have been found in every part of the intestine except the caecum, but are most common in the iliac and pelvic colons. In these situations they are frequently multiple, and occur between the bands of longitudinal muscle fibres. The diverticula consist of pouches formed from the whole thickness of the bowel or of hernial protrusions of the mucous membrane between the muscular bundles. They are usually about the size of a cherry, and the opening into the bowel will admit a fine probe. They may occur at any part of the circumference of the intestine, and frequently grow into the mesocolon or into the appendices epiploicae. A certain amount of faecal matter which may become inspissated into an enterolith, is always found in them.

The CAUSE is unknown, but they are most commonly found in elderly people who suffer from constipation, and are rare before the age of thirty. According to some writers, they are pressure diverticula due to the chronic constipation; but against this theory is the fact that they are very seldom associated with stricture of the intestine.

SYMPTOMS.—Diverticula give no symptoms in themselves, and they are most often found post mortem in elderly men who have suffered from chronic constipation. They may (1) become perforated by a foreign body, causing general peritonitis or localized abscess, or (2) become acutely or chronically inflamed, causing pericollitis.

Pericollitis.—This condition is most commonly met with in the iliac and pelvic colons, and may be due to—

1. Inflammation of an acquired diverticulum.
2. Ulceration of the colon—*e.g.*, stercoral, tubercular, syphilitic, or malignant ulcers and ulcerative colitis.
3. Perforation of foreign bodies that do not cause general peritonitis.
4. Actinomycosis.

PATHOLOGICAL ANATOMY.

—As a result of the chronic inflammation, the wall of the gut is thickened and indurated owing to the formation of fibrous tissue, and the lumen is considerably contracted. The mucous membrane may be unaffected, but ulceration or diverticula may occur, and in some cases small polypi are present. The peritoneal surface of the intestine is rough and thickened, and the gut is often firmly fixed by adhesions to the abdominal parietes. The appearance to the naked eye closely resembles carcinoma, and it may only be possible to differentiate the two conditions on microscopical examination. As a rule, however, there is more ulceration of the mucous membrane in carcinoma than in pericollitis.

Suppuration may occur in the thickened walls of the bowel, and lead to abscess formation in the pericolic tissue. This may result in the formation of a fistula either on the surface of the abdomen or into the bladder.

CLINICAL FEATURES.—The condition is most frequently met with in elderly men, and the symptoms are those of chronic intestinal obstruction, with the presence of a hard, irregular, fixed tumour in the left iliac region. The lymphatic glands are often involved, and



FIG. 307.—MULTIPLE DIVERTICULA OF THE COLON.
(London Hospital Medical College Museum.)

clinically the case is indistinguishable from carcinoma in the same situation.

When suppuration occurs, peritonitis follows, or an abscess may form in the left iliac fossa. On opening this abscess, its connection with the colon may be demonstrated. A faecal fistula is apt to follow.

TREATMENT.—If an abscess is present, it should be opened and drained, and recovery may result; but many cases die of general peritonitis. In cases with obstruction the diseased portion of the bowel should be excised, and a colostomy established, or the divided ends of the intestine joined. If it is impossible to resect the gut, a colostomy should be established above the stricture, but any suppurative focus round the colon must be drained at the same time.

The mortality of pericolicitis, with or without operation, is about 70 per cent.

Chronic Constipation.—Owing to the belief that chronic constipation is the cause of general degeneration of the tissues and premature old age from the absorption of toxic products from the large intestine, it has been proposed to treat this condition by surgery. Operation is only performed after medical treatment has failed to relieve the condition, and when the general health of the patient is beginning to suffer; but it should not be delayed until the patient is emaciated and unable to withstand the shock of a severe operation.

Two methods of procedure are proposed—(1) To perform a lateral anastomosis between the ileum and the omega loop (ileo-colostomy); and (2) to excise the whole of the large intestine, and then perform ileo-colostomy. The latter operation is stated to be the more efficacious, but is much more severe than the former, and has a considerable mortality. The results, if the patient survives, are stated to be excellent.

Faecal Impaction.—Faecal impaction, apart from stricture of the intestine, is due to habitual constipation, and is most frequently seen in women. It often occurs in bedridden patients whose bowels are not properly attended to, and whose diet is dry and leaves little residue, or in those who from some cause are constantly vomiting. The mass of hardened faeces usually accumulates in the rectum or omega loop, though it may sometimes be in the caecum or other part of the large intestine.

The SYMPTOMS are those of mild chronic intestinal obstruction, and when the mass is in the rectum there is usually spurious diarrhoea, with severe tenesmus and incontinence of faeces. Difficulty of micturition may also be present.

The faecal mass may be felt in the abdomen, and can be indented with the finger. When it is in the rectum it can be felt on digital examination.

TREATMENT.—The mass should be gradually washed away with copious enemata or by irrigation of the bowel. When it is in the rectum, it can be removed with the finger or with forceps. Purgatives should not be given until the main mass has been removed from below.

Enteroptosis (Gleason's Disease).—This condition is a slipping down of the whole of the abdominal viscera towards the pelvis, and is usually associated with weakness of the anterior abdominal walls. It is more common in women than in men, and is often the consequence of repeated pregnancies, the wearing of corsets which compress the waist without supporting the lower abdomen, and the downward drag of the skirts. In both sexes it may follow loss of intra-abdominal fat, with impairment of the muscular tone and the general health, and it is associated with, or partly dependent upon, chronic constipation.

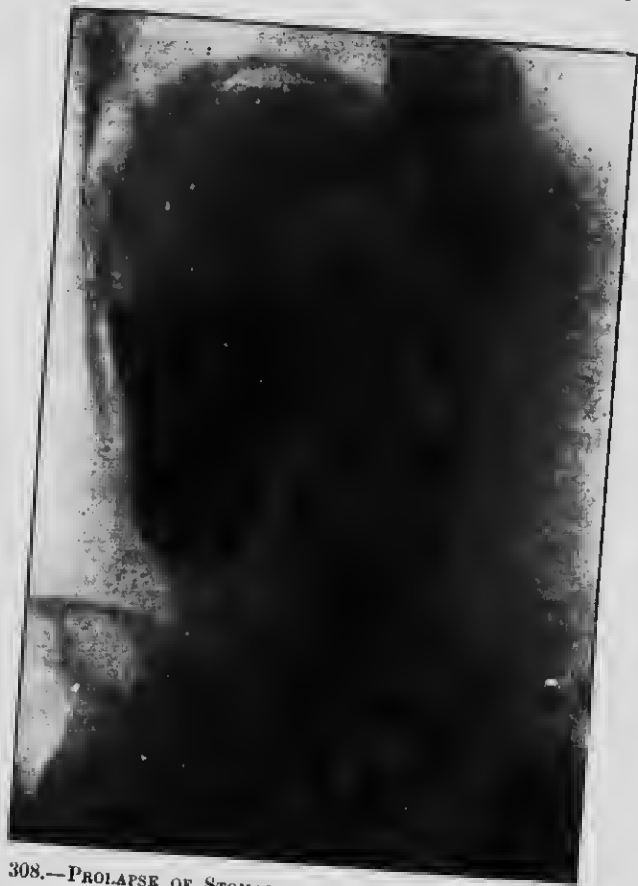


FIG. 308.—PROLAPSE OF STOMACH SHOWN IN A RADIOGRAM AFTER A BISMUTH MEAL.

PATHOLOGICAL ANATOMY.—The stomach, which is usually somewhat dilated, is displaced downwards, often extending below the umbilicus, and the gastro-hepatic omentum is lengthened. The transverse colon, which generally has a V-shape, may be found in the true pelvis when the patient stands erect. The cæcum slips down into the

pelvis, and if the appendix is retained in the abdomen by adhesions, kinking of this organ occurs. The adhesions are believed by some pathologists to be inflammatory, and by others to be compensatory bands developed to prevent the downward sipping of the viscera. The mesentery slips down on the spine, and the small intestine is crowded down into the pelvis and against the lower relaxed abdominal wall. The kidneys, especially the right, are displaced downwards, and are more freely movable than normally. The liver is displaced downwards, and may reach the false pelvis; the spleen is displaced, and unusually movable. Prolapse of the uterus, with rectocele and cystocele, and sagging down of the perineum, with prolapse of the rectum, or piles, are common. Of course, all these features are not present in every case, and any combination of them can occur.

CLINICAL FEATURES.—The symptoms from which the patient suffers have often little reference to the amount of displacement, as they are largely dependent upon associated *neurasthenia*. For example, a patient with a slightly movable kidney may complain of many more symptoms than a patient with general enteroptosis and splanchnoptosis. On the whole, the symptoms are chronic indigestion, constipation, and a dragging pain in the back and abdomen aggravated by standing, and relieved by lying down. The general health is affected by the indigestion and constipation. Wasting, a furred tongue, foul breath, loss of appetite, headache, laxity and pigmentation of the skin, are often present.

The **DIAGNOSIS** is made by examination of the various viscera in the abdomen and pelvis, and recognizing them in their abnormal situations, and by examining the patient lying down, standing, and in the knee-elbow position, and recognizing the alteration in the shape of the abdomen. A series of X-ray examinations after a bismuth meal will demonstrate the position of the stomach and the various parts of the colon.

TREATMENT.—The treatment consists of—

1. Improving the general health, and treating the neurasthenia by appropriate medical means. In people who have wasted, an attempt should be made to increase the amount of abdominal fat.
2. Improving the tone of the abdominal muscles by suitable easily carried out exercises, and massage with intervals of rest in the recumbent position.
3. Regulating the bowels by diet, medicines, and abdominal massage.
4. The abdominal muscles should be supported by a well-fitting abdominal belt or a pair of corsets made to support the lower abdomen. The belt or corsets should be applied whilst the patient is lying down, and the pressure should be from below upwards.

If this treatment is carried out thoroughly, the patient, although not cured of the condition, is made perfectly comfortable in the majority of cases, and no further treatment is necessary. In the exceptional cases it may be necessary to fix any of the abdominal viscera, such as a kidney or the spleen, that are excessively mobile, or the liver may be firmly attached to the diaphragm by stitching, and the gastro-hepatic omentum shortened by plication. These operations often appear successful at first, but the relief is probably in most cases due to the enforced rest in bed, the careful dieting, and attention to the bowels; and the cases relapse when allowed to get about unless the above directions are carried out.

In cases associated with chronic constipation, removal of the colon and the performance of ileo-colostomy have been advised.

NEW GROWTHS OF THE INTESTINES

Innocent Neoplasms of the small intestine are so rare as to be pathological curiosities, but in a few cases **adenomata** or **papillomata** may be the starting-point of an intussusception.

Innocent Growths in the large intestine are also rare, but are seen more often than in the small bowel. The chief varieties are—(1) **Multiple Adenomata**, sessile or pedunculated, most common in the descending and pelvic colons, and associated with intractable hæmorrhage and diarrhoea; (2) **Villous Papillomata**, which are also frequently multiple, and tend to become malignant; (3) **Lipomata**. This last growth has been known to cause chronic obstruction.

The **DIAGNOSIS** of any of these growths is usually only made on exploratory laparotomy, and the **TREATMENT** depends on the nature and situation of the growth.

Malignant

Sarcoma.—Sarcoma of the intestine is rare. The growth is generally situated at the lower end of the ileum and in the cæcum. The growth usually has the form of a diffuse infiltration of the walls of the intestine, and two clinical types may be differentiated. In the first the symptoms are those of chronic intestinal obstruction, owing to constriction of the lumen of the bowel; and in the second, the tumour in the abdomen is the primary feature, obstructive symptoms being almost entirely absent.

TREATMENT.—The intestine containing the growth should be freely excised, the divided ends closed, and the lumen of the gut restored by lateral anastomosis. The prognosis is bad.

Carcinoma.—Carcinoma of the small intestine is rare, but it is comparatively common in the large intestine, and is the most frequent disease of the colon necessitating surgical interference. The two sexes are equally liable to the disease, and although it more often affects patients over forty, cases under thirty are by no means uncommon.

The order of frequency of situations in which the growth is found is as follows: Most commonly the pelvic and iliac colon, then the cæcum, transverse colon, splenic flexure, and ascending colon.

PATHOLOGICAL ANATOMY.—The growth is a columnar-celled carcinoma, which often undergoes colloid degeneration, and may be encephaloid or scirrhus in type. *Encephaloid carcinoma* shows itself as a cauliflower-like growth of the mucosa, which projects into the lumen of the gut. The centre is ulcerated, the ulcer having hard, everted edges. Small polypoid growths are often situated round the main growth, and the lumen of the bowel is more or less obstructed. *Scirrhus carcinoma* appears as a tight annular stricture of the bowel, looking almost as if a string had been tied round the gut. The fatty



FIG. 309.—CARCINOMATOUS STRICTURE OF THE COLON, SHOWING HYPERTROPHY AND DILATATION OF THE INTESTINE ABOVE THE STRICTURE.

tissue in the neighbourhood is generally increased. The constriction is very hard, and on opening the intestine, the lumen is found to be extremely narrowed, although there may be little or no ulceration of the mucosa. The intestine above the growth is dilated, and the muscular coat hypertrophied. In cases with chronic obstruction, stercoral ulceration of the mucous membrane is frequently present. The intestine below the growth is often ballooned from paresis of the intestinal muscle and accumulation of gas. In cases where the growth has formed the apex of an intussusception, the gut below the obstruction may be hypertrophied.

The growth tends to remain localized in the gut wall for a consider-

able time, and to spread round the lumen of the gut and into the retroperitoneal tissue, binding the intestine down; later, however, involvement of the glands of the mesentery and the retroperitoneal glands occurs. The first enlargement of these glands is generally due to infection by the colon bacillus, so that enlargement is not a contra-indication to operation, and a microscopic examination of the glands must be made before a prognosis is given. Secondary extension to the peritoneum, resulting in a general carcinomatosis, is not uncommon, and the organ most commonly affected by secondary deposits is the liver. General infection is uncommon, as death usually occurs from intestinal obstruction before secondary deposits appear.

SYMPTOMS.—In the majority of cases the symptoms of carcinoma of the colon are those of chronic intestinal obstruction—*i.e.*, colicky abdominal pain, increasing constipation alternating with attacks of "spurious" diarrhoea, during which mucus is passed, and flatulency.

On examination, the patient is found to be somewhat wasted, visible peristalsis of the small intestine is seen, and a hard nodular lump may sometimes be discovered in the abdomen. In other instances examination of the pelvic colon with the sigmoidoscope will reveal the growth. A series of radiograms after a bismuth meal, or a radiogram after injection of bismuth emulsion *per rectum*, may be an aid to diagnosis.

The exceptional symptoms which bring the patient under observation are—(1) An attack of acute intestinal obstruction; (2) wasting and the discovery of a tumour in the abdomen, particularly in caecal carcinoma; (3) the passage of blood-stained mucus; (4) onset of general peritonitis or localized abscess due to perforation of the bowel just above the carcinomatous stricture or in the caecum; (5) faecal in-paction; (6) vomiting of faecal matter or passage of faeces in the urine, due to the establishment of an internal fistula with the stomach or bladder.

The **DIAGNOSIS** can often only be made on exploratory laparotomy, which should not be long delayed in a case of suspected obstruction in a patient over forty.

TREATMENT.—The method of treatment depends on the situation of the growth, the condition when diagnosed, and the presence or absence of intestinal obstruction, either acute or chronic.

1. *With Symptoms of Acute Intestinal Obstruction.*—The abdomen is opened in the middle line, and the site of the growth determined. It should then be carefully examined as to its fixity. Search should be made for the presence of enlarged glands and secondary growths in the peritoneum and liver. These examinations are to determine the advisability of removal of the growth later.

(A) If it is decided that removal is possible, an artificial anus should be made above the obstruction in such a position that it will not interfere with the second operation. For example, with a growth in the iliac or pelvic colon, a right lumbar colostomy should be performed to drain the intestines. The second operation (which is performed as soon as the gut is well emptied, and the patient has recovered from

the acute condition) can then be carried out without fear of contamination of the wound by the colostomy, and the lumbar opening will usually close spontaneously.

(B) If the condition of the growth contra-indicates removal later, a permanent artificial anus should be made at a convenient place. In cases of iliac or pelvic carcinoma it should be made just above the growth, but with growths higher up in the bowel a caecostomy or a transverse colostomy will probably be necessary.

2. *With Chronic Obstruction.*—An attempt should be made with enemata, and later with aperients, to empty the intestine; but if this cannot be done, a preliminary artificial anus should be established, and the growth removed at a second operation.

3. *Removable Carcinoma in the Iliac or Pelvic Colon without Symptoms of Obstruction, or after Drainage of the Intestine.*—The portion of the colon containing the growth is "mobilized," and the growth and several inches of the colon above and below it, together with a large portion of the mesocolon containing the glands, are removed. If the ends of the gut can be approximated without tension, an end-to-end or lateral anastomosis is made. If this is not possible, an artificial anus is established, with the upper end and the lower end closed, or both ends are closed, and an ilea colostomy performed. Some surgeons prefer to do this operation in two stages, but this is not necessary if the gut has been thoroughly emptied.

4. *Removable Carcinoma in the Cæcum.*—The growth, with a part of the ileum and the ascending colon, is removed together with part of the mesocolon, and the divided end of the ileum joined to the ascending colon, transverse colon, or the pelvic colon.

5. *Irremovable Carcinoma.*—Two methods of treatment can be employed—(1) An artificial anus is established at a convenient place above the obstruction; or (2) the portion of the gut containing the growth is "short-circuited," a lateral anastomosis being performed between the intestine above and below the growth.

PROGNOSIS.—The mortality of removal of the growths of the colon is heavy (30 per cent.), but as the advisability of thoroughly emptying the intestine before attempting the removal of the growth is being more and more recognized, the operative death-rate is steadily decreasing.

Local recurrence after operation is not very common, and many cases are now on record of freedom from recurrence five or ten years after removal of the carcinoma.

In the diagnosis of diseases of the colon two special methods are used—viz., radiography and sigmoidoscopy.

Radiography.—The patient is given an emulsion of bismuth, and a series of radiograms is taken tracking the path of the bismuth through the intestine. The following conditions can frequently be recognized: Prolapse of the cæcum into the pelvis, prolapse of the transverse colon, dilatation of the colon above a stricture, delay in the passage along the colon. Considerable experience is necessary in interpreting the radiograms. The bismuth may also be injected from below, and radiograms taken.

Sigmoidoscopy.—The sigmoidoscope is a metal tube about 25 centimetres long, in which is fitted a small electric lamp, so that the colon at the orifice of the tube is illuminated. It is passed through the anus, and with great care can be made to pass along the bowel for 20 centimetres or more. The mucous membrane should be watched while the instrument is being passed; neglect of this precaution has led to perforation of the bowel. The part of the colon examined consists of the pelvic and part of the iliac colon (sigmoid or omega loop), and as this is the part of the colon most commonly diseased, this method of examination should never be omitted. The instrument may either be passed with the patient in the lateral or genupectoral position, and an anæsthetic is not necessary in most cases.

INTESTINAL OBSTRUCTION

Intestinal obstruction is not a disease, but a symptom of diseases of the intestine, as tuberculous ulceration or carcinoma, or of some mechanical condition, as volvulus or strangulated hernia, which prevents the forward passage of the fæces, and interferes with the blood-supply of the intestines.

The condition is divided into acute and chronic varieties.

Acute Intestinal Obstruction.—In this variety the obstruction of the lumen of the bowel is sudden and complete, and there is at the same time serious interference with the blood-supply of the part of the intestine affected.

PATHOLOGICAL ANATOMY.—The intestines below the seat of obstruction are contracted and pale in colour, and peristaltic movements cease, so that even if there are fæces present below the obstruction, the bowels do not act.

At the site of the obstruction the intestine is usually deeply congested, being almost black in colour, and if the obstruction is not quickly released, gangrene occurs. This gangrene is not solely due to the interference with the blood-supply of the intestine, but to invasion of the gut by infective bacteria, the condition being one of **infective gangrene** of the intestine. The gut immediately above the obstruction is acutely inflamed, and submucous hæmorrhages and focal ulceration are common, so that if resection of gut is necessary in the treatment, a large section of the gut above the actual gangrenous portion must be removed. During the operation this part of the gut requires very careful handling, as it is exceedingly liable to tear, or the peritoneum to give way at the anti-mesenteric border, and any stitches that are introduced tear out very readily.

The intestine above the obstruction becomes enormously distended with liquid fæces and gas. The gas is due to decomposition of the fæces by the bacteria present, and the liquid fæces are largely the result of pathological secretion from the gut wall. The mucous membrane of the intestine is congested, and the surface epithelium is shed; absorption of bacteriological toxins, therefore, takes place rapidly,

and is the most important cause of the death of the patient. Ulceration of the mucous membrane above the constriction may lead to perforation of the gut wall, faecal extravasation, and general peritonitis.

The gut above the obstruction is paralyzed, sometimes permanently, even if the obstruction is relieved. In these cases the symptoms continue, and the patient dies (ileus paralyticus).

SYMPTOMS.—If the onset of the condition is very sudden and the lesion a severe one, such as a volvulus of the cecum, the patient suffers from peritonism—*i.e.*, shock, abdominal pain, and vomiting due to the profound impression made on the nerves of the abdomen; but with a less sudden onset the symptoms of peritonism are not marked or are absent.

The characteristic symptoms of acute obstruction are *intense abdominal pain, vomiting, absolute constipation, and abdominal distension.*

Abdominal Pain.—If the obstruction is complete, the abdominal pain is continuous and severe; but with partial obstruction—*e.g.*, from intussusception—the pain is paroxysmal, the paroxysm corresponding to waves of peristalsis passing over the gut. The pain usually continues till the patient dies, unless gangrene occurs, in which case it may cease for a short time, to be replaced by the pain of general peritonitis.

Vomiting.—The vomiting is continuous and distressing. The contents of the stomach are first evacuated, then the bilious fluid of the duodenum, and lastly a dark brown oval-smelling fluid brought up in large quantities (faecal vomiting). The fluid is similar to that found in the intestine above the obstruction.

Absolute Constipation.—As a rule, after the onset of acute intestinal obstruction, the patient passes neither faeces nor flatus. If an enema is given, faeces actually present in the rectum or colon may be washed out, but even then no flatus is passed. In other cases the enema is retained or returns unchanged. In cases of partial obstruction, such as intussusception, faeces and flatus may be passed.

Abdominal Distension.—As the obstruction continues, the abdomen becomes more and more distended, and from the character of the distension the site of the obstruction can often be inferred. With marked distension the obstruction is usually in the large bowel, the distension being mainly in the flanks and the epigastric region; with small-gut obstruction the distension is mainly median. If the obstruction is high up in the jejunum, distension may be almost absent, but in these cases the other symptoms, especially the vomiting, are very severe.

Other Symptoms.—The abdomen is not rigid or tender at first, and pressure may even relieve the pain somewhat; but with the onset of peritonitis rigidity and tenderness appear. The breathing is usually thoracic, owing to the abdominal distension. The tongue is dry and brown, sordes collect on the teeth, and there is intense thirst. The face is drawn and anxious, and the eyes sunken.

The pulse-rate at first is normal or a little raised, but as the toxic absorption from the intestine continues, it becomes rapid and weak.

The temperature also is at first normal or a little raised, but later becomes subnormal, and often remains so after the onset of peritonitis. Consciousness is usually retained till the end, and the vomiting and thirst continue to distress the patient.

DIAGNOSIS.—During the period of *peritonism*, if it occur, the differential diagnosis from other acute abdominal lesions is impossible; but with the onset of the characteristic symptoms of vomiting, absolute constipation, and abdominal distension, the diagnosis becomes easy. The diagnosis is often finally established by the administration of an enema and the absence of any result, and the fact that the patient passes no flatus determines the surgeon to open the abdomen. The administration of morphia during this period of doubt is harmful, as it relieves the symptoms and so delays the diagnosis, and the prognosis of intestinal obstruction depends entirely upon early diagnosis and prompt treatment.

TREATMENT.—*If a patient is suspected of having acute intestinal obstruction, he should not be left until the diagnosis is established and the obstruction, if present, relieved.*

In the great majority of cases (the exceptions will be given later) the treatment consists of opening the abdomen and relieving the obstruction, and this should be done without unnecessary delay. During the interval between diagnosis and operation the stomach should be washed out, and the patient only allowed sips of water. Morphia in small quantities may be given if there is a necessary delay of some hours, and especially if the patient has to make a journey.

OPERATION.—In a large number of cases the exact cause of the obstruction will not be diagnosed before operation, so the abdomen should be opened just to one side of the median line below the umbilicus. A second incision is frequently necessary over the site of the obstruction, and in cases of suspected or diagnosed obstruction at the lower end of the colon or in the rectum an incision may be made in the left iliac region, so that a colostomy can be established without a second incision.

When the abdomen is opened, an excess of fluid is found in the peritoneal cavity, and the distended coils of intestine push their way through the wound. The hand should be passed into the right iliac fossa and the cæcum palpated. If it is distended, the obstruction is in the large gut, and this should be traced round till it is found. If the cæcum is empty, the obstruction is in the small gut, and the empty intestine should be traced up to the seat of obstruction. As little as possible of the intestine should be brought outside the abdomen, for escape of a large amount of intestine increases the shock. The intestines outside the abdomen should be well covered by pads wrung out in hot saline solution.

After the cause of the obstruction is found, the procedure varies with the condition present.

1. *The obstruction can be relieved—e.g., a band across the intestine, or an intussusception; the gut is not very distended, and after the*

obstruction is relieved, peristalsis starts. Relief of the obstruction is all that is necessary, and the abdomen should be closed.

2. *The obstruction can be relieved, but the gut above is enormously distended, and peristalsis has ceased.* The obstruction should be relieved, but it is not safe to close the abdomen with the gut so distended, as it may remain paralyzed. The gut can be punctured with a tenotomy knife, and the minute opening afterwards closed, or a large opening may be made in the gut, and an attempt made to empty the intestine through it, and then close it by careful suturing. If the obstruction is in the large intestine or low down in the ileum, it is better to establish an artificial anus, which can be closed subsequently.

3. *The obstruction cannot be relieved—e.g., a stricture from a carcinomatous ulcer, or ulcerative colitis.* The intestine should be opened at a convenient place above the stricture, and an artificial anus established. In the case of a carcinoma, a careful examination should be made of the extent and fixity of the growth, and the condition of the glands, the peritoneum and liver as regards secondary growths, as the later treatment is an attempt to remove the growth and re-establish continuity of the intestine.

4. *The gut is gangrenous at the site of obstruction.* In a few cases in which the obstruction is in the small intestine, and the patient's condition warrants it, a primary resection, with anastomosis of the ends of the gut, may be performed, a large section of the intestine being removed; but in the majority of cases the gangrenous gut should be brought out of the abdomen and removed, and an artificial anus established, which can be subsequently closed. Small patches of gangrene may be sequestered with purse-string sutures. As in all emergency abdominal operations, speed in operating is desirable. In cases of obstruction intestinal drainage is essential, and removal of the cause a secondary consideration. The simplest operation that will save the patient's life is the best. If the condition of the patient at the time of operation is desperate, no time should be wasted in ascertaining the exact cause of the obstruction, but an artificial anus at once established above the obstruction, which can be dealt with later.

CAUSES OF ACUTE INTESTINAL OBSTRUCTION.—The causes of acute intestinal obstruction are very numerous, but it is possible to group them so that in many cases a differential diagnosis may be made, as each group has some characteristics peculiar to itself. On the other hand, it must be remembered that the cause of acute intestinal obstruction is frequently only discovered on the operating-table, and inability to discover the cause clinically should not lead to delay in operating.

1. **Imperforate Anus.**—This condition is dealt with under Diseases of the Anus and Rectum (p. 746).

2. **Obstruction due to Strangulation by Congenital Bands—e.g., Meckel's diverticulum** (see p. 712), holes in the mesentery, and other congenital defects.

PECULIARITIES.—The obstruction is nearly always in the small intestine, and is usually very acute.

These cases are generally met with in children or young adults, and there is no previous history pointing to any cause for obstruction. The condition can only be really diagnosed on abdominal exploration.

TREATMENT.—The treatment is on the general lines laid down above.

3. Adhesions.

Obstruction due to peritoneal adhesions may be met with at any age, and may be either acute or chronic. It is astonishing in some cases how slight the adhesions are, for in one of the author's cases a single adhesion not thicker than a piece of cotton had produced complete obstruction.

The diagnosis may often be made from the previous history, such as a history of tubercular peritonitis, appendicitis, salpingitis, abdominal injury, or abdominal operations. Other causes are tubercular glands in the mesentery and cholecystitis. The onset may be quite sudden, but is more often rather gradual. There may be a history of previous attacks of colicky abdominal pain.

TREATMENT.—The treatment is on the general lines given above.

4. Strangulated Hernia.—Two kinds of hernia may be distinguished—the *external*, through the abdominal wall, and the *internal* into the various pouches of peritoneum, such as the ileo-caecal pouches, the fossa duodeno-jejunalis (fossa of Treitz), the intersigmoid fossa, and the foramen of Winslow. External herniae are diagnosed by their physical signs, and the condition will be considered in the chapter on Hernia (p. 714).

The **DIAGNOSIS** of strangulated internal hernia cannot be made until the abdomen is opened. It is most common in adults, and usually involves the small intestine.

TREATMENT.—The treatment consists of relieving the strangulation and draining the intestine if necessary.

5. Foreign Bodies.—Acute intestinal obstruction due to foreign bodies results most commonly from impaction of a gall-stone in the intestine.

GALL-STONE OBSTRUCTION.—The gall-stone passes into the upper part of the small intestine through a fistula established between the gall-bladder and the gut as a result of ulceration of the gall-bladder. The most common site of obstruction is at the lower end of the ileum, as the gut gets narrower here, and the symptoms are generally acute in onset.

The **DIAGNOSIS** is made from the previous history of gall-stone colic and jaundice, the patients being mostly fat, elderly females.



FIG. 310.—STRANGULATION OF A SMALL INTESTINE BY A MECKEL'S DIVERTICULUM.

In thin subjects the stone may possibly be felt on abdominal examination, or if the coil of intestine in which it is contained is lying in

Douglas's pouch, it may be felt on rectal or vaginal examination.

The PROGNOSIS of this form of obstruction is not good, owing to the general condition of the patient and to late diagnosis. The case is frequently mistaken for one of gall-stone colic.

TREATMENT.—The abdomen should be opened in the middle line, and the coil of intestine containing the stone brought out through the wound. The stone is then pushed backwards, as ulceration is nearly always present at the site of impaction, the bowel opened over the anti-mesenteric border, and the stone removed. The intestine is closed by a double row of sutures and the abdomen closed.



FIG. 311.—A LARGE GALL-STONE THAT CAUSED INTESTINAL OBSTRUCTION.

Obstruction of the large intestine may be due to impaction of a gall-stone, but these cases are rare. The stone has usually increased in size during its passage through the intestine by intestinal contents becoming attached to it, so that the cause of the obstruction is an enterolith, the nucleus of which is a gall-stone.

Gall-stone obstruction may also be subacute or chronic, and after severe attacks of colicky pain and vomiting, the stone may be passed.

OTHER FOREIGN BODIES causing acute intestinal obstruction are concretions of hair and fibre, aviculiths or oat-stones, met with in people who live largely on coarse oatmeal, concretions of magnetic sulphate taken as medicine, and foreign bodies that have been swallowed, usually by children and lunatics. The diagnosis in the absence of history is difficult, and is often only made on exploratory laparotomy.

6. **Volvulus.**—By this term is meant a condition in which the intestine is twisted round its mesenteric attachment so that the lumen of the bowel is occluded, and the blood-supply of the twisted loop is obstructed. The condition may be found in the small intestine, the cæcum, and the omega loop. It is doubtful if a normal loop of small intestine can be so twisted, although it is not uncommon when there are adhesions joining pieces of intestine together. The only common place for volvulus is the omega loop, and even here there is often cicatricial contraction between the two ends of the loop so that they are too closely approximated, and the occurrence of volvulus is favoured.

Volvulus of the Omega (Sigmoid)—CLINICAL FEATURES.—This form of intestinal obstruction is most common in young adults or in elderly men. In either case there is as a rule an antecedent history of constipation. The onset of the condition is sudden and without obvious cause, and the symptoms of acute intestinal obstruction rapidly develop; vomiting is not a marked feature. The peculiarity

of the symptoms is the very rapid distension of the abdomen, so that in twelve hours the abdomen may be so distended that breathing is difficult and the heart action disturbed. In the early stages the distended gut may be felt as a rounded resonant swelling in the left iliac fossa. Death frequently occurs in twenty-four to forty-eight hours.

On opening the abdomen, the enormously distended omega loop appears to fill the whole cavity, lying in front of the small intestine and reaching sometimes to the right hypochondrium. The loop of gut is intensely congested, and if the condition has not been diagnosed early, patches of gangrene are present on it, as well as thickets of lymph from peritonitis. The bowel is generally twisted a half or a whole turn, but in a few cases two or three turns have been present.

TREATMENT.—After the abdomen has been opened, the distended coil of intestine must be brought outside, and the volvulus untwisted. In some cases this is impossible until the gut has been opened and emptied, and this should always be done. It may sometimes be possible to close the opening in the intestine by suture after the gut has been emptied and to return it to the abdomen with safety; but in the majority of cases the best treatment is the establishment of an artificial anus in the omega by tying in a Paul's tube. This artificial anus is closed by a subsequent operation.

The Prognosis of volvulus of the caecum in the past has been bad.

Volvulus of the Caecum and Ascending Colon This is rarer than the author followed
volvulus of the omega, and in a case seen by rupture of a pseudo-cyst of the pancreas by injudicious handling. The abdomen was opened within an hour or two of the occurrence, and the volvulus was easily untwisted.

7. Intussusception.—An intussusception is the prolapse of one piece of intestine into the adjoining part, and as a rule the condition is steadily progressive.

PATHOLOGICAL ANATOMY.—An intussusception consists of three layers—an outer sheath or "intussuscipiens," an internal or entering layer, and a middle or retiring layer, and the two latter sheaths, taken together, are termed the "intussusceptum."

In the majority of cases (the exception is the ileo-caecic variety) the apex of the intussusception remains constant, and the condition increases at the expense of the outer layer, which becomes more and more infolded. The cause of the growth of the intussusception is the attempt of the intestines to pass the intussusceptum as a foreign body, and this may be so successful that it protrudes at the anus.

As the gut becomes invaginated, it drags the mesentery in with it, and this being firmly attached to the posterior wall of the abdomen, causes the intussusception to become curved with the concavity



FIG. 312.—COMMENCING INTUSSUSCEPTION.

toward the mesentery. The squeezing of the mesentery into the intussusciens causes constriction of the veins, and this leads to extreme congestion of the intussusception, which becomes purple in colour. Hæmorrhage from congestion also occurs into the wall of the gut and into the lumen, and the blood appears at the anus mixed with mucus, and forms the characteristic stools. The congestion of the gut may be so extreme, particularly at the apex of the intussusceptum, that it may be impossible to reduce it, and the congestion may continue to increase until gangrene of the gut occurs. The onset of gangrene is also due to infection of the walls of the gut with microorganisms. Ulceration of the mucous membrane is common, and this occasionally leads later to narrowing of the lumen of the gut and chronic intestinal obstruction. Inflammation of the intestine and the formation of adhesions between the peritoneal surfaces occurs in the subacute and chronic varieties, and these adhesions may also be a cause for irreducibility of the intussusception.

In a few cases the entire intussusceptum may become gangrenous and separate off as a slough, which is then passed *per anum*, and if adhesions have formed between the inner and outer layer at the entrance of the intussusceptum, recovery may follow with more or less constriction of the gut; this is said to occur in 2 per cent. of untreated cases.

Ulceration and gangrene of the outer layer is rare.

CAUSE.—In the majority of acute cases no cause can be discovered, but there may be a history of constipation or diarrhœa or some indiscretion in diet, suggesting irregular and forcible peristalsis as the cause. In a few cases a tumour projecting into the lumen of the gut forms the apex of the intussusception, or, as a still rarer cause, hæmorrhage into the wall of the gut may be present. In chronic intussusception the



FIG. 313.—ADVANCED INTUSSUSCEPTION.

condition may be due to a stricture of the intestine, particularly an annular carcinoma.

The caput cæci may also form the apex of the intussusceptum, and in a few cases the appendix has been found turned completely inside out.

ANATOMICAL VARIETIES.—There are four chief anatomical varieties of intussusception, but combinations of these frequently occur:

1. *Ileo-cæcal*.—According to Treves, 44 per cent. of all intussusceptions are of this variety. The apex of the intussusception is formed by the ileo-cæcal valve, which passes into the ascending colon and may progress until it appears at the anus.

2. The *enteric* form comes next in frequency, and is a prolapse of small gut into small gut. It is most generally seen in the jejunum, and does not as a rule grow very large.
3. The *colic* variety is an invagination of large gut into large gut, and is most commonly associated with new growth in the intestine. It is usually of small size.
4. *Ileo-colic*.—This consists of an invagination of the small intestine into the large, through the ileo-cæcal valve, and is the rarest (8 per cent.) of all the forms of intussusception. It differs from the other varieties in that the apex is constantly changing, and the intussusception grows at the expense of the inner layer. This method of extension soon changes, and the apex becomes constant, the growth then proceeding as usual at the expense of the outer layer.



FIG. 314.—ILEO-CÆCAL INTUSSUSCEPTION.

Intussusception of the Dying.—During post-mortem examinations of children who have died from various complaints, it is not uncommon to find intussusceptions. These intussusceptions are often multiple, and may occur in the opposite direction to normal peristalsis. They shew no signs of congestion or inflammation, and are believed to occur just before death owing to irregular intestinal movements.

CLINICALLY, intussusception is divided into acute and chronic forms.

CLINICAL FEATURES OF ACUTE INTUSSUSCEPTION.—Acute intussusception is most common in children below the age of two years, who at the time of onset are healthy, well-nourished, and often breast-fed.

The onset is sudden, the child suffering from acute colicky pain in the abdomen, and vomiting. Shock is often well marked, and the change in a few hours from a healthy child to a condition of profound collapse is striking. The pain is at first paroxysmal, being due to waves of peristalsis passing over the gut, and between the spasms of pain the child may sleep. Vomiting occurs at the onset, but is not a marked feature of the condition and rarely becomes faecal. The bowels are not absolutely constipated, but there is a discharge of blood-stained mucus which, however, is often mixed with faecal matter, and in the less acute cases almost normal stools may be passed. The passage of blood-stained mucus after a rectal examination has been made is very characteristic.

On examination, the abdomen is not markedly distended, but is a little rigid, and the right iliac fossa may feel empty (sign of Dance). In the majority of cases, but sometimes only under anaesthesia, a "sausage-shaped" tumour with a curve toward the umbilicus can be felt, generally on the left side of the abdomen. The tumour is movable, and becomes more obvious during a paroxysm of pain. On examina-

tion of the rectum, the apex of the intussusception may be felt, or it may protrude at the anus.

The conditions most readily mistaken for acute intussusception are the acute colitis of infants, other varieties of acute intestinal obstruction, and Hæmoch's purpura. The last condition may be associated with intussusception.

TREATMENT.—Immediately the diagnosis is made, the abdomen should be opened, and the intussusception reduced by squeezing it backwards with the finger and thumb. Traction may lead to tearing of the gut. It is of the utmost importance to see that the last part of the intussusception is reduced completely, or there is danger of recurrence. With early diagnosis and rapid operating, the prognosis is excellent. If the surroundings are such that skilful aseptic operating cannot be obtained, a trial may be made of running water into the gut through the anus, either by a tube and funnel or a Higginson's syringe. This, in the majority of cases, partially reduces the intussusception with improvement of the symptoms, and in some cases reduction is complete, recovery following. This method is, however, uncertain, and recurrence from inability to completely reduce the intussusception is common, and valuable time wasted. It should not be tried in preference to operation, but only when means for successful operation are wanting.

In some cases—and these not necessarily large intussusceptions—reduction is impossible, owing to the intense congestion of the intussusceptum or to the formation of adhesions in the more chronic cases.

Two methods of treatment may be employed: (1) Resection of the whole mass, with the formation of an artificial anus, or anastomosis of the divided ends of the intestine; (2) suture of the entering and the outer layer at the mouth of the intussusception, opening the gut by a longitudinal incision beyond the suture line, and excising the intussusceptum, finally closing the gut where it has been opened. In young children both methods are equally unsuccessful, but in older children and young adults either may succeed. In the author's experience the former is the better operation.

RECURRENCE.—Recurrence after one attack of intussusception is rare, but is not unknown, the operation having to be repeated.

SPONTANEOUS CURE.—In a few instances it is believed that spontaneous reduction has taken place, but spontaneous cure is usually brought about by sloughing of the intussusceptum, which is then passed *per anum*.

The prognosis of acute, untreated intussusception is extremely grave, the patient generally dying within a week.

Chronic Intussusception.—Chronic intussusception is more common in adults than in children, and in 60 per cent. of the cases occurs at the ileo-cæcal junction.

SYMPTOMS.—The symptoms are those of chronic intestinal obstruction with anomalous features. Constipation may alternate with diarrhoea, and blood-stained mucus is not uncommon in the stools.

Vomiting is slight, and the pain colicky and intermittent. Abdominal distension does not occur, but waves of visible peristalsis and hypertrophy of the gut walls may be present. A tumour with the usual characteristics of an intussusception is present in about half the cases. The general health soon begins to suffer, the appetite is poor, and the patient loses flesh and strength, and finally dies of exhaustion or complete obstruction. The illness in untreated cases lasts from one month to a year, but mostly about two months.

TREATMENT.—The abdomen should be opened and the intussusception reduced, as in acute cases. This may be readily done even if the intussusception has been present for weeks. Irreducibility of the last portion, however, is not uncommon and resection and anastomosis of the gut is then necessary.

8. Acute on Chronic Obstruction.—Chronic intestinal obstruction from any cause frequently ends with an acute attack. The sudden onset of acute symptoms may be due to—(1) The narrowed orifice of the gut suddenly becoming blocked with faeces, often caused by the administration of a purge; (2) kinking or volvulus of the stenosed gut; (3) intussusception usually associated with an annular carcinoma; (4) congestion of the mucous membrane near a stricture, owing to inflammatory changes.

CLINICAL FEATURES.—In many cases the patient has suffered from the usual characteristic symptoms of chronic obstruction (see p. 700), and then, more or less suddenly, acute symptoms supervene. In other cases, especially when the chronic obstruction is due to malignant disease of the colon, an acute attack of obstruction may be the first indication that serious disease is present. On careful inquiry, the patient may give a history of nothing more serious than dyspepsia, constipation, and some vomiting.

TREATMENT.—If the condition of acute on chronic obstruction is diagnosed, the careful administration of one or two enemata may relieve the acute symptoms, and the case passes back to one of chronic obstruction, which should then receive appropriate treatment. However, should the acute symptoms not promptly yield to treatment, no further time must be wasted before opening the abdomen and draining the intestine above the seat of obstruction. No attempt should be made to perform a resection of the gut until the intestines have been well emptied. It will often happen that the chronic obstruction will be undiagnosed until the abdomen is opened, but this is of little immediate importance, as laparotomy and drainage of the intestine is the correct treatment.

If the cause of the chronic obstruction is carcinoma of the large bowel, a careful examination should be made of the liver, peritoneum, growth and glands, with a view to removal later. If it is decided that removal is possible, with restoration of the continuity of the bowel, the artificial anus should be so placed that it will not seriously interfere with the second operation. For example, with a removable carcinoma of the descending colon, a right lumbar colotomy is used for drainage of the intestine, as the opening is situated far away from the

position of the second operation for removal of the growth. After continuity of the bowel has been established, it frequently closes spontaneously.

9. **Ileus Paralyticus.**—By this term is understood a condition of acute intestinal obstruction due to paralysis of the intestinal muscle, but in which there is no mechanical obstruction.

The causes are—

- (1) Injury to the intestine from: Blows on the abdomen; strangulation of a piece of gut in a hernia and its reduction by taxis; or during the course of an operation. After every abdominal operation in which the intestine has been exposed and handled, a certain degree of ileus paralyticus follows. The abdomen is distended, and the patient complains of abdominal pain, which is only relieved by the passage of flatus. The condition, however, may be so extreme as to cause the patient's death.
- (2) Acute inflammation of the peritoneum over the intestines. After acute peritonitis has been present for some little time, the intestines become distended with gas, and it may be difficult or impossible to secure an action of the bowels with enemata or purgatives. This condition of ileus paralyticus, secondary to inflammation of the peritoneum, accounts for the great difficulty in some cases of distinguishing between acute peritonitis and mechanical obstruction of the intestines. This form of ileus is perhaps most definitely seen in post-operative peritonitis.
- (3) Thrombosis of the mesenteric arteries and veins. This condition, which has already been described on p. 633, leads to paralysis of the intestine and a condition of ileus paralyticus. The symptoms are those of acute intestinal obstruction.
- (4) Overuse of purgatives. The administration of drastic purgatives may, after a preliminary purging, lead to a paralysis of the intestinal muscle and a condition of intestinal obstruction. In a case seen by the author severe purgation as a remedy for cerebral concussion was followed by such marked abdominal distension that the patient had to be propped up in bed, and no flatus was passed for forty-eight hours.

TREATMENT.—The treatment of this condition varies with the cause. After injury or operation the patient should be treated by rest, and in severe cases purgatives should be avoided; but in mild cases a turpentine enema and the administration of small doses of strychnine is often beneficial. Grain doses of calomel every two hours until the bowels act are also recommended. If the ileus is extreme, the abdomen may be opened and an artificial anus established in a piece of the distended intestine, but this is rarely followed by recovery.

If the condition is due to peritonitis, the treatment is laparotomy

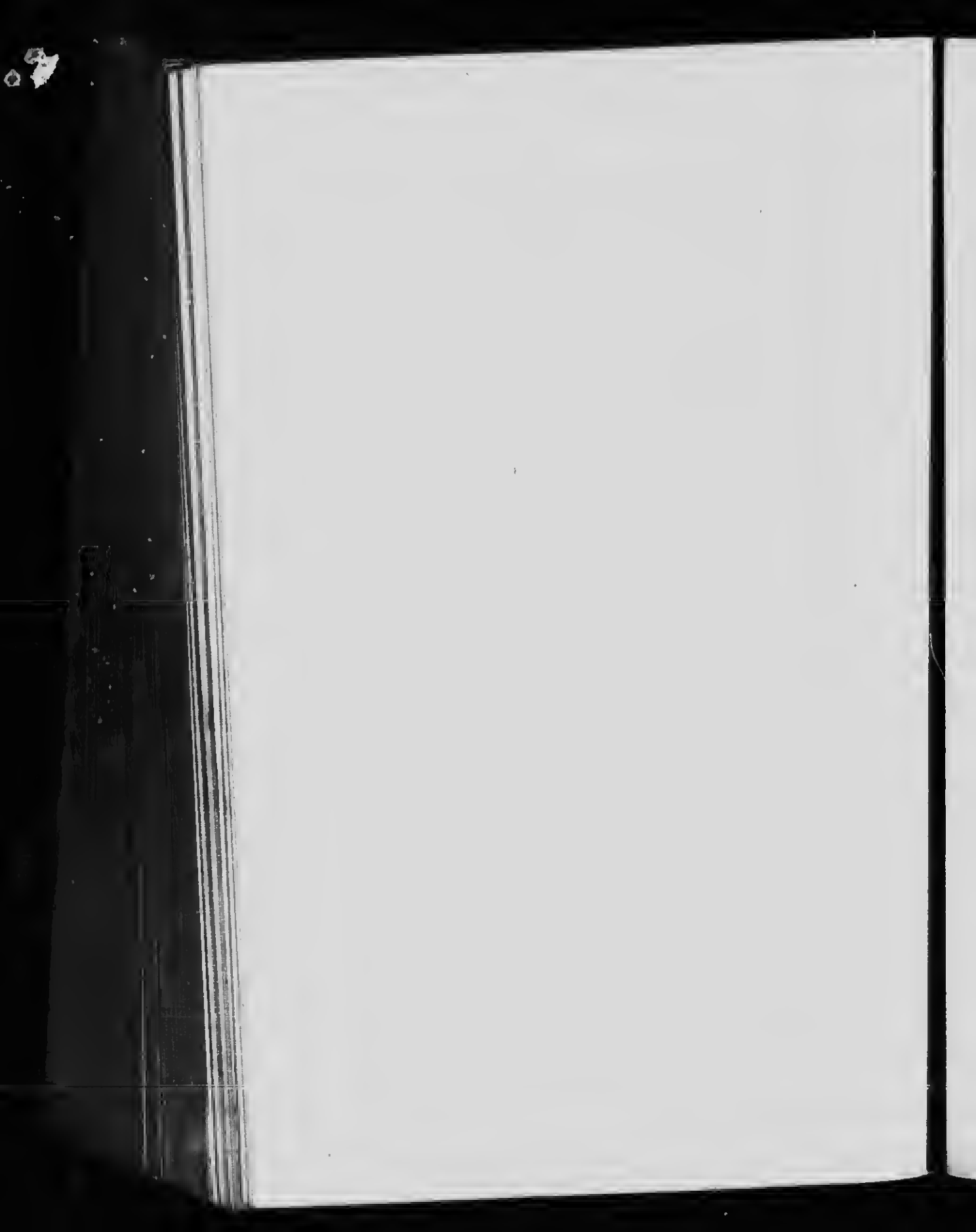
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Mr. Hart
St. Michael's Hosp
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PLATE IV.



Gangrene of the small Intestine and Mesentery due to thrombosis of the superior Mesenteric vein. The symptoms were those of acute intestinal obstruction.

(London Hospital Medical College Museum.)



and drainage of the peritoneal cavity; but with post-operative peritonitis, treatment is seldom successful.

Thrombosis of the mesenteric artery or vein is treated by laparotomy and resection of the affected intestine if possible; but as a rule such a large area of gut is affected that nothing can be done, and the abdomen is closed.

Ileus paralyticus due to overpurgation is treated by leaving the gut to recover its tone, but with extreme distension the abdomen may be opened and the gut punctured to let out the gas.

Entero-Spasm.—In this condition the patient exhibits all the symptoms of acute intestinal obstruction, but on operation, no mechanical obstruction is found. It is believed to be due to spasmodic contraction of the circular fibres of the intestinal wall.

CLINICAL FEATURES.—The condition is met with in neurotic men and women, and the part of the intestine most frequently in spasm is the pelvic colon. There is frequently a history of chronic colitis. The attacks of obstruction occur without obvious cause, and the symptoms usually closely resemble a case of chronic obstruction with subacute attacks. The patient complains of constipation, with sudden sharp attacks of pain, with vomiting and abdominal distension. As a rule the attacks only last a few hours, but in a case under the author the symptoms lasted for four days, and the vomiting became faeculent. An exploratory operation was performed, and beyond firm contraction of some coils of small intestine nothing abnormal was found. The patient made an uninterrupted recovery.

Occasionally, on examination of the abdomen before operation, the contracted colon may be felt.

TREATMENT.—If entero-spasm is diagnosed, it should be treated by doses of belladonna, hyoscyamus, or morphia; but if there is the least doubt that the patient has organic obstruction, it is safer to perform laparotomy, as entero-spasm causing severe symptoms of obstruction is rare. In some cases cause for the spasm exists in ulceration of the mucous membrane.

Chronic Intestinal Obstruction

The causes of chronic intestinal obstruction are—

1. Causes in the lumen of the gut—*i.e.*, impaction of faeces or foreign bodies.
2. Causes in the wall of the gut. The most important of these causes are stricture due to carcinoma, or simple stricture following ulceration and congenital stenosis of the intestine.
3. Causes outside the intestine—*i.e.*, pressure on the bowel from tumours of the uterus, ovaries, omentum, kidney, etc.—or constriction of the gut due to adhesions.

PATHOLOGICAL ANATOMY.—The lumen of the gut behind the stricture becomes dilated, and the muscular coat hypertrophied, so that the gut wall is much thicker than normal. Immediately above the ob-

struction the mucous membrane is inflamed owing to the irritation of the retained faeces, and this inflammation may result in ulceration of the intestine. As a consequence, a mucous discharge, which is sometimes blood-stained, mixed with faecal matter, is constantly passing through the stricture; and if this is near the anus, the discharge is evacuated frequently, and the patient complains of "diarrhoea," although he is really constipated. The ulceration of the intestine may finally lead to perforation and peritonitis. This generally occurs just above the obstruction. In stricture of the large gut ulceration and perforation of the caecum are common, as the faeces tend to collect in this cul-de-sac.



FIG. 315.—CARCINOMA OF THE COLON OBSTRUCTING THE LUMEN OF THE GUT.

CLINICAL FEATURES.—In the early stages of chronic obstruction the patient will complain of attacks of colicky pain in the abdomen,

especially after meals, and a sense of fulness, which he ascribes to indigestion. There is increasing constipation, which at first yields to aperients, but steadily becomes more obstinate. This constipation may be alternated with "spurious diarrhoea" if the obstruction is in the large intestine. Later, there are attacks of abdominal distension with vomiting, due to subacute attacks of obstruction. Pain may be complained of at the site of obstruction, but general abdominal discomfort is more common.

On examination, the abdomen is found to be distended, and the hypertrophied moving coils of small intestine may mark patterns on the abdominal wall (ladder patterns). Distension of the transverse colon and the caecum may be evident in cases of large gut obstruction, but peristaltic waves are not seen passing over them. Visible peristalsis does not necessarily mean intestinal obstruction, for it may be seen in patients—usually women—whose abdominal walls are atrophied from stretching. The hypertrophied coils of intestine and the waves of peristalsis may be felt, and the abdomen is hyper-resonant on percussion. A *tumour* may be felt in some part of the abdomen, or on rectal or vaginal examination. The passage of the faeces may be traced through the intestines by giving a bismuth meal, and taking a series of X-ray photographs, but this method of diagnosis of chronic obstruction is open to many fallacies. Cases of obstruction due to carcinoma or simple stricture of the lower end of the colon that cannot be reached by the finger may be diagnosed by use of the sigmoidoscope.

If the condition of intestinal obstruction is left unrelieved, the patient begins to lose weight, the complexion becomes sallow, the breath offensive, the tongue furred, and the elasticity of the skin is lost. These symptoms are due to auto-intoxication from the absorption of poisonous products from the alimentary canal, and are present in simple as well as in malignant stricture. Death usually occurs from an acute attack of obstruction, or from perforation of the intestine and peritonitis.

TREATMENT—1. *Suspected Cases.*—As soon as the condition of chronic intestinal obstruction is suspected, every effort should be made to ascertain the cause, and if this cannot be diagnosed by any other means, exploratory laparotomy should be advised. It is only by early diagnosis that radical cure of malignant growth of the intestine can be obtained, and in cases of simple obstruction the earlier the condition is recognized and treated, the better is the immediate prognosis and the hope of permanent relief.

2. *Chronic Obstruction of which the Cause is Recognized.*—These cases fall into two groups: (1) Cause is considered removable; and (2) cause is irremovable.

In the first group of cases, which includes such different conditions as fibroids of the uterus and carcinoma of the rectum, the cause should at once be removed by operation in the hope of obtaining permanent cure, with or without the establishment of an artificial anus.

The treatment of the second class of case depends on several factors, but the following are the methods available:

1. The patient may be carefully dieted, and the bowels kept open by aperients and enemata until the obstruction is becoming complete, and then an artificial anus is made above the obstruction. The operation must not be delayed too long.
2. An artificial anus may be made as soon as the presence of chronic obstruction is diagnosed, in order to rid the patient of pain and discomfort; and in the case of ulceration of the intestines, simple or malignant, in order to lessen the amount of discharge and the rapidity of ulceration.
3. A lateral anastomosis can be made between two pieces of intestine—one above and one below the obstruction—so that the feces have no longer to pass through the narrowed piece of gut. This operation is termed "short-circuiting," and is especially valuable in cases of inoperable carcinoma and dense adhesions.

If an acute attack of intestinal obstruction supervenes on chronic obstruction, enemata should be given to relieve the acute symptoms. If this treatment is not quickly successful, however, the abdomen must be opened and the intestines drained above the obstruction (see also p. 690).

DISEASES OF THE APPENDIX

Appendicitis

The CAUSE of inflammation of the appendix is infection with micro-organisms, the most common being the staphylococcus, streptococcus, *Bacillus coli communis*, tubercle bacillus, and actinomyces. The predisposing causes, as far as they can be ascertained, are—

1. *Congenital Malformations*.—The appendix may be abnormally long or situated in an abnormal position, as in these cases in which



FIG. 316.—DIAGRAM OF CÆCUM AND APPENDIX.

the cæcum does not descend into the right iliac fossa, but remains under the liver. The appendix may also be twisted on itself.

2. *Acquired Abnormalities*

—The appendix may be involved in adhesions due to previous inflammation of the organ or to inflammation of surrounding structures, such as the Fallopian tubes. The adhesions cause kinking of the appendix, interference with its blood-supply, and constrict its lumen. In cases due to previous inflammation of the appendix itself, stricture of the mucous membrane is common, and leads to distension of the part beyond the stricture, thus predisposing to subsequent

attacks of inflammation. Kinking and adhesions round the appendix are also associated with visceroptosis and the development of extra-peritoneal bands in an attempt to fix the viscera in position.

3. *Inflammation of Surrounding Organs*.—Inflammation of the cæcum and colon may extend to the appendix, and a chronic inflammation of the appendix may be the cause of colitis. Inflammation of the Fallopian tubes and ovaries may also extend to the appendix.

4. *Foreign Bodies*, including intestinal worms, are frequently found in inflamed appendices, the foreign bodies comprising pins, tacks, grape-stones, orange-pips, etc.; but the presence of foreign bodies cannot be regarded as a common predisposing cause.

5. *Constipation*, leading to accumulation of faecal matter in the appendix, certainly predisposes to attacks of inflammation; but on the other hand, a chronic appendicitis may be a cause of constipation.

There can be no doubt that the number of cases of appendicitis has largely increased in the last ten or twenty years, but the cause of the

increase is obscure. It has been put down to various causes, such as—
 (1) The increase of meat-eating, especially of imported frozen meat;
 (2) the increase of dental caries and the want of proper mastication of the food; (3) the extended use of "white" in place of the wholemeal bread, and



FIG. 317.—CECUM LAID OPEN, SHOWING A WORM (*Ascaris lumbricoides*) IN THE APPENDIX.
 (London Hospital Medical College Museum.)



FIG. 318.—APPENDIX PERFORATED BY A PIN.

(5) the sedentary life led by town-dwellers, and the increase of visceroptosis and chronic constipation. None of these conditions, however, have been definitely proved to be the cause of the great increase in this disease.

CLINICAL FEATURES.—Appendicitis may occur at any age, but is most common in young adults between the ages of eighteen and thirty. It is more common in men than in women, and in town-dwellers than in those who live in the country.

The onset of the disease is usually abrupt. There is sudden pain in the abdomen, at first referred to the umbilicus, and afterwards localized in the right iliac fossa. Vomiting is generally present, and the patient is constipated. If the appendix is in the pelvis, diarrhœa may be a symptom. The abdomen is rigid, especially in the lower right quadrant, and the patient tends to lie with the right hip flexed. There is a rise of temperature and pulse-rate, and the tongue is furred and dry. For the sake of further clinical description, the following varieties of appendicitis and their treatment are considered:

Acute Appendicitis with General Peritonitis.—The symptoms and physical signs of this condition have already been considered under Acute Infective General Peritonitis (p. 616), and the diagnosis that this condition depends on acute appendicitis is suggested for the following reasons:

(1) The absence of any cause, as ruptured gastric or duodenal ulcer, or evidence of inflammation of the Fallopian tubes; (2) the history of previous attacks of appendicitis; (3) the pain and rigidity are most marked in the right iliac fossa; and (4) appendicitis is by far the most common cause of acute onset of general peritonitis. These acute cases are more common in children than adults, and the prognosis is very grave.

CONDITION OF THE APPENDIX.—In these cases the appendix is usually found to be gangrenous at one place where perforation has occurred, or the whole of the organ may be represented by a greyish-black, slimy, evil-smelling tube. An enterolith is frequently present, lying loose in the peritoneal cavity, having perforated the appendix on the mesenteric border close to the root of the appendix. In other cases there is evidence that the appendix has been full of pus, which has burst through a part that has become gangrenous.

PROGRESS OF THE DISEASE.—The symptoms of acute general peritonitis progress rapidly, and death occurs in from two to four days.

TREATMENT.—As soon as the condition is diagnosed the patient should be placed in the Fowler position, thus causing the pus to drain into the pelvis, and preparations must be made for immediate operation. As the diagnosis of the cause of the general peritonitis is often uncertain, an incision is often made in the middle line of the abdomen; but it is better to make an incision at the outer border of the right rectus, as through this incision the appendix is easily reached. If the diagnosis is wrong, an inflamed right tube or gall-bladder, a gangrenous Meckel's diverticulum, or other cause of general peritonitis, can readily be dealt with by enlarging the incision. The incision need not be more than 2 inches in length, and the appendix is rapidly found, brought into the wound, ligatured and removed. The stump may be sequestered, but this is not absolutely necessary, and should not be done if difficult. A large drainage-tube, with a gauze wick down the centre, is inserted into Douglas's pouch, and the patient placed in the Fowler position. Quickness in operating is essential, and the intestines should be disturbed as little as possible.

There is very seldom any occasion to make more than one incision through the abdominal wall, and multiple drainage is unnecessary. The after-treatment is given on p. 620.

The **PROGNOSIS** in these cases has considerably improved during the last few years, and with early operation the majority of cases recover.

Acute Appendicitis.—The symptoms are those already given above, and vary from those of general peritonitis in degree only. The pain, tenderness, and rigidity, are all well marked in the right iliac fossa, and after twenty-four hours an inflammatory lump can usually be felt. On rectal examination, a well-marked, tender swelling can generally be felt high up on the right side.

CONDITION OF THE APPENDIX.—The appendix may be gangrenous or perforated, but the inflammation is often localized by the inflamed omentum wrapping round the appendix. In other cases the situation

of the appendix behind the caecum or in the pelvic points the inflammation, the walls of the intestine shutting in the inflammatory exudate.

If the case is operated upon early, the appendix may be rigid and congested, and on incising it, the mucous membrane is found to be acutely inflamed or gangrenous, and the lumen distended with pus, while in other cases the appendix is simply a pus sac.

TREATMENT.—The treatment of this condition varies with different surgeons, and the following methods each have their advocates:

1. Appendicectomy should be performed as soon as possible. The appendix should be removed and the stump invaginated. If perforation has not occurred, the abdomen should be closed completely, but in other cases drainage of the appendix area or of Douglas's pouch should be carried out.

2. Appendicectomy should be performed as above if the diagnosis is made within twenty-four or thirty-six hours of the onset of the illness. If it is made later, the patient should be treated medically, until the inflammation passes off or an abscess forms.

3. The patient should be put to bed in the Fowler position, treated medically, and carefully watched. If the symptoms progress, appendicectomy should be performed, but if they subside, medical treatment should be continued. The chief symptom to watch is the pulse-rate. Medical treatment consists of rest in bed in the Fowler position, with a minimum of diet in a fluid form. No aperient or enema should be given during the acute symptoms. Fomentations may be applied in the right iliac fossa for the relief of pain. The use of morphia in acute peritonitis is given on p. 619.

The author is strongly in favour of the first method of treatment, as it is impossible to foretell the course of an acute appendicitis, and the condition of the appendix can only be ascertained on opening the abdomen. The operation in skilled hands has a low mortality.

Appendicitis terminating in Abscess Formation.—The onset of the illness is usually acute, and the symptoms are those already described in Acute Appendicitis. After three or four days, the acute symptoms subside as the pus becomes localized, and an abscess cavity is formed by the matting together of the surrounding intestines. The general symptoms then change to those of a chronic toxæmia, with evening rise of temperature, sweating, anæmia, and loss of appetite. The local symptoms are those of a tender swelling in the abdomen over the site of the appendix, which is at first deep-seated, but gradually approaches the surface. The outline of the abscess is somewhat indefinite, unless it becomes very chronic, and then it may be difficult to differentiate from malignant disease. Fluctuation can only be appreciated when a very large quantity of pus is present. At first the swelling is resonant on percussion, as the intestines lie in front of it, but as the pus increases in amount, it becomes dull as a rule, unless gas forms in the cavity, when it will remain resonant. If the abscess forms in the pelvis, it may be felt on rectal examination lying in front of the rectum between it and the bladder or uterus; but as the abscess

increases in size, it may be felt rising above the symphysis pubis, and may simulate a distended bladder. The general symptoms are usually slight when a pelvic abscess is present (see p. 622). The situation of the abscess depends largely on the original position of the appendix, and the following are the most common sites: (1) In the right iliac fossa, lying on the iliacus muscle. (2) Behind the cæcum, passing up into the right kidney area and behind the liver. (3) In the pelvis, between the rectum and bladder or uterus, the roof



FIG. 319.—DIAGRAM SHOWING METHOD OF FORMATION OF A PELVIC AND LEFT-SIDED ABSCESS IN A CASE OF SUPPURATING APPENDICITIS.

of the abscess being formed by coils of small intestines and omentum matted together by adhesions and inflammatory lymph. (4) Towards the middle line of the abdomen, the walls of the abscess being formed by the mesentery and coils of small intestines. This is the most dangerous situation. (5) Very occasionally on the left side of the abdomen. (6) Extraperitoneal. Although the appendix is surrounded by peritoneum, it may form adhesions to the parietal peritoneum, and an abscess be formed extraperitoneally, or an intraperitoneal abscess may burrow in the extraperitoneal tissue. The most common of these extraperitoneal abscesses are—(a) In the iliac muscle, in which the pus may pass below Poupart's ligament; (b) in the perinephritic fat pointing in the lumbar region; (c) in the pelvi-rectal fascia, finally pointing in the ischio-rectal fossa; and (d) the gluteal region, the pus having burrowed through the sacro-sciatic foramen.

Localized abscesses in the peritoneal cavity are further described on p. 622.

TERMINATIONS.—Small abscesses may be absorbed, but after an abscess is large enough to be diagnosed clinically, it generally continues to enlarge until it reaches a free surface. The abscess may burst externally through the skin, which first becomes red and oedematous, or in the bowel—usually the rectum—the pus being discharged *per anum* or into the vagina. Very occasionally it may burst in the bladder, causing cystitis, or in the general peritoneal cavity, causing general peritonitis. The last accident is mostly brought about by the injudicious administration of an aperient or an enema. Appendix abscesses which burst into the rectum usually do well, but if they burst in the vagina, a fistula frequently results.

TREATMENT.—A localized abscess following appendicitis must be opened and drained, although this operation is attended with considerable risk of causing a general peritonitis. The incision should be made over the most prominent part of the swelling, and the peritoneum very carefully excised, as the gut may be adherent to the abdominal wall. If the abscess is adherent to the abdominal wall, the abscess cavity has merely to be opened, and a drain inserted; but in many cases the abdominal cavity has first to be opened. The pus may be prevented from spreading to the general peritoneal cavity by packing off the abscess cavity with gauze before it is opened. It is better, however, to trust to careful opening of the abscess with the finger, without disturbing the surrounding parts, and quickly swabbing away the pus as it exudes. The appendix should be removed if the operation is easy and there is no need to invaginate the stump; but if the appendix is buried in the wall of the abscess cavity, it is better to leave it for a future operation. After the abscess has been emptied of pus, a drainage-tube should be inserted.

Pelvic abscesses may be opened through the posterior wall of the vagina, but the abdominal route is the better.

PROGRESS OF THE CASE.—If general peritonitis does not supervene—and it seldom does—the abscess cavity will close in about three to six weeks. After the first few days a faecal fistula may form, but it will usually close again within a week, though sometimes it persists. In other cases, instead of healing, a small sinus leading down to the appendix or to a faecal concretion loose in the peritoneal cavity may follow.

REMOVAL OF THE APPENDIX AFTER OPENING AN ABSCESS.—If the appendix has not been removed, and the abscess cavity has closed, it is advisable for the patient to have the appendix removed after his convalescence. If this is not done, he is liable to subsequent attacks, or he may suffer from chronic appendicitis. If a fistula persists, there should be no hurry to close it, but between six weeks and three months the remains of the appendix should be removed and the stump invaginated. The fistula will then usually close. Faecal fistula is described on p. 710.

Subacute Appendicitis.—The symptoms are similar to those of an acute appendicitis, only much milder, and the attack may not last longer than twenty-four or forty-eight hours. The condition is often diagnosed as a bilious attack or an attack of acute indigestion, and the patient may suffer frequently from these attacks without consulting a doctor.

CONDITION OF THE APPENDIX.—The appendix is inflamed and congested, and there is a little sero-purulent fluid in the abdomen near the appendix. On slitting up the appendix, the mucous membrane is found to be inflamed, and faeces are usually found in the lumen. Evidence of old inflammation, as peritoneal adhesions or a stricture in the appendix, may be present. This form of appendicitis is often spoken of as **catarrhal appendicitis**, but in every case in which symptoms are present the peritoneum covering the appendix is inflamed.

TREATMENT.—One of two courses of treatment may be advised—(1) The patient may be treated medically until all the symptoms have disappeared, and in the course of the next fortnight appendicectomy is performed; and (2) the appendix may be removed during the course of the attack. The advantage of the second method is that the illness is shortened, and it is difficult to say in the first twenty-four hours of an attack of appendicitis how the case will progress. Removal of the appendix removes all anxiety, as the prognosis is excellent.

Recurrent Appendicitis.—By this term is understood a condition in which there is a series of subacute attacks of appendicitis, with complete freedom from symptoms between the attacks. The interval between the attacks may be weeks or months.

TREATMENT.—The appendix should be removed in one of these intervals. Interim appendicectomy has practically no mortality, and complications of any kind are rare. The incision should either be made at the outer edge of the right rectus (Battle's incision), and the abdomen opened behind that muscle after it has been displaced, or in the right iliac fossa and the muscular layers split in the direction of their fibres (gridiron incision). The caecum should be brought out of the wound, and any adhesions round the appendix divided. A ligature is then placed on the appendicular artery as it lies in the free border of the mesappendix, so as to control all the hemorrhage. The mesappendix is then divided. A purse-string suture is placed round the base of the appendix in the caecum, the appendix crushed near the root and removed. The stump of the appendix is then pushed into the caecum and the purse-string suture tightened. The abdominal wall is closed in layers. There is rarely any need for the incision to exceed $1\frac{1}{2}$ inches, and the patient may be allowed up at the end of the first week.

Chronic Appendicitis.—Chronic appendicitis, apart from tubercle and actinomycosis, is usually the sequel to an acute attack, though it may occur as a chronic condition from the first. The symptoms may be referred to the appendix region or be quite anomalous.

(1) In the first case there is constant pain or discomfort in the right iliac fossa, usually increased by eating or by the use of aperients and enemata during attacks of constipation, and sometimes also by exertion. On examination, there is tenderness in the right iliac fossa, and a lump may often be felt. The lump may be so hard and definite that a clinical diagnosis cannot be made between it and carcinoma of the caecum and appendix, and the condition present is only decided on exploratory incision. In other cases no lump can be felt, but there is muscular resistance to deep palpation.

(2) In the second group of cases the symptoms may not be referred to the appendix. (a) The patient may complain of general abdominal discomfort, constipation, and lowering of the general health. Attacks of acute pain may occur, which simulate gall-stone colic or Diotl's crises in movable kidney. The attacks of pain have been termed *appendicular colic*, and are believed to be due to spasms of the muscle of the appendix during attempts to remove mucus or a

faecal concretion. (b) The symptoms may closely simulate those of gastric or duodenal ulcer, the pain being entirely epigastric. A test meal may reveal hyperacidity of the gastric contents, the patient having chronic dyspepsia. In all cases of operation for gastric or duodenal ulcer, if no external evidence is discovered of the ulcer, the appendix should be examined, and if inflamed or adherent, should be removed. Gastro-jejunostomy should *not* be performed, and in many cases all the symptoms of ulcer will disappear. The two conditions may, however, be combined. (c) The symptoms may be those of a mild mucous colitis, and will disappear after removal of the appendix. (d) Some cases of coli cystitis appear to depend upon a chronically inflamed appendix, and cure may follow removal of the appendix when urinary antiseptics and vaccines have failed.

CONDITION OF THE APPENDIX.—The appendix is usually found bound down by adhesions to the abdominal walls, the intestines, the bladder, ovary, or Fallopian tube. It may be buried in the posterior wall of the caecum, or lie in the pelvis, or be adherent to the iliac vessels. The formation of adhesions often leads to kinking of the tube, which may be completely doubled back on itself. The mucous membrane may show a stricture or strictures, and the lumen is frequently quite obliterated at the terminal portion. In some cases the whole appendix is small and sclerosed—a condition which has been termed "sclerosing or obliterating appendicitis," and which ultimately will lead to cure.



FIG. 320.—SECTION OF AN APPENDIX DISTENDED WITH MUCUS.
(London Hospital Medical College Museum.)



FIG. 321.—A LARGE FÆCAL CONCRETION IN AN APPENDIX.
(London Hospital Medical College Museum.)

TREATMENT.—The appendix should be separated from the surrounding structures and removed. When there are dense adhesions, this may be a long and tedious task, and there is some danger of wounding the caecum. The results of operation are usually most satisfactory.

Complications of Appendicitis—1. *Enteroliths (Appendicular Concretions)*.—Calculi composed of lime salts, faecal debris, mucus, and bacteria, may be found in the appendix in any variety of appendicitis. They may be multiple, and are oval or rounded bodies, brownish-

yellow in colour, easily crushed in the fingers. Very occasionally they contain a definite foreign body. These calculi are due to a chronic inflammation of the mucous membrane of the appendix, causing a morbid secretion, and, when present, tend to keep up the chronic inflammation, and prevent the escape of the secretions of the appendix into the cæcum. In cases of acute gangrene of the appendix the wall of the appendix frequently gives way over a concretion, which may become loose in the peritoneal cavity. It is possible that attempts to get rid of a concretion cause appendicular colic.

2. *Fæcal Fistula*.—A fæcal fistula may form after an appendix abscess has been opened or the appendix removed during an acute attack. Two varieties may be distinguished. In the first group of cases, when the appendix has been ligatured, but not invaginated, the fæcal discharge occurs through the stump. The discharge usually ceases in four to five days. In the second group of cases the wall of the cæcum has either sloughed or been injured during operation. Both conditions occur mostly when an abscess has formed. A fæcal fistula due to loss of part of the cæcal wall may be permanent, and need operative treatment; but there is no need to operate early, as the fistula may close spontaneously. It may, however, be assumed that a *fæcal fistula that has not closed in six months is permanent*, and a plastic operation must be undertaken to remedy the defect. These operations are difficult, and even when carefully carried out, may result in failure.

3. *Ventral Hernia*.—A ventral hernia after an interim appendicectomy is rare, but if suppuration has occurred, necessitating the drainage of the appendix wound, ventral hernia is common. It is especially common if extensive suppuration has followed in the abdominal wall.

TREATMENT.—The prophylactic treatment consists of wearing an abdominal belt, and this should be done in all cases in which the abdomen has been drained.

Radical cure for these herniæ is satisfactory, but the operation must be carefully performed. All the scar tissue should be cut away, the various layers of the abdominal wall separated from one another, and then each layer carefully sutured.

4. *Subdiaphragmatic Abscess*.—This complication is most common in connection with pus formation round the appendix, but in some cases the appendicitis is quite overlooked, and the formation of a diaphragmatic abscess may appear to be a primary lesion. The clinical features are described on p. 623.

5. *Portal Pyæmia*.—Portal pyæmia following appendicitis is usually fatal, but in a few cases a localized abscess may form, which can be opened and drained.

6. *Intestinal Obstruction*.—Acute intestinal obstruction may develop within a few days of opening an appendix abscess or operating upon an acute appendicitis, owing to the formation of adhesions. These adhesions are slight, and the condition can readily be relieved by operation. Any time after an attack of appendicitis, with or with-

out operation, acute or chronic intestinal obstruction may occur from occlusion of the gut by adhesions or inflammatory bands. These complications are not common, however, considering the prevalence of appendicitis.

7. *Inflammation in Other Organs*, as the bladder, ovaries, and tubes, may occur from direct extension, or a large bloodvessel, as the common iliac, may be opened in cases of appendicular abscess, causing fatal hæmorrhage.

Tuberculosis of the Appendix.—Primary tuberculosis of the appendix is a rare condition, but this organ may be involved in tuberculosis of the cæcum and tuberculous peritonitis. The bacillus reaches the appendix in the majority of cases through the alimentary canal, and most frequently attacks the base of the appendix and the surrounding portion of the cæcum. Secondary infection with the colon bacillus always occurs.

CLINICAL FEATURES.—The disease may be subacute or chronic. The subacute variety differs in no way from subacute appendicitis due to other organisms, and is only to be diagnosed on careful examination after removal. The chronic variety is the more common. There is pain and tenderness in the right iliac fossa, and the gradual formation of a swelling which has the characters of a chronic intra-abdominal abscess. Diarrhœa is often present. The abscess may burrow in the usual way into the iliac muscle or into the retrocæcal tissue, or it may burst into the cæcum, rectum, or bladder. Secondary infection of the ovaries and tubes may occur.

TREATMENT.—The appendix with a part of the cæcum should be removed as soon as the condition is diagnosed. A chronic abscess should be opened and drained in the usual way.

The **PROGNOSIS** is bad, as a fistula which will not close usually results.

Actinomycosis.—Actinomycosis of the appendix and cæcum cannot be distinguished clinically from other forms of chronic suppuration in the right iliac fossa. The diagnosis can only be made by cutting sections of the appendix after removal or by finding the streptothrix in the escaping pus if sinus formation occurs.

The treatment is thorough removal, and scraping the walls of the abscess cavity or sinuses if these are present. Large doses of iodide of potassium should be given. The prognosis is bad, the pus generally burrowing in all directions, and death from chronic toxæmia taking place after some months.

NEW GROWTHS OF THE APPENDIX

Innocent

Innocent tumours of the appendix are so rare as to be pathological curiosities.

Malignant

Sarcoma is much more common and more fatal than carcinoma. The symptoms are those of a mild appendicitis, and infection always occurs.

Carcinoma of the appendix is rare, and the condition is always diagnosed as chronic appendicitis. Even after removal the true pathological condition may be missed unless a routine microscopic examination is made. The growth is a columnar-celled carcinoma occurring most frequently in the terminal part of the appendix, and it is always associated with infective inflammation.

The clinical features are those of a chronic appendicitis, and the treatment is removal with a portion of the cæcum. The prognosis is not good, as local and general recurrence is common.

Endothelioma of the appendix has also been described.

MECKEL'S DIVERTICULUM

Meckel's diverticulum, the remains of the omphalo-mesenteric or vitelline duct, is situated on the small intestine within 3 feet of the ileo-cæcal valve. It is present in about 2 per cent. of subjects, and presents several anatomical varieties:



FIG. 322.—MECKEL'S DIVERTICULUM.
(London Hospital Medical College
Museum.)

1. A complete tube passing from the intestine to the umbilicus, and causing a congenital faecal fistula (see p. 615).
2. A blind pouch projecting from the intestine—the commonest variety.
3. A fibrous cord running from the intestine to the umbilicus.
4. A fibrous cord ending freely or attached to the root of the mesentery.

In the majority of cases Meckel's diverticulum is discovered on post-mortem examination, but it may be associated with the following pathological conditions:

1. **Acute Intestinal Obstruction**, the diverticulum causing strangulation of a loop of the small intestine (see p. 690).
2. **Torsion of the Diverticulum**, followed by gangrene.
3. **Intussusception**, the diverticulum being the starting-point of the invagination.
4. **Acute Inflammation (Acute Diverticulitis)**.—The causes and symptoms of this condition are the same as those of acute appendicitis, from which it can rarely be diagnosed before operation. Inflammation

mation of the diverticulum is suggested if, with the sudden onset of diffuse or localized peritonitis, the rigidity and tenderness are more marked near the middle line in the lower abdomen than in the right iliac fossa.

The results of acute diverticulitis are—Gangrene of the diverticulum, with perforation and general peritonitis; a localized intraperitoneal abscess; distension of the diverticulum with pus.

TREATMENT.—The abdomen should be opened, the diverticulum removed, and the stump invaginated in a similar manner to that used in treating acute appendicitis. The peritoneal cavity should be drained if necessary.

5. Chronic Inflammation (Chronic Diverticulitis).—The causes, symptoms, and treatment of this condition are precisely similar to those of chronic appendicitis. It cannot be diagnosed from appendicitis before operation. Enteroliths may form in the diverticulum, as in the appendix.

6. Cysts due to retention of Secretion, Tuberculosis, Typhoid Ulceration, and New Growths, may all occur in the diverticulum, but are very rare.

7. Congenital Abnormalities, such as fistulæ or papillomatous growths at the umbilicus, have been considered on p. 615

CHAPTER XXI

HERNIA

THE term "hernia," when used by itself, indicates a protrusion of the abdominal contents through a weak place in the abdominal wall. Protrusion of tissue in other parts of the body through its normal covering is termed "cerebral hernia," "hernia of the testis," etc.

CAUSES.—The causes of hernia are—(1) A weak condition of the abdominal wall, congenital or acquired; and (2) increase of intra-abdominal pressure.

CONGENITAL WEAKNESS OF THE ABDOMINAL WALLS.—There are several places where the abdominal wall tends to be congenitally weak. They are—

1. The inguinal region, where the spermatic cord in the male and the round ligament in the female traverse the abdominal wall, passing through the internal abdominal ring, the inguinal canal, and the external abdominal ring. The weakness of the abdominal walls in this situation is often accentuated by the persistence after birth of the whole or part of the process of the peritoneal cavity, which is normally found passing out through the rings in the foetus. This process in the male is known as the "processus vaginalis" or the "funicular process," and in the female as the "canal of Nuck."

2. The femoral ring lying on the inner side of the femoral vein, which is normally closed by a little loose cellular tissue and fat, the septum crurale, and which gives passage to lymphatic vessels.

3. The umbilicus, where the abdominal wall may be congenitally deficient.

4. The diaphragm, one of the constituent parts of which may be congenitally absent.

5. The linea alba, in which small congenital openings may be found.

6. In the lumbar region, where a gap occurs between the attachments of the latissimus dorsi and the external oblique to the crest of the ilium, the so-called "triangle of Petit."

ACQUIRED WEAKNESS.—The most common cause of acquired weakness of the abdominal walls is the scar tissue formed after an operation on the abdominal contents, especially if the wound has had to be drained or suppuration has occurred. Other causes are—

(1) Penetrating wounds of the abdomen, or rupture of the abdominal walls; (2) stretching and weakness of the abdominal muscles following pregnancy, or the presence of large tumours; (3) flabbiness of the abdominal muscles from deficient exercise or old age.

THE CAUSES OF INCREASED INTRA-ABDOMINAL PRESSURE ARE—

1. Difficulty of micturition associated with straining due to phimosis, stricture of the urethra, or enlarged prostate.
2. Difficulty of defæcation, with straining due to chronic constipation, stricture of the rectum, either simple or malignant, or the presence of polypi in the rectum.
3. Chronic cough from such causes as chronic bronchitis, bronchiectasis, or asthma.
4. Obesity, with increase of intra-abdominal fat.
5. The presence of tumours in the abdomen, such as the pregnant uterus, fibroid or ovarian tumours.
6. Visceroptosis, with slipping down of the mesentery, causing increased pressure on the lower abdominal segment.
7. Severe continuous or intermittent muscular efforts, especially in the lifting of heavy weights.

MUSCULAR EFFORT AND ACCIDENT AS A CAUSE OF HERNIA.—The relationship between work and accident and hernia has become an important question in view of the Workmen's Compensation Act, and it is necessary for the surgeon to exercise extreme caution in stating definitely the cause of a hernia. Herniæ following penetrating wounds and rupture of the abdominal muscles need no comment, as they are certainly primarily due to the accident; but it is extremely doubtful if a blow in the groin (a common reason given for the production of a "rupture") is ever a cause of hernia.

Where there is already a congenital sac, a sudden muscular strain may force a piece of gut or omentum out of the abdominal cavity, and it may at once descend into the scrotum, where it frequently becomes strangulated. Such a condition is associated with a sharp, sudden pain in the groin, and the immediate appearance of the hernial swelling. Symptoms of intestinal obstruction may follow. The hernia is partly due to the pre-existing congenital abnormality and partly to the muscular strain.

When a hernia develops as a result of sudden muscular strain without a congenital sac being present, there is a sudden pain at the site of the hernia, and a sense of weakness. On examination, if the hernia is inguinal—as it usually is—there is a bulging swelling at the external abdominal ring—i.e., a bubonocele.

To sum up:

1. Accidents causing a distinct lesion of the abdominal wall may be followed by hernia.
2. Hernia following sudden muscular strain is usually associated with a preformed sac, and the hernia frequently becomes strangulated.
3. Hernia following sudden muscular strain without a preformed sac is associated with severe pain, and is usually a bubonocele.
4. If a patient with a hernia gives a vague history of some muscular effort unassociated with pain and the sudden appearance of the hernia, it is unlikely that the hernia is due to the alleged accident.

PATHOLOGICAL ANATOMY.—The *sac* of a hernia consists of a diverticulum of the peritoneum, which is usually congenital, but may be acquired. It consists of two parts: a narrow neck, where it passes through the abdominal wall, and an expanded lower end or fundus.

In recent hernie, the sac is thin-walled, but in old-standing cases it is thickened and adherent to surrounding structures, so that on re-



FIG. 323.—INGUINAL HERNIA.

(1) External ring opened; (2) testis; (3) cord lying behind the sac; (4) rectus; (5) external oblique aponeurosis; (7) conjoined tendon.



FIG. 324.—LIPOMA OF THE SPERMATIC CORD SIMULATING AN INGUINAL HERNIA.

(London Hospital Medical College Museum.)

duction of the hernia the contents only pass back into the abdominal cavity, and the sac remains *in situ*. If a truss is worn and the contents are always kept reduced, the neck of the sac may be closed by adhesions or filled by a piece of adherent omentum. If the sac then becomes filled with fluid, the condition is known as *hydrocele of a hernial sac*.

The *contents* of a hernia may be any of the viscera of the abdominal

cavity, but in the great majority of cases they consist of small intestine or omentum. A hernia filled with intestine is called an **enterocele**, if with omentum, an **epiplocele** or an **omentocoele**.

The coverings of a hernia are derived from the various layers of the abdominal wall through which the hernia passes, but they soon become atrophied from stretching and indistinguishable from one another.

Clinical Features.—Hernia are met with at all ages, and in both sexes, but men are more liable than women to suffer from this complaint, owing to the great frequency of non-obliteration of processus vaginalis, and the mere heavy work performed by the male sex.

The patient may complain of nothing except the swelling. Usually, however, some pain in the part—which, in the case of inguinal hernia, is referred along the spermatic cord—and a sense of weakness preventing violent muscular effort are present.

EXAMINATION.—A swelling is found at one of the hernial orifices, and its upper limit cannot be reached. It is soft, has an expansile impulse on coughing, and can be reduced into the abdomen. If the swelling contains gut, it is resonant on percussion, and there is a characteristic gurgle when reduction is effected. Hernia containing omentum are dull on percussion, and the contents slip back gradually into the peritoneal cavity. In children inguinal hernia containing gut may be translucent, and in this case may be mistaken for hydroceles.

PROGNOSIS.—If untreated, the hernia tends to increase steadily in size, and complications are likely to occur.

TREATMENT.—Two methods of treatment are usually open to the patient—(1) The wearing of a suitable truss, and (2) cure of the hernia by operation.

The advantage of wearing a truss is the avoidance of the danger and time spent on an operation which, although generally successful, is not always so; while the great advantage of operation is the disappearance of the risk of strangulation which is constantly present as long as the hernia is uncured. A minor advantage of operation is the avoidance of the discomfort and expense of constantly wearing a truss.

In the following cases operation is contra-indicated:

1. Patients with general constitutional diseases such as diabetes, Bright's disease, and *merbus cordis*, which contra-indicate any operation except these actually necessary to save life.
2. Very elderly patients.
3. Patients with very weak abdominal walls and large hernial orifices.
4. When the cause of the hernia is irremovable, as in patients suffering from chronic bronchitis or fibrous stricture of the rectum.
5. Very obese patients.

Operation is especially needed in the following:

1. Patients who desire to enter the public services.
2. Patients who propose to reside away from immediate medical aid.
3. Patients engaged in laborious occupations who are fit subjects for operation.
4. Patients whose hernia cannot be controlled by trusses. If a good instrument-maker is consulted, these cases are found to be very few, and the majority of such patients are not fit subjects for operation. The usual causes of inability of the truss to support a hernia are—The presence of ascites; too free division of the integuments in the operation for strangulated hernia; very old people with senile decay; and some cases of direct inguinal hernia with very weak abdominal walls.
5. Patients with irreducible hernia.

The varieties of trusses worn and the operations performed for the various forms of hernia will be described later.

COMPLICATIONS OF HERNIA—1. Irreducibility.—A hernia is said to be irreducible when the contents cannot be returned to the abdomen, and there are no other symptoms present. The causes of irreducibility are—

- (1) Adhesions either between the sac and its contents or matting the contents together. These adhesions are the results of past inflammation.
- (2) Increase in the size of the contents during the time the hernia is unreduced. The chief cause of this is increase of fat in an omentocele, but other causes are secondary deposits of malignant growth in the contents of a hernia, and deposits of tubercle.
- (3) The size of the hernia. If a hernia has been for years outside the abdomen, and has steadily increased in size, there is no longer room in the abdominal cavity for the contents, and the hernia is irreducible. In these large hernia there are usually adhesions as well, or a part of gut, such as the cæcum and ascending colon, which is uncovered posteriorly by peritoneum, has slipped out of the abdomen into the hernial sac.

SYMPTOMS.—The symptoms and the physical signs of an irreducible hernia are similar to those of a reducible hernia, except that the contents cannot be replaced into the abdomen. An irreducible hernia is more liable to strangulation than a reducible, as it cannot be properly controlled by a truss.

TREATMENT.—The need for radical cure is more urgent in irreducible than in reducible hernia, and should always be advised unless some strong contra-indication is present.

If operation is refused or contraindicated, the following methods of treatment are useful:

(1) The patient is kept in bed with the foot of the bed raised, and put on a diet that reduces fat. Constant pressure is exerted on the hernia by means of a pad and elastic bandage, and the hernia may in the course of weeks become reduced.

(2) If the hernia is a scrotal hernia, a hinged cup truss which exerts constant pressure on the hernia may be worn, and the hernia may gradually be reduced.

(3) For inguinal, femoral, and umbilical hernia a truss with a hollow pad may be worn. Such a truss prevents the hernia from enlarging, but does not as a rule succeed in becoming reducible.

(4) The hernia, if a large scrotal one, may be supported in a bag truss. This resembles a large suspensory bandage and merely adds to the comfort of the patient.

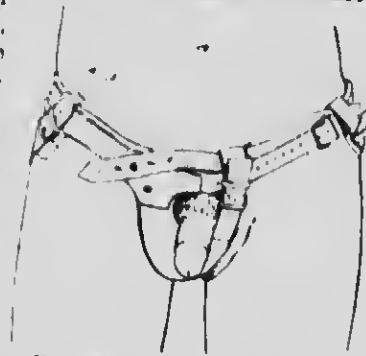


FIG. 325.—HINGED CUP TRUSS.

If an irreducible hernia becomes strangulated, taxis should not be tried.

2. Incarcerated or Obstructed Hernia.—By this term the blocking of the lumen of the gut in a hernia with fecal matter is indicated. The hernia becomes irreducible, and the symptoms of intestinal obstruction develop. It is most frequently met with in elderly women having large umbilical hernia containing the transverse colon, who allow themselves to become constipated.

SYMPTOMS.—The symptoms are gradual in onset, and consist of abdominal pain, constipation, and, later, vomiting; flatus is usually passed. The hernia, which is generally an irreducible one, becomes larger, harder, and tender; it is painful and doughy to the feel, dull on percussion, and hoavy and solid. If previously reducible, it becomes irreducible, but still retains its expansile impulse on coughing. The true cause of the symptoms is frequently overlooked, as the patient may not mention the hernia, and the case is treated as one of constipation, or a bilious attack. If this is so, the gut gradually becomes congested, and the hernia is strangulated, and ultimately gangrene supervenes. Incarceration is therefore an important and often fatal complication of hernia owing to late diagnosis of the condition.

TREATMENT.—The patient should be given a *small* dose of opium, and as soon as she is comfortable large enemata containing turpentine or alum should be administered. If the enemata act—or before if the hernia is not painful—gentle massago and kneading of the sac

should be tried, so as to pass on the intestinal contents. After the bowels have been opened by enemata, a purge should be administered, but if this is given too early, the symptoms are often aggravated.

If the case is not seen until the symptoms are becoming severe, or if the above methods are not quickly successful, herniotomy should be performed, or gangrene of the gut will supervene from interference with the blood-supply. So great, however, is the danger of operation in elderly fat people with large herniæ, that early reduction of the hernia by the use of enemata and taxis is of the utmost importance.

3. Strangulated Hernia.—A hernia is said to be strangulated when the blood-supply of the contents of the sac is seriously interfered with, and if the condition is not relieved, gangrene will follow. Strangulation may occur at the first appearance of a hernia, especially if the sac is congenital, and a patient with a hernia is never free from the danger of this complication. Strangulation is more common in small herniæ than in large. The strangulation occurs at the neck, which is the narrowest part of the sac, and surrounded by dense unyielding structures. The common cause is a sudden contraction of the abdominal muscles forcing a larger piece of gut or omentum than usual into the sac. In the case of a hernia that is already down or irreducible, the expulsive effort adds another piece of intestine to the contents, and strangulation follows. In some cases a piece of gut or omentum in a hernial sac becomes twisted or strangulated by adhesions in the sac, and the condition is similar to strangulated hernia, but is more properly termed "intestinal obstruction," occurring in a hernial sac. It is most common in large irreducible herniæ.

PATHOLOGICAL ANATOMY.—When a piece of gut is strangulated, it first becomes congested, and a serous exudate occurs into the sac. The lumen of the gut is closed, and the gut paralyzed, so that stasis of the intestinal contents occurs, and the general condition is one of intestinal obstruction. At the place where the intestine is actually constricted there is anæmia of the gut wall, and as it is in this part that gangrene first occurs, it should always be most carefully examined when the gut is exposed by a herniotomy.

If the gut is opened, it is found to contain blood-stained fluid due to hæmorrhage from the mucous membrane. Ulceration of this membrane may be present, especially at the point of constriction. This ulceration may lead to perforation after the hernia has been reduced, or to chronic obstruction from contraction of the cicatricial tissue formed in the healing of the ulcer.

Following the congestion of the gut wall, the intestinal bacteria become active and pathogenic, and pass through the epithelial lining of the mucous membrane; inflammation of the gut wall follows, resulting in an infective gangrene of the loop of intestine involved. *On examination*, the sac is found to be filled with dark, evil-smelling serum or pus, and the gut, which may be covered by inflammatory lymph, is black or mottled in colour, flabby and slimy to the touch,

while the peritoneum over it has lost its lustre. In some cases the sac also is gangrenous. If the patient survive the general toxæmia from the intestinal obstruction, an abscess forms in the sac, comes to the skin surface and bursts, and a fæcal fistula forms, with spontaneous recovery from the obstruction.

The gut below the strangulated loop is empty and contracted, whilst that above is inflamed, distended with gas and fluid fæces, and congested, showing petechial hæmorrhages in the mucous membrane.

At first the skin over the hernia is unaffected, but later it becomes reddened and inflamed, finally giving way when the abscess points.

STRANGULATED OMENTUM is first congested and then inflamed. If the blood-supply is not too seriously interfered with, the inflamed omentum contracts adhesions to the sac wall, and the patient recovers with an irreducible hernia; but with a tighter strangulation the omentum becomes gangrenous. It is then brown in colour, soft and friable, with hæmorrhage into it. Infection with the colon bacillus may occur, the omentum becomes offensive, and suppuration follows.

CLINICAL FEATURES.—The symptoms may be divided into *general* and *local*.

The *General* symptoms are those of acute intestinal obstruction—*i.e.*, abdominal pain and distension, persistent vomiting becoming fæulent, and absolute constipation of flatus and fæces. The acuteness of the symptoms vary considerably. In some cases, especially in small, recently formed herniæ containing small intestine, the symptoms are exceedingly acute, and gangrene of the gut may occur in less than twenty-four hours. In other cases, especially in large umbilical herniæ with strangulated large intestine, the onset of the symptoms is insidious, and the condition may be mistaken for a bilious attack, particularly if attention is not called to the hernia. With a **Richter's hernia**—*i.e.*, strangulation of a portion of the lumen of the gut only—the constipation may not be absolute, and in any case the contents of the rectum and pelvic colon may be passed if an enema is given.

If the strangulation is not relieved, the patient suffers from a general toxæmia, the pulse becomes rapid, weak, and irregular, hiccough develops, and the temperature falls below normal. The eyes are sunken, the tongue dry and brown, sordes collect on the teeth, and the patient dies of exhaustion with a distended abdomen.



326.—GANGRENOUS OMENTUM IN A STRANGULATED HERNIA. (London Hospital Medical College Museum.)

When gangrene supervenes, the pain is often relieved, and occasionally the contents of the lower bowel may be passed, so that an apparent improvement may occur; but the toxæmia and vomiting continue, and unless a fæcal fistula forms, the patient soon dies. When the omentum is strangulated, the symptoms are similar but not so severe, and recovery may occur without fistula formation.

The *Local* symptoms are a swelling at one of the hernial orifices, which is tense, tender, and painful. It cannot be reduced into the abdomen, and *there is no impulse on coughing*. If a hernia has been present before, it is larger than usual, and becomes painful. The skin over the swelling is at first normal, but later is red and inflamed. When gangrene occurs, the swelling becomes less tense and painful, and with abscess formation fluctuation may occur. If the condition is one of intestinal obstruction in a hernial sac, the impulse on coughing may not be lost.

TREATMENT.—The treatment of strangulated hernia is immediate reduction of the strangulated bowel or omentum, and every hour wasted adds to the patient's danger, and makes gangrene more probable. The two methods of effecting the reduction are *taxis* and *herniotomy*, and one of these should be employed as soon as the diagnosis is made. Any other method of treatment—as hot baths, or application of cold or warmth—will waste valuable time.

TAXIS.—By this term is understood the reduction of a strangulated hernia by manipulation. This method must be used with caution, and only in selected cases. Its use presupposes that the gut or omentum is in a fit condition to be returned to the abdominal cavity, and neither the condition of the skin over the hernia nor the severity of the general symptoms is a certain criterion of the condition of the contents of the hernial sac. The length of time the symptoms of strangulation have been present does not necessarily indicate the condition of the gut, but at the same time the duration and severity of the symptoms correspond fairly with the extent of the local injury.

Taxis should only be tried in cases of recent strangulation with mild symptoms. The safest rule to go on is thus stated by Macready: "Taxis should be used solely in the early hours of strangulation, and only then if the local and constitutional state is favourable." It should be tried more readily in inguinal than femoral hernia. Taxis should *not* be tried in the following cases:

- (1) If the skin is inflamed, gangrenous, or contused.
- (2) If the symptoms have been present for several days, no matter how mild they may be.
- (3) If marked shock is present.
- (4) If the hernia has been irreducible before it became strangulated.
- (5) In very small herniæ, especially femoral, as the strangulation will be severe.
- (6) If the vomiting is fæculent.
- (7) In very large herniæ.
- (8) If some competent person has already tried taxis.

Method of Applying Taxis—(1) *Inguinal Hernia*.—The patient should be lying flat on the back with the lower extremities fully extended, and the surgeon should stand facing the patient. The hernia is drawn a little downwards with the right hand, so as to define the neck of the sac, on each side of which are placed the thumb and fingers of the left hand, thus forming a kind of funnel, which prevents the hernial contents from being bunched up against the abdominal wall. The hernia is held in the right hand, the fundus of the sac in the palm, and the thumb in front of the fingers behind. The fingers are then used to push up the structures at the back of the sac, which are the contents most recently descended, while the thumb gently draws down the front part of the sac. The pressure must be exerted in the long axis of the swelling, and the hernia made to return by the same route as it escaped. As the posterior part of the sac is emptied, the anterior part is attacked and cleared.

In large herniæ the surgeon must use both hands, the neck of the sac being steadied by an assistant, and while pressure is being made on the contents, the sac must be drawn away from the hernial orifice. The gut, which lies posteriorly, is returned first, and the omentum follows.

Taxis should not be tried for more than five minutes, except in the case of children and in large herniæ in elderly people. The utmost gentleness, consistent with firm, steady pressure, should be used.

(2) *Umbilical Hernia*.—In large umbilical hernia the sac should be well lifted away from the abdomen, and moved from side to side fairly vigorously, so as to cause a displacement of its contents, which is frequently followed by reduction.

(3) *Femoral Hernia*.—These are usually more difficult to reduce than inguinal or umbilical herniæ, because the hernia cannot be so readily grasped.

The sac must first be pressed *downwards*, so as to bring the axis of the neck of the sac into the same straight line as the femoral canal. The sac is then held in the same way as for inguinal hernia, and the thumb draws down the sac in front at the same time that the fingers press upwards behind.

Taxis can only be considered successful when all the contents of the sac are reduced; but if after taxis all the symptoms disappear from a hernia which the surgeon knows to have been irreducible for a long time, he is justified in waiting for further symptoms; but in all other cases it is better to proceed with herniotomy. Herniotomy should also be performed at once if the symptoms continue, though taxis is apparently successful.

Apparent success may be attended by no relief owing to the following conditions: (1) Reduction *en masse*. (2) Reduction through a rent near the neck of the sac. (3) Incomplete reduction. (4) Reduction into another sac. (5) Volvulus of the gut on reduction. (6) Reduction of gangrenous gut. (7) The symptoms depending upon some other cause of obstruction, and not on the hernia.

If taxis is successful, a pad of lint should be placed on the hernial

orifice, and a bandage applied so that recurrence may not take place until a truss is obtained or a radical operation performed.

If taxis is not successful or is not tried, the patient must be prepared for the operation of herniotomy. If there is any necessary delay, an injection of morphia ($\frac{1}{4}$ grain) may be given. An icebag or a fomentation can also be applied to the hernia if it be a recent one in an adult. When everything is ready for the operation, the patient is anesthetized, and if the conditions are favourable, gentle taxis should be tried again, and will frequently be successful. It should not be persisted in, however, for in those cases in which it is likely to be successful the operation is simple, and a radical cure can be performed at the same time, while taxis is always uncertain, and nothing but evil can result from delay.

Herniotomy.—The preparation of the patient and the after-treatment of this operation is similar to those of any urgent abdominal operation. The instruments necessary are scalpel, hernia knife, artery forceps, and dissecting forceps, hernia director, retractors, and the instruments for radical cure and resection of gut.

HERNIOTOMY FOR STRANGULATED INGUINAL HERNIA.—An incision is made over the neck of the hernial swelling and following its long axis the length of the incision depending upon the size of the hernia. The skin is incised, and the subcutaneous tissue carefully divided in layers the whole length of the incision. The division continues until the sac is reached. It is recognized by its bluish colour, and by its manner of gliding over the contents. If the division, however, is done *very* carefully, there is little danger of wounding the contents of the sac, and the moment it is opened there is a gush of fluid which is characteristic. The opening is most carefully enlarged, and the contents of the sac thoroughly examined. The hernia director is then introduced, the hernia knife slid along the groove, and the neck of the sac incised in an *upward and inward* direction. The incision in the neck of the sac should be small, and two or three small nicks are better than one long incision. The director can be dispensed with, and the contents of the sac guarded by the finger, the hernia knife being guided along this. Many surgeons now divide the tissues over the neck of the sac from the outside, and this is the easiest and best method to follow.

The contents of the sac are then pulled farther out of the wound and examined, especially at the place where the constriction was, and if considered healthy, are returned to the abdomen. All adhesions should be divided between ligatures, and inflamed omentum should be cut away. The operation is then completed by a radical cure by one of the approved methods, the essential points being the removal of the sac, ligature of its neck, and the suturing of Poupart's ligament to the conjoined tendon. The superficial tissues are then repaired, and the wound closed.

Gangrenous gut can be recognized by its flaccidness, grey colour, absence of bleeding, loss of peritoneal sheen, and smell. It may be dealt with in several ways:

(1) If a small patch is gangrenous, it should be inverted by a purse-string suture.

(2) If a loop of intestine is gangrenous, it is safest to establish an artificial anus by removing the gangrenous portion, tying in a Paul's tube, and suturing the edges of the gut to the skin.

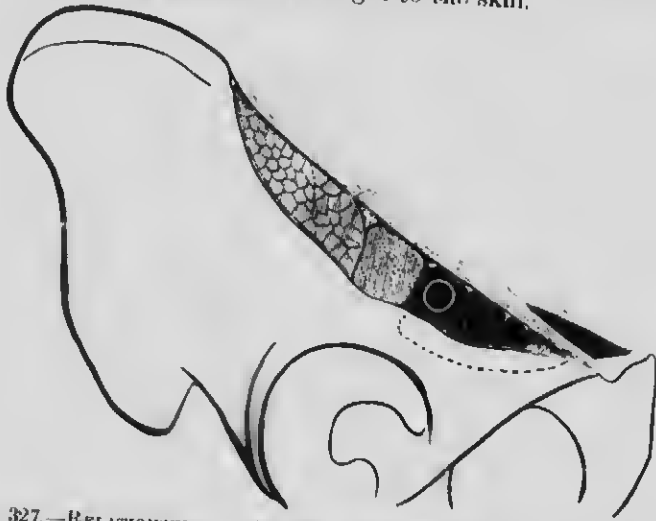


FIG. 327.—RELATIONSHIPS OF STRUCTURES UNDER POUPART'S LIGAMENT.

(3) If the patient's condition warrants it, the gangrenous gut can be excised, and the ends of the intestine anastomosed together. Gangrenous omentum should always be removed.

HERNIOTOMY FOR STRANGULATED FEMORAL HERNIA.—Instruments as for inguinal hernia. A vertical incision is made over and a little to the inner side of the hernial swelling. The tissues are divided layer by layer, as in herniotomy for an inguinal hernia, until the sac is opened. The hernia director or finger is passed to the inner side of the contents, and the incision into the neck of the sac is made directly inward, nicking Gimbernat's ligament. Care must be taken in small hernia that the gut does not slip back at this stage of the operation before it has been properly examined. This is particularly apt to occur with a Richter's hernia.

Examine the gut as above, and deal with it in a similar fashion. As it is difficult to get enough room in a femoral hernia to deal with gangrenous gut, if this is present a second incision should be made above Poupart's ligament, and the gangrenous portion brought out through the abdominal wall. If this is done quickly and neatly, there is little danger of infecting the peritoneal cavity.

After the gut has been returned, the femoral hernial sac should be removed, the neck ligatured, and radical cure performed by one of the various methods, an easy and useful way being to suture Poupart's ligament to the pectineus fascia. The wound is then closed.

4. Inflamed Hernia.—This term has been used to indicate several different conditions, all of which, however, are associated with inflammation of some part of a hernia.

(1) Inflammation of the skin and coverings of the hernia. This commonly follows the wearing of an ill-fitting truss which causes excoriation of the skin, or blows on the hernia.

The SYMPTOMS are those of inflammation of the skin elsewhere, and the TREATMENT is usually obvious.

(2) A localized peritonitis of the sac with or without involvement of the contents. With inguinal hernia on the right side, the cæcum and appendix are frequently found in the sac, and if an attack of appendicitis occurs, the patient has an inflamed hernia, and an appendix abscess may form in a hernial sac. The more common causes of inflammation of the sac are injury from taxis or truss pressure.

The SYMPTOMS are—(1) General—i.e., rise of temperature, general malaise with vomiting and constipation; and (2) local, the hernia being tender and enlarged, and the skin over it red and inflamed. The hernia is irreducible, and the symptoms somewhat resemble those of strangulation. The inflammation may resolve or adhesions form between the sac and the contents, rendering the hernia irreducible. Suppuration occasionally follows.

TREATMENT.—The patient should be put to bed, and fomentations applied to the hernia; but if the symptoms are not quickly relieved, herniotomy should be performed, as the condition may merge into that of strangulation. Should suppuration occur, the sac must be opened and drained, and the contents dealt with according to the condition found.

(3) Inflammation of the gut from the presence of foreign bodies or typhoid or tuberculous ulceration also constitutes an inflamed hernia, and the SYMPTOMS and TREATMENT vary with the cause.

ANATOMICAL VARIETIES OF HERNIA

Inguinal Hernia.—An inguinal hernia is a hernia passing through the inguinal canal, making its appearance at the external abdominal ring. If it continues to enlarge, it passes into the scrotum or the labium majus. An inguinal hernia reaching the external ring is termed a **hernocoele**, and if it reaches the scrotum, a **scrotal** or **complete** hernia.

Inguinal herniæ are divided into **INDIRECT** or **OBLIQUE**, and **DIRECT**. In the former case the sac may either be congenital in origin or acquired.

An **INDIRECT** inguinal hernia leaves the abdominal cavity at the internal abdominal ring, passes along the inguinal canal, and emerges at the external abdominal ring. The neck of the sac lies above and internal to the pubic spine, and this distinguishes the rupture immediately from a femoral hernia, in which the neck of the sac always lies below and external to the pubic spine. As the hernia passes along the canal, it takes with it a layer from every part of the abdominal wall, so that when the sac reaches the scrotum it is covered by (1) skin, (2) dartos, (3) intercolumar or external spermatic fascia, (4) cremasteric muscle and fascia from the internal oblique and transversalis, (5) infundibuliform or internal spermatic fascia from the



FIG. 328.—ACQUIRED INGUINAL HERNIA.

1. Peritoneum; 2. omentum in sac; 3. end of sac; 4. spermatic cord; 5. vas; 6. body of testis; 7. epididymis; 8. tunica vaginalis.

transversalis fascia, (6) subperitoneal tissue; but practically it is usually only possible to recognize at operation the subcutaneous tissue and the cremaster muscle.

A **congenital** inguinal hernia is present when the whole extent of the processus vaginalis remains unclosed, and the tunica vaginalis forms part of the hernial sac. It is more frequent on the right side than on the left, and the sac is always very intimately attached to the spermatic cord and vas. Although the sac is congenital in origin, the hernia may not appear till long after birth. When it does appear, the contents pass immediately to the bottom of the scrotum, and strangulation frequently follows. The



FIG. 329.—HERNIA LEAVING THE EXTERNAL ABDOMINAL RING.

contents of the sac lie in front of and partly surround the testis. In performing radical cure great care must be taken in separating the sac from the cord, and the lower part of the sac should be sutured to form a tunica vaginalis. This form of hernia frequently occurs with imperfect descent of the testis.

A hernia into a **funicular** process is present when the processus vaginalis remains open above, but is closed at the top of the testis to form a tunica vaginalis. It has the characteristics of a congenital hernia, but the testis can be easily distinguished below the hernia at its first appearance.

An **infantile** hernia is one in which the processus vaginalis is closed above but open below, so that the tunica vaginalis extends to the internal abdominal ring. The hernial sac descends behind the con-

genital sac, so that during operation a sac containing the testis and a little fluid is first opened. This does not communicate with the abdominal cavity, and behind it is a sac forming the hernia.

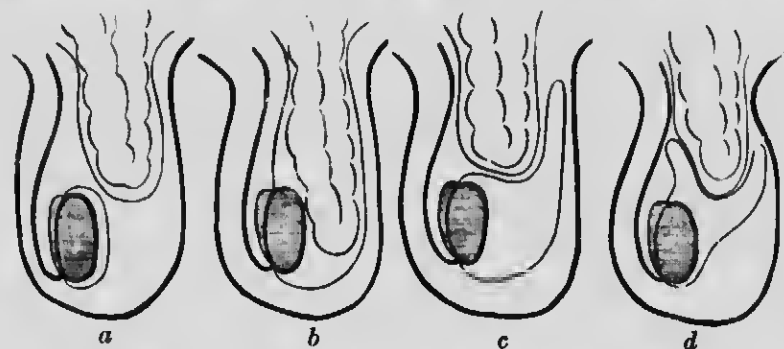


FIG. 330.—DIAGRAM OF VARIOUS FORMS OF INGUINAL HERNIA.
(a) Acquired; (b) congenital; (c) infantile; (d) encysted.

An **encysted** hernia is very similar, only instead of the hernial sac lying behind the congenital sac, it invaginates it, and the hernial contents appear to lie in a double sac. These conditions can only be recognized on operation.

An **acquired** indirect inguinal hernia is one in which the sac is formed from the normal peritoneum. It gradually increases in size, being first a bubonocoele and later a scrotal hernia. The sac is usually thick-walled, and not so intimately connected with the structures of the cord as in the congenital type. At first the testis can be readily distinguished below the hernia, but in old-standing cases the hernia may completely envelop the testis. As the hernia enlarges, it drags the internal ring opposite the external ring, so that it may be impossible before operation to distinguish an indirect from a direct hernia. With a very large hernia the penis becomes buried in the scrotal tissues, causing interference with its functions.

TREATMENT—TRUSSES.—The most commonly used and the best form of truss for an inguinal or a femoral hernia is the steel spring truss. This consists of a steel spring encircling the body just below the crest of the ilium, having a pad, which lies over the inguinal canal or the femoral ring, fixed to it, which prevents the slightest protrusion of the hernia from the abdominal cavity. An understrap, passing along the perineum, helps to keep the pad in position. The spring of the truss should be strong enough to prevent the descent of the hernia during all movements of the body, no matter what strain is put upon it; but during the intervals of rest the pressure exerted should be but slight, or the truss will be uncomfortable, and the excessive pressure will cause atrophy of the abdominal wall, and so increase the tendency to hernial protrusion.

Other forms of trusses are sometimes useful in special varieties

of hernia, and the indications for their use will be given, but there is no efficient substitute for the spring truss in ordinary cases.

DIRECTIONS FOR USE OF A SPRING TRUSS—In Adults.—The truss must be constantly worn when the patient is up, and should always be put on and taken off in the recumbent position. Unless the hernia is very large, or the patient has a cough, there is usually no need to wear the truss at night; but if the hernia comes down, a light truss should be worn when the patient is in bed. The truss is generally covered with leather and wash-leather, the latter being next to the skin. It

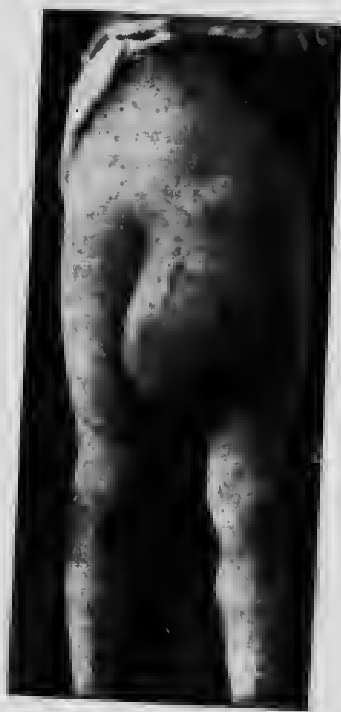


FIG. 331.—LARGE INGUINAL HERNIA BURYING THE PENIS.

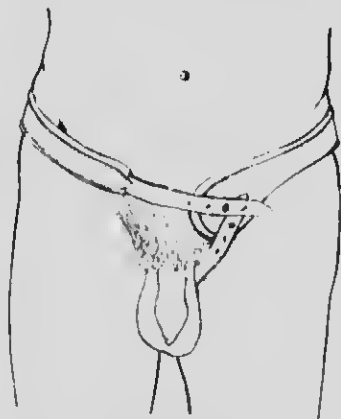


FIG. 332.—INGUINAL TRUSS (AFTER MACREADY).

is well for the patient to have an extra truss covered with india-rubber, gum-elastic, or celluloid, to be worn when bathing. If the truss has to be worn constantly, it should be removed once a day, and the hernial region washed and dried. Care must be taken that there is no chafing, or it may be necessary to discard the truss for a few days; if this be so, the patient should be kept recumbent till the truss can be resumed.

It is important that the understrap be loose, otherwise it will be irksome to the patient, and he will remove it, and the pad of the truss may then slip out of position.

Cure of a hernia is not to be expected from the use of truss in an adult. The "life" of a truss is usually about two years.

DIRECTIONS FOR USE IN CHILDREN.—In infants the truss should be covered with, or made entirely of, india-rubber, and as the truss may bring about a cure, it should be worn constantly day and night. As

soon as the child wets it, it must be removed, dried, and replaced, and while this is done the child should be lying down and not crying. If the hernia comes down very readily whenever the truss is removed, a finger should be placed over the ring, and not removed until the truss is readjusted. The child should be bathed in the truss, which is only removed for sufficient time to dry the part thoroughly. A little powder should be put under the truss, but no ointment must be used, as this destroys the india-rubber. It is well to have at least two trusses, so that one can be thoroughly dried while the other is in use. As in adults, the truss should be removed at least once a day, and it should not fit too tightly, the understraps particularly being loose. The truss will last about six months, and it must be renewed as soon as the india-rubber is worn through, or the child outgrows it. There is no criterion as to when the hernia is cured; but if it has not appeared for two years, the truss may be removed. Recurrence after this time probably means that the truss alone cannot affect a cure, and in no case should the surgeon promise that a cure will result.

WITH UNDESCENDED TESTIS.—If a truss is used for a hernia complicated by this condition, there is no need to obtain a special truss; Wood's horseshoe truss is quite unnecessary and useless for the purpose of allowing the testis to descend.

When adjusting a truss for this condition, the surgeon may entirely ignore the testis; and if the organ has a tendency to pass into the scrotum, the truss will probably be powerless to prevent this natural process.

In OLD PEOPLE there is sometimes difficulty in retaining the hernia by a truss owing to the slipping down of the truss behind, due to atrophy of the muscles of the buttock. To remedy this, a brace or lifting-strap must be used, which runs from the middle of the truss posteriorly and divides into two parts, one going over each shoulder. These two bands cross on the front of the chest, and descend to be buckled on each side to the truss behind the line of its transverse diameter.

MEASUREMENT FOR A TRUSS.—The circumference of the pelvis should be taken 2 inches below the crest of the ilium, the patient being measured in the recumbent position. The tape should be drawn tightly, as the usual mistake is to have the truss too large. The instrument-maker should be informed on the following points: Whether the hernia is right, left, or double; whether inguinal or femoral; and if inguinal, whether a bubonocoele or a scrotal hernia, and whether direct or indirect. The age, sex, and physical power of the patient, and whether his occupation is laborious or not, should also be given.

APPLICATION OF A TRUSS—*Indirect Inguinal Hernia : Bubonocoele*—The pad of an inguinal truss should be about $4\frac{1}{2}$ inches long, $2\frac{1}{2}$ inches broad, and $1\frac{1}{2}$ inches thick. It should be pyriform in shape, and inclined downwards to correspond to the obliquity of the inguinal canal. With the patient lying on his back and the hernia reduced,

the truss is passed beneath the small of the back, and fitted so that the spring lies just below the crest of the ilium. The crest of the pelvis is then defined, and the pad of the truss is brought down so that its lower border lies immediately above the pubis, and its inner extremity just in contact with the outer edge of the rectus. The pad will then cover both the inguinal canal and the internal ring, and should press upwards, backwards, and outwards, but mainly upwards. The understrap is placed just behind the shoulder of the truss, and should cross the buttock, pass under the thigh, and be attached to the lower button. It must not be too tight, or the patient will not wear it.

Care must be taken that the pad lies *above*, and not *on*, the pubis, or the truss is ineffectual, and the skin pressed between the truss and the bone may become sore. The usual error is to wear the pad too low.

Scrotal Hernia.—For this variety of hernia a rat-tailed truss with a strong spring is most frequently used. This truss has a larger pad than the ordinary one, which is continued downwards over the pubis, ending in a tail which is fastened behind to a loop near the shoulder of the truss. It is important that only the tail portion of the pad rests on the bone, the pad resting in the same position as the ordinary truss over the ring. There is only one button on the pad in a lower position than usual, and to it the cross-strap is fastened. It is claimed that if this truss is worn constantly, the hernia will become so reduced in size that it can be retained by the simpler form of truss. The rat-tailed truss is seldom necessary for infants.

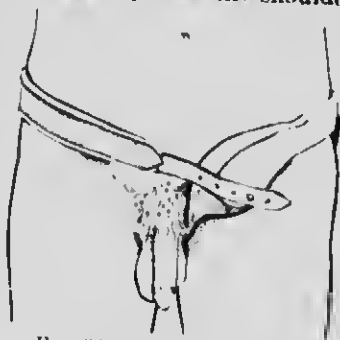


FIG. 333.—RAT-TAIL TRUSS.

Infants.—The ordinary spring truss can be adjusted to infants of any age, and worn with absolute comfort. It should be covered with india-rubber, so that it can be readily cleaned and the child bathed in it.

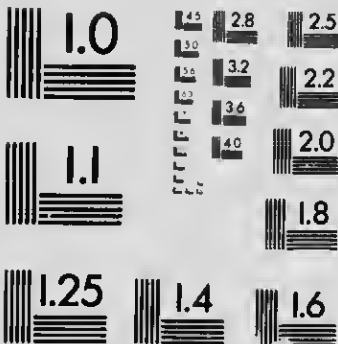
Horseshoe Truss.—This variety of india-rubber truss is particularly useful for boys with double inguinal hernia. It consists of an india-rubber waistband, which fits round the pelvis in the usual way, and has a horseshoe-shaped india-rubber pad, which is filled with glycerine, or it can be inflated with air. The curve of the horseshoe fits round the external genitals, and thus both rings are efficiently guarded. The truss can also be used for females, and a single truss made in the same way can be obtained.

TEST FOR USEFULNESS OF A TRUSS.—After the surgeon has seen that a truss is properly applied, its value may be tested in the following way: The patient is made to sit on the edge of a high chair, with his legs opened widely and fully extended, and the body bent forwards. He is then told to cough forcibly several times. If the hernia is then



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retained by the truss, it can be trusted to keep it up under all ordinary circumstances. The absolute tests of a well-fitting truss are perfect comfort and retention of the hernia during all movements and strains.

OPERATIVE TREATMENT.—The operative treatment of indirect inguinal hernia in selected cases is exceedingly satisfactory, less than 10 per cent. of the cases recurring. Operation is suitable in both the congenital and the acquired varieties, and although the most favourable results are obtained in young adults, the operation is highly satisfactory in infants, and should always be advised in those cases when truss treatment has failed, or when it is unlikely that careful truss treatment will be carried out.

Cases that recur after operation generally do so within eighteen months of the attempted radical cure, and the usual causes are—(1) Faulty technique during the operation or the after-treatment; (2) suppuration in the wound; (3) operation in unsuitable cases. The contra-indications for operation are given on p. 717.

Many methods of operation are described, but in all cases the essential features consist of—(1) Careful isolation of the sac from the tissues of the spermatic cord in males and the round ligament in females, and ligation of its neck flush with the abdominal cavity; (2) closure of the inguinal canal, sufficient room only being left for the passage of the spermatic cord or round ligament of the uterus.

The following are the best-known methods of carrying out the latter indication:

1. **Bassini's Method.**—The conjoined tendon of the internal oblique and transversalis are sewn to Poupart's ligament *underneath* the spermatic cord. The external oblique aponeurosis has to be freely divided, and after the inguinal canal has been closed the edges of the divided aponeurosis are stitched together over the cord.

2. **MacEwen's Method.**—The external oblique aponeurosis is not opened, but the operation carried out through the external abdominal ring. The conjoined tendon of the transversalis and internal oblique is sewn to Poupart's ligament *over* the spermatic cord.

3. **Halstead's Method.**—The inguinal canal is opened as in Bassini's method, and all the layers of the abdominal wall are sutured behind the spermatic cord, so that this structure comes to be between the external oblique muscle and the skin.

In very large herniæ a silver "filigree" may be introduced into the wound so as to bind the structures together and with the resulting scar tissue to form a dense, unyielding obstruction to the recurrence of the hernia.

AFTER-TREATMENT.—The patient should remain in bed for two weeks, but this period may be reduced in children and in young adults with small herniæ and muscular abdominal walls. It should be increased in elderly people with large herniæ and lax abdominal walls.

If the hernia has been very large, or if the abdominal wall is weak, a light truss should be advised when the patient gets up. It is better

for him to wear a truss if suppuration has occurred and the deep stitches have come away.

A Direct Inguinal Hernia is always acquired, and the hernia leaves the abdomen through Hasselbach's triangle. This triangle is bounded by the outer edge of the rectus muscle, the deep epigastric artery, and Poupart's ligament, and on its peritoneal aspect is divided into two

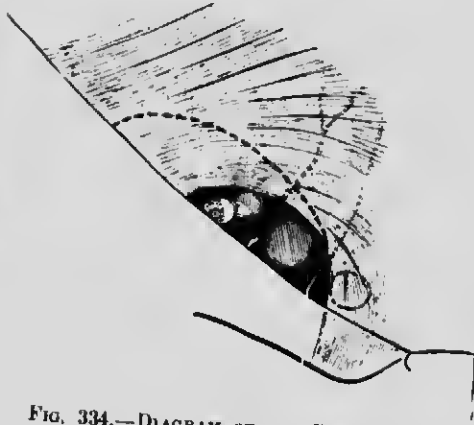


FIG. 334.—DIAGRAM OF THE RELATIONSHIP OF INDIRECT AND DIRECT INGUINAL HERNIA.

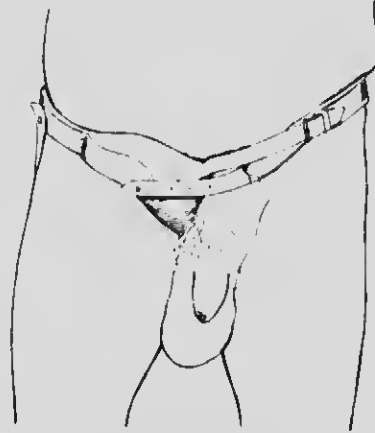


FIG. 335.—FORKED-TONGUE TRUSS, WITH ABDOMINAL EXTENSION (AFTER MACREADY).

parts by the obliterated hypogastric artery. A hernia passing out external to the hypogastric artery is an *external direct* inguinal hernia, and one passing out internal to the artery is an *internal direct* inguinal hernia.

The spermatic cord lies to the outer side of the hernia at first, but the two pass together through the external abdominal ring, with the hernia in front. The sac is not covered by the coverings of the cord in the same way as in an indirect hernia. These herniæ are most common in elderly men with lax abdominal walls who suffer from constipation or an enlarged prostate.

TREATMENT—Truss.—The truss most generally useful for this variety of hernia is the rat-tailed truss, and the pad should slightly overlap the edge of the rectus muscle. If the hernia still tends to escape at the inner side of the truss, the pad is continued upwards, and its inner edge fastened to the spring on the sound side, forming the forked-tongue truss.

Operative.—The operative treatment of direct inguinal hernia is similar to that of the indirect, but as these herniæ are most common in elderly men with lax abdominal walls, the likelihood of radical cure is not so great, and in the majority of cases truss treatment is to be advised.

Interstitial Hernia

An interstitial hernia is the name given to an indirect inguinal hernia, which, after it has passed the internal abdominal ring, passes in an abnormal direction, or which—as is more usually the case—develops a diverticulum of the sac in an abnormal position. The following varieties are distinguished:

Intraparietal or Properitoneal Hernia.—In this variety the hernia or a diverticulum from the sac of a scrotal hernia lies between the peritoneum and the transversalis fascia. Two types are distinguished—(1) The hernia passes forwards in front of the bladder; and (2) the hernia passes into the iliac fossa.

This variety of interstitial hernia gives no physical signs, and the condition is only discovered on operation. A properitoneal hernia may become strangulated whilst the parent hernia is unaffected, and this may lead to errors in diagnosis.

Intraparietal.—The hernia in this case lies between the internal and external oblique muscles, and as it enlarges, passes upwards and outwards towards the anterior superior spine. It can usually be readily recognized, and is the most common variety of interstitial hernia.

Extraparietal.—In this form the sac lies between the external oblique muscle and the skin, after it has passed through the external abdominal ring, and the hernia enlarges outwards along Poupart's ligament.

All these varieties are probably congenital in origin, and are generally associated with imperfect descent of the testis, and according to Hamilton-Russell, the sacs are formed from diverticula of the processus vaginalis.

TREATMENT—Truss.—For an interstitial hernia a truss with a large abdominal pad must be used, the pad extending so as to almost reach the anterior superior spine. It may be found impossible to control the hernia by a truss.

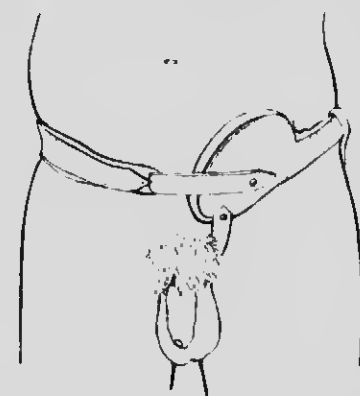


FIG. 336.—INGUINAL TRUSS, WITH ABDOMINAL EXTENSION (AFTER MACREADY).

Operative Treatment.—Operative treatment is to be advised in the majority of cases, especially as the hernia is usually complicated by imperfect descent of the testis—a condition which also requires operation. The radical cure is carried out on similar lines to those of the more common indirect inguinal hernia, and it is generally necessary to remove the testis.

Femoral Hernia

A femoral hernia leaves the abdomen through the femoral ring, passes down the crural canal, and comes through the deep fascia of the thigh at the saphena opening, pushing forwards the cribriform fascia. It then turns upwards and outwards over Poupart's ligament, probably being guided in this direction by the attachment of Scarpa's fascia. Occasionally the hernia passes down the thigh along the side of the saphena vein.

The femoral ring is bounded in front by Poupart's ligament, internally by Gimbernat's ligament, externally by the femoral vein, and posteriorly by Cooper's ligament, which lies along the ramus of the pubis.

CAUSE.—After the age of twenty-five femoral hernia is more common in women than in men, and especially in women who have borne children. In young subjects femoral hernia is more often seen in males, and the predominance of inguinal hernia in female children makes that form of hernia more common than femoral in the female sex.

The reason given for the greater number of femoral hernia in women than in men is the greater relative width of the pelvis in adult females. The exciting causes of the hernia are probably loss of fat removing some of the support of the femoral ring, straining during parturition and defæcation, and the formation of a properitoneal fatty hernia which frequently accompanies a femoral sac. According to some authorities, a femoral sac is congenital in origin, and the above causes only increase it in size, and force contents into it.

The sac usually contains small intestine and omentum, and the latter frequently becomes adherent to the sac, making the hernia irreducible.

CLINICAL FEATURES.—The hernia is most commonly found in women over forty, and as it is generally small and the women frequently fat, it may pass unnoticed until strangulation occurs, or the patient, although aware of it, will not seek treatment. Although the hernia is usually small, it may grow to a large size and contain several coils of intestine. In these cases, as the hernia enlarges over Poupart's ligament, it may present a superficial resemblance to an inguinal hernia. If the finger is placed on the spine of the pubis, it will be found that the neck of the sac lies outside and below the finger, whilst the neck of the inguinal sac lies above, and the hernia passes to the inner side of the finger. The hernia is frequently irreducible, and the **DIAGNOSIS** has to be made from the following conditions:

1. An enlarged gland in the groin, especially when lying over the saphena opening. There is no impulse on coughing, the swelling is rounded, and there is no neck passing up into the abdomen.
2. Psoas abscess. The swelling in this case has an impulse on coughing, but it communicates with a larger swelling lying deep in the abdomen above Poupart's ligament. There is also usually an obvious cause in an angular curve of the spine.

3. Varix of the saphena vein. This condition is generally associated with varicose veins below. The swelling does not pass into the abdomen, and although there is an impulse on coughing, it is a thrill rather than an expansile impulse.

4. A peritoneal fatty tumour coming through the femoral ring can hardly be distinguished from a femoral hernia, but the distinction is unimportant, as the lipoma usually leads to the formation of a hernia.

5. Enlargement of the ilio-psoas bursa. There is no expansile impulse on coughing, and the femoral vessels are pressed forwards by the swelling.

TREATMENT.—The treatment is either by truss or operation, and the same rules given for the choice of treatment for inguinal hernia apply to femoral hernia. Femoral hernias which are either irreducible or cannot be retained by a truss demand radical cure.

TRUSS FOR FEMORAL HERNIA.—The pad of a femoral truss is smaller than that of an inguinal one, measuring about $3\frac{1}{2}$ inches in length, $2\frac{1}{4}$ inches in breadth, and $1\frac{1}{4}$ inches in thickness, and it should incline more downwards. The spring of the truss also is lighter.

The truss should be applied with the patient recumbent, and the pad should lie below Poupert's ligament, over the femoral canal. If the pad project too far internally, it will press against the pubic spine; and if too far externally, it will press on the femoral vein. If the pad is too large, it is liable to be displaced when the leg is flexed. The spring should pass just below the crest of the ilium like an inguinal truss, but the understrap should be fixed farther forwards, and lie

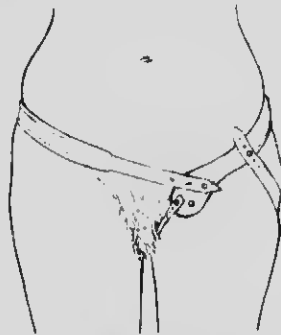


FIG. 337.—FEMORAL TRUSS (AFTER MACREADY).

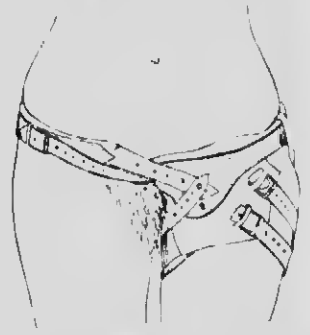


FIG. 338.—FEMORAL TRUSS, WITH INGUINAL AND THIGH PIECES (AFTER MACREADY).

in front of the anterior superior spine. The button on the pad for the understrap should be fixed at a higher level than on an inguinal truss, so that it tends to twist the pad and cause it to face upwards. If the hernia be a large one, the small pad on the femoral truss is not sufficient to retain it, and a thigh-brace must be added. This thigh-brace contains a triangular extension of the pad downwards, which prevents the escape of the viscera below the truss. Should the hernia come out above the truss, an inguinal piece must be added, which

should resemble the pad of a fork-tongue truss, and the same form of apparatus should be used if inguinal and femoral hernia both exist on the same side. When such a truss is applied, the thigh-piece is fixed first, then the cross-straps, and finally the understrap.

RADICAL CURE.—In the radical cure of femoral hernia the sac is exposed by a vertical incision, and carefully cleaned as far as the femoral ring. The neck is then securely ligatured and the sac removed. According to some authorities, there is no need to do anything further, but others prefer to close the ring by one of the following methods:

1. Poupart's ligament is sutured to Cooper's ligament, which lies along the ramus of the pubis, by kangaroo tendon, care being taken not to press on the femoral vein.
2. Poupart's ligament is fixed down to the pelvic bone either by driving in a Ω -shaped staple over the ligament, or by boring a hole in the bone, and passing a suture through the hole and over the ligament.
3. A layer of the pectineus fascia and muscle is turned up and sutured at Poupart's ligament in front of the femoral opening.
4. The abdomen is opened and the ring closed from the inner aspect.

The saphena opening is then closed by sutures and the skin-wound sutured. The after-treatment is the same as that for inguinal hernia.

STRANGULATED FEMORAL HERNIA is more dangerous than strangulated inguinal hernia, as the strangulation is usually tighter and the diagnosis more frequently overlooked, as the hernia is smaller and the patient often unaware of its existence. The sac should be exposed by a vertical incision, opened, and the strangulated contents released by dividing Gimbernat's ligament, the cut being made directly *inward*. Should an abnormal obturator artery be passing along the outer border of the ligament it may be divided, and fatal hemorrhage has occurred from this cause. After the gut has been pulled out of the sac it should be carefully examined, especially the part that has been lying in contact with the sharp edge of Gimbernat's ligament, and it should only be returned to the abdomen if it is viable. If the gut is gangrenous, the following methods of treatment may be adopted:

1. A small gangrenous patch may be sequestered with a purse-string suture.
2. An artificial anus may be formed at the femoral ring and closed at a future operation.
3. The abdomen may be opened in the middle line, the gangrenous gut brought out, and either a primary resection performed or an artificial anus established.
4. Poupart's ligament may be divided, the gut brought out of the abdomen, and a primary resection performed.

Of the last three methods, the formation of an artificial anus is the one to be preferred.

Richter's Hernia

Richter's hernia is a special variety of strangulated hernia, in which a portion only of the circumference of the bowel is strangulated, and is most commonly found in femoral hernia. The gut involved is, as a rule, the ileum, and the constriction is so tight that gangrene soon occurs.

The *Symptoms* are those of acute intestinal obstruction. In some cases flatus and feces may be passed in the early stage of the strangulation, and this, with the small size of the hernia, may cause the diagnosis to be overlooked, and serious delay in operation may follow. When the sac has been opened during herniotomy, and the constriction is about to be divided, care should be taken that the small piece of gut is securely held, or it will slip back into the abdomen when it is released, and if gangrenous, feces will become extravasated into the peritoneal cavity.

The mortality following Richter's hernia is higher than that following the more common type of strangulation.

Umbilical Hernia

An umbilical hernia is one occurring at or near the umbilicus, and three varieties are described: (1) Congenital umbilical hernia; (2) umbilical hernia of children; (3) umbilical hernia of adults.

1. Congenital Umbilical Hernia.—This condition is due to imperfect closure of the anterior abdominal wall, so that there is a protrusion of the intestinal contents into the umbilical cord. If the prolapse is small in amount, the condition is called a "congenital umbilical hernia," but if there is a large gap, with protrusion of much of the viscera, the term **exomphalos** is given to the condition.

CLINICAL FEATURES.—A swelling is present at the root of the umbilical cord when the child is born, and if the cord is ligatured too close to the abdominal wall, a piece of gut may be included in the ligature, and intestinal obstruction result. If the child escapes this danger, the peritoneal cavity is opened, when the cord sloughs away and infective peritonitis will follow.

TREATMENT.—The abdomen should be opened as soon as the diagnosis is made, the contents of the sac reduced, the umbilical cord dissected away, and the abdomen closed with sutures. With a severe degree of exomphalos no treatment is possible.

2. Umbilical Hernia of Children.—This condition is a yielding of the umbilical scar, and generally occurs during the first three years of life. The causes are rickets, with flatulent distension of the abdomen, and straining, due to phimosis or constipation.

The **SYMPTOMS** are the presence of a soft swelling at the umbilicus ("starting of the navel" or "windy navel"), which increases when the child cries, and is readily reducible into the abdomen. The condition tends to undergo spontaneous cure, as it is common in children, very rarely persists to adult life, and seldom requires operative treatment.

TREATMENT.—Any cause, such as improper feeding, constipation, or phimosis, should receive appropriate treatment. An umbilical band made of india-rubber, or with cotton or silk sides, with a *flat* pad to fit over the umbilicus, may be worn, or an excellent support may be made by wrapping a penny in a piece of lint, and fixing this over the umbilical ring by two broad pieces of strapping, making a cross on the abdomen. The band or strapping is worn day and night, and is only removed for washing purposes. It should be worn until the hernia is cured.

Operative cure is carried out by removing the sac and the skin over it, and suturing the abdominal wall. This treatment is rarely necessary.

3. Umbilical Hernia of Adults.—This variety of hernia is most common in fat, middle-aged subjects, usually women who have borne children. The opening is situated either just above or below the umbilicus, mostly the former, and the condition is often associated with divarication of the recti.

The peritoneal sac is thin and, according to some authorities, congenital in origin; and as the subcutaneous tissue usually disappears, the contents of the sac have only a thin covering of skin and peritonium. The contents of an umbilical hernia are commonly omentum and the transverse colon, but large herniæ—and an umbilical hernia may be enormous—contain small intestine as well. The omentum is frequently adherent to the sac, causing the hernia to be irreducible, and the sac may be loculated so that strangulation inside the sac is not uncommon.

CLINICAL FEATURES.—The hernia as a rule steadily increases in size, and lies pendulous on the abdominal wall, so that it may reach to the symphysis pubis. Eczema may occur in the fold between it and the abdominal wall, and ulceration of the skin over the hernia is common.

The hernia is liable to attacks of inflammation, which lead to adhesion between the contents and the sac, and render it irreducible, but a more important complication is incarceration or obstruction. This complication is due to the inclusion of the transverse colon in the hernia, and the condition of constipation which is usually present in these patients. Incarceration frequently ends in strangulation, and the prognosis in these cases is bad, owing partly to late diagnosis, and partly to the general condition of the patient, who is usually elderly and fat.

TREATMENT—Truss.—The pad in an umbilical truss is a large slightly convex shield, which is fastened to a spring embracing the body, and ending behind in a smaller pad which rests on the spine. A soft leather strip connects the two pieces on the opposite side to the spring. Many instrument-makers put a plug in the middle of the shield, but this is useless, as it is impossible to be certain that it is in place. The spring passes round the trunk midway between the iliac crest and the costal arch, and the pad is placed with the hernial orifice just behind the upper edge of the pad, so that it supports the belly

wall below the umbilicus. For irreducible hernia a similar truss can be applied, but the pad must be large enough to cover the hernia completely, and must be more concave. In measuring for this truss the circumference of the body at the umbilicus should be taken with the patient lying down. If, as is frequently the case, the umbilical hernia is part of a pendulous belly, the pad of the truss is incorporated into an abdominal belt.

Radical Cure.—There are many methods of performing a radical cure of an umbilical hernia, but in all the two essential points are removal of the sac and closure of the hernial orifice. This latter step may be easy or difficult, and in large herniæ it may be necessary to close the opening with a silver filigree. After the operation the patient should be kept recumbent for three weeks, and when allowed up should wear a well-fitting abdominal belt.

Incarceration should be treated by manipulation of the sac and the giving of enemata high up into the bowel, followed by purgation after the enemata have acted. If this form of treatment is not quickly followed by the relief of all symptoms, herniotomy should be performed.

Strangulated umbilical hernia should be treated by opening the sac, removing any adherent omentum, and, if necessary, incising the margin of the hernial ring so that the intestine can be reduced. This should be immediately followed by radical cure of the hernia.

Divarication of the Recti.—By this term is meant a separation of the two recti muscles from one another, so that when the patient strains or lifts the head and shoulders from the bed a ridge appears in the middle line of the abdominal wall, whilst the recti are felt as two firm bands on either side of it.

Divarication of the recti is not uncommon in young children with rickets and flatulent distension of the intestine. The only treatment necessary is the treatment of rickets, and the divarication tends to disappear as the child gets older.

In adults divarication of the recti is most frequently seen in middle-aged obese women who have had many children, and the condition is most marked below the umbilicus. It is frequently associated with umbilical hernia and Glenard's disease, and the patients complain of flatulency, indigestion, and constipation.

TREATMENT.—As a rule the treatment consists of wearing an abdominal belt or scientifically made corsets that support the abdominal wall; but in some cases, especially if an umbilical hernia is present, operative treatment may be carried out, and the two recti brought together in the middle line.

Ventral Hernia.—Ventral hernia is a term used to describe a hernia through the anterior abdominal wall at some other place than one of the regular hernial orifices, and several varieties may be described.

1. *Hernia due to the yielding of a Scar following an Operation or an Accident.*—When an operation or an accidental wound of the abdo-

minimal wall has been carefully sutured in the folds by the first intention, it is rare for the scar to yield and allow a hernia to form. In some cases, however, such a condition does occur in spite of the most careful treatment. The usual cause of the development of this traumatic ventral hernia is suppuration in the wound, and the condition is therefore most frequently seen after incisions for appendix abscesses or suppuration in the Fallopian tubes. In some cases the scar only yields at the place where the drainage-tube has been inserted. When operation is undertaken, it is usually found that the intestines or omentum are adherent to the scar.

The presence of the hernia gives a feeling of weakness to the abdominal wall, and if the condition is neglected, a very large hernia may form. These hernia are nearly always reducible, and as the internal opening is a large one, strangulation is uncommon, though it may occur.

TREATMENT.—The patient may wear an abdominal belt, with a pad over the hernial orifice, or a second operation may be performed to close the hernia. All the scar tissue is carefully cut away, and a dissection of the layers of the abdominal wall carried out. When every layer on each side of the wound is distinct, they are carefully sutured together across the gap, and care is taken that the wound heals by the first intention. A light abdominal belt should be worn after the operation.

2. *Fatty Hernia of the Linea Alba (Epigastric Hernia).*—These hernia are most commonly met with in men between the ages of thirty and fifty, and are situated in the middle line of the abdomen, about midway between the umbilicus and the ensiform cartilage. They start as a protrusion of subperitoneal fat between the interlacing fibres of linea alba (fatty hernia), and as this protrusion of fat increases, it drags with it a small pouch of peritoneum. This pouch may remain empty and the hernia increase in size very slowly, or a piece of gut or omentum may pass into it, and the hernia grow more rapidly.

CLINICAL FEATURES.—The patient may merely complain of the small swelling, or state that there is a sense of weakness in the abdominal wall, and at times attacks of pain and vomiting. Strangulation may occur in these hernia, and if this happens, gangrene of the gut rapidly follows.

On examination, a small rounded swelling is found in the middle line in the epigastrium. It has a faint expansile impulse on coughing, and is not as a rule reducible into the abdomen.

TREATMENT.—These hernia cannot be treated by a truss, and a radical cure following the lines of operation for an umbilical hernia should be advised. If this is refused or contra-indicated by the general condition of the patient, the hernia should be left alone.

3. Hernia may also occur in the lineæ semilunaris, either above or below the deep epigastric artery, but is so rare as to need no detailed description. It is treated in the same way as an umbilical hernia.

Lumbar Hernia

Lumbar hernia may be divided into two groups: (1) Spontaneous, and (2) traumatic.

1. Spontaneous lumbar hernia occur between the crest of the ilium and the last rib coming through Petit's triangle, the gap left between the free borders of the external oblique and the latissimus dorsi. This form of hernia is rare, and in one case dissected by the author was preceded by the formation of a properitoneal fatty hernia. They cause no symptoms, and may be treated by wearing a belt or by radical cure.

2. Traumatic lumbar hernia usually follows operations on the kidney, especially when suppuration has occurred in the wound, or after the opening and draining of a lumbar abscess, and may attain a very large size. The patient complains of a sense of weakness in the part, and the diagnosis is obvious. Strangulation rarely occurs.

The TREATMENT consists of wearing a belt, or resuture of the wound after dissecting away all the scar tissue.

Obturator Hernia

An obturator hernia escapes from the abdomen through the canal for the obturator vessels at the upper and inner part of the obturator foramen. The hernia may remain situated between the obturator membrane and the obturator externus, or lie in front of that muscle and pass down the thigh.

This form of hernia is most common in elderly women, and is rarely seen in men. The condition is usually unrecognized until strangulation has occurred, and then only when the abdomen has been opened for acute intestinal obstruction of unknown cause.

Before strangulation the patient may complain of pain and discomfort in the thigh, and a swelling may be felt deeply in the inner side of the thigh. In a minority of the cases pain is referred along the obturator nerve. This hernia cannot be controlled by a truss.

TREATMENT.—If recognized before strangulation, the hernia may be exposed by an incision on the inner side of the thigh. The interval between pectineus and adductor longus is sought for, and on separating these muscles the hernia comes into view. The contents are reduced, the neck of the sac ligatured, and the sac removed.

When strangulation has occurred, the hernia will usually be discovered during exploratory laparotomy, and reduction can be accomplished from within the abdomen, the obturator ring being divided upwards and inwards if necessary. In a case operated upon by the author the sac was pulled into the abdomen and removed, and the gap closed by sutures, with a satisfactory result.

An ischiatic hernia leaves the abdomen by the great sacro-sciatic foramen either above or below the pyriformis muscle, and forms a swelling in the gluteal region.

Perineal herniæ pass out of the abdomen through some part of the pelvic diaphragm, and the following varieties are described:

1. A protrusion into the perineum to one or other side of the median line; only met with in men.
2. An ischio-rectal hernia most common in women.
3. A vaginal hernia into the vagina.
4. A pudendal hernia extending into the posterior part of the labium majus.

TREATMENT.—Special trusses and pessaries are made to support these hernia, or they may be treated by various plastic operations.

Diaphragmatic Hernia

Hernia through the diaphragm may be either congenital or traumatic, and both varieties are much more common on the left side than on the right (7 to 1).

CONGENITAL DIAPHRAGMATIC HERNIA passes through congenital gaps in the muscular tissue of the diaphragm, usually associated with imperfect development of one of the elements that go to form that muscle.

The contents of the abdomen pass up into the thorax, and the patient may live for years with the condition unsuspected. The diagnosis may be suggested by finding anomalous physical signs in the thorax during an examination. These signs vary considerably before and after a meal, or after the bowel has been emptied by an aperient.

TRAUMATIC DIAPHRAGMATIC HERNIA follows stabs in the chest

involving the diaphragm; and severe crushes which rupture the diaphragm. The original injury is often fatal, and the condition only discovered on post-mortem examination. If the condition develops gradually, the clinical features are similar to those of the congenital type.

TREATMENT.—If the diagnosis is made before strangulation, the thorax should be opened by resection of one or more ribs, the hernia reduced, and the opening in the diaphragm closed.

In the majority of cases the first marked symptoms of the hernia will be those of intestinal obstruction following strangulation, and the abdomen will be opened before the diagnosis is made. The strangulation should be released, and radical cure deferred to a second operation if trouble is experienced in reaching the opening in the diaphragm

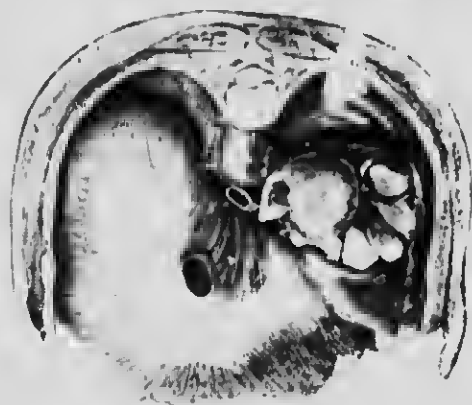


FIG. 221. DIAPHRAGMATIC HERNIA SEEN FROM THE CHEST.
(London Hospital Medical College Museum.)

SPECIAL VARIETIES OF HERNIA FROM THE CONTENTS

Littre's Hernia.—A Littre's hernia is a hernia, usually inguinal or femoral, that contains a Meckel's diverticulum. It is only to be diagnosed at operation. When strangulated, the condition resembles a Richter's hernia.

Hernia of the Cæcum and Appendix.—The cæcum and the appendix are most often found in right inguinal herniæ, but may also occur in right femoral and umbilical herniæ, and even in inguinal and femoral herniæ of the left side.

Two varieties may be distinguished: (1) The cæcum and appendix lie free in a hernial sac in the same way as any other portion of the gut, and the condition calls for no special remark. (2) The cæcum and the appendix, and sometimes the ascending colon, with the peritoneum in relationship with them, slide down into the scrotum and form part of the hernial sac, so that the intestine is uncovered by peritoneum on its posterior surface. This form of hernia of the cæcum may be either congenital or acquired. The congenital variety is due to the pulling down into the scrotum of the cæcum and the peritoneum lining the right iliac fossa by contraction of the gubernaculum testis, which has an attachment to the peritoneum at the ileo-cæcal junction as well as to the lower pole of the testis. As the testis descends into the scrotum, it pulls the cæcum and its peritoneum down with it.

The acquired variety is found in very large old-standing herniæ in patients with lax abdominal walls and general prolapse of the intestine (enteroptosis).

Hernia of the cæcum is frequently irreducible, but on account of the large size of the ring usually present in these herniæ, is rarely strangulated. Inflammation of the appendix, ending in suppuration, may occur in the sac. The appendix is occasionally the sole occupant of the hernial sac.

TREATMENT.—The first variety of cæcal hernia is indistinguishable from, and the treatment does not differ from that of other forms of inguinal or femoral herniæ.

Treatment of the acquired variety by means of a truss is unsatisfactory, as the hernia cannot as a rule be retained, and operation is essential.

The complete diagnosis is generally only made on operation, and some care must be taken that the gut is not opened during the attempt to ascertain the exact condition present. The method of effecting a radical cure differs with the condition found, and no definite rules can be laid down. These operations are not infrequently followed by recurrence, and if this is to be feared, the patient should wear a light truss after the operation.

Hernia of the Iliac Colon.—The remarks made on hernia of the cæcum on the right side exactly apply to hernia of the iliac colon on the left, except that hernia of the colon is not so commonly congenital as hernia of the cæcum. Hernia containing this part of the gut is usually very large, and replacement is a long and tedious operation. There is danger of a hæmatoma of the scrotum following these operations, and great care should be given to hæmostasis.

Hernia of the Ovary.—Hernia of the ovary is most common in inguinal hernia, usually of the left side, and may occur either in infants or adults.

In **INFANTS** the ovary, with the Fallopian tube, is herniated into the canal of Nuck, and it is usually the sole content of the sac. It is recognized as a firm, rounded body lying outside the external abdominal ring. The condition may be temporary and the hernia return to the abdomen, or it may become irreducible. Torsion of the ovary in a hernial sac may occur, the condition exactly resembling acute torsion of the imperfectly descended testis (see p. 1183).

In **ADULTS** hernia of the ovary is generally associated with hernia of other of the abdominal contents, but it may be herniated alone. In all cases a careful examination of the organ should be made, as it may turn out to be an imperfectly descended testis, and that even in individuals who have lived married lives as women, the patient being an external pseudo-hermaphrodite.

TREATMENT.—In infants truss treatment or radical cure may be carried out; but the latter is probably the better. If torsion occur, the ovary should be removed. In adults, especially if the hernia is irreducible, radical cure should be advised, and if necessary, the organ should be removed and submitted to microscopic examination.

Hernia of the Uterus.—The uterus, and even the gravid uterus, has been found in large ventral or inguinal herniæ, and as surgical curiosities herniæ in males have been found to contain a uterus, the patients being internal pseudo-hermaphrodites.

Hernia of the Bladder.—The bladder has been met with in ventral, inguinal, femoral, obturator and sciatic herniæ, and the following varieties are distinguished: (1) In large herniæ the fundus of the bladder is dragged through the hernial orifice by its peritoneal covering. The hernia of the bladder is extraperitoneal. (2) A diverticulum of the mucous membrane of the bladder may pass into the hernia and be either intra- or extra-peritoneal. (3) The bladder may be pulled into the hernial orifice during operation if excessive traction is made on the peritoneum. (4) In congenital cases a part of the bladder covered by peritoneum may pass into a patent processus vaginalis.

CLINICAL FEATURES.—The condition may only be discovered on operation, but in some cases there are—Irritability of the bladder; a desire to micturate when the hernia is pressed upon; increase in size of the hernia as the bladder fills. Micturition is assisted by pressing on the hernial sac. In some cases a calculus has formed in the pouch of the bladder in the hernia. During the performance of a radical cure, the bladder may be unrecognized and injured, and after the operation the patient may pass blood-stained urine, this being the first indication noticed of the condition. The wound must be reopened, and the condition found treated.

TREATMENT.—Radical cure of the hernia should be carried out and the bladder replaced in the abdomen. If this is refused or contra-indicated, a truss should be worn.

CHAPTER XXII

INJURIES AND DISEASES OF THE ANUS AND RECTUM

CONGENITAL MALFORMATIONS

Imperforate Anus—Embryology.—The rectum is developed from the hind-gut, which at first ends blindly at the lower part of the embryo. About the fourth week of intra-uterine life an invagination of the epiblast, the proctodæum, occurs at the future anal orifice, and later it unites with the hind-gut to form an open passage. Before this occurs, the allanteis—*i.e.*, the embryonic bladder, and the Wolfian ducts (the embryonic urinary and genital ducts)—open into the hind-gut, and there is



FIG. 340. — IMPERFORATE ANUS SHOWING END OF THE ALIMENTARY CANAL AND THE PROCTODÆUM.



FIG. 341. — IMPERFORATE ANUS IN A FEMALE CHILD.

therefore a common cul-de-sac, or cloaca, for the hind-gut and the urogenital sinus. About the tenth week this cloaca becomes divided by the growth of a longitudinal septum, the anterior, or urogenital, segment being thus separated from the posterior, or rectal segment.

the perineum forming between the two. About the twelfth week the proctodeum joins the hind-gut. The development of the rectum and anus is then complete. Errors of development—the cause of which is quite unknown—give rise to the various malformations of the rectum and anus which are classed under the term “imperforate anus.” These malformations may be divided into two groups—(1) Those in which the proctodeum does not join the hind-gut, and (2) those in which the longitudinal septum is incomplete, causing the hind-gut to communicate with some part of the urogenital apparatus.

GROUP I

1. The anal canal and the rectum are both present, but the membrane between the two has not broken down. The anus looks normal, but on examination with the finger, the anal canal is found to end blindly. The rectum, which is full of meconium, is felt bulging down the membrane.
2. The anal canal is absent, and the rectum ends blindly. The anus is represented by a small dimple or patch of pigmentation.
3. The anal canal is normal, but ends blindly, and the rectum is absent, or represented by a fibrous cord. This absence of the rectum may include the absence of a large part of the colon.
4. The anus and rectum are both absent, and the colon ends blindly some distance from the perineum. The anus is generally represented by a shallow depression.

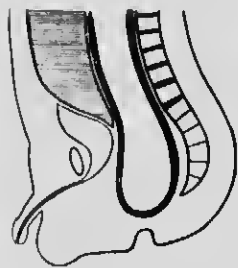


FIG. 332.

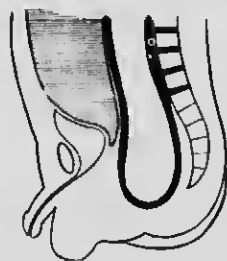


FIG. 313.

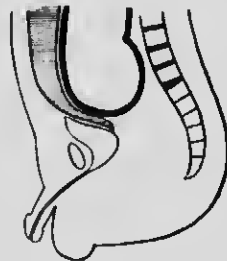


FIG. 344.

CLINICAL FEATURES.—The child does not pass meconium, and has the usual symptoms of intestinal obstruction—viz., vomiting and abdominal distension. Examination may show the absence of an anus, or, if it be present and the little finger is passed into it, it will be found to end blindly.

TREATMENT.—If a septum only is present, it should be divided, and the opening enlarged by stretching with a blunt instrument or the finger.

If the anus be absent, and the rectum can be felt to bulge in the perineum, an artificial anus should be made, and the edge of the mucous membrane of the rectum sutured to it; but as the sphincter is usually absent, there will be incontinence of feces.

When no bulging can be felt, an attempt to find the rectum may be made by dissecting up into the hollow of the sacrum for about $1\frac{1}{2}$ inches. If the rectum cannot be found, the abdomen must be opened and an inguinal colostomy performed in order to make a permanent artificial anus.

Fortunately, the majority of cases—except those with a thin septum—die soon after the operation from exhaustion, cellulitis, or peritonitis.

GROUP II

1. The rectum opens into the bladder or urethra, and the meconium is passed through the penis—during micturition in the first case, and independently of it in the latter. Symptoms of cystitis supervene, followed by those of intestinal obstruction.
2. The rectum very rarely opens into the uterus, but more commonly into the lower part of the vagina. The condition may escape detection during the first year of life, but later the mother will suspect that something is wrong when the child is found to have no control over defæcation. Examination at once discloses the condition. In these cases the anus may be normally developed, or it may be absent.

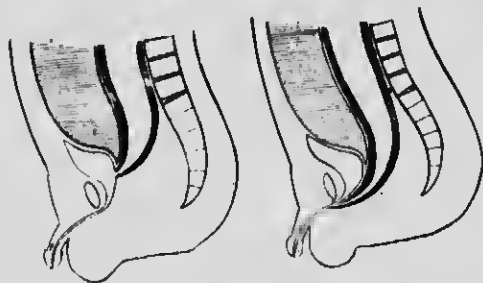


FIG. 315.

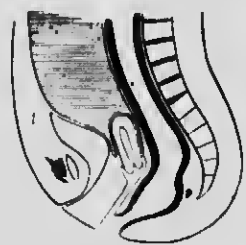


FIG. 316.

TREATMENT.—If the rectum communicates with the bladder or urethra, a colostomy should be performed, and the fistulous opening may then close spontaneously or be occluded by operation.

In cases where the opening is into the vagina, the operation may be postponed for a few years until the parts are well developed. An attempt may then be made to establish an artificial anus in the perineum.

Stenosis of the Anal Canal.—The septum between the anal canal and the hind-gut may not be complete, and meconium may trickle through a hole in its centre. In these cases the opening should be stretched with bougies.

INJURIES OF THE ANUS AND RECTUM

Injuries of the anus, with division of the external sphincter, are most commonly made by the surgeon during operation. The division of the sphincter is followed by a temporary incontinence of feces, but this is never permanent unless the sphincter has been divided in two or more places. Injuries of the rectum from within are not infrequently caused by the unskillful use of enemas, the rectal tube, the proctoscope, and the sigmoidoscope. It is surprising how little pain is caused by the passage of an instrument through the rectal wall into the peritoneum. Unless the treatment be prompt, the patient will die of peritonitis.

The rectum may also be injured by foreign bodies introduced by the patient, and in a few cases the rectum has been ruptured during the passage of a large mass of hard feces.

Severe laceration of the rectum and anus may occur during labour, and the child may actually be born through a widely torn anus.

Injury of the rectum from without is usually caused by falls on pointed stakes, railings, or broken pieces of china. The rectum may be perforated, and the sharp-pointed instrument causing the lesion pass into the peritoneal cavity. A diffuse suppurative inflammation of the perirectal cellular tissue frequently follows these wounds, and general peritonitis may also result. The wounds often bleed profusely. A considerable amount of shock is nearly always present.

TREATMENT.—The wound should be thoroughly explored, for it is very easy for a foreign body to remain hidden in it. Hæmorrhage should be checked by tying the bleeding-points, or by careful suturing if the wound is clean-cut. Lacerated wounds should only be partially closed and left to granulate.

If the peritoneal cavity has been opened, a median laparotomy should be performed in order that the peritoneum may be cleaned, and efficient drainage established. If cellulitis of the perirectal tissue or peritonitis should occur, it should receive appropriate treatment.

Foreign Bodies in the Rectum.—Foreign bodies of the most diverse nature have been introduced into the rectum by children, criminals, lunatics, etc. Of more clinical importance are the lodgment in the rectum of hard masses of feces and foreign bodies that have been swallowed.

1. Impacted Fæces.—A hard mass of feces may not infrequently be found in the rectum of lunatics, of patients with chronic constipation, and of those who are kept in bed from any cause, and whose bowels are not properly regulated. The centre of such masses may be a gall-stone, or a fruit-stone that has been swallowed. The condition may be mistaken for a new growth.

The patient complains of a sense of fulness in the rectum, and suffers from spurious diarrhœa, passing mucus coloured with fecal matter, or with blood. The mass may cause ulceration of the rectum by pressure.

A digital examination of the rectum usually makes clear the diag-

nosis. In some cases, however, the patient shows the symptoms of intestinal obstruction before the condition is discovered.

TREATMENT.—The mass of faeces must be broken up with forceps, the handle of a spoon, or with the fingers. In cases where the mass has been present for years, and is impregnated with lime salts, it may be necessary to crush it with a lithotrite or some such instrument. The rectum should then be thoroughly washed out, so that all the mass is removed. In early cases a well-administered enema is all that is necessary.

2. **Foreign Bodies** that have been swallowed (fish-bones, nails, teeth of combs, etc.) often lodge in one of the pouches of the lower end of the rectum, and cause ulceration and perirectal abscesses.

SYMPTOMS.—The patient complains of intense pain *c.*: defaecation, and often suffers from a discharge of blood and pus from the rectum. The rectum does not feel empty after defaecation, and tenesmus is frequently present.

The diagnosis is made by examination with the finger or the proctoscope. The foreign body, however, is often only discovered during the operation for rectal ulceration or ischio-rectal abscess or fistula.

A foreign body in the rectum may find its way into the bladder, uterus, vagina, or the peritoneal cavity.

TREATMENT.—The sphincter should be dilated, and the foreign body removed in any way that ingenuity suggests.

DISEASES OF THE RECTUM

INFLAMMATION OF THE RECTUM (PROCTITIS)

Primary inflammation of the mucous membrane of the rectum is not a common condition, but may result from—

1. Irritation of foreign bodies or scybalous masses in the rectum.
2. Extension from an inflammation of the colon, as in dysentery.
3. Direct infection following an injury, or, in the case of gonorrhœal proctitis, from pus trickling from the vagina into the rectum, or from unnatural sexual practices.

The organisms of syphilis, tubercle, and diphtheria may also cause inflammation of the rectum.

Acute Proctitis—**SYMPTOMS.**—Burning pain in the rectum, which is worse on defaecation, and associated with tenesmus and spasm of the external sphincter and levator ani. The mucous membrane of the rectum is red and swollen, often protruding through the anus, and discharging blood-stained mucus or pus.

TREATMENT.—The rectum and lower part of the alimentary canal should be completely emptied by enemata, and any cause, such as dysentery, should receive appropriate treatment. The patient should be kept in bed, and have warm injections or irrigation of the rectum. Morphia may be necessary for the relief of pain.

Chronic Proctitis may follow an acute attack, or the inflammation of the rectum may be chronic from the first. The condition is nearly always associated with ulceration of the rectum, and will be con-

sidered under that heading. A chronic superficial inflammation of the mucous membrane of the rectum has been described analogous to chronic superficial glossitis.

Ulcers of the Anus and Rectum.—

1. Ulcers due to the presence of impacted feces or foreign bodies. These ulcers are due to pressure on the mucous membrane, causing sloughing, or to suppuration occurring in the lymph follicles of the rectum—follicular ulceration. The ulcers are shallow, and have irregular outlines. They are most commonly found just inside the internal sphincter on the posterior wall of the gut.

SYMPTOMS.—Burning and itching near the anus, and as a rule an irritating discharge. The diagnosis is made by examination with the proctoscope.

TREATMENT.—The rectum is kept thoroughly empty, and is washed out daily. Applications of silver nitrate are made to the ulcer through a speculum.

2. Ulceration associated with piles. These ulcers may be due to suppuration of the piles or to ulceration of the mucous membrane following prolapse. They are apt to become very chronic, with hard indurated edges. They are thus easily mistaken for malignant disease.

Their **SYMPTOMS** are similar to those of the above variety. Perirectal suppuration, fistula formation, and ultimately stricture, frequently follow these ulcers.

TREATMENT.—The piles should be treated by operation, and the ulcer excised or thoroughly scraped. The after-treatment consists in keeping the bowels loose and the rectum clean.

3. **DYSENTERIC** ulceration. This is usually associated with dysenteric ulceration of the colon. The ulcers are at first multiple and superficial, but they tend to run together, forming large irregular ulcers with ragged edges. Perirectal suppuration is not uncommon, and stricture may result.

The **CLINICAL FEATURES** and **TREATMENT** are considered under Ulceration of the Colon (p. 676).

4. **TUBERCULAR** ulceration of the anus and rectum is most frequently met with in patients who suffer from phthisis. It is generally due to a local infection of the mucous membrane by the bacilli conveyed in the feces. The ulcers are mostly multiple, and have undermined edges and sloughing floor. Occasionally one large ulcer may be present, involving the anus and surrounding skin. This type of ulcer closely resembles a carcinoma, and may only be diagnosed on microscopic examination. The most characteristic feature of tubercular ulceration is the presence of small tubercular nodules in the neighbourhood of the ulcers. Perirectal suppuration and the formation of fistulae are common.

The PROGNOSIS of these ulcers is very unfavourable. There is usually progressive destruction of the rectal mucous membrane. Tubercular fistulæ either do not heal after operation or soon break down again. The symptoms are those of any form of rectal ulceration.

TREATMENT.—The treatment is mainly palliative, especially if the patient has advanced phthisis, and the ulcer should be kept clean. In some instances it should be excised or cauterized with a Paquelin's cautery. Fistulæ should be dealt with in the usual way. If the disease is attended with much pain, it may be advisable to perform colostomy to keep the part at rest.

5. SYPHILITIC ULCERATION.—

- (a) Primary chaneres of the anus and anal canal may follow sodomy or accidental infection.
- (b) In the secondary stage of both the acquired and congenital varieties condylomata and superficial ulceration are frequently seen round the anus and in the anal canal. They are characteristic of the disease.
- (c) In the tertiary stage ulceration of the rectum follows the breaking down of circumscribed gummata, or diffuse gummatous infiltration of the submucosa and the perirectal tissues. The ulcers are most commonly situated just above the internal sphincter, and have the ordinary syphilitic characteristics—i.e., they are serpiginous in outline, with hard clean-cut edges, and a yellowish slough on the floor. Confirmation of their nature should always be sought in the history and presence of other syphilitic lesions and Wassermann's serum reaction. The diagnosis of syphilis as a cause of rectal ulceration has been assumed much too often. Fistulæ form frequently, and the condition may be associated with dense cicatricial stricture of the rectum.

The SYMPTOMS are similar to those of other forms of rectal ulceration.

TREATMENT.—Antisyphilitic remedies should be given, the rectum and anus kept clean, and a dusting-powder of calomel, iodoform, and boracic acid applied. If the ulceration is extensive, contraction of the scar during healing should be guarded against by the passage of bougies.

6. MALIGNANT ULCERATION. This will be considered under Tumours of the Rectum (p. 770).

Fissure.—An anal fissure is a small superficial ulcer situated at the anal verge. It is commonly associated with piles or fistulæ, but it may be present alone. The condition is most frequently seen in patients who suffer from chronic constipation. In its typical form it is, according to Ball, due to the tearing down of one of the small anal valves by the passage of a hard mass of faeces. The fissure is usually single, and situated on the posterior wall of the anal canal. When

associated with stricture of the rectum, however, several fissures may be present.

CLINICAL FEATURES.—The patient complains of severe cutting or burning pain during defecation, and lasting a variable time afterwards. The pain is so severe that the patient fears and puts off defecation as long as possible, and when obliged to pass a motion the pain is intensified.

On examination, the sphincter is found to be in spasm, and the introduction of the finger will cause the same pain as complained of during defecation. If the patient bears down, the fissure may be brought into view. It may, however, be necessary to conduct the examination under anaesthesia.

The fissure presents itself as a small triangular ulcer, with the base downwards, at the junction of the anus and the anal canal. The edges may be soft, and the ulcer superficial; but if it has been neglected, the edges are hard, and it may have invaded the muscular tissue. At the lower end of the fissure there may be a small oedematous tag of tissue known as the "sentinel pile."

TREATMENT.—In mild cases the application of a lotion or ointment, or canterization with silver nitrate, and keeping the bowels loose, will effect a cure; but in the majority of cases the pain is so intense that patients want immediate relief, and this can always be procured by operation.

The sphincter is thoroughly stretched, and the fissure and sentinel pile excised, or the sphincter may be cleanly divided through the base of the ulcer. If the condition is associated with piles, fistulae, or stricture, these should be treated at the same time.

PERIANAL AND PERIRECTAL SUPPURATION

Suppuration in the perianal and perirectal regions is of frequent occurrence. It is generally due to infection spreading from the rectum, as is the case in all forms of rectal ulceration, but may also be due to direct infection from the exterior or to extension from neighbouring organs—for example, the prostate or the appendix. The inflammatory condition may spread through the cellular tissue (perirectal cellulitis), and rapidly cause death from toxæmia, or from infection of the peritoneum. In the majority of cases, however, localized abscesses are formed, which require incision and drainage. If these abscesses are not efficiently treated, they are apt to leave complicated fistulae and sinuses, which will not heal spontaneously, but will need radical operative treatment. The organisms most frequently concerned in the formation of these abscesses are staphylococcus, streptococcus, *Bacillus coli communis*, and the tubercle bacillus.

The following varieties of abscesses and fistulae are to be distinguished:

- Perianal.
- Ischio-rectal.
- Submucous; and
- Pelvi-rectal.

Perianal Abscess.—A perianal abscess is situated in the subcutaneous tissue at the anal verge, superficial to the external sphincter.

The common causes are suppuration in one of the hair follicles or sebaceous glands of the anus, or suppuration in a thrombosed external pile.

CLINICAL FEATURES.—The patient complains of burning and itching round the anus, and acute pain on defaecation. On examination, a small inflammatory focus is found near the anus, the centre of which is soft and fluctuating.

TREATMENT.—The abscess is held under the finger and thumb, and a Syme's knife passed through it twice, the incisions being at right angles to each other. A general anaesthetic is not necessary. Fistula formation is uncommon.

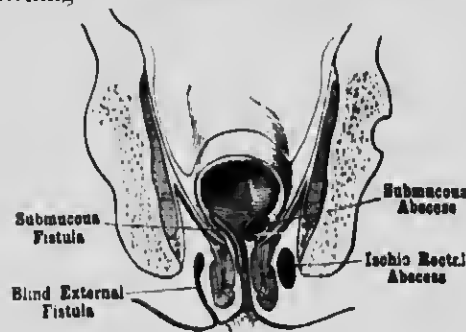


FIG. 347.—DIAGRAM SHOWING THE SITUATION OF ABSCESSES AND FISTULAE ROUND THE ANUS.

Perianal Fistula.—Fistula formation with permanent abscess as a rule only results if the abscess be allowed to burst. The fistula may end blindly internally, or may communicate with the anal canal below the external sphincter.

TREATMENT.—The fistula is laid open and the tract packed with gauze. Healing occurs readily.

Ischio Rectal Abscess.—Abscess formation in the ischio-rectal fossa is the most common form of perirectal suppuration. The condition may be acute or chronic.

The common causes are—

1. Infection of a hæmatoma produced by a kick or similar injury.
2. Spread of inflammation from perianal suppuration.
3. Infection from ulceration in the rectum.
4. Penetration of the lower end of the rectum by a foreign body—*e.g.*, fish-bone.
5. Suppuration above a stricture, either fibrous or malignant.
6. In a few cases there is a primary infection by the tubercle bacillus.

SYMPTOMS OF ACUTE ISCHIO-RECTAL ABSCESS.—The *General* symptoms are those of an acute infection.

Locally, there is throbbing pain in the anus, perineum, and rectum. A hard, brawny swelling forms by the side of the anus, which can be felt bulging into the rectum. Later, the swelling softens, and the usual physical signs of an abscess are found. The abscess may burst into the rectum, commonly on the posterior wall, and between the internal

and external sphincters, or through the skin. It may also burst in both places, forming a complete fistula.

Formation of an abscess in the opposite ischio-rectal fossa is not uncommon, and the two abscesses may open by a common opening on the posterior wall of the rectum (horseshoe fistula).

SYMPTOMS OF CHRONIC ISCHIO-RECTAL ABSCESS.—These abscesses occur insidiously, especially in patients suffering from phthisis. They often cause so little inconvenience that the patient does not come for treatment until a fistula has formed.

On examination there is seen a soft fluctuating swelling on the side of the anus, the skin over which is dull red in colour. On rectal examination, the swelling is found to lie deep in the ischio-rectal fossa.

TREATMENT.—The abscess should be opened by a T-shaped incision. The first incision is made across the swelling, parallel to the anus, dividing all the indurated tissue. The second incision runs outwards from the centre of the first.

If the abscess has already an opening into the rectum, the whole tract should be laid open in order to avoid the formation of a fistula.

After thoroughly opening the abscess and evacuating the pus, the cavity should be tightly packed with gauze, and a dressing applied.

AFTER-TREATMENT.—This must be careful in order to avoid fistula formation. A warm bath should be given night and morning until healing has taken place. In the intervals between the baths fomentations should be applied four-hourly. The gauze should be replaced after each bath, and the cavity kept clean.

It is better to have the patient lying down until healing is well advanced. The bowels should be kept confined for the first forty-eight hours. After that they should be kept open with medicine, and the wound cleaned and dressed after each action of the bowels.

Ischio-Rectal Fistula.—Ischio-rectal fistulae are of three kinds:

1. Blind internal, opening only into the rectum.
2. Blind external, opening only on the skin.
3. Complete, opening both on the skin and into the rectum.

The third variety is by far the most common.

The opening into the rectum is usually single, and situated between the internal and external sphincters. The external opening may also be single, but two or more external openings are not unusual, as the

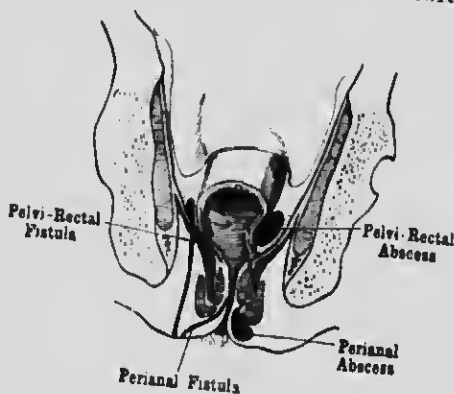


FIG. 348.—DIAGRAM SHOWING THE SITUATION OF ABSCESSES AND FISTULAE ABOUT THE ANUS.

pus tends to burrow through the fat in the ischio-rectal fossa, and burst through the skin in several places. An opening may occur in each ischio-rectal fossa, forming a horseshoe fistula.

CLINICAL FEATURES—1. *Blind Internal Fistula*.—The patient may complain of some pain on defecation and a discharge from the anus, which keeps the skin moist, often causing intense itching (*pruritus ani*). On rectal examination, the internal opening may be felt, and on using a rectal speculum, it can be seen, and pus squeezed from it.

2. *Blind External Fistula*.—The patient complains of little beyond a discharge and occasional attacks of pain when the fistula closes a short time. *On examination*, one or more openings, discharging pus, are seen near the anus; but on passing a probe, no communication with the rectum can be made out.

3. *Complete Fistula*.—The patient complains of discharge from the external openings, and has frequently an escape of flatus or faecal matter along the fistulous tract. Pain is not often a marked symptom, but it may be present on defecation, and occasional attacks may occur from closure of the external opening and collection of pus behind it. *On examination*, one or more external openings are seen, with induration leading from them up to the anus. On rectal examination, the internal opening can usually be felt, and it can be seen with the rectal speculum. A probe can often be passed through the external opening into the rectum. This is not always possible, as the tract may be very tortuous, but if a coloured fluid be injected into the external opening, it will pass into the rectum, and can be recognized. The fistula does not necessarily terminate at the internal opening, for it often runs upwards in the submucous tissue, forming a cul-de-sac.

TREATMENT.—Operation is the only treatment. The patient is prepared for a rectal operation in the usual way, and is placed in the lithotomy, or the left lateral position. A flexible, probe-pointed director is passed along the tract from the external opening into the rectum. The point of the director is brought out through the anus, and the tissue lying on the director, including the external sphincter, is completely divided. Every tract or pouch of the fistula should then be opened up, but care must be taken not to divide the sphincter again, or incontinence of faeces may follow.

If the fistula is of the blind external variety, the probe should be pushed through the mucous membrane of the rectum in order to make the fistula complete. It is then freely laid open.

In the case of a blind internal fistula, the fistula must be made complete by introducing a probe into the internal opening, and cutting down on it from the skin surface. The fistula is then treated as a complete fistula.

In a few cases, if the fistula is small—especially if it is a blind external one—it may be completely excised, and the wound sutured.

AFTER-TREATMENT.—The bowels should be kept confined, and the pain relieved by the administration of tincture of opium in suitable doses. The wound should be dressed twenty-four hours after the operation, but the gauze in the wound should not be disturbed, and

fomentations should be applied four-hourly until the bowels have been opened. On the third evening after the operation a calomel pill should be given, to be followed in the morning by a saline aperient, and after this the bowels should be opened once a day, aperients being given if necessary. After the bowels have been opened it is well to give the patient a bath; or if not, the wound must be thoroughly cleaned, and then lightly packed with gauze, care being taken that all the tracts are filled. The dressing must be done at least once in twenty-four hours and, if possible, immediately after the bowels have been opened, otherwise the cleaning and dressing must be repeated. The dressing should be a gauze pad, secured with a T-bandage. If granulations are slow in forming, the gauze should be soaked in *lotio rubra*.

Until the bowels have been opened the diet should be milk or milk-puddings, but after that the patient may resume his ordinary diet. It is well to keep the patient lying down until the healing is well advanced, otherwise there may be a recurrence. Healing takes place in from three weeks to six months, according to the extent of the fistula and the condition of the patient.

It is, of course, understood that if fistulae are complicated by stricture, hemorrhoids, new growths, etc., the associated condition should receive appropriate treatment.

Submucous Abscess.—This variety of abscess lies between the mucous membrane and the muscular coat of the rectum. It is due to extension from an ulcer of the rectum, or suppuration of a thrombosed internal pile. The abscess tends to point just above the anal canal.

SYMPTOMS.—The patient complains of pain on defecation, and general throbbing in the rectum. In acute cases there are the usual general symptoms of infection. Externally there is often nothing to be seen, but on rectal examination, a soft fluid swelling, which is exceedingly tender, can be felt bulging one side of the rectum.

TREATMENT.—The swelling should be freely incised and packed with gauze, and allowed to granulate. The surgeon must be prepared for free bleeding.

Submucous Fistula.—Fistulae following submucous abscess are of the blind interanal variety.

The CLINICAL FEATURES and TREATMENT have been already sufficiently described.

Pelvi-Rectal Abscess.—A pelvi-rectal abscess lies in the rectovesical fascia above the levator ani muscle. It rarely originates in the rectum. It arises mostly from suppuration in the prostate, vesiculæ, broad ligament, ovary, appendix, etc., and tends to burrow downwards through the levator ani muscle into the ischio-rectal fossa. The opening through the muscle is usually small, and the pus then spreads widely in the fat of the fossa, so that the abscess assumes an hour-glass form.

CLINICAL FEATURES.—These are the symptoms of the original cause of the abscess—for example, appendicitis, prostatitis, or pyo-

salpinx, followed by the formation of an abscess by the side of the rectum, often in the ischio-rectal fossa. On examination of the rectum the swelling is found to pass up above the internal sphincter, and its upper limit cannot be reached.

TREATMENT.—The abscess should be freely opened in the ischio-rectal fossa by a T-shaped incision. The finger or a pair of dressing forceps should be passed through the opening in the fibres of the levator ani, so that a wide aperture is left in that muscle for the exit of pus. The gauze draining the abscess should be passed through the opening to the bottom of the cavity, which must granulate from below. otherwise a fistula will result.

It will often be necessary to treat the original cause—for example, by removal of the appendix or a stone from the prostate—before the abscess will heal.

Fistulae between the Rectum and Other Organs

Fistulae frequently develop between the rectum and neighbouring organs, especially the vagina, urethra, and bladder, a recto-vaginal fistula being the most common.

Recto-Vaginal Fistula follows prolonged pressure of the head on the recto-vaginal septum during parturition, or ulceration due to syphilis or malignant disease. The patient complains of escape of pus and faeces from the vagina, and the diagnosis is made by inspection.

The **TREATMENT** consists of plastic operations on the vagina to close the fistula unless the condition is due to malignant disease.

Recto-Vesical and Recto-Urethral Fistulae are seen in men chiefly in connection with diseases of the urinary passageways, such as urethral stricture, prostatic abscess, removal of the enlarged prostate, etc. They may also follow malignant disease of the bladder or rectum.

The patient complains usually of an escape of urine from the rectum, but sometimes of flatus and faeces passing along the urethra. The diagnosis is made by seeing the opening with a rectal speculum, or injecting coloured fluid into the urethra, and noting its exit in the rectum.

TREATMENT.—In non-malignant cases the bladder should be kept drained through the urethra, and the rectum kept empty by means of a temporary colostomy, in order that spontaneous healing may occur.

There is no treatment for fistula secondary to malignant disease.

Prolapse of the Rectum.—By this term is meant eversion of the anal canal and the rectum through the anus. A slight amount of eversion always occurs during defaecation, but when this is excessive, or persists after defaecation, the condition is pathological.

CAUSES.—The causes of prolapse of the rectum are—

1. Straining at stool, caused by constipation, diarrhoea, the presence of worms, or a rectal growth.
2. Straining during micturition, due to urethral obstruction or the presence of a vesical calculus.

3. Raised intra-abdominal pressure, caused by whooping-cough or the cough of chronic bronchitis.
4. Inflammatory conditions of the rectum, and the presence of hæmorrhoids.
5. Damage to the levator ani (pelvic diaphragm) during child-birth or operation on the rectum.
6. Loss of power in the sphincter, due to injury or loss of nervous control.

The condition is most common at the two extremes of life, and is rarely seen in patients between the ages of ten and sixty; but severe degrees may occur in young and middle-aged adults, the cause of these cases being often obscure.

PATHOLOGICAL ANATOMY.—For the convenience of description and treatment, the condition is divided into incomplete and complete, but the distinction is largely one of degree.

Incomplete Prolapse.—This is present when the mucous membrane only is prolapsed, and is rarely more than 1 or 2 inches in length. The mucous membrane is bright red in colour at first, but may become blue owing to congestion. If the prolapse is permanent, ulceration occurs.

Complete Prolapse occurs when all the coats of the rectum are present in the prolapse. It is usually preceded by incomplete prolapse. It may be excessive. In a case seen by the author it was 9 inches in length.

In the case of women, complete prolapse is generally associated with prolapse of the vagina and uterus.

In these excessive cases the peritoneal pouch lying between the rectum and the bladder in males, and between the rectum and vagina in females, is pulled down by the descent of the rectum, so that it may lie outside the anus. Coils of small intestine may descend into the pouch, forming a rectal hernia, and strangulation of the gut may occur.

In cases of constant prolapse the mucous membrane of the rectum becomes tough and leathery, ulceration being common. In a few cases strangulation of the prolapse by contraction of the external sphincter may occur.

CLINICAL FEATURES.—The prolapse as a rule is incomplete at first, occurring only after defæcation. The patient shows a protrusion of bright red mucous membrane at the anus arranged in folds, with the sulci between them radiating to the centre. The prolapse can be readily returned, and will remain in position.

Later, it may appear without expulsive efforts, and may then become permanent.

There is usually a mucopurulent discharge, and often some hæmorrhage from the prolapse.

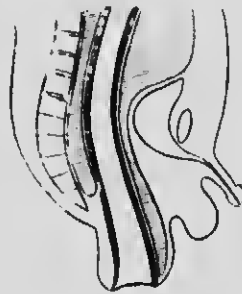


FIG. 349.—COMPLETE PROLAPSE OF THE RECTUM.

After the partial prolapse has existed for some time it becomes complete, and the folds in the mucous membrane are seen to run parallel to the anal margin. The wall of the prolapse is thicker than in the incomplete variety.

It may not be possible to return a complete prolapse by pressure, or if it can be, it often reappears directly the pressure is removed.

A HERNIA into the anterior peritoneal pouch is recognized by an increased swelling in front, which may disappear with a gurgle on pressure, or when the patient is placed in the exaggerated lithotomy position.

Complete prolapse is frequently accompanied by incontinence of feces.

The only error which can possibly be made in the diagnosis is to mistake an intussusception protruding through the anus for prolapse, but an appreciation of the general condition of the patient and a careful examination should prevent this mistake.

Acute Complete Prolapse.—It occasionally happens, especially in elderly people, that a complete prolapse occurs suddenly from a violent expulsive effort. Death may follow from shock.

TREATMENT—Reduction of the Prolapse.—The prolapsed bowel should be covered with a piece of linen smeared with vaseline, and gentle squeezing and pressure made until the bowel slips back. This is generally easy, but in old-standing cases it may be impossible, or if the protrusion is associated with inflammation the prolapse may return immediately after reduction.

Prevention of Recurrence.—Any cause, such as chronic constipation, diarrhoea, phimosis, cough, etc., must receive immediate attention. The buttocks should be strapped together after reduction is effected. For some weeks afterwards the patient should pass his motions in the recumbent position. Children may do so lying on the side or in the upright position if supported. The customary squatting position must be avoided. The patient should rest for some time after the evacuation of the bowel. This treatment is successful in the majority of cases, especially in children.

Instruments.—Pessaries and perineal bands of various kinds have been used to support cases of habitual prolapse, but they are not very successful, and can often not be worn for any length of time.

Operation.—1. In cases of incomplete prolapse, lessening the size of the lumen of the gut may be all that is necessary. This can be done by—

- (a) Making vortical lines on the mucous membrane with the actual cautery in order to produce ulcers, which will cause contraction on healing.
- (b) Constricting the lumen of the bowel by a purse-string suture.
- (c) Excision of elliptical portions of the mucous membrane, and closing the gaps by suturing.

2. *Excision of the Prolapsed Portion.*—This method can be used for either complete or incomplete prolapse. In the case of complete prolapse care must be taken to empty the anterior peritoneal pouch of intestine before the prolapse is clamped and removed.

With incomplete protrusion the operation is practically that of Whitehead's operation for piles. The operation is liable to be followed by excessive cicatricial contraction, but is probably the best form of treatment for habitual prolapse.

3. *Proctopexy.*—The coccyx is removed, and after reduction of the prolapse the rectum is sutured to the sacro-sciatic ligaments.

4. *Colpexy.*—The abdominal cavity is opened, and after reduction of the prolapse the colon is anchored by fixing its mesentery to the lateral wall of the pelvis and shortening the peritoneum.

Both the last methods of treatment may be followed by recurrence.

Fibrous Stricture of the Rectum.—Fibrous stricture of the rectum follows—

1. Proctitis, especially gonorrhœal.
2. Ulceration of the rectum, either stereoral, dysenteric, syphilitic, or tubercular.
3. Injuries to the rectum, with loss of substance, including operation for piles, malignant disease, or fistula.
4. Perirectal suppuration.
5. Pelvic cellulitis, particularly in cases due to infective conditions of the uterus.

Fibrous stricture of the rectum may be situated at any part of the rectum, the two commonest places being near the anus or at the junction of the rectum and the sigmoid loop. All the coats of the gut are usually affected, and the rectum may be firmly fixed to the sacrum, vagina, or bladder by dense fibrous tissue. The mucous membrane is generally ulcerated, and polypoid masses of oedematous mucous membrane are frequently present.

Perirectal suppuration, with the formation of fistulæ, may also occur.

The gut above the stricture is hypertrophied, the lumen dilated, and the mucous membrane is, as a rule, in a state of chronic inflammation, owing to the irritation of retained feces. If the stricture is situated high up in the rectum, the gut below is usually also dilated, partly owing to paralysis of the muscular coats and partly to chronic invagination of the strictured portion into the gut below.

If the stricture is situated near the anal verge, multiple fissures may be present, causing intense pain on defæcation or rectal examination.

CLINICAL FEATURES.—The condition is most common in married women about thirty years of age, and of the poorer class, but it is not infrequently met with in men. There is generally a history of previous

rectal trouble, which may have required treatment. The patient complains of increasing difficulty in passing motions, but the symptoms vary somewhat with the situation of the stricture.

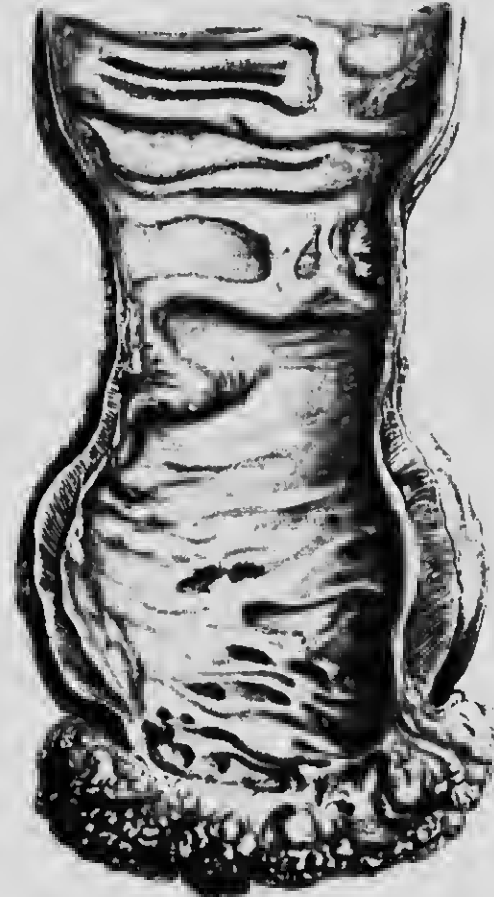


FIG. 350.—FIBROUS STRICTURE OF THE RECTUM
EXTENDING TO THE ANUS.
(London Hospital Medical College Museum.)

1. *With stricture near the anus* there is usually great pain on defaecation, and frequently incontinence, due to involvement of the sphincter, the incontinence chiefly consisting of an escape of blood, mucus, and faecal matter between the acts of defaecation.

2. *With stricture high up in the rectum* pain is not a prominent feature, but there is increasing constipation associated with a *spurious diarrhoea*, caused by the inflamed condition of the mucous membrane above the stricture. The anus is patulous, and prolapse of the mucous membrane below the stricture is common.

With the stricture in either position, the symptoms of complete intestinal obstruction may supervene, usually

owing to closure of the lumen of the stricture by a mass of faeces.

On examination, the skin round the anus is frequently sodden and hypertrophied, and the openings of fistulae may be present. If the stricture is low down, rectal examination, which may be very painful, reveals a dense, hard stricture, through which it may not be possible to pass the finger. If the situation is high up, the rectum below is generally dilated (hallooning of the rectum), and the stricture may not be reached with the finger, but it can be seen with the proctoscope or sigmoidoscope. The shape and condition of the faeces have little diagnostic value, but in the case of a stricture near the anus the faeces

are often thin and tapelike. Examination of the rectum with bougies is very liable to lead to errors of diagnosis, as the bougie is apt to catch in the folds in the rectum, and appear to be arrested by a stricture.

TREATMENT.—The bowels should be kept lax by the daily administration of a suitable laxative, and any condition, such as syphilis or dysentery, should receive appropriate treatment.

With stricture near the anus, the following methods are useful:

1. The stricture is kept dilated with bougies, which are passed at regular intervals (every three or four days).
2. The stricture is divided internally (internal proctotomy), the cut being made in the middle line into the hollow of the sacrum. The stricture must subsequently be kept dilated with bougies.
3. The stricture is divided externally (external proctotomy). The cut also divides the external sphincter, and the stricture is subsequently kept dilated with bougies.
4. The stricture is excised, and the healthy mucous membrane above it brought down to the anus. Unless healing by the first intention is obtained, the condition is liable to return.

With stricture high up in the rectum, the first three methods are unsuitable, and excision of the stricture, if possible, will give the best results.

With the stricture either high or low, if these methods of treatment fail, or if incontinence of faeces be present, or if excision would involve loss of power of the sphincter, a permanent inguinal colostomy should be established.

Hæmorrhoids

Hæmorrhoids, or piles, are a varicose condition of the veins of the lower end of the rectum and the anal canal. These veins are the superior, middle, and inferior hæmorrhoidal veins, which start as plexuses at the lower end of the rectum, and end in the inferior mesenteric, the internal iliac, and the pudic veins.

The most important CAUSES of this condition are—(1) Chronic constipation, usually associated with a sedentary life; (2) overuse of purgatives; (3) constant presence of solid faecal matter in the rectum; (4) pregnancy; (5) tumours in the pelvis; (6) straining due to urethral stricture and enlarged prostate; (7) obstruction to the portal circulation—*e.g.*, cirrhosis of the liver; (8) stricture of the rectum, either simple or malignant.

Piles are met with at all ages and in all conditions of life, but in young adult life are most common in men of the middle and upper classes who lead sedentary lives. In middle age the condition is more common in women owing to pregnancy and the frequent occurrence of constipation in elderly females. Men, however, apply for radical treatment more commonly than women.

For the sake of clinical description, piles are divided into **external** and **internal**. **External** piles are situated at the anal verge, and are varicosities of the inferior hæmorrhoidal vein. They are covered

with the skin of the anus or the stratified epithelium of the anal canal. **Internal piles** are situated above the anal canal, and are chiefly varicosities of the superior hæmorrhoidal veins which run longitudinally under the mucous membrane of the rectum, forming the columns of Morgagni. Each pile consists of a central artery and a surrounding plexus of varicose veins, and is covered by the mucous membrane of the rectum. In old-standing cases the whole of the venous plexuses round the lower end of the rectum and anal canal are varicose, and a condition of **intero-external piles** exists.

External Piles—**CLINICAL FEATURES**.—A patient with external piles is often unaware of them, complaining only of moisture round the anus, itching, and a sense of fulness at the anus after defæcation.

On examination, especially when the patient strains, small bluish swellings, which are easily identified as varicose veins, are seen at the anal verge.

COMPLICATIONS.—A patient who has external piles frequently suffers from the sudden appearance of a soft blue swelling about the size of a cherry at the anal verge. This swelling is exceedingly painful, and contains coagulated blood. After a few days it becomes firmer and finally subsides; but a "tag" of skin and fibrous tissue is left to mark its situation. Suppuration sometimes follows, and a perianal abscess results. The condition is spoken of by the patient as "an attack of piles."

Two explanations of the condition are given: (1) That it is a condition of phlebitis, with thrombosis of the varicose vein (thrombosed external pile); (2) that it is an extravasation of blood due to rupture of the vein from increased pressure during straining. It is probable that either condition may occur.

TREATMENT.—Any cause that can be discovered should be removed, if possible, and a suitable laxative taken regularly to prevent constipation. The anus should be kept very clean, and the patient warned against the use of rough, harsh paper for toilet purposes. An astringent ointment or powder may be used if there is much moisture and itching of the anus. No further treatment is necessary.

Thrombosis may be treated by incising the swelling and removing the blood-clot, or the condition may be left and the blood allowed to absorb. The remaining tag of skin may be snipped off with scissors. If a perianal abscess forms, it must be opened in the usual way.

Internal Piles—**CLINICAL FEATURES**.—The most important, and usually the earliest, symptom of internal piles is bleeding. The bleeding is at first slight, and occurs only when the patient passes a hard motion; later, it may be very profuse, and occur between the acts of defæcation, so that the patient is rendered anæmic, and the general health suffers. The hæmorrhage is as a rule venous, and comes from the dilated veins; but if ulceration takes place over the piles, the bleeding may be arterial.

In addition to the hæmorrhage, there is a sense of fulness in the rectum, especially after defæcation, as if the evacuation were not

complete. Moisture round the anus and pruritus are common, owing to an excessive secretion of mucus, due to the overvascularity of the mucous membrane.

Examination.—On examination of an early case of internal piles, there is little to be made out. The anus is often slightly patulous, but, on the other hand, the external sphincter may be hypertrophied. The mucous membrane feels more fleshy than usual, and it may be possible to make out the outline of a pile. On dilating the sphincter, the piles often prolapse, or the patient can, by straining, cause them to prolapse.

COMPLICATIONS.—Prolapse.—This may be acute or chronic.

Acute Prolapse is sometimes the first intimation to the patient that he is suffering from piles, and is one of the conditions called an "attack of piles." The piles are protruded through the anus during straining at defæcation, and are caught by spasmodic closure of the sphincter. The patient suffers acute pain and tenesmus, and on examination, a red and often bleeding mass is found protruding from the anus. It can be returned by gentle pressure, and the anus will assume its normal appearance.

Strangulation and Sloughing.—If the condition is not at once treated, the mass may be so tightly grasped by the sphincter that the circulation through the veins is obstructed, and the piles become swollen and œdematous, and finally gangrenous. If the condition is untreated, the piles slough off and spontaneous cure results; but the process is painful, and not unattended with the risk of portal pyæmia or stricture of the rectum.

Chronic Prolapse is a condition of constant slight prolapse of the piles during defæcation, so that finally the anus becomes patulous and slightly everted. The mucous membranes over the piles become firmer and paler than normal, owing to fibrosis of the submucous tissue, and the normal columnar epithelium is changed to a stratified epithelium. Superficial ulceration is general, and small polypoid growths are frequently seen on the mucous membrane. *Fissure in ano* is a common complication of this condition.

Inflammation and Thrombosis.—The veins of a pile may be inflamed and cause thrombosis of the blood. The patient complains of severe pain and tenesmus, the anal verge is swollen and œdematous, and the inflamed piles often protrude. This protrusion is distinguished from prolapse by the fact that the pile is firmer and redder than in prolapse, and if pushed back, immediately protrudes again. If no protrusion occurs, and a rectal examination is made, the pile can be readily felt. The condition usually ends in sclerosis and obliteration of the vein, but a phlebolith may form by calcareous salts being deposited in the clot, or the inflammation go on to suppuration. In the last case a submucous or ischio-rectal abscess will be present, and there is grave risk of portal pyæmia supervening. Inflammation of internal piles is another condition spoken of as an "attack of piles."

TREATMENT.—Any cause that may be discovered should receive careful treatment, and the bowels should be kept open by a suitable laxative. The anus should be washed in cold water after defæcation, and a very soft paper or cotton-wool, or a piece of sponge, should be used for toilet purposes. It is well for a patient to rest for a short time after defæcation. If bleeding is severe, astringent suppositories or ointments of adrenalin, hamamelis, tannic or gallic acid, should be used; for moisture and itching, soothing ointments or powders are ordered.

OPERATIVE TREATMENT is indicated (1) If the loss of blood is rendering the patient anæmic or interfering with the general health; (2) if prolapse is frequent and causes pain and tenesmus; (3) if attacks of inflammation are frequent. It is contra-indicated if the piles are secondary to some condition that cannot be relieved, such as cirrhosis of the liver or fibrous stricture of the rectum. In cases of very severe piles increasing during pregnancy, it may be necessary to terminate the pregnancy.

Operations.—There are many operations for removal of internal piles, but they may all be considered under the following heads:

1. **LIGATURE.**—The sphincter is dilated, the pile seized with a pair of pile forceps, and pulled out through the anus. The mucous membrane is divided round the base of the pile and a stout ligature firmly tied round it. The pile and ligature are then cut short, or both may be left to slough off. As many piles as necessary—usually three or four—are treated in this way. Redundant skin round the anus is removed, and a dressing applied.

2. **EXCISION.**—The lower edge of the pile is seized with artery forceps, and pulled out of the anus, and the upper end of the pile is seized with a second pair of artery forceps. A hæmostatic suture is then run backwards and forwards through the base of the pile so that the bleeding is securely controlled. The pile is removed beyond the hæmostatic suture, and the cut edges of the mucous membrane secured by a continuous suture. Three or four piles are dealt with in this way. This method is easy, requires no special instruments, and is attended with little bleeding, both during or after the operation, and is not very painful. This operation, or some modification of it, is to be preferred to other methods, as no raw surface is left to granulate, and the patient is about in a week.

3. **CLAMP AND CAUTERY.**—After dilatation of the sphincter, the pile is pulled out of the anus and clamped firmly in one of the numerous forms of pile-clamps. The pile beyond the clamp is then cut away with the cautery and the clamp removed. This method is very painless but there is considerable risk of hæmorrhage, and it is now little used unless the piles are sloughing.

After any of these operations a short wide tube should be left in the anus to allow the passage of flatus.

AFTER-TREATMENT.—The dressing, which should be secured by a T-bandage, should be changed daily and the part kept clean by bathing with a dilute antiseptic lotion. Morphia is usually necessary

at first to relieve the pain. Retention of urine may occur, and necessitate the use of a catheter. The diet should be light, consisting of boiled fish, milk-pudding, and toast, until the bowels have been opened, and then an ordinary diet should be resumed. The bowels should be opened on the third day after the operation by the administration of a dose of calomel, castor oil, senna, or any simple aperient, and before the bowels act the tube should be removed. After the first action, the bowels should be kept acting daily. The patient should remain in bed for seven to fourteen days.

The chief danger immediately after the operation is hæmorrhage, and the patient should be carefully watched for the general signs of bleeding, for if no tube is left in the rectum, blood to the extent of a pint or more may collect above the sphincter without any appearing externally. Hæmorrhage should be treated by dilating the sphincter and securing the bleeding-point, but if this is not possible, a vaginal speculum may be introduced, and gauze packed between it and the rectal wall.

ACUTE PROLAPSE is treated by squeezing the piles gently back, and in cases in which this often occurs the patient generally does it for himself after defæcation.

STRANGULATION, with gangrene of the piles, may be treated by rest in bed and the application of fomentations until the gangrenous piles separate. Better results are, however, obtained by dilating the sphincter, removing the gangrenous mass, and completing the treatment by one of the methods of operating on piles.

INFLAMMATION AND THROMBUS are treated by rest in bed, keeping the motions soft, and applying fomentations to the anus. Later, a pile operation is to be recommended. Suppuration, with the formation of perirectal abscess, should be treated in the usual manner.

Intero-External Piles.—It frequently happens that internal and external piles are present at the same time, and in old-standing cases with slight chronic prolapse of the rectum, the whole of the venous plexuses round the anus and lower end of the rectum are varicose, and the symptoms of internal and external piles are mixed. The piles are then partly covered with skin and partly with mucous membrane, and the condition is spoken of as "intero-external piles."

TREATMENT.—Palliative treatment, as described above, can be continued; but if relief is not obtained, and the case is otherwise suitable, operation is to be advised.

The operation for this condition is **Whitehead's Excision of the Pile-Bearing Area**, or some modification of it. The sphincter is dilated, and the skin and mucous membrane, with the subcutaneous and submucous tissue containing the varicose veins, is dissected off the muscular coat. The mucous membrane of the rectum is then brought down to the anal margin and sutured there. This operation may cause considerable hæmorrhage, and there is a risk of anal stricture following it if the wound does not heal rapidly. It is too severe a proceeding for ordinary piles, but in the case of a varicose condition of the whole pile-bearing area is the operation to be performed.

Pruritus Ani.—Itching of the anus is generally due to some local disease of the anal canal or rectum, which is associated with a discharge from the anus. The usual causes are piles, ulcers of the rectum, polypi, and fistulae. In other cases it is due to the irritation of thread-worms or pediculi, or is associated with eczema of the anus, either dry or moist.

In a certain number of cases, however, no cause can be discovered, and the condition is considered to be a *neurosis* of the anus.

It is most common in elderly men, and the itching is intense at night. Scratching as a rule aggravates the itching, although it may give temporary relief; but though the patient knows this, the desire to scratch may be irresistible.

On examination, the skin round the anus, which usually shows marks of scratching, is glazed, and without elasticity.

TREATMENT.—Any cause that can be discovered must be treated, and if it can be removed, the itching will usually cease. In cases without any apparent cause ointments containing sedatives, such as cocaine or morphia, may be tried. Cauterization of the skin round the anus with the actual cautery, or with silver nitrate, may give relief, or the skin may be scraped with a sharp spoon under anæsthesia.

Operative Treatment.—The skin round the anus is dissected up and all the cutaneous nerves divided, and the skin then stitched back into position. This may give relief in very intractable cases.

NEW GROWTHS

Innocent

The common innocent new growths of the anus and rectum are papilloma, adenoma, and teratoma.

Papilloma of the Anus.—Papillomata of the anus are most common in young subjects, and may grow to an enormous size. In some cases they are syphilitic in origin, or they may be associated with gonorrhœal or other irritating discharges from the rectum or vagina (gonorrhœal warts); but they may occur without any apparent cause. It is most important not to convict a patient suffering from them of improper practices without strong confirmatory evidence.

The patient complains of a growth at the anus, and on examination, there is seen a mass of softish papillomata, usually with a profuse fetid discharge. The case may be mistaken for malignant disease.

TREATMENT.—The part should be kept dry and clean, and the papillomata may disappear; but it is better to remove them with scissors or to excise the piece of skin from which they are growing.

Adenoma of the Rectum.—Adenomata arise from the rectal mucous membrane, and simulate in structure the glands of the rectum. They are at first sessile, but gradually become pedunculated under the

efforts of the rectum to expel them, when they are spoken of as "rectal polypi." As a rule they are single, but they may be multiple. In appearance they are soft, vascular tumours, about the size of a cherry.

CLINICAL FEATURES.—Adenomata are most common in children, who are usually brought for treatment on account of a blood-stained mucous discharge from the rectum. There may be also some



FIG. 351.—VILLOMATA OF THE ANUS IN A CASE OF SYPHILIS.

tenesmus and straining, and not infrequently the tumour appears at the anus during defaecation. The diagnosis is made on rectal examination, and it may be possible to bring the tumour out of the anus.

TREATMENT.—The sphincter is dilated, the polypus seized, the pedicle tied, and the tumour removed. If the tumour is not pedunculated, it should be shelled out of the mucous membrane, and the gap closed with a stitch. There is no danger of recurrence.

Papilloma of the Rectum.—Papillomata of the rectum are usually soft, villous growths, which may reach a considerable size. They resemble villous growths of the bladder, and are often multiple and pedunculated. Like soft papillomata elsewhere, they have a great tendency to bleed, and are liable to undergo malignant change.

CLINICAL FEATURES.—These tumours are most common in adults, and the symptoms are the passage of blood and mucus *per anum*, and a sense of fulness in the rectum. The hæmorrhage may be so severe as to render the patient anæmic.

The **DIAGNOSIS** is made by examining the rectum with the finger and the proctoscope.

TREATMENT.—The sphincter should be dilated, and the tumour, with the piece of mucous membrane from which it grows, excised.

Microscopic examination of the base should be made, and if the cells are found to have invaded the basement membrane, the case should be regarded as one of malignant disease. Recurrence after removal should lead to excision of the rectum.

Teratoma (Dermoid).—Teratomata may either form pedunculated tumours in the rectum (rectal teratoma) or occur between the rectum and the sacrum (post-rectal teratoma). **Rectal teratomata** form pedunculated tumours on which hair and teeth frequently grow, and are attached to the posterior wall of the rectum. The hair may project from the anus, and thus attract the patient's attention to the condition. They are almost entirely limited to women. **Post-rectal teratomata** are rarer, but may form large tumours lying in the hollow of the sacrum. The origin of these tumours is not yet settled. The treatment is removal.

Malignant

Melanoma of the Anus.—A malignant melanoma sometimes arises in the pigmented skin round the anus. The growths, which are generally deeply pigmented, have the usual features of melanomata (see p. 229), and there is early infection of the glands of the groin.

TREATMENT.—The treatment is similar to that of carcinoma—viz., free removal of the growth and the inguinal glands.

Carcinoma of the Anus.—Carcinoma of the anus is a squamocelled carcinoma which first appears as a small nodule or nodules by the side of the anus, but which ultimately ulcerates, and then presents the usual characters of a carcinomatous ulcer. The early condition may be mistaken for a thrombosed external pile. The glands affected are the glands in the groin.

TREATMENT.—The growth should be very freely excised, and the glands in both groins removed. As this operation involves destruction of the sphincter, an inguinal colostomy may be performed at the same time to prevent the discomfort of an artificial perineal anus.

Sarcoma of the Rectum.—Sarcoma of the rectum arises in the submucous tissue, and forms at first a smooth swelling covered by mucous membrane projecting into the rectum. The tumour may become pedunculated from attempts of the muscular coat to expel it.

Later, ulceration occurs, and the case closely resembles a carcinoma of the rectum, from which it may only be distinguished by microscopic examination after removal. The condition is rare.

The **TREATMENT** is complete excision of the rectum, as described under Carcinoma.

Carcinoma of the Rectum.—Carcinoma of the rectum is a cobblestoned growth imitating the structure of Lieberkühn's follicles. The following clinical types can be distinguished:

- 1 A dense fibrous annular growth constricting the rectum without marked ulceration.

2. A growth, often starting as a papilloma, which sprouts into the lumen of the gut, and also invades the rectal walls (cauliflower type).
3. A large excavated ulcer, with hard and everted edges, a sloughing floor, and an indurated base, situated on one



FIG. 352. — EARLY CARCINOMATOUS
ULCER OF THE RECTUM.
(London Hospital Medical College
Museum.)



FIG. 353. — ANNULAR CARCINOMA OF
THE RECTUM.
(London Hospital Pathological
Institute.)

- aspect of the rectum, and firmly adherent to surrounding structures. There is usually a copious foul discharge, and the ulcer bleeds readily on examination.
4. A hard, flat growth spreading in the wall of the rectum, the mucous membrane remaining intact for a considerable time, but ultimately becoming ulcerated.
 5. A rapidly infiltrating growth spreading into the peritonemum, the vagina, or the bladder.

The glands first affected are those lying behind the rectum in the hollow of the sacrum, but enlargement of these glands does not neces-

sarily mean infiltration with carcinoma, as the enlargement is at first inflammatory, owing to absorption from the surface of the ulcer. Later, the iliac and the labial glands become infiltrated.

Every type of growth ultimately becomes adherent to the surrounding structures—*i.e.*, sacrum, prostate, bladder, vagina—and causes the rectum to be fixed. Later, fistula forms between the rectum and the various organs invaded. Direct spread to the peritoneum, with development of a general carcinomatosis of that membrane, is not uncommon. Colloid degeneration of the growth often takes place. Secondary growths follow later, usually in the liver, and general dissemination sometimes occurs. In every case obstruction to the lumen of the bowel is present, and the condition is spoken of as a malignant stricture.

The growth is as a rule situated well above the anal canal, so that there is a clear piece of mucous membrane between the anus and the growth; but extension takes place in both the upward and downward directions, so that on operation, a wide margin of apparently healthy mucous membrane must be removed on each side of the growth.

The gut above the growth is dilated and hypertrophied, and stercoval ulcers are not infrequently present in addition to small polypoid growths, which may be adenomata or carcinomata. Infection of the perirectal tissue with pus-forming organisms frequently occurs in the last stages of the disease, and ischio-rectal abscesses and fistulae ensue.

CLINICAL FEATURES.—Carcinoma of the rectum is most common in patients above the age of forty, though it is by no means rare to find it in much younger patients. Men are affected slightly more often than women.

In some cases the symptoms that bring the patient under observation are those of acute intestinal obstruction or general carcinomatosis of the peritoneum, as the early symptoms of the condition are slight, and frequently attributed by the patient to constipation and piles. Haemorrhage is a common symptom of the disease, and a careful examination should always be made to exclude carcinoma in every case in which a patient complains of the recent development of piles or haemorrhage from the rectum.

The usual symptoms are increasing constipation, and difficulty in passing the motions, often accompanied by a spurious diarrhoea, which is most marked in the morning. The spurious diarrhoea consists of blood, pus, mucus, fragments of growth, and liquid faeces, which collect in the rectum below the growth during the night. Severe haemorrhage is uncommon, but the motions, which may be "tape-like," are sometimes blood-stained. After defaecation there is a sense of fulness in the rectum, as if it were not emptied. Pain is not a prominent feature unless the growth is low down near the anus. If this is the case, pain on defaecation and incontinence of faeces, due to interference with the action of the sphincter, may be present. Later, the patient complains of pain down the legs, owing to involvement of the great sciatic nerve, the left being usually affected earlier than the right.

PLATE V



*Edge of a Carcinomatous Ulcer seen
with the Sigmoidoscope.*



*Ulceration in the Colon seen with
the Sigmoidoscope.*



As the disease progresses, the constipation becomes more and more marked until complete obstruction may ensue, owing to sudden blocking of the lumen of the stricture by a mass of faeces or to the growth causing an intussusception. Ulceration and perforation of the wall of the gut, causing peritonitis, may occur, the common situation of the perforation being just above the growth or in the caecum.

Cystitis follows involvement of the bladder, and causes pain and frequency of micturition. If the vagina is invaded, there will be a blood-stained foul-smelling discharge.

EXAMINATION.—The diagnosis is made by rectal examination and the use of the proctoscope. In some cases the growth actually involves and presents at the anus, but more often it is situated well inside the rectum. The condition is felt as a stricture with hard, unyielding walls, or as an excavated ulcer on one aspect of the gut. The rectum is more or less fixed, and the examination usually causes bleeding. A foul discharge is found on the examining finger.

When making the examination, the size, situation, and fixity of the carcinoma should be ascertained as far as possible, and for these purposes an anaesthetic is frequently necessary. Examination should also be made of the hollow of the sacrum to ascertain the presence of enlarged glands. Abdominal examination is also necessary in order to determine the presence of secondary growths in the liver, peritoneum, or lumbar glands, and the amount of intestinal obstruction present.

PROGNOSIS.—Death in untreated cases takes place as a rule within two years of the onset of the disease, and is due to exhaustion from pain, discharge, and cachexia; general carcinomatosis of the peritoneum; hæmorrhage; intestinal obstruction; or general peritonitis from perforation.

TREATMENT.—The radical treatment of carcinoma of the rectum is removal of the growth with a wide area of apparently healthy surrounding tissue and the lymphatic drainage-area. The contra-indications for this operation are—Marked fixity of the growth, especially to the bladder and prostate; secondaries in the peritoneum and liver; extensive glandular involvement; and an impaired condition of the general health of the patient.

Many operations have been devised for removal of a rectal carcinoma, but they can be classified as perineal, trans-sacral, abdominal, and abdomino-perineal. In deciding the one most suitable for the given case, the following statements must be considered:

1. That the extent of the growth and the involvement of glands, peritoneum, and liver can be most fully investigated by exploratory laparotomy. Clinical investigation is very inefficient.
2. The external sphincter must nearly always be sacrificed, so that there will be complete loss of control.
3. A well-planned inguinal colostomy is much preferable to an artificial perineal or sacral anus.

4. The removal of the lymphatic area is imperfect in perineal operations, and can be most thoroughly carried out in abdominal operations.
5. That one of the chief causes of failure and death from infection is due to imperfect emptying of the alimentary canal above the growth, and that if this cannot be secured by enemata and purgatives, a preliminary colostomy is essential before the growth is removed.

Perineal Operation.—In this operation the lower end of the rectum is removed from the perineum by an incision surrounding the anus and running back to the coccyx. The external sphincter is removed with the rectum, and the operation should always be combined with the establishment of a permanent iliac colostomy. This operation is only suitable for growths low down in the rectum, and is always incomplete, as the lymphatic area is very imperfectly removed.

Trans-Sacral Operation.—The rectum is reached by removal of the lower end of the sacrum and coccyx, great care being taken that the third sacral nerve, which supplies the bladder, is not injured. In a few selected cases it *may* be possible to save the external sphincter, and unite the divided ends of the gut; but it is rarely advisable to attempt this, and the attempt often ends in failure. In nearly every case an artificial anus must be established below the cut end of the sacrum, and if this is unnecessary on account of the establishment of an iliac colostomy, a fistula leading to the divided end of the gut usually forms, and needs closure by a plastic operation. The removal of the lymphatic area is incomplete.

Abdominal Operation.—The abdomen is opened in the middle line, and after mobilization of the omega loop of the colon, an attempt is made to remove the portion of the gut containing the neoplasm, and unite the cut ends by an end-to-end suture, the external sphincter being preserved. This is an ideal operation as far as the comfort of the patient is concerned, but it is rarely possible. If the ends of the gut cannot be joined, the lower end may be closed and the upper end brought out of the wound, and a permanent colostomy established. The removal of the lymphatic area is incomplete.

Abdomino-Perineal Operation.—This is the only operation that fulfils the condition of complete removal. After the abdomen is opened, the growth, peritoneum, liver, and glands are thoroughly examined before removal is undertaken. The colon is mobilized, and the superior hæmorrhoidal and omega branches of the inferior mesenteric artery are tied close to their origin from the main branch, or the artery itself may be ligatured. The gut is then divided, and the upper end brought out of the wound to form the colostomy opening. The lower end, with all the cellular tissue between it and the sacrum, is stripped down into the pelvis, and the cut peritoneum is sutured over it so as to form a false floor for the peritoneal cavity. The abdominal wound, except for the colostomy opening, is then closed. The patient is placed in the lithotomy position, and the

further operation carried out as in perineal excision, the growth, rectum, and all the cellular tissue being removed. The divided levator ani musculo is sutured, and the lower wound completely closed except for drainage. The operation can be done in two stages, the first consisting of freeing the rectum and forming the colostomy, the second the perineal removal.

The objection to this operation is its high mortality, but improvement in its technique is steadily diminishing its death-rate.

Inoperable Cases.—The treatment of inoperable cases, and cases in which complete removal is refused, consists of careful dieting, the administration of laxatives, morphia for the relief of pain, and rectal washes to diminish the amount of the discharge. Colostomy should be advised as soon as the symptoms of obstruction are causing distress, and has the following advantages: (1) The amount of discharge is lessened; (2) the pain on defecation is removed; (3) the rate of growth is retarded; (4) constipation is completely relieved; (5) the danger of sudden, complete obstruction, with the necessity of an immediate operation with a high mortality is avoided; (6) ulceration into the bladder or vagina, or the formation of ischio-rectal abscesses and fistula, does not cause so much distress.

The prolongation of life after colostomy is sometimes remarkable. In one case under the care of the author the patient continued to live in comparative comfort and support herself by her own work for five years after the operation, in spite of the fact that the growth ulcerated into the vagina.

The amount of discharge may be lessened in inoperable cases by scraping the growth and cauterizing it with a Paquelin cautery, and this may also diminish the rate of growth.

Artificial Sphincter.—Some amount of control over a permanent artificial anus may be obtained by twisting the lower end of the bowel on its long axis before securing it into position. An attempt may be made to form an artificial sphincter in the case of a perineal anus by utilizing some of the fibres of the gluteus maximus on each side.

CHAPTER XXIII

INJURIES AND DISEASES OF THE PANCREAS, SPLEEN, LIVER, GALL-BLADDER, AND BILE-DUCTS

PANCREAS

Congenital Abnormalities.—The important abnormalities are those affecting the ducts of the pancreas and the common bile-duct. Normally, the main duct of the pancreas, the duct of Wirsung, and the common bile-duct open into the ampulla of Vater; and the accessory duct, the duct of Santorini, opens separately into the duodenum about $\frac{1}{2}$ inch above the opening of the ampulla. As abnormalities—(1) All three ducts may open separately into the duodenum; (2) the pancreas may only have one duct opening into the duodenum, and in this case the terminal portion of the duct will represent the duct of Santorini; (3) the pancreas may have three ducts opening separately into the duodenum. The abnormal relationship of the pancreatic ducts to the common bile-duct explains the variation in symptoms which may occur when the common bile-duct is obstructed with gall-stones.

Wounds of the Pancreas—1. *Severe Wounds of the Pancreas.*—Severe wounds of the pancreas, either penetrating or otherwise, are usually complicated by other lesions, such as rupture of the stomach, duodenum, or spleen, or laceration of important vessels, as the portal vein or the superior mesenteric artery. As a consequence injuries of the pancreas are generally fatal, but the actual lesion is easily overlooked. The symptoms are peritonitism, followed by signs of internal hæmorrhage. The bleeding, however, chiefly comes from the other injured structures, as hæmorrhage from the pancreas is comparatively slight. The diagnosis of injury of the pancreas will probably only be made on exploratory laparotomy.

TREATMENT.—The wounded pancreas should be sutured, or if a portion is severely crushed, it should be resected. Failing these procedures, the wound should be packed with gauze. These injuries are usually fatal.

2. *Slight Wounds of the Pancreas.*—These follow injuries to the abdomen, from which the patient may apparently recover in a few hours, but in the course of a few days are followed by an epigastric swelling containing blood and pancreatic fluid. The condition is

spoken of as pseudo-cyst of the pancreas, and will be referred to under Cysts (p. 784).

Symptoms of Pancreatic Disease.—Before discussing diseases of the pancreas, it is convenient to consider the symptoms that will be present if the pancreas is so far destroyed by the disease that its functions are seriously disturbed. These symptoms do not depend on the nature of the disease, but on the absence from the alimentary canal and the blood of the pancreatic secretions.

The pancreas has two secretions—(1) An external secretion passed into the alimentary canal by the ducts, and of great importance to digestion; and (2) an internal secretion absorbed into the blood and concerned with the metabolism of carbohydrates.

The external secretion contains trypsin, for digesting proteid; amylase, converting starch into sugar; steapsin, breaking up fats into glycerine and fatty acids; and a milk-curdling ferment.

The symptoms and signs of advanced lesions of the pancreas are—

1. *Wasting, with dyspepsia, flatulency, and epigastric pain.*
2. *Constipation or diarrhoea, with large, bulky, offensive stools, which are whitish in colour from undigested fat (liporrhœa or steatorrhœa), and contain an excessive amount of undigested muscle fibres (azotorrhœa).*
3. *Sahl's Test.*—The patient is given 10 grains of salol in a cachet made of gelatin hardened with formalin. Such a capsule is not attacked by the gastric juice, but is readily digested by the pancreatic juice; and later, the urine is examined for the presence of salicylic acid. Delay in the appearance or complete absence of this acid in the urine indicates pancreatic disease. Normally, salicylic acid should appear in about five hours, and it is recognized by a port-wine colour given with ferric chloride.
4. *Glycosuria, from absence of the internal secretion.*
5. *Cambridge's Reaction in the Urine.*—This reaction, which involves considerable chemical skill, results in the formation of long light yellow-coloured crystals, which are soluble in 33 per cent. sulphuric acid in ten or fifteen seconds. The value of this reaction has been much doubted, and certainly it is not so valuable as first claimed by its discoverer. It occurs in many diseases which only indirectly affect the pancreas, but taken with the clinical features of the disease and a chemical examination of the feces, may be a help in diagnosis.
6. *Tumour Formation.*—A pancreatic swelling is situated deeply in the epigastric region, and usually comes forward between the stomach and the transverse colon, although it may appear above the stomach or below the colon. It is resonant on percussion unless it is very large, and it does not move markedly on respiration.
7. *Jaundice, from obstruction of the common bile-duct.*

8. *Fat Necrosis*.—This sign can only be found after the abdomen is opened, and consists of the presence of whitish plaques in the subperitoneal fat of the omentum and mesentery. This appearance is due to the escape of the fat-splitting ferment (steapsin) from the pancreas, which splits the fat into fatty acids and glycerine. The fatty acids combine with calcium to form insoluble salts, which remain in the fat cells. The condition is not pathognomonic of primary diseases of the pancreas, and in some cases of acute pancreatitis it is absent.

It must not be supposed that all these signs are necessarily present in every case of pancreatic disease, but they should all be looked for in suspected lesions of the gland.

INFLAMMATION OF THE PANCREAS

Acute Pancreatitis.—Acute inflammation of the pancreas is due to invasion of the pancreas by micro-organisms, which may reach it—(1) By extension along the ducts, the most usual route; (2) by the blood-stream; or (3) by direct extension from surrounding organs. The predisposing causes are inflammatory conditions of the bile passages, usually associated with gall-stones, duodenal ulcers, gastric ulcers, pancreatic stone, injury, the infective diseases—*e.g.*, typhoid fever and influenza, and perigastric abscess. In a number of cases occurring in apparently healthy patients, no predisposing cause can be discovered.

PATHOLOGICAL ANATOMY.—The pancreas is congested and swollen, and frequently extensive extravasation of blood takes place; but this does not warrant a separate division into hæmorrhagic pancreatitis. The omentum, the mesentery, and the mesocolon are usually swollen, œdematous, and covered with lymph. The inflammation frequently terminates in gangrene, and the pancreas may be necrotic and evil-smelling. In less severe cases suppuration occurs, and the pus is either diffuse throughout the whole pancreas or a localized abscess forms. In a few cases, part of the pancreas has sloughed through the wall of the duodenum, and has been passed *per anum*. Fat necrosis may or may not be present. In milder cases resolution of the inflamed pancreas may occur.

CLINICAL FEATURES.—The patient who has been in good health previously, or gives a history of dyspepsia or gall-stone colic, is suddenly seized with violent epigastric pain, becomes collapsed, and vomits (peritonism). The shock is usually profound, owing to the proximity of the inflammation to the solar plexus, and the patient may die in twenty-four or forty-eight hours without recovering from the collapse. More commonly, peritonism is followed by acute infective peritonitis, the rigidity and tenderness of the abdomen being most marked in the epigastric region. A large, indefinite, tender swelling may be felt in the epigastrium, which is formed by the swollen pancreas and omentum, and perhaps by extravasated blood. A slight degree

of jaundice may be present, from obstruction of the common bile-duct.

The **DIAGNOSIS** has to be made from acute intestinal obstruction, gangrenous appendicitis with general peritonitis, perforated gastric

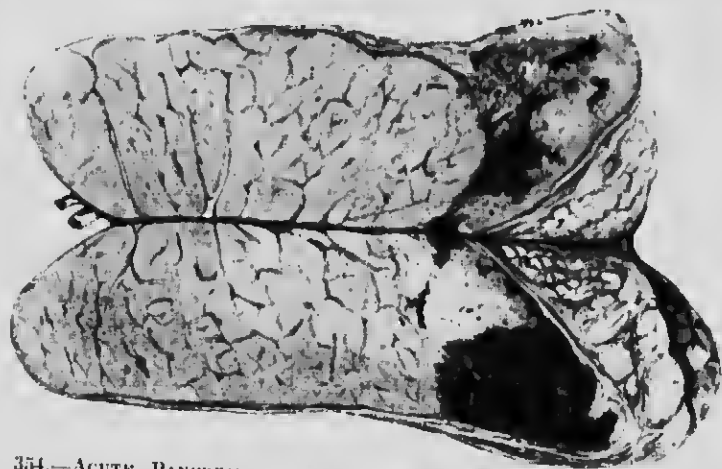


FIG. 354.—ACUTE PANCREATITIS, WITH HÆMORRHAGE AND GANGRENE OF THE PANCREAS.

(London Hospital Pathological Institute.)

or duodenal ulcer, and acute perforative cholecystitis; but as in all these conditions the treatment is immediate laparotomy, an exact differential diagnosis is not of great importance.

RESULTS.—Acute pancreatitis may end in—(1) Death from shock or general peritonitis; (2) formation of a pancreatic abscess; (3) recovery. This last termination is probably rare, but it certainly may occur with or without necrosis of some portion of the pancreas. There is no doubt that some cases recover without operation, and fibrosis of the gland may follow; but it is impossible to say how frequent these cases are, as the symptoms are not pathognomonic.

TREATMENT.—Immediately the condition is suspected the abdomen should be opened above the umbilicus, and the diagnosis is often at once confirmed by finding extensive fat necrosis. The pancreas should be reached by dividing the great omentum, pulling the stomach up and the transverse colon down, and dividing the supra-colic fold of the parietal peritoneum. Necrosed pancreatic tissue should be removed, and a large drainage-tube inserted down to the gland. The gall-bladder and ducts should be rapidly examined, but in the very acute cases it is better to leave any operative interference that may be necessary to a later operation. If, however, the gall-bladder is distended from obstruction of the common bile-duct, it should be drained. If general peritonitis is present, a drainage-tube should be inserted into Douglas's pouch through a small incision just above the pubes, and the patient nursed in the Fowler position.

Pancreatic Abscess.—Pancreatic abscess may be part of a general or portal pyæmia, or may follow an attack of acute pancreatitis which is not severe enough to cause general peritonitis or gangrene of the pancreas. An abscess may also form round a pancreatic stone. The initial symptoms are those of an acute localized peritonitis in the epigastric region, and no definite line can be drawn between this condition and the acuter forms of pancreatitis.

After a few days the temperature becomes irregular, and rigors may occur; but there is often an apparent general improvement, followed by rapid loss of flesh and strength. The initial constipation is succeeded by diarrhœa, and blood and pus may be present in the stools. When the abscess becomes palpable, it forms a swelling in the epigastric region either below or above the stomach, or the pus may pass—(1) into the loin, forming a lumbar abscess; (2) up under the diaphragm, causing a subdiaphragmatic abscess; (3) into the psoas sheath, causing a psoas abscess, which may point in the groin; (4) through the diaphragm, causing an empyema; (5) the abscess may burst into the stomach and the pus be vomited; or (6) into the bowel, and pus appear in the stools.

Death is the usual result, although recovery may follow efficient drainage.

TREATMENT.—With a swelling in the epigastric region, the abdomen should be opened from the front, and the exact localization of the abscess determined. It may then be possible to open and drain the abscess by a posterior incision in the costo-vertebral angle, but if this is not possible, the general peritoneal cavity must be isolated with gauze packing, and the abscess drained from in front. If the abscess points in any other direction, it should be opened by an incision over its most prominent point, and thorough drainage established.

Chronic Pancreatitis.—Attempts have been made, especially from the pathological point of view, to differentiate a chronic interstitial pancreatitis due to chronic intoxication, as from syphilis, alcoholism, etc., and resulting in fibrosis of the organ, and a chronic parenchymatous pancreatitis, due to infection of the glands by micro-organisms spreading up the ducts. It is probable that this distinction is correct, but *clinically* it is not possible at present to distinguish between the two conditions, although such a distinction would be most desirable.

In the majority of cases, chronic pancreatitis is secondary to gall-stones in the common duct, especially if they are impacted in the ampulla of Vater; but it may also be secondary to duodenal or gastric ulcer, or follow subacute attacks of pancreatitis. Fibrosis of the pancreas is also found in children suffering from inherited syphilis.

PATHOLOGICAL ANATOMY.—The disease may affect part or the whole of the gland, which becomes harder than normal. At first the affected portion is enlarged, but later it becomes smaller and firmer from contraction of the fibrous tissue. Pus may be present in the ducts, and the chronic inflammation may lead to the formation of pancreatic stones which, as they contain a large quantity of calcium,

give a shadow with the X rays. Obstruction of the ducts may lead to cyst formation, the cyst usually being quite small, and surrounded by fibrous tissue.

If fibrosis of the head of the pancreas occurs, the bile-duct may be obstructed, and dilatation of the duct above the obstruction follow.



FIG. 355.—CHRONIC PANCREATITIS, WITH STONE FORMATION AND DILATATION OF THE DUCTS.

(London Hospital Pathological Institute.)

In many cases the pancreas may be so hard and nodular that the condition may be mistaken for carcinoma until a microscopic section of the gland is examined.

CLINICAL FEATURES.—Chronic pancreatitis is most commonly met with between the ages of thirty and fifty, and there may be an antecedent history of cholelithiasis, gastric or duodenal ulcer, or sub-acute pancreatitis. The onset of the symptoms is gradual, the patient first complaining of dyspepsia and epigastric discomfort. Gradually the other symptoms of general pancreatic disease supervene (see p. 774), and in cases of suppuration in the ducts, there may be an intermittent temperature and rigors. It will usually be months before the symptoms are sufficiently marked to establish a diagnosis. The most important points to be considered are—(1) The slow progressive nature of the disease; (2) the examination of the faeces; (3) the presence of jaundice; (4) Sahli's and Cammidge's reaction in the urine; and (5) evidence of cholelithiasis. An X-ray examination may show the presence of pancreatic stone.

In a certain number of cases a hard swelling may be felt in the pancreatic area, or the gall-bladder may become distended and form a palpable tumour under the costal margin.

TREATMENT.—The treatment of chronic pancreatitis is operative, and the operation is partly diagnostic and partly curative. By means of a laparotomy it is possible to ascertain and treat the presence of stones in the bile-passages, stone in the pancreatic duct, and gastric and duodenal ulcers, all of which are causes of chronic pancreatitis. The diagnosis of chronic pancreatitis can also be confirmed, and a differentiation made between this condition and carcinoma of the

pancreas. In cases where there is jaundice from obstruction of the common bile-duct, this may be relieved by cholecystenterostomy.

If the pancreatitis is due to extension of inflammation along the ducts (the most common cause), the condition may be cured in the early stages or relieved in the later by drainage of the ducts, which can be accomplished either by cholecystotomy or cholecystenterostomy. The latter is the better operation, as the drainage is permanent. If cholecystotomy is performed, the drainage should be continued until the discharge from the gall-bladder is aseptic.

In many cases cholecystotomy or cholecystenterostomy is not followed by improvement except as regards the jaundice, and this is to be expected if sclerosis of the pancreas is present. Under these circumstances, the further treatment consists of careful dieting and the giving of pancreatin.

Pancreatic Calculi.—Pancreatic stones are generally small greyish-white concretions, composed chiefly of phosphato and carbonate of calcium, and so give a shadow with X rays. They are usually multiple, ovoid, or branched in shape, and chiefly found in the ducts in the head of the pancreas.

CLINICAL FEATURES.—Pancreatic calculi are always associated with more or less chronic pancreatitis, and the symptoms are those of that disease, with attacks of colicky pain resembling, but not so severe as, gall-stone colic. Fragments of stone may be passed in the feces after an attack.

TREATMENT.—The treatment consists of removal of the stones, and the treatment of the chronic pancreatitis.

NEW GROWTHS

Innocent

Apart from cysto-adenoma, which is described under Cysts (p. 784), innocent new growths of the pancreas are very rare.

Malignant

Malignant neoplasms of the pancreas are sarcoma and carcinoma.

Sarcoma.—Both primary and secondary sarcoma of the pancreas are so rare that description is unnecessary.

Carcinoma.—Carcinoma of the pancreas is most frequently found affecting the head of the gland, and it is only in this situation that diagnosis is possible without exploratory laparotomy. It is most common between the ages of forty and sixty, and males are more frequently affected than females. The growth may be spheroidal-celled or columnar-celled, and may undergo colloid degeneration.

CLINICAL FEATURES.—The onset of the disease is insidious. The early symptoms are wasting, loss of appetite, dyspepsia, and occasional vomiting. Pain may be a marked feature, and be either dull and persistent or intermittent (coeliac neuralgia). With carcinoma of the head of the pancreas *jaundice* is always present, but is usually absent

with carcinoma of the body and tail. The jaundice steadily deepens, and is nearly always associated with enlargement of the gall-bladder.



FIG. 356.—CARCINOMA OF THE HEAD OF THE PANCREAS INVADING THE DUODENUM.
(London Hospital Pathological Institute.)

so that persistent jaundice in an elderly patient, with enlargement of the gall-bladder, always suggests carcinoma of the head of the pancreas. The liver is also frequently enlarged.

A tumour can be felt in the region of the pancreas in somewhat less than half the cases. It is hard, nodular, and fixed, and may transmit the aortic pulsations.

As the disease progresses, the usual general symptoms of pancreatic disease appear (see p. 777), and vomiting may become a marked feature. Later, ascites and œdema of the legs from pressure on the portal vein and the vena cava are present.

TREATMENT.—In a few cases carcinoma of the tail of the pancreas has been removed, but when it involves the head, excision is not possible. The jaundice may be relieved by cholecystenterostomy, and the patient made more comfortable; but this operation is merely palliative.

CYSTS

Cysts of the pancreas are divided into true cysts and pseudo-cysts, and the latter again into intraperitoneal and extraperitoneal.

True Cysts of the pancreas are—(1) Retention cysts, associated with chronic interstitial pancreatitis. These are the most common, but

rarely reach a size to be clinically important. (2) Cysto-adenomata. These cysts are usually multilocular, and may grow to an enormous size. They frequently contain intracystic growths. (3) Hydatid cysts. (4) Cysts resulting from previous inflammation or hæmorrhago. (5) Malignant cysts. (6) Congenital cystic disease, resembling the similar condition met with in the liver and kidneys, but being exceedingly rare.

Pseudo-Cysts of the pancreas follow slight injury to the gland, and may be either intra- or extra-peritoneal. *Intra-peritoneal* pseudo-cysts are due to extravasation of blood and pancreatic ferments into

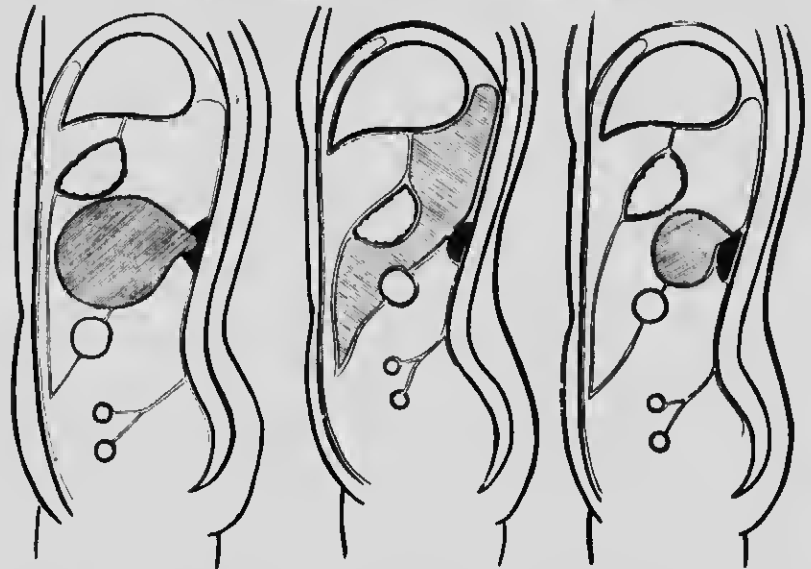


FIG. 357.—DIAGRAM OF TRUE CYST OF THE PANCREAS.

FIG. 358.—DIAGRAM OF INTRA-PERITONEAL PSEUDO-CYST OF THE PANCREAS.

FIG. 359.—DIAGRAM OF EXTRA-PERITONEAL PSEUDO-CYST OF THE PANCREAS.

the lesser sac of the peritoneum. The foramen of Winslow becomes closed by inflammatory adhesions, and a collection of fluid occurs in the lesser sac, which is partly inflammatory and partly pancreatic in origin.

Extraperitoneal pseudo-cysts are also traumatic in origin, and are due to injury to the pancreas, so that pancreatic fluid escapes into the retroperitoneal tissue. The irritation of the fluid leads to the formation of a cyst, which contains pancreatic ferment, and is situated in close proximity to the pancreas. Pseudo-cysts of the pancreas of both kinds rapidly develop after the causative injury.

CLINICAL FEATURES—1. *Presence of a Tumour*.—A cystic swelling is present in the upper part of the abdomen, usually to one side of the middle line, is deep-seated, and moves slightly on respiration. It may bear the following relationships to the viscera:

- (a) Most commonly it comes forward between the stomach and the transverse colon.
- (b) The cyst lies above the stomach between it and the liver, and pushes forward the gastro-hepatic omentum.
- (c) The swelling separates the two layers of the mesocolon, and the transverse colon lies across the cyst.
- (d) The cyst lies below the transverse colon.
- (e) The cyst may be in either loin, simulating a hydronephrosis.

2. *Contents of the Cyst.*—The cyst usually contains brownish fluid, which may be blood-stained, and on examination, pancreatic ferments may be present.

3. *Pressure Effects.*—The cyst may press on the stomach and duodenum, causing vomiting and dyspepsia, or, if very large, may interfere with the action of the diaphragm, causing dyspnoea. Pressure on the solar plexus may give rise to coeliac neuralgia, and pressure on the common bile-duct to jaundice.

4. *Signs of Pancreatic Disease.*—The presence in a case of cyst of the pancreas of the symptoms of general pancreatic disease depend on the cause of the cyst formation, and on the amount of destruction of the pancreas. If the cyst, for example, is a cysto-adenoma of the tail of the pancreas, general symptoms of pancreatic disease would probably be entirely absent; but a retention cyst, with advanced chronic pancreatitis, would probably be associated with all the usual symptoms of pancreatic disease (see p. 777).

The DIAGNOSIS of the nature of a cyst in the upper part of the abdomen is often only determined on dissection and examination of the contents for pancreatic ferments.

TREATMENT.—The best treatment is complete excision of the cyst, but this is rarely possible, and the cyst usually has to be incised and drained. In the majority of cases the cyst will be approached from the anterior aspect, as the diagnosis is often only completed on laparotomy, and the cyst wall may be stitched to the abdominal parietes, and drainage carried out from the front. If possible, however, after opening and removing the contents of the cyst, an incision should be made in the costal vertebral angle, and the cyst drained posteriorly. In some cases the cyst has been opened by the lumbar route.

Drainage is usually prolonged, and the cyst rarely becomes obliterated under six months.

INJURIES AND DISEASES OF THE SPLEEN

Rupture.—Rupture of the spleen occurs commonly in "run-over" accidents, and blows on the left side of the abdomen. In the case of the enlarged malarial spleen, slight violence may cause laceration. It is frequently associated with fracture of the lower ribs on the left side, and injury to the stomach and intestines. The extent of the lesion is, of course, very variable, but in those cases in which the

lesion is recognized clinically the laceration is usually extensive and near the hilus.

CLINICAL FEATURES.—There is a history of accident, followed by the symptoms of peritonism, which are succeeded by the signs of internal hæmorrhage. The effused blood causes dulness, chiefly on the left side of the abdomen, which steadily increases. The signs of internal hæmorrhage may follow the accident rapidly, but very frequently they are delayed for an hour or two, or exceptionally for twenty-four hours.

TREATMENT.—Immediate operation is necessary. If the diagnosis of ruptured spleen is definitely made, the abdomen should be opened in the left linea semilunaris; but if the exact nature of the lesion is doubtful, it is better to explore through an incision a little to one side of the middle line. Directly the abdomen is opened the pedicle of the spleen should be secured to arrest further hæmorrhage, and the spleen is removed unless the laceration can be securely closed by suturing.

Effects of Removal of the Spleen.—For practical purposes, it may be stated that apparently no serious effects follow removal of the spleen, and the absence of this organ does not shorten life. After removal, a secondary anæmia and a leucocytosis are present, but these soon pass off, and there is also, especially in young subjects, an increase in the lymphoid tissue in other parts of the body. There is also said to be at first a diminution of the pigment in the faces. An irregular pyrexia may follow removal of the spleen, but this is stated to be due to injury to the tail of the pancreas during the operation, and does not follow if the pedicle of the spleen is not clamped, but the vessels carefully ligatured in the hilus.

Pleuro-pneumonia and empyema have followed with undue frequency removal of the malarial spleen.

Abscess in the Spleen.—An abscess of the spleen that is recognized and treated clinically is exceedingly rare. Suppuration associated with septico-pyæmia, or infective infarcts from ulcerative endocarditis, may occur, and it may also follow injuries and typhoid fever.

The symptoms are those of deep-seated pus in the abdomen, with enlargement of the spleen. The abscess may burst externally into the peritoneal cavity, or through the diaphragm into the pleura.

TREATMENT.—An abscess of the spleen, if recognized while it is limited to the spleen, should be treated by splenectomy; but if the pus has already spread into the surrounding tissues, or if the spleen is adherent to other structures, the abscess should be opened and drained either by the transperitoneal or the transpleural route.

New Growths of the Spleen.—Primary new growths of the spleen, both innocent and malignant, are exceedingly rare. A primary sarcoma of the spleen gives no characteristic symptoms, but the patient wastes, and on examination, a hard, nodular, fixed tumour is found in the splenic area. Occasionally it may be possible to remove such a tumour.

Cysts of the Spleen.—The most important are simple cysts of unknown origin, and hydatid cysts, but both are rare. The clinical features are those of a symptomless cystic swelling in the left hypochondrium, and the treatment is removal.

Enlarged Spleen.—The spleen is enlarged in many conditions, such as the specific infectious fevers, especially typhoid, cirrhosis of the liver, valvular disease of the heart, blood diseases—*e.g.*, leucocythæmia, splenic anæmia, Hodgkin's disease, malaria, syphilis, lardaceous disease, and rickets.

The feature by which an enlarged spleen is recognized is a tumour coming from under the left costal margin, and enlarging towards the right iliac fossa. This tumour is superficial, dull on percussion, movable on respiration, and has a definite anterior margin, in which a deep notch is felt. It may increase in size after meals.

TREATMENT.—The enlarged spleen may be removed—(1) In malaria if it is very large to avoid the accident of rupture from slight causes; (2) in splenic anæmia as a curative measure; (3) for chronic enlargement without obvious cause; and (4) for new growths and cysts. It should not be removed in leucocythæmia, as the patients invariably die.

Floating Spleen and Dislocated Spleen.—A spleen is said to be **floating** when it is much more freely movable than usual, and **dislocated** when it becomes fixed by adhesions in some abnormal position.

The condition is nearly always met with in thin women, with the lax abdominal walls associated with repeated pregnancies, and the spleen may wander into any part of the abdomen or pelvis, and frequently gives rise to errors in diagnosis.

The condition is recognized by finding a tumour the size and shape of the spleen in some part of the abdominal cavity in a patient with lax abdominal walls, and usually with general splanchnoptosis and visceroptosis. There may be attacks of pain due to torsion of the



FIG. 360.—SARCOMA OF THE SPLEEN.
(London Hospital Pathological Institute.)

pedicle, or if the twist is a tight one, the spleen may become gangrenous.

TREATMENT.—The abdomen should be opened in the left linea semilunaris, and the spleen fixed near its usual position by incising the parietal peritoneum, and stitching the spleen to it (splenopexy). If there is any difficulty in performing this operation, or if there is torsion of the pedicle, the spleen should be excised. If this operation is refused, the patient should wear an abdominal belt or surgical corsets. It is advisable to wear a belt after operation.

LIVER

Abnormalities—CONGENITAL.—These are surgically unimportant. The liver may be absent, or found chiefly on the left side of the abdomen, and accessory livers may be found in the falciform ligament.

ACQUIRED—Reidel's Lobe.—This is a prolongation of the right lobe of the liver downwards until it may reach the right iliac fossa. In many cases the extra lobe is separated from the right lobe by a deep sulcus. It is possible that in some cases it was produced by tight lacing with the old-fashioned corset, but the modern corset can be held guiltless, and a Reidel's lobe is frequently found in people who have never laced tightly.

Its chief interest lies in the fact that it may be mistaken for an enlarged and movable kidney, and that it may be an added difficulty to operations on the right kidney and the gall-bladder.

No **TREATMENT** is possible or necessary.

Prolapse of the Liver.—The lower edge of the liver normally runs from the eighth left costal cartilage to the ninth right, and then follows the costal margin, so that it is not possible to palpate it, and the liver dulness ends at the costal margin.

If the edge can be felt, and the dulness extends lower than normal, it does not necessarily imply that the liver is enlarged, as it may be prolapsed downwards, and is then fixed by adhesions in its new position (**dislocated liver**) or remain freely movable, falling back into its proper position when the patient lies down (**wandering liver**). This prolapse of the liver is usually part of a general splanchnoptosis and visceroptosis (Glenard's disease), and is associated with movable kidneys, wandering spleen, etc., but it may be the chief feature of the condition.

CLINICAL FEATURES.—The patient seldom complains of the liver, but comes under observation for general abdominal discomfort, dyspepsia, constipation, and neurasthenia, and the condition is discovered on abdominal examination.

TREATMENT.—The treatment has already been considered under Prolapse of the Intestines (p. 681), and consists of the wearing of a well-fitting belt or scientifically planned corsets, with treatment for the dyspepsia, constipation, and neurasthenia.

Operative Treatment—Hepatopexy.—This operation consists of fixing the liver to the diaphragm by suturing and by the formation of adhesions by scraping the upper surface of the liver until it bleeds. The patient is kept with the foot of the bed well raised for four weeks after the operation, and the usual belt or corsets are worn when the patient gets about. It is doubtful if the operation is of much use, especially as in many cases of Clendard's disease the diaphragm itself is prolapsed.

Rupture of the Liver.—Rupture of the liver is caused by severe blows on the right side of the upper abdomen, "run-over" accidents, and in a few cases by violent flexion of the body. The right lobe is more frequently lacerated than the left, and a portion of the liver may be completely detached from the rest, and lie free in the abdominal cavity.

CLINICAL FEATURES.—There is the history of an accident, and on examination of the abdomen, marks of bruising and tenderness over the right hypochondrium may be found. The early symptoms are peritonism—*i.e.*, shock, abdominal pain, and vomiting—but the symptoms of internal hæmorrhage, with free fluid in the peritoneal cavity, rapidly supervene. Fracture of one or more ribs is a frequent complication, and causes embarrassment of breathing. If the patient does not die from internal hæmorrhage, and no operation is performed, jaundice and symptoms of cholæmia occur in a few days.

TREATMENT.—As soon as the condition is suspected, an exploratory laparotomy in the middle line above the umbilicus should be performed, as early operation gives the greatest chance of recovery. If the median incision does not give sufficient access to the wound, the rectus should be divided transversely. The bleeding from the liver is dealt with by tying the larger vessels, and then suturing the rupture with stout catgut on round needles, the ligatures being tied loosely, so as not to tear the liver substance. If suture is not sufficient to arrest the hæmorrhage, the rent in the liver may be plugged with gauze, or the bleeding-points touched with the cautery at a dull red heat.

Suppuration may occur in wounds of the liver, as in any other wounds, and if it does, drainage is necessary. The usual complications are subdiaphragmatic abscess and empyema.

Abscesses of the Liver.—The causes of abscess in the liver are—

1. Blood infection through the hepatic artery (systemic pyæmia) or through the portal vein (portal pyæmia).
2. Suppuration in the bile channels in the liver, usually associated with gall-stones in the common duct.
3. Extension along the lymphatics from suppuration in the lung or pleura.
4. Suppuration following wounds or foreign bodies in the liver.
5. Amoebic, tropical, or solitary abscess following amoebic colitis.
6. Suppuration around hydatid cysts of the liver.

Pyelphlebitis (Portal Pyæmia).—This is the commonest cause of abscess in the liver, and is a complication of suppuration anywhere in the area drained by the portal vein, such as appendicitis, suppurating hæmorrhoids, or suppurative colitis.

The abscesses are usually multiple, and due to infective emboli or infective thrombosis of the branches of the portal vein.

CLINICAL FEATURES.—

During the course of an illness, usually acute, in which there is suppuration in the portal area, the patient has a succession of rigors, and the liver becomes enlarged and tender, and there is profound toxæmia. The skin is sallow or actually jaundiced, and there is rapid wasting. Death generally occurs in a few days, but in some cases the multiple abscesses run together, and form one large abscess, which may burst into the pleura, lung, peritoneal cavity, or into the subdiaphragmatic area.



FIG. 361.—PYLEPHLEBITIS, SECONDARY TO ACUTE APPENDICITIS.

(London Hospital Medical College Museum.)

TREATMENT.—It is only when a localized abscess has formed that treatment is of any use, and the presence of such an abscess is usually determined by needling the liver through the thorax. The abscess forms in the upper part of the right lobe, and as soon as its presence is suspected the patient should be given an anæsthetic, and the liver explored. If pus is found, a portion of one or two of the lower ribs should be resected, the diaphragm sewn to the intercostal muscles, and an incision made through it. The abscess in the liver is opened, and the abscess cavity drained. Recovery is the exception.

Suppurative Cholangitis.—Extension of suppuration along the bile-passages into the liver is usually secondary to gall-stones in the common duct, and results in multiple abscesses in the liver.

CLINICAL FEATURES.—The symptoms are those of suppurative pyelphlebitis added to the symptoms denoting stone in the common duct, but rigors are not common. The liver is enlarged and tender, and jaundice is present.

TREATMENT.—The abdomen is opened, the stone removed from the common duct, and the gall-bladder opened and drained; but this complication of gall-stones is usually fatal.

Amœbic or Tropical Abscess.—This abscess in the liver is usually found in men who have travelled or lived in tropical countries, and in 75 per cent. of the cases there is a history of "dysentery." The abscess may show itself clinically during the attack of "dysentery," or it may appear years after the patient has left the tropics.

BACTERIOLOGY.—The organism most frequently found in the pus and the walls of the abscess is the *Amœba coli*, but it may be associated with other organisms, especially the *Bacillus coli*, and this possibly accounts for the variations of the clinical features. In old-standing cases the contents of the abscess may be sterile.

PATHOLOGICAL ANATOMY.—The abscess is most often situated in the upper part of the right lobe of the liver, and in acute cases the wall is made of necrotic liver tissue, in which the *Amœba coli* is found. In more chronic cases the abscess is encapsuled in a wall of fibrous tissue. The pus is mixed with reddish-brown necrotic liver tissue, giving it a characteristic appearance.

CLINICAL FEATURES.—The chronic cases with a pure infection of the amœba show very few symptoms, and the patient may have the abscess for years. The symptoms are a senso of weight and fulness over the liver, and some general malaise; but they may not be sufficient to bring the patient under observation, and the first serious symptom may be rupture of the abscess into the lung, pleura, or peritoneum.

In more acute cases, which are usually due to a mixed infection, or when a chronic abscess receives a fresh infection, the symptoms are more characteristic of pus formation. There are the ordinary general symptoms of an acute infection, rigors and sweating commonly occur, and there is usually a slight jaundice. The liver is enlarged, chiefly in the upward direction, and is tender on palpation. In some cases a well-marked fluctuating swelling appears in the right hypochondrium, but this is unusual. If the abscess is extending towards the upper surface, as it approaches the diaphragm there is generally a cough, and a friction rub between the inflamed peritoneal surfaces may be detected.

The most common place for the abscess to burst is into the lung, and the characteristic reddish-brown pus may be expectorated. Other situations are the pleura, causing empyema; the stomach, when the pus is vomited; the peritoneum, causing general peritonitis; and the intestine, when the pus appears in the stools.

DIAGNOSIS.—The diagnosis of pus in the liver is often extremely difficult, and is usually only settled by the aspiration needle. Before this is used, all the preparations necessary for opening and draining the abscess, should one be found, must be carried out. The liver should be systematically explored, the needle being introduced—
 (1) In the right mid-axillary line between the seventh and eighth ribs;
 (2) immediately below the costal margin in the nipple line; (3) in a

line drawn downwards from the angle of the scapula in the tenth interspace. The skin should be first incised, and then the needle thrust boldly into the liver.

TREATMENT.—If the abscess is a chronic one, directly the pus has been removed by the aspirating needle it should be examined microscopically, and if the amœba only is present, or the pus is sterile, the abscess may be aspirated, and the cavity injected with 40 grains of bihydrochlorate of quinine.

In acute cases, cases of mixed infection, or if aspiration and injection is not followed by cure, the abscess must be opened and drained. When the abscess is in its usual situation at the upper and back part of the liver, it must be approached by the transpleural method, the diaphragm being sutured to the intercostal muscles before it is incised. When the pus points in the abdomen, the abscess may be opened by an incision over its most prominent point, the general peritoneal cavity being shut off by suturing if the two layers of peritoneum are not adherent to one another.

During the after-treatment the abscess cavity should be washed out with a solution of the sulphate or the bihydrochlorate of quinine.

A biliary fistula may follow the operation.

If the abscess opens into the lung, the pus may be expectorated, and cure result; but in other cases there is extensive suppuration in the lungs, and death occurs. When the pleural cavity is infected, an empyema operation must be performed; but it is essential to see that the drainage-tube passes through the opening in the diaphragm into the abscess cavity in the liver, or a sinus will result.

Actinomycosis.—This is only one of the varieties of liver abscess, and infection is usually secondary to actinomycosis of the cæcum and appendix.

On examination after removal of the liver, small areas of suppuration are found, giving the liver a honeycomb appearance, and the abscess contains the characteristic yellow granules.

The symptoms and treatment are those of any other variety of liver abscess with the administration of large doses of iodide of potassium. The prognosis is bad.



FIG. 362.—ACTINOMYCOSIS OF THE LIVER.
(London Hospital Medical College Museum.)

Syphilis.—Inherited and acquired syphilis in the tertiary stage may cause sclerosis or gumma formation in the liver. The chief interest to the surgeon lies in possible mistakes in diagnosis, the condition frequently being mistaken for carcinoma, and *vice versa*.

The diagnosis is made from the history and presence of other syphilitic lesions, Wassermann's blood-serum reaction, and the effects of treatment.

NEW GROWTHS

Innocent

Angeiomata frequently occur in the livers of elderly people, and may grow to a large size, forming a palpable tumour in the right hypochondrium. It is doubtful whether they are neoplasms in the strict sense of the word, but rather dilatation of the capillaries associated with atrophy of the liver cells. When they have formed a palpable tumour they have been excised, but usually they are discovered on post-mortem examination.

Adenoma occurs in the liver, and occasionally cysto-adenoma, but they are chiefly of pathological interest.

Malignant

Carcinoma.—Primary carcinoma is rare, and may be associated with cirrhosis of the liver. It is not amenable to surgical treatment.

Secondary carcinoma is much more common, and usually follows carcinoma of the stomach, rectum, and other parts of the alimentary canal. Before radical operations on these organs for carcinoma are undertaken, the surface of the liver should always be examined with the hand in the abdomen, as a secondary nodule in the liver contraindicates extensive operations.

Sarcoma.—Sarcoma is more rare than carcinoma as a primary growth. It is sometimes met with as a congenital condition in the liver of children.

Cysts

Cysts of the Liver.—Apart from hydatid cyst,

cysts of the liver are very rare. The best-known variety is *congenital cystic disease*, consisting of multiple small cysts in the liver substance closely resembling congenital cystic disease of the kidney, with which it may be associated. There is no treatment.



FIG. 363.—CARCINOMA OF THE LIVER, WITH BULGING OF THE CHEST WALL.

Hydatids of the Liver.—Hydatid cysts are most frequently found in the right lobe of the liver, and have the usual etiology of hydatids (see p. 246).

CLINICAL FEATURES.—The physical signs are a painless, cystic, symptomless swelling in the right hypochondriac or epigastric region. If the tumour is in the upper part of the liver, the dull area of the liver will be increased upwards, and the lower half of the thorax on the right side may be enlarged. In those cases in which calcification has occurred in the cyst wall, the tumour may appear to be solid. When the cyst grows to a large size, there may be pain over the liver, referred under the right scapula, and there may be pressure effects on the stomach and interference with the movements of the diaphragm.

The **DIAGNOSIS** should be made by exploratory incision.

TERMINATIONS.—If the cyst continues to grow, it will ultimately reach a free surface and burst. Bursting may occur—(1) *Externally*, and the contents of the cyst be discharged; (2) *into the peritoneal cavity*, causing a mild general peritonitis, with an excessive amount of fluid in the peritoneal cavity; (3) *into the pleura or into the lung*, when the characteristic daughter cysts may be coughed up; or (4) *into the stomach*, when they will be vomited. Rupture into one of the body cavities usually causes the appearance of a profuse urticarial rash.

If the cyst dies, it may become obsolete and calcified, and only found on post-mortem examination, or it may become infected, and suppuration occur in the tissue round it. The local clinical features then change to those of hepatic abscess, and the usual general symptoms of infection are present.

TREATMENT.—If the cyst is pedunculated, it should be excised, but in the majority of cases the cysts are embedded in the liver tissue and excision is impossible. Two methods of treatment are then open. (1) The cyst may be incised after it has been reached either by the abdominal or the thoracic route, and the contents removed. The endocyst is then enucleated, and the cavity left drained or allowed to fill with blood-clot, the wounds in the liver and parietes being completely closed; (2) the cyst is emptied by aspiration, and then a 1 per cent. solution of formalin is injected to kill the parasite, nothing further being done.

If suppuration has occurred, the treatment is that of any other hepatic abscesses, by incision and drainage, as much of the cyst as possible being removed at the time of operation without causing excessive hæmorrhage.

Omentopexy—Talma-Morrison Operation.—This operation is designed with the idea of establishing a collateral circulation between the veins of the omentum and liver and those of the abdominal wall in cases of ascites due to cirrhosis of the liver, with obstruction of the portal vein.

The abdomen is opened, the fluid drained away, and the omentum is fixed to several points of the abdominal wall. The upper surface of the liver may also be scraped, so that adhesions form between it

and the abdominal wall and the diaphragm. The abdomen is then closed, with the exception of a drainage-tube in Douglas's pouch, so that the peritoneal cavity is kept empty until adhesions have formed.

This operation has been followed by disappearance of the ascites for some years, but in many cases it is useless, and the mortality is high. It should not be undertaken as "a last-resource operation," but after one or two tapplings have failed to relieve the patient for more than a short time.

AFFECTIONS OF THE GALL-BLADDER AND BILE-DUCTS

Congenital Deformities.—The gall-bladder may be absent, or any of the bile-passages may be stenosed or obliterated. Obliteration of the common duct is not compatible with life for more than a few months.

Abnormalities of Attachment.—Normally, the fundus and inferior aspect of the gall-bladder are covered by a reflection of the peritoneum, and the superior surface is attached to the liver by loose connective tissue, in which veins and lymphatics run. In some cases the peritoneum covers a large part of the superior surface, and the gall-bladder is more freely movable than normal. This looseness of attachment may be followed by gall-bladder colic or torsion of the gall-bladder.

Gall-Bladder Colic.—This term is applied to recurrent attacks of pain closely resembling gall-stone colic, in which, on examination, no stone is found in the gall-bladder, but this organ is abnormally loose. Removal of the gall-bladder is followed by cessation of the attacks.

Torsion of the Gall-Bladder is rare. The symptoms are acute pain in the right hypochondrium, followed by symptoms of peritonitis, the local signs being most marked over the gall-bladder. On exploration, the neck of the gall-bladder is found to be twisted, and the organ itself is extremely congested and even gangrenous. The treatment is removal.

Rupture of the Gall-Bladder and Bile-Ducts.—Rupture of the gall-bladder or one of the bile-ducts usually results from "run-over"



FIG. 364.—DIAGRAM OF THE BILE-PASSAGES.

accidents, but it may also follow ulceration of the gall-bladder, which is generally associated with the presence of gall-stones. This latter condition will be considered later.

CLINICAL FEATURES.—The usual symptoms of peritonism will be present immediately after the accident, but when these pass off there are no marked signs of the accident, as normal bile is sterile, and does not cause an acute general peritonitis. In a few days the patient becomes jaundiced from absorption of bile, the urine contains bile, and the stools are clay-coloured. The abdomen is distended, free fluid is present in large quantities, and there is constipation and vomiting.

On opening the abdomen, the cavity is found filled with blood-stained bile and serum, and there is fibrin over the intestine and the abdominal wall. A bacteriological examination of the fluid will probably demonstrate the presence of the *Bacillus coli*.

In some cases the extravasated bile becomes limited to the region round the gall-bladder area by the formation of adhesions.

If, as sometimes happens, the bile is infected before the accident, the symptoms are those of acute general infective peritonitis (see p. 615).

TREATMENT.—As soon as the condition is suspected, the abdomen should be opened, the fluid removed, and a search made for the lesion. If the gall-bladder is ruptured, it should be sutured or removed according to the extent of the injury. When the common duct is torn across, the ends may be sutured, but it is probably better to ligature the two ends and perform cholecystenterostomy.

The prognosis is good if the condition is treated early, and even when infection has already occurred, and the abdomen has to be drained, early operation will probably be successful.

Penetrating Wounds and Gunshot Wounds of the gall-bladder are rare, and the diagnosis and treatment are on the usual lines of the surgery of the abdomen.

INFLAMMATORY CONDITIONS

Inflammatory conditions of the gall-bladder are so constantly associated with the presence of gall-stones that it is convenient to consider the condition of *cholelithiasis* at the same time as that of *cholecystitis*, and afterwards describe those cases of cholecystitis that occur independently of gall-stones.

Cholelithiasis, or Gall-Stones.—Gall-stones may arise in any of the bile-passages, but they are most frequently formed in the gall-bladder. They may be solitary, in which case they are oval, or hundreds may be present, and then the individual stones are usually faceted from lying against one another. Gall-stones for the most part are composed of cholesterol (a non-atomic alcohol), but they also contain bilirubin, biliverdin, and calcium salts. The stones are usually hard, and break with a crystalline fracture, but they may be soft and easily crumbled. They are, as a rule, readily traversed by the

X rays, and so give no diagnostic shadow unless they are particularly rich in lime salts—a condition which is fulfilled in about 3 per cent. of the cases.

CAUSE.—The generally accepted view of the cause of gall-stones is that they are due to a chronic infective inflammation of the mucous membrane of the gall-bladder or the bile-passages. This chronic inflammation leads to a pathological secretion, which is rich in cholesterol, and the stones are formed by a deposit of crystals on small masses of mucus, blood-clot, or even clumps of bacteria. Once the stone is started, it grows steadily from fresh deposits. The presence of the stones in the gall-bladder helps to maintain the condition of chronic inflammation, so that a vicious circle is established. The original cause of the inflammation is infection of the gall-bladder by organisms that have—(1) passed through the capillaries of the portal vein; (2) reached the gall-bladder by spreading up the common duct from the duodenum or pancreatic duct; (3) been carried to the gall-bladder directly by the blood-stream. In a very few instances gall-stones have followed penetrating wounds or the presence of a foreign body in the gall-bladder.

The organisms most commonly found are the *Bacillus coli* and the typhoid bacillus, and an antecedent history of typhoid fever is often obtained. Other pathogenic bacteria may also be present.

Chronic inflammation and infection is *predisposed* to by any condition that does not allow free exit of the bile from the gall-bladder. Gall-stones are therefore most common in elderly females, whose sedentary habits of life, chronic constipation, lax abdominal walls, and methods of dressing do not allow free movements of the diaphragm and the abdominal muscles, and who often suffer from visceroptosis, with stretching or kinking of the cystic or common bile-duct.

Although most common in elderly females, gall-stones may occur at any age, even in the newly born, and in either sex. They are rare below the age of twenty-five, and most common after sixty.

Another view held of the origin of gall-stones is that they are deposited from the bile itself, and their cause must be sought in altered metabolism and delay in emptying the gall-bladder.

EFFECTS OF GALL-STONES ON THE GALL-BLADDER.—A gall-bladder that contains gall-stones is in a state of chronic inflammation, and this leads to fibrosis and contraction of the gall-bladder, the walls of which become thickened. The muscular tissue disappears, and a small, firm, non-distensible gall-bladder results. In many cases this is followed by atrophy of the walls, and the gall-bladder may be represented by a thin sac of fibrous tissue closely surrounding one or more stones. The gall-bladder also frequently becomes firmly attached to the liver, stomach, duodenum, and transverse colon by adhesions formed during attacks of localized peritonitis.

In other cases, when the infection is more severe, ulceration of the mucous membrane is present, and perforation of the gall-bladder may occur either into the peritoneal cavity, causing infective peritonitis, or into the stomach, duodenum, or transverse colon, a fistula being

formed. The gall-stones may then either be passed *per anum* or cause intestinal obstruction (see p. 692). At any time during the continuance of gall-stones in the bladder an acute infection may supervene on the chronic, and the patient suffer from acute infective cholecystitis and its complications.



FIG. 365.—ATROPHIC AND SHRUNKEN GALL-BLADDER CONTAINING TWO STONES. (London Hospital Medical College Museum.)



FIG. 366.—ATROPHIC GALL-BLADDER WITH STONES. SHOWING THE CYSTIC AND PART OF THE COMMON BILE DUCT.

If the stone becomes impacted in the cystic duct, dilatation of the gall-bladder may occur, and in some cases this distension is so enormous as to simulate a hydronephrosis or even an ovarian cyst. If the bladder is distended with mucus, the condition is termed *hydrops* of the gall-bladder; but if it is full of pus, *empyema* of the gall-bladder.

CLINICAL FEATURES OF STONES IN THE GALL-BLADDER.—In a large number of cases patients with stones in the gall-bladder do not come under observation, the condition being found post mortem, when the patient has died from some other disease, or during the course of an abdominal operation. On the other hand, cases presenting well-marked symptoms often remain undiagnosed if neither gall-stone colic nor jaundice is present, as the symptoms are not pathognomonic.

The symptoms are pain and discomfort on the right side of the abdomen, dyspepsia, and flatulency. The only physical signs are rigidity of the upper right rectus, and pain and sudden arrest of respiration on taking a deep breath whilst the examiner's finger is pressed in just below the ninth right costal cartilage (Murphy's sign). These symptoms may also occur with chronic gastritis, pyloric ulcer, chronic appendicitis, and movable kidney, and an exact diagnosis is often only possible on exploratory laparotomy. In a few cases the stones can be readily felt on abdominal examination, and very occasionally a crepitus may be felt due to rubbing of the stones together.

In other cases, typical attacks of **gall-stone colic** are present, and probably represent the attempts of the gall-bladder to expel the stone along the cystic duct. The symptoms are—Agonizing pain in the epigastrium, doubling the patient up and radiating round to the right scapula, the pain being relieved somewhat by pressure; vomiting; sweating; and a feeling of chilliness, amounting in some cases to a rigor. The abdomen is rigid, especially the upper part, and the gall-bladder area is tender. In many cases a slight jaundice appears during the next forty-eight hours. The attack may pass off suddenly, and in the interval between the attacks (which occur without obvious cause) the patient feels perfectly well, or complains of the symptoms given above. After an attack of gall-stone colic a stone may be passed *per anum*.

TREATMENT—1. *Gall-Stone Colic*.—Gall-stone colic is treated by administering a full dose of morphia and applying fomentations to the abdomen. For three or four days after the attack the stools should be examined for the evidence of a stone, and if one is passed, it should be noted if it is faceted, as this fact indicates the presence of other stones in the gall-bladder.

2. *Stone in the Gall-Bladder*.—As soon as the diagnosis of stones in the gall-bladder is made, the patient should be advised to have them removed, for at any time serious complications, such as acute cholecystitis, perforation and peritonitis, or intestinal obstruction, may arise, as well as the patient suffering from further attacks of colic.

OPERATIVE TREATMENT.—The abdomen is opened by an incision through the right rectus muscle, extending vertically downwards for about four inches from the tip of the ninth costal cartilage. If further room is required later, the upper end of the incision can be carried along the costal margin towards the middle line.

After the gall-bladder has been exposed, a careful search for stones is made in the cystic duct, hepatic ducts, and common bile-ducts, and then the further procedure determined, which may consist of either cholecystotomy or cholecystectomy.

In **cholecystotomy** the gall-bladder is opened, and all the stones removed. It then is stitched to the peritoneum at the upper end of the incision, and a tube inserted into it for drainage. The abdominal wound is then closed.

Cholecystectomy consists of removal of the gall-bladder and sequestration of the cystic duct, and the abdomen is either completely closed, or a drainage-tube is inserted down to the stump of the duct.



FIG. 367.—STONE IN A THICKENED GALL-BLADDER, WITH A FISTULA WHICH OPENED INTO THE TRANSVERSE COLON.

The operation of election is cholecystotomy, for the following reasons:

1. It preserves a useful organ.
2. It is usually the easier operation.
3. The mortality is lower.
4. The gall-bladder can be used later for the performance of cholecystenterostomy, if this operation should be necessary.
5. Drainage of the bile-passages is usually a necessary part of the treatment.
6. Recurrence of gall-stones after efficient drainage of the gall-bladder is rare.

On the other hand, if the gall-bladder is small and contracted, if there is difficulty in bringing it up to the abdominal wall, if it is dilated, if it is inflamed, or there is any suspicion of malignant disease, cholecystectomy should be performed without hesitation if the bile-passages are clear. The modern tendency is to perform this operation much more frequently than formerly.

Fistulæ.—The special COMPLICATION of cholecystotomy is the formation of a fistula, which may either discharge mucus from the walls of the gall-bladder (*mucous fistula*) or bile (*biliary fistula*). The latter condition is much the more serious, as such a fistula may discharge over a pint of bile in twenty-four hours; whilst in the former the discharge rarely exceeds an ounce in the same time. The loss of bile does not lead to emaciation of the patient, but it is a serious inconvenience, and may cause eczema of the surrounding skin. The cause of these fistulæ is usually that a stone has been overlooked at the operation, but they may be due to stricture, kinking of the ducts, or adhesions.

TREATMENT.—As many of these fistulæ close spontaneously, time should be given for this to occur; but if it does not, the abdomen must be reopened and the cause of the obstruction in the ducts removed. If this cannot be done in the case of a mucous fistula, the gall-bladder should be excised, but in the case of a biliary fistula the gall-bladder must be anastomosed with the small intestine (cholecystenterostomy).

Stone Impacted in the Cystic Duct.—The symptoms of this condition are attacks of gall-stone colic, with or without distension of the gall-bladder. If the gall-bladder becomes enlarged, it gives rise to a pear-shaped tumour coming from under the right costal margin, and enlarging toward the umbilicus. This tumour is superficial, and dull on percussion, the dullness being continuous with the liver dullness. It may be moved from side to side, but not up and down, although it moves on respiration. The tumour may be so large as to simulate hydronephrosis, a pancreatic cyst, or even an ovarian cyst. The contents of the gall-bladder are either mucus (hydrops of the gall-bladder) or pus (empyema of the gall-bladder).

TREATMENT.—The abdomen should be opened by the usual gall-bladder incision, and cholecystotomy or cholecystectomy performed.

PLATE VI.



Dilated Gall bladder (*hydrops*) with several stones impacted in the Cystic duct.

(London Hospital Medical College Museum)



In the majority of cases the latter operation is advisable, the cystic duct being divided below the impacted stone; the abdomen can then be closed without drainage. Drainage of the gall-bladder is apt to be followed by fistula formation.

Suppurative Cholecystitis.—This condition may occur at any time while there are stones in the gall-bladder, but is most common when a stone is impacted in the cystic duct. When the suppuration is chronic, it causes empyema of the gall-bladder, and there is a gall-bladder tumour, which is tender and associated with the usual general symptoms of infection. The distended gall-bladder may burst at the umbilicus and a fistula form, or it may perforate into the peritoneal cavity, causing general or localized peritonitis.

Acute Cholecystitis.—The symptoms of this condition are those of any other localized infective peritonitis. There are the usual general symptoms of an acute infection, with rigidity of the upper part of the abdomen, hyperæsthesia of the skin, vomiting, constipation, and abdominal distension. A tumour may be present in the gall-bladder region, but it is often difficult of detection, owing to the rigidity of the rectus muscle. Perforation of the gall-bladder may occur, and the bile, pus, and stones burst into the peritoneal cavity, causing acute general infective peritonitis, or a localized abscess, if the gall-bladder is surrounded by adhesions.

TREATMENT.—The abdomen should be opened by the usual gall-bladder incision, and the gall-bladder and its contained stones removed, if possible, without opening. If this operation is difficult, drainage of the gall-bladder, with removal of the stones, should be carried out: but a fistula is apt to result, necessitating a second operation. If an abscess has formed outside the gall-bladder, or if the inflammation is severe, the abdomen should not be completely closed, but a large drainage-tubo, containing a gauze wick, inserted into Rutherford-Morrison's pouch. This pouch of peritoneum is bounded by the liver and gall-bladder above and in front, the transverse mesocolon below, the peritoneum covering the right kidney behind, and on the inner side by the spine and the foramen of Winslow. It will hold about a pint of fluid without overflowing into the general peritoneal cavity or into the lesser sac through the foramen of Winslow.

Gall-Stones in the Common Bile-Duct.—A gall-stone impacted in the common bile-duct has usually come from the gall-bladder, but occasionally stones are formed in the bile-passages themselves. The common bile-duct may contain only one stone (20 per cent. of the cases), or there may be a string of stones extending from the duodenum to the cystic duct, and in this case it is not uncommon to find stones in the hepatic ducts as well.

EFFECTS.—When a stone obstructs the common duct, the duct above the stone becomes dilated, sometimes enormously, and the bile-capillaries in the liver also become dilated (*cholangectasis*), so that in old-standing cases the liver may become almost sponge-like. As a rule the gall-bladder is *not* dilated, as it has already be-

come contracted and adherent from past cholecystitis and pericholecystitis. The absence of enlargement of the gall-bladder is one of the most constant distinctions between gall-stone obstruction and blocking of the common duct due to other causes, especially carcinoma of the head of the pancreas (Courvoisier's law). The bile-passages behind the stone are inflamed from infection by organisms—usually the *Bacillus coli*—and this inflammation may proceed to pus formation (*suppurative cholangitis*), and multiple abscesses appear in the liver. On the other hand, gall-stone obstruction may be present for years without suppuration occurring in the liver.



FIG. 363.—SECTION OF THE LIVER SHOWING DILATATION OF THE BILE CAPILLARIES (CHOLANGIECTASIS.) (London Hospital Medical College Museum.)

CLINICAL FEATURES.—There is usually a history of attacks of gall-stone colic, and the patient is jaundiced.

The *jaundice* is as a rule not so intense as that occurring with obstruction due to malignant disease, for the obstruction by stone is rarely complete, and there are often fluctuations in the intensity of the jaundice.

Associated with jaundice are—Itching of the skin; slow pulse; mental depression; bile in the urine; constipation, with clay-coloured stools due to the absence of bile in the intestine and the imperfect digestion of fat; a tendency to hæmorrhage from the mucous membranes and from the wound after operation; and *xanthelasma palpebrarum*.

Cholangiectasis shows itself by enlargement of the liver, and *cholangitis* by the general symptoms of infection—i.e., rise of temperature and general malaise. In many cases rigors are present, the jaundice deepening after each attack, and in places where malaria is common, this symptom of gall-stones in the common duct has been mistaken for ague.

When a stone becomes obstructed in the diverticulum of Vater, the above symptoms are present, but the jaundice is more apt to be intermittent, the stone acting as a ball-valve, and there are also added the signs of pancreatic disease—viz., undigested fat and muscle fibres in the stools, wasting, and glycosuria.

The **COMPLICATIONS** are—Perforation of the duct, with suppurative peritonitis or localized abscess; extensive suppuration in the liver; and the onset of malignant disease.

TREATMENT.—The abdomen is opened by the gall-bladder incision, and the bile-passages are carefully searched for stones. The

common duct is best explored by passing the finger into the foramen of Winslow and examining the duct by pinching it between the finger and thumb. As in the great majority of cases stone in the common duct is associated with stones in the gall-bladder, this organ is opened and all the stones are removed. The common duct is then opened (**choledochotomy**) by pulling the stone forwards and cutting on it, and the stone removed with a scoop. A careful examination for other stones is then made, and this is best conducted by passing the finger through the opening into the duct, which is usually sufficiently dilated to allow thorough exploration. It is as a rule easy to remove stones from the hepatic duct through the opening in the common bile-duct, and with a little patience the finger can be made to explore the lowest limits of the common duct. When it is ascertained without a doubt that all the stones have been removed, the common duct is closed by suturing; but if this is difficult, the opening can be left to close spontaneously. The gall-bladder is removed or sutured to the peritoneum and drained according as its condition dictates. Rutherford-Morrison's pouch (p. 801) should also be drained, either by a tube containing a wick passed down through the abdominal wound, or through a stab wound in the loin.

A stone in the diverticulum of Vater can generally be removed by the opening in the common duct, or it may be pushed on into the duodenum. If neither of these procedures can be carried out, the second part of the duodenum may be opened by a longitudinal incision, and the stone extracted by incising the ampulla from within, or the duodenum can be turned inwards, and the stone removed by incising the ampulla from behind.

Recurrences of gall-stones are uncommon, and if the symptoms recur, it usually means that a stone has been overlooked. In order to prevent recurrence, the patient should take a sufficiency of exercise, keep the bowels well open, and avoid excesses and indiscretions in diet.

Adhesions.—After inflammation of the gall-bladder and gall-bladder operations, adhesions usually occur between the pylorus or the duodenum and the liver, and their presence may prevent the proper emptying of the stomach, with consequent dyspepsia and gastric dilatation. If this condition occurs, the adhesions must be separated and the raw surfaces covered by peritoneum to prevent re-formation; but if they are very numerous, it is probably better to perform gastro-jejunostomy.

Stricture of the bile-ducts is uncommon after gall-stones or operation on the bile-passages, but it may occur. When it does, it is usually from ulceration of the duct wall, due to the presence of a stone.

Stricture of the Cystic Duct generally causes the gall-bladder to become distended with mucus, and the treatment is cholecystectomy.

Stricture of the Common Duct causes jaundice and cholangectasis, and the symptoms are similar to those of an impacted stone. The

gall-bladder is not enlarged as a rule, but it may be distended with bile.

TREATMENT.—A plastic operation on the stricture is sometimes possible, but in the majority of cases the gall-bladder has to be anastomosed with the small intestine (cholecystenterostomy), or, if this has been removed or is very contracted, the dilated duct above the stricture is joined to the jejunum (choledoch-enterostomy).

Intestinal Obstruction due to impaction of a gall-stone in the intestine after it has ulcerated through the wall of the gall-bladder into the bowel has already been considered on p. 691.

INFLAMMATION OF THE GALL-BLADDER AND DUCTS NOT ASSOCIATED WITH CHOLELITHIASIS

Acute Phlegmonous Cholecystitis.—This condition may be associated with the presence of gall-stones in the gall-bladder, but may also follow typhoid fever, infection of the gall-bladder with the *Bacillus coli*, and other conditions not yet recognized. The pathological anatomy is that of an acute infective inflammation, usually ending in gangrene of the gall-bladder, associated with general peritonitis.

CLINICAL FEATURES.—The onset is sudden, and the patient shows the usual local and general symptoms of acute general infective peritonitis, the local signs of tenderness, rigidity, and swelling being most marked in the right hypochondrium. Jaundice may or may not be present. Death from general peritonitis usually follows, or an abscess may form round the gall-bladder in the less acute cases.

TREATMENT.—The abdomen should be opened at once by the usual gall-bladder incision, and the gall-bladder removed, if possible, and the peritoneal cavity drained. If removal is not possible, the gall-bladder should be incised and drained, and a drainage-tube also placed in Rutherford-Morrison's pouch. It will be noticed that the treatment is similar to that adopted in the treatment of gangrenous appendicitis.

Acute and Chronic Cholecystitis, with the formation of pus in the gall-bladder, is rare apart from gall-stones, but may occur from infection of the gall-bladder with the typhoid bacillus, *B. coli communis*, streptococcus, etc. The organism enters the gall-bladder either through the blood-stream or by the bile-duct from the duodenum, the latter mode of infection being the commoner.

SYMPTOMS.—The symptoms are pain and tenderness over the gall-bladder, with rigidity of the right rectus, and in many cases the appearance of a tender gall-bladder swelling. The general symptoms of an infective localized peritonitis are also present.

In chronic cases a large, tender gall-bladder can be felt, and when this is opened, it is found to contain pus and bile.

TREATMENT.—The abdomen should be opened, and the gall-bladder drained or excised.

NEW GROWTHS

Innocent tumours of the gall-bladder are so rare as to be pathological curiosities.

Malignant new growth of the gall-bladder is usually a **columnar-celled carcinoma**, but squamous-celled carcinoma has been described.

The condition is not very uncommon, and is generally associated with the presence of gall-stones. It is probable that there is a direct causal relationship between the two conditions. The presence of stones in the gall-bladder is always associated with inflammation of the mucous membrane, and long-continued inflammation is believed to predispose to the formation of carcinoma.

The growth may be of the cauliflower type, with papillary growths projecting into the cavity of the bladder, or a diffuse infiltration of the walls of the gall-bladder, causing enormous thickening.

The carcinoma may spread directly to the liver by continuity, or secondary growths may appear in that organ from infection by the blood. Secondary growths also appear in the peritoneum and in the glands in the hilum of the liver.

SYMPTOMS.—There are no early symptoms of carcinoma of the gall-bladder, and the disease is rarely diagnosed before extensive infiltration has taken place. The patient, who may give a history of past gall-stone colic, complains of pain and discomfort in the gall-bladder area, dyspepsia, and wasting. In some cases the symptoms of dilated stomach are present, due to obstruction of the duodenum, and in others the common bile-duct is involved, and the patient is jaundiced.

On examination, a hard, fixed nodular tumour is felt in the region of the gall-bladder; but in many cases an exact diagnosis is only made on abdominal exploration.

TREATMENT.—A wedge-shaped piece of liver to which the gall-bladder is attached should be removed, and the glands in the hilum of the liver should also be dissected away. This operation is, however, seldom feasible, owing to the late diagnosis of the condition.

Carcinoma of the Bile-Ducts may occur, the most common site being the ampulla of Vater. The symptoms are those of obstruction of the common duct—*i.e.*, jaundice and cholangectasis, with a distended gall-bladder.

TREATMENT.—It is usually impossible to remove the growth, but cholecystenterostomy may be performed to relieve the jaundice.



FIG. 369.—CARCINOMA OF THE MUCOUS MEMBRANE OF THE GALL-BLADDER. (London Hospital Medical College Museum.)

CHAPTER XXIV

INJURIES AND DISEASES OF THE SCALP—INJURIES AND DISEASES OF THE CRANIUM AND ITS CONTENTS

THE SCALP

THE skin of the scalp is hard and dense, and very intimately connected with its subcutaneous tissue, which contains an excessive amount of fibrous tissue in the meshes of which lie coarse granules of fat. This connective tissue is again intimately connected with the epicranial aponeurosis, a firm sheet of fibrous tissue formed by the tendon of the occipito-frontalis muscle and its expansion. The epicranial aponeurosis is attached to the superciliary ridges of the frontal bone in front, the superior curved line of the occipital bone behind, and the zygoma on each side. Under the aponeurosis is a layer of very loose connective tissue, so that the three layers of the scalp move freely over the underlying bone, and effusion of blood, serum, or pus can readily collect beneath the aponeurosis. Covering the skull-bones is a thin membrane, the pericranium, which is the periosteum of the skull-bones, but has very little osteogenetic powers.

Injuries and diseases of the scalp present the same characteristics that are met in similar tissues in other parts of the body, and demand similar treatment, and it will therefore only be necessary to point out some of the peculiarities due to their special situation.

Hæmatoma of the Scalp.—Hæmatomata of the scalp are divided into three groups, according to their situation.

1. *Subcutaneous.*—The hæmorrhage takes place into the dense subcutaneous tissue, and is always limited in extent. It is the ordinary contusion of the scalp, and calls for no special comment.

2. *Subaponeurotic.*—Hæmorrhage takes place into the loose connective tissue under the aponeurosis, and may be so excessive that the scalp is lifted up as if on a water-bed, these cases being usually associated with fracture of the skull and bleeding from one of the venous sinuses. When the hæmatoma is of more limited extent, there is a soft fluctuating swelling present, with definite firm edges, and the differential diagnosis from a depressed fracture of the skull is difficult. It can be made by exercising pressure on the edge of the swelling, when, in the case of a hæmatoma, it will disappear, and the smooth skull can be recognized below it. Of much greater value, however, is an X-ray photograph of the skull, and this should always be taken

if possible, as fissured fractures can then be recognized, which are impossible to diagnose by any other means.

TREATMENT.—The hæmatoma should be left alone, and the blood will become absorbed unless infection of the clot takes place through an abrasion. Massage will hasten the absorption of the blood.

3. *Subpericranial (Cephalhæmatoma).*—This variety occurs most commonly in infants, and is due to some injury at or soon after birth, although in some cases no history of any definite injury can be obtained. It usually occurs over one of the parietal bones, more often the right, and is limited to one bone by the attachment of the pericranium at the sutures of the skull to the dura mater. It presents a soft fluctuating swelling, with an indurated margin, and also somewhat resembles a depressed fracture, but the appearance in an infant is characteristic.

TREATMENT.—No treatment is necessary, and the swelling will usually have disappeared in three months. Exceptional results are blood-cyst formation, suppuration, and ossification spreading from the pericranium at the margin of the hæmatoma.

Wounds of the Scalp.—Wounds of the scalp present several peculiarities. On account of the tenseness of the epicranial aponeurosis over the skull, a blow with a blunt instrument may split the scalp as if it were divided with a knife, a matter of importance from the medico-legal standpoint. Hæmorrhage from wounds of the scalp is difficult to arrest on account of the vessels retracting into the dense subcutaneous tissue. It is usually waste of time to attempt to secure the bleeding-point with artery forceps, but a suture should be passed under the vessels and tied. Owing to the great vascularity of the scalp, sloughing of part of the scalp—even when it is extensively bruised and lacerated—is uncommon, and torn portions of scalp should be accurately stitched into position. The iodine method of treating wounds is exceedingly useful and efficient on the scalp. Infection of wounds of the scalp is fraught with special danger on account of the relationship of the underlying skull and brain. Infection of superficial wounds is of little importance, but if the loose subaponeurotic tissue is opened and infected, it may lead to widespread suppuration, with possibly necrosis of the skull-bones, septic thrombosis of the venous sinuses, and meningitis. The subaponeurotic tissue is sometimes spoken of as the "dangerous area."

Avulsion of the scalp commonly occurs in women from machinery accidents. The hair is caught in moving machinery, and the scalp may be torn completely away, the plane of division usually being the loose subaponeurotic tissue, but the pericranium may be detached as well. As long as any part of the scalp is attached, it may be sutured into position, and it will usually unite. A bare area should be covered with Thiersch's skin-grafts.

TREATMENT.—The treatment of wounds of the scalp differs in no way from the treatment of wounds in other parts of the body.

COMPLICATIONS OF SCALP WOUNDS.—There are the usual complications due to infection—viz., erysipelas and cellulitis—but the diagnosis between the two complications is sometimes difficult. In erysipelas the redness and swelling have a well-defined margin, and they speedily extend beyond the scalp, invading the face and commonly involving the pinna of the ear. In diffuse cellulitis beneath the aponeurosis the swelling does not go beyond the limits of that membrane, which are the superior curved lines of the occipital bone, the base of the mastoid process, the zygoma, the superciliary ridges, and the glabellum. The pinna of the ear is not involved.

TREATMENT OF CELLULITIS OF THE SCALP.—Free incisions must be made into the inflamed tissue at its most dependent parts, the scalp being first shaved all over. The incisions should be about 1 inch in length, and vary in number according to the extent of the inflammation. They should be placed to avoid the main vessels (see Fig. 20). No drainage-tubes are necessary, and fomentations should be applied. If the bone has been exposed and suppuration occurs in a wound, septic osteomyelitis and its sequelæ often follows. The **TREATMENT** is similar to that of osteomyelitis in other bones.

DISEASES OF THE SCALP

Inflammatory Diseases of the scalp, such as abscesses, carbuncles, syphilitic ulcers, tubercular ulcers, and malignant pustules, call for no special comment, except that any infective condition of the scalp may be followed by necrosis of the skull-bones and intracranial complications.

CYSTS

1. **Sebaceous Cysts.**—These have the usual clinical features of sebaceous cysts elsewhere; they are frequently multiple, and are often allowed to grow to a very large size. If suppuration occurs and the abscess is allowed to burst, extensive ulceration may occur, and granulation tissue, with a foul-smelling discharge, may spread over most of the scalp, giving an appearance of carcinoma. Carcinoma may, however, develop in a neglected case. This granulation tissue is sometimes termed "Cock's peculiar tumour," from the surgeon who first described it.

TREATMENT.—A sebaceous cyst of the scalp should be dissected out. In neglected cases with the formation of excessive granulation tissue, the granulation tissue should be scraped away and cauterized with pure carbolic acid or the actual cautery, and healing promoted by cleanliness. If the ulceration has been extreme, it may be necessary to cover the healing surfaces with Thiersch's skin-grafts.

2. **Dermoid Cysts.**—Dermoid cysts of the scalp are most commonly found at the outer angle of the orbit. Other situations at which they may be found are near the anterior fontanelle in the median line, at the root of the nose, and in the occipital region. They are situated under the aponeurosis, and are therefore not attached to the skin like sebaceous cysts. There may be a hollow in the bone under

the cyst or the bone may be perforated so that the wall of the cyst is attached to the dura mater. Dermoid cysts of the scalp usually remain quite small, and are removed early for the sake of appearance. Occasionally they suppurate, and a fistula will persist until the remains of the cyst are removed. Like any other infective condition of the scalp, suppuration in the cyst may be followed by meningitis.

TREATMENT.—The small cyst should be dissected out under full aseptic technique, and the wound closed.

3. Serous Cysts.—Serous cysts of the scalp are rare, and may arise in one of three ways:

(1) From a meningocele, which becomes shut off from its attachment to the dura mater.

(2) From a cephalhematoma (blood-cysts).

(3) From a traumatic cephalhydrocele.

The **TREATMENT** is removal.

NEW GROWTHS

Innocent Connective-Tissue Tumours—1. **Lipoma.**—Lipomata of the scalp are usually situated *beneath* the epicranial aponeurosis and therefore are not attached to the skin. Their chief importance is that they cause errors in diagnosis. The treatment is removal if the patient desires it.

2. Plexiform Neuroma (*Molluscum Fibrosum* or *Pachydermatocele*).—This form of tumour is not uncommon on the scalp, and may form huge pendulous masses. Its pathology and treatment are given on p. 218.

3. Angeloma.—Capillary and cavernous naevi are common in the scalp, and frequently grow in the region of the anterior fontanelle, and there may be direct vascular connection with the superior longitudinal sinus. They have the usual clinical characteristics of naevi, and should be excised.

4. Plexiform Angeloma (Cirsoid Aneurysm).—This condition, which most frequently occurs on the scalp, has already been described in *DISEASES OF BLOODVESSELS* (p. 333).

Malignant Connective-Tissue Tumours—**Sarcomata.**—These tumours have either an intracranial origin or arise in the bones of the skull, and affect the scalp secondarily.

Innocent Epithelial Tumours.—**Papillomata**, especially hard papillomata (warts) are common on the scalp, and as they may be irritated by brushing and combing the hair, and develop into squamous-celled carcinomata, they should be removed.

Adenomata arising from the sweat or sebaceous glands are rare, but when present they are liable to ulceration, and may develop into carcinomata, so that they should always be excised.

Malignant Epithelial Growths.—**Squamous-Celled Carcinomata** may arise from neglected ulcerating sebaceous cysts, from sebaceous adenomata, or in wounds of the scalp which do not heal readily. They

present no unusual features, with the exception that horns frequently form on them.

TREATMENT.—They should be freely removed, and the raw area covered with Thiersch's skin-grafts.

Rodent Ulcers usually affect the scalp secondarily.

INJURIES AND DISEASES OF THE CRANIUM

HEAD INJURIES

It may be stated in general terms that the immediate seriousness or otherwise of head injuries depends upon the extent to which the brain is damaged, and the liability to intracranial infection. For example, a fracture of the bone of the skull without serious lesion of the brain may be apparently a trivial injury, from which the patient may suffer no serious inconvenience after a few minutes, while a blow on the head of apparently trivial importance may cause intracranial hæmorrhage, cerebral compression, and death. This, however, is a general statement to which there are many exceptions. The author recently had a case under his care in which, as the result of a tram-car accident, a woman sustained an extensive compound depressed fracture of the skull. She was stunned for a few moments, then came up to hospital in the tramcar, walked into the ward, and gave a lucid account of the accident while brain matter was actually oozing out of the cranium through the fracture. The skull was trephined, bone removed, the dura mater sutured, and the patient made an uninterrupted recovery, and six months later was apparently perfectly well, with no cerebral symptoms.

On the other hand, head injuries, both trivial and severe, the immediate effects of which are not serious, may be followed later by important sequelæ, and the aphorism of Hippocrates should always be remembered: "There is no head injury so trivial that it should be despised, or so serious that it should be despaired of."

After any head injury the brain is subject to three principal states of functional disturbance giving definite clinical symptoms—viz., cerebral concussion, cerebral irritation, and cerebral compression—but it must be fully understood that these terms imply only clinical manifestations and not pathological entities, and are entirely independent of the nature and extent of the injury to the skull.

Cerebral Concussion.—The exact pathological condition underlying the symptoms of concussion is a matter of dispute, but the condition may be regarded as shock following an injury to the head. On post-mortem examination, no evidence of cerebral injury may be seen, and the changes found in the body are those which are present in shock due to other causes. On the other hand, it is not uncommon to find punctiform hæmorrhages in the brain, or actual disintegration of the brain substance.

It has been suggested by Duret that the symptoms are caused by a wave of cerebro-spinal fluid, produced by the blow on the head.

passing out of the lateral and third ventricles through the aqueduct of Sylvius, and distending the fourth ventricle. This distension stimulates the restiform bodies, and produces an anæmia of the brain, which brings about a depression of the cardio-vascular centre in the medulla.

CLINICAL SYMPTOMS.—The condition may only last for a few moments, or continue for twenty-four hours. In a few cases it may result in sudden death from a general spasm of the muscles causing arrest of respiration. A well-marked case shows the symptoms of shock—*i.e.*, slow, feeble, and often irregular pulse, shallow respiration, and a subnormal temperature. The musculature is relaxed, the sphincters being incompetent, and the patient is bathed in a cold, clammy sweat; the pupils are usually contracted, but may be dilated; they react sluggishly to light, and the conjunctival reflex is present. The patient is usually semiconscious—that is, he can be partially aroused by external stimuli—and if he is shouted at may give his name, etc., but when left alone relapses into a lethargic state. If the accident has caused a gross intracranial lesion, the symptoms gradually give place to those of cerebral compression.

After a variable period, from minutes to hours, a stage of reaction sets in, and this is usually indicated by vomiting, or occasionally by an epileptiform attack. The patient turns on his side, the pulse gets quicker and fuller for a time, then becomes slow and full; the respiration deepens, the temperature rises, and the patient suffers from severe headache. He may react abnormally to external stimuli, and be irritable and excited, or, especially in the case of children, may sleep most of the time.

This stage of reaction in a well-marked case lasts for about a week, and may be followed by complete recovery or one of the sequelæ of head injuries (see p. 816).

TREATMENT.—The treatment is the same as that for shock due to other causes (see p. 201). The patient should be placed in bed with a warm blanket over him, and hot-water bottles at his feet and sides. The head should be kept low, and no stimulant given. After the patient has vomited and the stage of reaction has set in, a calomel (gr. v.) purge should be given, and he should be kept quiet in bed on a low diet. Venesection may be performed with benefit if the reaction is severe.

During the stages of depression and reaction, the patient must be closely watched for the onset of symptoms of compression due to hæmorrhage, spreading œdema, or sepsis, in order that surgical interference may not be delayed.

After two or three days the stage of convalescence will begin. All mental work and excitement must be avoided, and reading discouraged. The longer mental rest is carried out, the less likely are unpleasant sequelæ to follow. Fresh air and a light diet are important factors in a rapid recovery. The patient should be kept under supervision for some length of time, as serious symptoms are apt to develop suddenly.

Cerebral Irritation.—This condition after head injuries is always associated with previous concussion. It is believed to be due to contusion or laceration of the brain, particularly in the frontal or antero-parietal region. The symptoms may be divided into two groups, physical and mental.

PHYSICAL SYMPTOMS.—The patient lies curled up in bed in a state of general flexion of the joints, but is restless, and if irritated, throws himself about, and may become very violent. The eyelids are closed and the pupils contracted. The temperature is normal or subnormal, the pulse small, feeble, and slow, and the respiration shallow. The sphincters are competent, although there may be retention of urine, or the urine and feces may be passed into the bed.

MENTAL SYMPTOMS.—The characteristic feature is extreme irritability of temper, occasioned by interference of all kinds, and if the interference is persisted in, the patient uses strong or blasphemous language and may become violent. Food is refused if offered, but it may be taken if left at the side of the bed. Attempts to keep the patient clean are resisted.

This condition lasts usually for one or two weeks, and recovery may be perfect, but it is apt to be followed by various mental changes (see *Sequelæ of Head Injuries*, p. 816).

On recovery the patient has often only a vague idea of the condition in which he has been.

TREATMENT.—Complete rest in bed in a darkened and quiet room is the first essential of treatment. Care should be taken that a sufficiency of food is taken in liquid or semi-solid form. A mild purge or an enema is given from time to time if necessary, and if there is retention of urine, a catheter must be passed at regular intervals. Bromide of potassium in 30-grain doses is useful if there is great restlessness, but this and other opiates should be administered with great care, not being used if there is elevation of temperature or a quick pulse. Stimulants should be avoided. The treatment chiefly consists of careful and quiet nursing and strict attention to minor details, such as the avoidance of noise, of unnecessary examination as to consciousness, and of conversation in the patient's room. Unpleasant sequelæ as in concussion are best avoided by prolonged mental rest.

Cerebral Compression.—The term "cerebral compression" used after head injuries is a clinical expression denoting a general compression of the whole central nervous system produced by effusion of blood, serum, or inflammatory exudates into the cranium. It is often accompanied by a local compression of some particular portion of the brain. When blood or inflammatory exudates are poured out into the skull the cerebro-spinal fluid leaves the subarachnoid space along certain lymph tracks, and at the same time the sheath of the spinal cord becomes distended, and fluid is displaced from the ventricles of the brain and the canal of the cord. In this way a certain amount of increased pressure is accommodated, but as the effusion continues, this safety-valve action of the cerebro-spinal fluid becomes insufficient, and the intracranial pressure begins steadily to rise. As a consequence,

the circulation in the brain is interfered with, and the cerebral functions are disturbed. At first the various centres are *stimulated*, but as the effusion increases, they are *depressed*, and finally *paralyzed*. The last centres to suffer are the vital centres in the medulla—that is, the cardio-vascular and the respiratory centres.

A depressed fracture of the skull, or the presence of a foreign body in the cranium, cannot probably in themselves cause cerebral compression, but both of them may be associated with a *spreading oedema* of the brain. This spreading oedema is produced in the following manner: In the part of the brain pressed on by the bone or foreign body, the thin-walled veins suffer more than the thicker walled arteries, and as a consequence there is venous obstruction and an exudate of serum. This exudation will cause still further pressure on the vessels, and will therefore lead to more exudation, and a vicious circle is established. The pressure will now be distributed over a wide area, and this will lead to the exudate being more widely diffused, the oedema spreading to an indefinite distance from the part compressed.

A depressed fracture or a foreign body may also cause focal symptoms, owing to a localized pressure or destruction of part of the brain where it is situated. On the other hand, foreign bodies may be encapsuled in the brain for years without causing any symptoms.

CLINICAL SYMPTOMS.—The symptoms of cerebral compression do not usually appear for some hours after the head injury owing to the slow effusion of blood or inflammatory exudates, and their appearance may even be delayed for days (see Traumatic Apoplexy, p. 823). The condition is frequently preceded by cerebral concussion, and the symptoms of the one may insensibly pass into those of the other, or there may be a lucid interval of some hours between concussion and compression.

Consciousness.—The patient, if previously conscious, first complains of headache and becomes drowsy, finally passing into a condition of complete coma from which it is impossible to rouse him.

Pulse.—The blood-pressure is increased at first, the heart's beat being *slow* and *forcible*, and the arteries constricted. The pulse-rate may fall as low as 40. Later, as the cardio-vascular centre becomes paralyzed, the pulso becomes rapid, weak, and irregular.

Respiration.—At first the respiration is deep and slow; then, owing to paralysis of the soft palate and facial muscles, it becomes stertorous, and at each expiration the cheeks and lips are puffed out. Finally, after a period of Cheyno-Stokes respiration, the centre fails, and the respiration becomes shallow and irregular until it ceases. Death takes place from cessation of respiration.

Temperature.—The temperature generally falls at first, then rises to 100° to 103° F. but the rise differs on the two sides of the body, between which there may be a difference of 1° F. The higher temperature is usually on the side opposite the lesion. If the temperature continues to rise, the prognosis is bad, and in some cases there is cerebral hyperpyrexia (106° and 107° F.). This is frequently associated with hæmorrhage into the pons.

Musculature.—As a rule the musculature is progressively paralyzed, the paralysis starting on the opposite side to that of the lesion,

the final result being a hemiplegia, or, in slowly increasing hemorrhage, monoplegia. As an exception, there may be general or localized spasms or convulsions. General spasms are termed "traumatic" or "Jacksonian epileptic fits" (see p. 818).

Facies.—The face is flushed, moist, and warm, the veins being distended, and if the optic discs are examined, the veins are seen to be distended and tortuous.

Pupils.—The early characteristic of the pupils is that they are unequal in size; later, they become widely dilated, and do not react to light. The inequality is due to the pupil on the side of the lesion first contracting and then becoming dilated, while the pupil on the opposite side undergoes the same changes

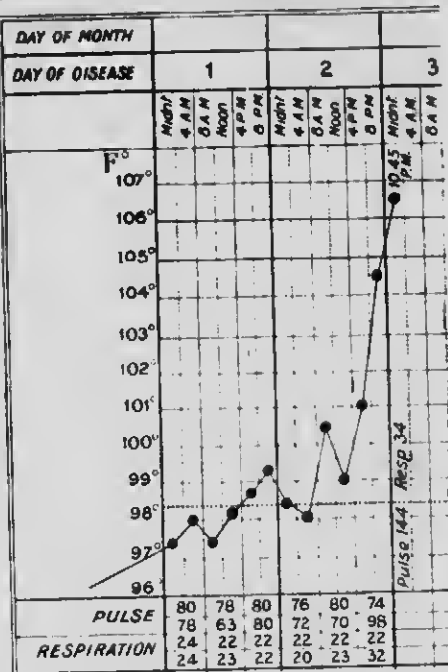


FIG. 370.—TEMPERATURE CHART OF A PATIENT WHO DIED AFTER A FRACTURE OF THE BASE OF THE SKULL AND LACERATION OF THE BRAIN.

a little later. This alteration in the size of the pupil is due to pressure on the cortical centres. In the later stages of compression the conjunctival reflex is lost.

Sphincters.—The detrusor muscle of the bladder becomes paralyzed first, and there is retention of urine, followed by overflow. Occasionally there is incontinence from paralysis of the sphincter. A substance reducing Fehling's solution may appear in the urine. There is often involuntary defecation from paralysis of the sphincter ani.

Reflexes.—As the compression increases, both superficial and deep reflexes disappear.

DIAGNOSIS.—The most important differential diagnosis has to be made from cerebral concussion, and the table on p. 815 shows the chief distinctions.

A differential diagnosis has also to be made from diabetic coma, uremic coma, alcoholic and opium poisoning, cerebral hemorrhage or embolism, post-epileptic coma, sunstroke, and exposure to cold.

DIFFERENTIAL DIAGNOSIS OF CONCUSSION AND COMPRESSION.*

	Concussion.	Compression.
1. Relation of onset of symptoms to injury	Always immediately after the injury	Frequently some hours after injury.
2. Mode of onset of symptoms	Always sudden	Headache and drowsiness, gradually passing to unconsciousness.
3. Condition of muscular system	General relaxation, but no profound paralysis	Definite paralysis (1) localized to one group of muscles or to one side of body (readily recognized); (2) general paralysis (recognized by stertor and puffing out of cheeks during expiration).
4. Pulse	Always weak, usually slow, occasionally rapid and irregular	(1) In early stages slow, irregular, and heavy; (2) in later stages rapid, irregular, and weak.
5. Respiration	Always slow and shallow, occasionally sighing	(1) In early stages regular, deep, and slow; (2) in later stages, irregular in force and rhythm, approaching Cheyne-Stokes type.
6. Bladder	Incontinence of urine	Retention and overflow.
7. Pupils	Equal and dilated; react to light	Unequal to last stage; when equal, widely dilated, and no reaction to light.
8. Surface temperature	Equal on two sides	Usually unequal.

The diagnosis is usually arrived at by the history and the presence of an obvious injury; but the patient may be discovered unconscious without any history of an accident, or the head injury or fall may have resulted from one of the above conditions—*e.g.*, a man may become unconscious and fall as a result of cerebral hæmorrhage.

DIABETIC COMA.—Previous history, wasting, smell of breath, presence of sugar in large amount in the urine.

URÆMIC COMA.—History, condition of arteries, dry tongue, smell of breath, albumin in urine.

ALCOHOLIC POISONING.—Smell of breath (a patient with a head injury may have been given alcohol), history, examination of stomach contents.

OPIMUM-POISONING.—Odour of landanum, pin-point pupils, examination of stomach contents.

* Dean in Treves's "System of Surgery," vol. ii., p. 116.

CEREBRAL HÆMORRHAGE.—History, age of patient, condition of arteries (diagnosis very difficult in absence of history).

CEREBRAL EMBOLISM.—History, presence of a cardiac lesion.

POST-EPILEPTIC COMA.—History, and evidence of friends.

SUNSTROKE AND COLD EXPOSURE.—The condition under which the patient is found.

In many cases it is not possible to make an accurate diagnosis immediately, and the following rule should be adhered to: *In cases of doubtful diagnosis, the patient should always be put to bed and kept under observation for twenty-four hours.*

TREATMENT.—The local condition may be left alone, or an attempt made to remove the compressing agent or relieve the pressure by operation. In the following cases operation is contra-indicated:

1. In cases of slight compression.
2. In cases of severe compression, with extensive crushing of the skull and cerebral laceration.
3. In cases of extensive fracture of the base of the skull.
4. If diffuse, septic meningitis is present.
5. When other severe injuries are present, making the prognosis fatal.

In cases of *mild* compression the patient should be kept quiet, and the bowels freely opened with calomel or croton oil. Vonesection may be useful. Lumbar puncture may be used to relieve the intracranial pressure, and it is also an aid to exact diagnosis.

If operation is not contra-indicated, an attempt should be made to localize the situation of the compression. A careful examination of the skull should be made in order to discover any wound or depressed fracture. It must be always remembered, however, that the compressing lesion may be on the opposite side to the external evidence of the blow, and that the evidence of paresis or spasm of muscles is of more importance in localizing a lesion than the evidence of a wound of the scalp.

A widely dilated and fixed pupil on one side points to a lesion on that side, while a rise of temperature on one side points to a lesion on the opposite side of the brain.

An X-ray photograph may be of the utmost value in localizing a fracture of the skull or the presence of a foreign body.

If the injury can be localized in any way, the skull should be trephined, and the lesion sought and treated; but if localization is not possible, a decompression operation can be performed. A large area of bone is removed from under the temporal muscle on the right side, the dura mater incised, and a hernia cerebri allowed to develop. This may relieve the pressure, and the patient recover. If the compression is chiefly below the tentorium cerebelli, the decompression should be performed in the suboccipital region (see p. 856).

After-Effects of Head Injuries.—The prognosis given after any head injury (especially if it has been followed by symptoms of concussion,

compression, or irritation) should be guarded, as serious symptoms may arise weeks or months later.

The most important of these are—

INTELLECTUAL.—

1. **Loss of memory.** The loss chiefly affects the period of the accident and the time immediately preceding and following it, or it may be for long periods, or the loss of memory may be complete. In a few instances recovery of a lost memory has followed a blow on the head.
2. **Irritability of temper and loss of power of attention,** so that a patient's business, social, and family relationships suffer.
3. **The patient may be easily affected by small doses of alcohol,** or he may develop alcoholic or drug habits.
4. **Loss of moral control,** so that the patient may become idle and vicious.
5. **Loss of some of the intellectual faculties,** so that the patient, without any definite symptoms, and remaining perfectly sane, is on a lower intellectual plane than he was before the accident.
6. **Traumatic insanity.** Head injury is an uncommon cause of insanity, comprising about 0.2 per cent. of all causes. The insanity has no special form, and may be maniacal, melancholic, cyclical, etc., or the patient may become demented. The prognosis is bad.

SENSORY AND MOTOR SYMPTOMS.—These depend upon the part of the brain injured. The motor effects may be monoplegia, hemiplegia, or motor aphasia. The common sensory effects are the various sensory aphasias.

AFFECTIONS OF THE SPECIAL SENSE ORGANS.—There may be loss of sight, hearing, or smell, according to the part of the brain injured. In other cases there are disturbances of the faculties without actual loss.

HEADACHE.—Persistent headache may follow a head injury, and is of two kinds: (1) A pain which radiates over the head, and often along the track of the fifth nerve; (2) a localized persistent headache over the place of injury. The latter condition, **traumatic cephalalgia**, is frequently associated with a definite scar on the scalp, or thickening of the bone or meninges. If other methods of treatment do not give relief, excision of the scar in the scalp and trephining of the underlying bone may be followed by cure.

GLYCOSURIA.—A symptom sometimes seen after head injury is glycosuria. It usually appears a day or two after the accident, and may or may not be associated with polyuria. It is transient, usually disappearing at the end of a week, but it may last for months. Its presence does not affect the prognosis, and in the treatment it might be well to avoid much carbohydrate in the diet.

IMPOTENCE.—Loss of virility, with or without atrophy of the testes, is one of the rarer sequelæ of head injury.

EPILEPSY.—Idiopathic epilepsy may supervene on a head injury, but more usually Jacksonian epilepsy follows.

Jacksonian Epilepsy is a discharge of the nerve force from the motor cortex resulting in muscular convulsions, due to an irritative lesion in the cerebral cortex.

PATHOLOGICAL ANATOMY.—The lesion is either in the skull, the meninges, or the brain substance, and is usually situated in the Rolandic area.

The lesions in the skull are a depressed fracture, a detached spicula of bone, or inflammatory thickening. In the meninges inflammatory thickenings are common, with adhesion of the meninges to one another and to the brain itself. In some cases a blood-cyst forms in the meninges.

The cerebral cortex may show scars, indurated patches of extravasated blood, or blood-cysts.

Jacksonian epilepsy may also occur with any irritative lesion of the cortex, and is not necessarily due to injury. It may be a symptom of tumour or inflammatory conditions of the brain, meninges, or skull.

SYMPTOMS.—The epileptic fit begins in a particular group of muscles, which are frequently paretic in the intervals between the fits, and spreads to other groups of muscles in an orderly sequence, as marked out in the Rolandic area. As a variation, an aura, such as a sudden flash of light, aphasia, or a cutaneous sensation, may mark the onset of the fit, and indicate the situation of the irritating lesion. The patient is at first quite conscious, and may watch the progress of the fit; but when it becomes general, he loses consciousness. The fit is followed by a post-epileptic state, usually coma. In some instances the fit can be arrested by a particular manoeuvre—for example, when the fit starts in the muscles of the hand, compression of the forearm has been known to arrest it. A series of fits may succeed one another rapidly, constituting the *status epilepticus*, and this may be followed by coma and death. At first the fits usually occur at infrequent intervals, but the intervals tend to become shorter and the fits more severe. Degenerative changes in the brain follow, and the patients ultimately become mental degenerates or insane.

Having established the diagnosis of Jacksonian epilepsy, it is next necessary to localize the seat of the irritative lesion, and this is done by accurately noting the mode of onset of the fit, and then determining by cerebral topography the portion of the brain in which the convulsion originates. It sometimes happens that with a scar or depressed fracture in the skull, the site of the original head injury can be accurately determined, and that this does not correspond with the area of the brain in which the fit starts. Under these conditions the physiological and pathological evidence of the brain lesion outweighs the anatomical evidence, and that part of the brain in which the convulsion starts must be first exposed if surgical interference is undertaken.

TREATMENT.—The results of treatment of Jacksonian epilepsy following head injury have been unsatisfactory, for it is obvious that

a lesion cannot be removed by operation without leaving a scar, and this scar is in itself an irritative lesion. The question of operation can be summed up as follows:

1. Medicinal treatment by bromides is palliative only.
2. Continuance of the fits leads to mental degeneration.
3. Exploratory trephining is an operation which in itself has little danger. It is usually only on exploration that the nature of the lesion can be determined and dealt with.
4. Permanent cure has followed operation in some instances.
5. The number of fits is usually decreased, and the fits may not recur for months or years.
6. Return of the fits usually occurs at some period.

As regards the times at which operations should be undertaken, the sooner it is done, the better. If the surgeon waits till the "fit habit" has become well established, the chances of cure, or even relief, are very poor. The operation consists of removing a large portion of bone over the suspected area, opening the dura mater, and examining the brain.

Any definite pathological condition found should be removed, but it is probably worse than useless to remove a portion of the cortex which looks healthy, but in which the symptoms indicate that the convulsion originates.

Treatment of the After-Effects of Head Injuries.—With the exception of Jacksonian epilepsy and some cases of traumatic cephalalgia, operation is useless in the treatment of the after-effects of head injury. Both prophylactic treatment and after-treatment consist of prolonged mental rest.

The period of complete rest necessary after a head injury is determined by—

1. The work of the patient, whether it involves mental strain and anxiety or not.
2. The severity of the head injury and the immediate symptoms after it.
3. The mental condition of the patient before the accident, whether nervous or phlegmatic.
4. The family history as regards insanity, epilepsy, or eccentricity.
5. The personal history as regards alcoholism and nervous exhaustion from sexual excesses, etc.

As regards actual time, it may be stated generally that after any injury of moderate severity a month's rest is the minimum, and in the case of a nervous intellectual patient whose work involves mental strain, one or two years' rest is essential. In ordering mental rest, the temperament of the patient must be carefully considered, as one man may find rest in a long sea voyage, whilst another must be surrounded by friends and kept constantly amused.

INJURIES AND DISEASES OF THE BRAIN

Wounds of the Brain.—Wounds of the brain are always associated with compound fracture of the skull, and there is grave danger of infection. Penetrating wounds may reach the brain through the roof of the orbit or mouth, and in the latter case infection is almost inevitable. Bullet wounds of the brain are not very uncommon, and frequently pieces of skull, hair, and cloth, are carried into the brain with the bullet. If a foreign body is aseptic, it may lie in the brain for years without causing symptoms.

TREATMENT.—A large horseshoe-shaped flap of the scalp should be raised round the wound and a sufficiency of bone removed to thoroughly expose the wound in the brain. Any foreign body should be removed, if possible, its situation having been first localized by the X rays. The wound is then drained and closed, but the bone removed is not replaced.

Contusion and Laceration of the Brain.—In nearly every case of head injury that comes to post-mortem examination or is operated upon, contusion or laceration of the brain is found. The following degrees of severity of the lesion can be differentiated, but it must be understood that they may all be present in the same case.

1. Minute petechial hæmorrhages scattered through the brain substance. This condition is frequently found when the patient has died soon after a head injury, with symptoms of concussion.

2. Areas of extravasated blood occurring on the cortex of the brain and in the pia mater, or in the substance of the brain (brain bruising). These areas are most marked at the place struck and on the opposite side of the brain (contrecoup). It is probable that this condition is present in cases of cerebral irritation which do not end in death, especially if the bruising is in the frontal area. In cases where this condition alone is found in fatal cases of cerebral compression, the compression is possibly brought about by spreading œdema.

Various focal symptoms, such as aphasia, damage to the special senses, or monoplegia, may be due to these injuries. In the case of hæmorrhage into the pons varolii, there may be hyperpyrexia, with pin-point contraction of the pupils.

3. Laceration of the brain substance, so that it becomes soft and pulpy. This condition is usually found in cases of fatal compression in which there has been no injury to a large vessel.

RESULTS.—In cases that are not rapidly fatal, the following results may occur:

1. The minute hæmorrhages are absorbed, and as far as can be ascertained there is a complete *restitutio ad integrum*.
2. The extravasated blood is absorbed, degeneration of some of the brain cells occurs, and a scar is formed which may be the pathological lesion underlying Jacksonian epilepsy or may give no evidence of its presence.

3. A progressive sclerosis may occur in the brain, showing itself clinically by insanity and dementia.
4. A thick-walled blood-cyst may form, containing hæmatoidin crystals.

The CLINICAL FEATURES and TREATMENT of contusion and laceration of the brain are those of cerebral concussion, irritation, and compression, and their after-results.

Besides these general lesions, certain special lesions following head injuries must now be described.

Middle Meningeal Hæmorrhage.—Middle meningeal hæmorrhage is the commonest form of extradural bleeding due to head injury, and may occur with or without a fracture of the skull. In some cases the hæmorrhage comes from the artery on the opposite side to that struck.

The most common site for bleeding to occur is where the anterior branch of the artery crosses the antero-inferior angle of the parietal bone. This point is situated $1\frac{1}{2}$ inches behind the external angular process of the frontal bone, and $1\frac{1}{2}$ inches above the zygoma, and from here the artery runs upwards and backwards.

Exceptionally (5 to 10 per cent. of the cases) the bleeding is from the posterior branch.

Although in many cases there is a definite rupture of the middle meningeal artery, the lesion is not always discoverable, and it has recently been suggested that in a certain number of cases of extradural hæmorrhage it is not the artery that is divided, but the venous plexuses that accompany the artery running in the substance of the dura mater. If this is so, it would account for the slow onset of the symptoms in many cases, and the dark venous appearance of the clot.

SYMPTOMS.—For the symptoms to be typical, the bleeding must not be associated with any other severe cranial lesion, and if this is the case, the symptoms can be divided into three stages:

1. A stage of cerebral concussion, which may only last a few minutes.
2. A lucid interval, sometimes lasting for hours, or even one or two days, during which the patient may resume his ordinary life.
3. Gradually increasing unconsciousness, until the typical symptoms of cerebral compression are present.

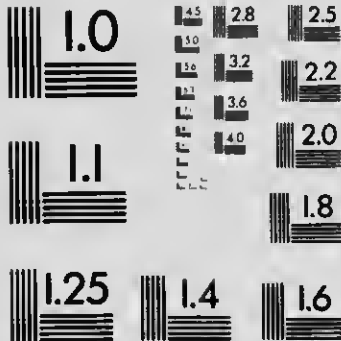
Lumbar puncture gives no evidence of extradural hæmorrhage. The side of the lesion can be determined by the presence of paralysis. As the pressure increases, the arm and face on the *opposite* side first become paralyzed, and following this there is complete hemiplegia. There may also be congestion of the eye and proptosis on the *same* side as the lesion from pressure on the cavernous sinus.

PROGNOSIS.—If the condition is untreated, death usually occurs within twenty-four hours; and even with treatment the prognosis is unfavourable, partly on account of associated intradural lesions.



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and partly from non-expansion of the brain after the hæmorrhage has been arrested, or to the onset of spreading œdema.

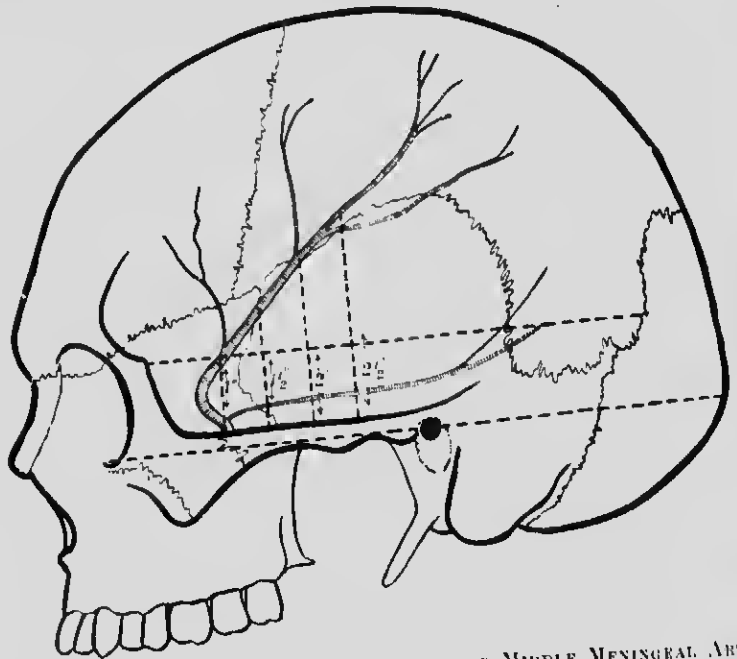


FIG. 371.—DIAGRAM OF THE RELATIONSHIP OF THE MIDDLE MENINGEAL ARTERY TO THE OUTSIDE OF THE SKULL.

TREATMENT.—As soon as the condition is suspected, the patient should be trephined. If there is a definite wound, or indication from the symptoms of the site of the lesion, the skull should be opened at this situation, but if not, the trephine wound should be placed over the anterior inferior angle of the parietal bone (see Fig. 371). A large opening should be made and the surface of the dura explored. If there is no hæmorrhage, the posterior branch on the same side should be examined through a trephine hole just above and behind the ear (see Fig. 371), and if no hæmorrhage is found here, the anterior and posterior branches of the artery on the opposite side should be exposed. The artery and the venous sinuses can usually be easily secured by passing a stitch under them and tying it.

If the patient's condition does not improve after tying the vessel and removal of the clot, the wound should be reopened and the dura mater incised so that a hernia cerebri forms to relieve tension.

Hæmorrhage from the Venous Sinuses.—The venous sinuses of the skull may be torn across or injured in fracture of the skull and from penetrating wounds. The sinuses most frequently injured are the superior longitudinal, the lateral, and the cavernous.

SYMPTOMS.—The symptoms are similar to those of middle meningeal hæmorrhage, but owing to the low blood-pressure in the sinuses, spontaneous arrest of the bleeding is more common, and the symptoms of compression are not severe. In the case of a compound depressed fracture there may be a steady loss of dark venous blood from the wound, or the laceration of the wall of the sinus may only become evident when the fracture is elevated. In simple fracture hæmorrhage may occur under the epicranial aponeurosis, so that the scalp is lifted up and fluctuation easily obtained.

TREATMENT.—The skull should be trephined, and the bleeding sinus thoroughly exposed. The hæmorrhage can then be arrested by plugging the sinus with gauze, or in some cases by careful suture.

Hæmorrhage from the Internal Carotid and Vertebral Arteries and their Branches—Subdural and Intracerebral Hæmorrhage

Injuries to these arteries occur with fracture of the skull and penetrating wounds. If the main trunk or one of the large branches is torn across, the condition is invariably fatal.

Recovery often follows bleeding from the smaller branches, either extra- or intra-cerebral.

SYMPTOMS.—The symptoms are those of concussion, which merge gradually into those of compression without any lucid interval, though exceptionally this may be present. In cases of small hæmorrhages, localization can be made by carefully observing the onset of spasm, rigidity, or paralysis of the muscles. Lumbar puncture will withdraw blood-stained cerebro-spinal fluid.

An X-ray photograph is of the greatest value in determining the presence of a simple fracture of the skull.

TREATMENT.—In mild cases the treatment consists of absolute rest and the giving of a purge, or possibly venesection and lumbar puncture; but if the symptoms of compression progress, the question of operation must be *immediately* considered.

Two operations are possible: If the situation of the hæmorrhage can be localized, the patient should be trephined over this situation, the dura mater incised, and the blood-clot removed. An attempt should then be made to secure the bleeding vessel, or the wound may be plugged with gauze. In the majority of cases, however, of subdural or intracerebral hæmorrhage, no localization is possible. The condition of the patient, the extent of the cranial damage, and the rapidity of the onset of the compression, must be considered. In many cases operation will be considered useless, but in others it may be decided that a decompression operation may give the patient a chance of life. This operation is being more and more employed, often with unexpected success. In cases associated with fractured base, the skull should be trephined in the suboccipital region.

Traumatic Late Apoplexy.—This is a condition of cerebral hæmorrhage occurring some days, or even weeks, after a head injury, and directly due to it. The primary injury is often slight, and during the

interval the patient may resume his ordinary occupation. The symptoms of compression then come on gradually, and the condition ends in paralysis or death. The usual explanation given is that the primary injury caused slight cerebral hæmorrhage, leading to softening of a part of the brain, and this is followed by severe hæmorrhage.

There is no treatment.

The condition is of great importance from a medico-legal standpoint, but before a previous slight injury can be accepted as a cause for cerebral hæmorrhage, all such conditions as arterio-sclerosis, atheroma, endarteritis, raised blood-pressure, etc., must be definitely excluded.

Subdural Hæmorrhage in the Newly Born.—This is an exceedingly important condition, as it accounts for a large number of the spastic paralysees met with in children. The hæmorrhage usually takes place from the veins running between the cerebral cortex and the superior longitudinal sinus, and is associated with—(1) Severe moulding of the skull, due to contracted pelvis; (2) injury from crushing with forceps; (3) rupture from venous congestion, due to asphyxia.

It is most common in the first-born, and especially with male children, owing to the greater difficulty in the labour. There is usually a history that artificial respiration was necessary to make the child breathe, but after that there are frequently no symptoms until the child develops fits or spastic paralysis, which may be either a monoplegia, a hemiplegia, a diplegia, or a paraplegia. In some cases the usual symptoms of cerebral compression are present, the fontanelle is bulging, and focal symptoms of paralysis or spasticity may occur.

TREATMENT.—If the evidence of the presence of blood pressing on the brain is conclusive, a large flap of scalp and skull should be raised, and the blood-clot removed.

FRACTURES OF THE SKULL

Fractures of the skull are divided into fractures of the vault and fractures of the base, but in many cases both vault and base are fractured at the same time. There is no essential difference between the two.

Fractures of the Vault

GENERAL CONSIDERATIONS.—A fracture of the vault of the skull is caused by direct violence, which may be localized or diffused. Localized violence is caused by blows with sharp instruments, falls on projecting corners, bullets, etc. The fracture is usually localized, a portion of the vault being cracked or driven in. At the same time there may be some fissuring spreading from the site of the fracture. Diffuse violence is applied by falls on the head from a height, or blows with very blunt instruments, such as a bludgeon. The fracture is produced by bending the bones of the skull beyond the limit of their elasticity, so that they give way. These fractures are extensively fissured.

Fractures may be incomplete or complete. Incomplete fractures are chiefly seen over the air sinuses of the skull, especially the frontal sinus, the outer wall of which may be fractured without the inner wall being affected. In one case the author removed a bullet from the frontal sinus fired by a suicide, the inner wall of the sinus remaining intact. In other situations also the outer table may be fractured without the inner. Fracture of the inner table may also occur without fracture of the outer, especially as a result of gunshot wounds.

Complete fractures are often classified as "pond-shaped," "gutter-shaped," or "star-shaped," and are frequently comminuted. The inner table is as a rule more extensively fractured than the outer. This, however, is not due to its great brittleness (vitreous table), but to the following causes: (1) When the fracturing force falls on the outer table, it is supported by the inner, but the inner has no such support, so that it gives way more readily, and splinters; (2) the fracturing force is more diffused when it reaches the inner table, and so causes fracture over a larger area; (3) the fractured bone of the outer table forms a wedge, which drives in the inner table; (4) in the case of gunshot wounds the velocity of the bullet is diminished when it reaches the inner table, and the higher the velocity, the more "clean" the hole a bullet makes.

In those cases where the bullet has completely penetrated the skull, at the place of exit the outer table is more extensively fractured than the inner.

Fractures of the vault may be *fissured* or *depressed*; each of them, again, may be *simple* or *compound*; but the importance of the fracture chiefly depends upon the damage to the underlying brain and the advent of infection. In every case there is a violent concussion of the brain and often cerebral irritation or compression. These have the usual clinical symptoms and sequelae already described, and demand the usual treatment.

Simple Fissured Fracture of the Vault.—These fractures are mainly produced by blows with blunt instruments, such as a policeman's baton, or by falls on the head. They are frequently extensive, and may involve the base of the brain as well as the vault.

PHYSICAL SIGNS.—Although there may be a point of maximum tenderness, and on percussion the skull may give a "crack-pot" note, the diagnosis of these fractures is really only made by *X-ray examination*. Since this method has been used as a routine in the diagnosis of head injuries, many fissured fractures that were undiagnosable previous to the discovery of X rays are recognized with the utmost ease.

TREATMENT.—The patient is treated for the cerebral concussion, but no special treatment for the fracture is necessary unless definite symptoms of an intracranial lesion are present. Some surgeons have advised trephining in all these cases, as it is impossible to diagnose the exact condition associated with the fracture, and if symptoms are waited for, valuable time may be lost. Undoubtedly, however,

the great majority of patients with simple fissured fracture of the vault recover without serious symptoms or sequelae.



FIG. 372.—SKIAGRAM OF A SIMPLE FISSURED FRACTURE OF THE SKULL.

Compound Fissured Fractures.—These are caused in the same way as simple fractures, but the scalp is split by the same violence that produced the fracture. They have the added danger of great liability to infection.

PHYSICAL SIGNS.—On examination of the skull—the wound being enlarged if necessary—a bright red streak, which is not serrated and is not in the usual position of a suture, indicates a fissured fracture. If the patient is not seen until a few days after the accident, the streak is dark red or almost black. The fracture can also be felt with the finger in the wound. X-ray examination will show the extent of the fissure.

TREATMENT.—The usual aseptic treatment of the wound should be carried out. It is probably best to trephine all cases over the centre of the fissure without waiting for symptoms to appear. The inner table may be depressed, and a spicule of bone may later give rise to Jacksonian epilepsy, or there may be laceration of the dura mater or brain. The operation of trephining is simple and has little danger, and enables more thorough inspection, disinfection, and drainage of the wound to be carried out. There is also less danger of serious after-effects of head injury following.

Simple Depressed Fractures.—These fractures are usually due to localized violence, and are more common in children than in adults.

In infants a depression of the skull *may* occur without the bones being fractured; but in the majority of cases of obstetrical injury there is fracture as well as depression.



FIG. 373.—DEPRESSED FRACTURE OF THE SKULL AND SUPERNUMERARY DIGIT.

PHYSICAL SIGNS.—The diagnosis is as a rule simple, the depression being both seen and felt; but in some cases of hæmatoma of the scalp the similarity of the physical signs may make diagnosis extremely difficult (see Hæmatoma of the Scalp, p. 806). An X-ray photograph will at once differentiate the two conditions.

TREATMENT.—All cases should be at once trephined, and the bone elevated, except very shallow depressions in young infants. In the latter case the depression will often spontaneously disappear in a very few days. If the depression is deep, or does not disappear, or if symptoms are present, the bone must be elevated, or sequele such as epilepsy, spastic paralysis, and insanity frequently follow.

Compound Depressed Fractures.

—These fractures are usually due to a localized violence, but there may be extensive fissuring of the skull as well as the depression. A striking feature of many of these fractures is the absence of severe cerebral symptoms. A patient with a



FIG. 374.—COMPOUND DEPRESSED FRACTURE OF THE SKULL.

(London Hospital Medical College Museum.)

large portion of the skull driven in may only exhibit symptoms of slight concussion, and if a careful examination of the scalp wound is not made, the condition may be overlooked. This is probably accounted for by the escape of the blood externally, so that the symptoms of compression are absent. Later, if the bone is not elevated, or if infection occurs, the symptoms of compression appear due to spreading œdema or the presence of inflammatory exudates.

PHYSICAL SIGNS.—A careful examination (enlarging the wound if necessary) will always lead to a correct diagnosis. Merely examining a wound with a probe is not sufficient, and may lead to serious errors in diagnosis.

TREATMENT.—The depressed fracture should be thoroughly exposed by reflecting the soft parts, and the skull trephined at the site of the fracture in such a manner that two-thirds of the trephino rests on the sound bone. The depressed bone is then elevated, pieces of it being removed if necessary. If there is effusion of blood beneath the dura mater, this membrane should be incised. The bone removed is not replaced, and the wound in the soft tissues closed with drainage.

Fractures of the Base

METHOD OF PRODUCTION.—In many cases fracture of the base of the skull is due to violence applied directly to the base, and not through the vault. This is the case in fracture of the middle fossa due to blows on the jaw, the condyles being driven directly against the glenoid fossa; fracture of the posterior fossa from falls on the buttock, feet, or hands, the condyles of the atlas being driven against the bone round the foramen magnum; in penetrating wounds through the mouth or through the roof of the orbit, and in many blows on the side of the head.

A second great cause of fracture of the base is irradiation of a fissure from the point struck on the vault. The fissure travels to the base, and across it along the line of least resistance—i.e., through the foramina, and avoiding the strong buttresses of bone which separate the fossæ from one another.

FIG. 375.—FRACTURE OF THE BASE OF THE SKULL.

(London Hospital Medical College Museum.)

The great majority—if not all fractures of the base—are accounted for in these ways, but it is possible that some are due to “bursting.” When a skull is struck, it becomes depressed at the point struck, and bulges in another, so that the shape of the skull is altered. If the part which bulges is less elastic than the part which is depressed,

fracture takes place here instead of at the point struck, and a fracture by indirect violence may occur. This may account for some few cases of fractured base. Fracture of the base by contre-coup is not possible.

Fractures of the base are broadly divided into transverse and longitudinal. A transverse fracture is usually limited to one fossa of the skull, although it is by no means uncommon for fissures to radiate into other fossae. A longitudinal fracture frequently invades all three fossae.

The great majority of fractures of the base are compound through wounds of the nose, mouth, or ear, and there is grave danger of infection occurring.

CLINICAL FEATURES.—The clinical features of fractures of the base may be divided into—Symptoms of concomitant brain lesions—*i.e.*, concussion, irritation or compression—escape of cranial contents from the skull; injury to cranial nerves.

Fractures of the base can also be seen on X-ray examination.

SIGNS OF BRAIN INJURY.—Any violence sufficient to cause a fracture of the base will cause some symptoms of brain injury, especially concussion. Compression from extravasation of blood is also common, and later, infection of the brain and meninges may occur.

ESCAPE OF CRANIAL CONTENTS—1. *Brain Matter.*—In very severe fractures, such as follow bullet wounds, brain matter may escape into the nose, mouth, pharynx, or externally. This sign is, of course, absolutely diagnostic of fracture of the skull.

2. *Blood*—**ANTERIOR FOSSA.**—In fractures of the anterior fossa blood may escape through a fractured cribriform plate, and appear at the nose, or it may be swallowed and subsequently vomited. The escape of blood from the nose is not diagnostic, as the nose itself is frequently injured in blows on the head. If the orbital plate of the frontal bone is injured, blood escapes into the orbit, and the appearance of the blood is characteristic. It is convenient to contrast it with an ordinary "black eye."

FRACTURED ANTERIOR FOSSA.

"BLACK EYE."

- | | |
|---|---------------------------------------|
| 1. Appears late, twenty-four hours or more, and spreads slowly. | 1. Appears at once; diffuses rapidly. |
| 2. Proptosis is present. | 2. Not present. |
| 3. Blood dark in colour, subconjunctival, triangular in shape. | 3. Bright red, conjunctival, diffuse. |
| 4. Posterior limit not seen. | 4. Limits seen. |
| 5. Late effusion into lower lid; none into the upper lid. | 5. Rapid effusion into both lids. |

If the orbital ridge of the frontal bone is fractured, blood readily finds its way into the upper lid, and frequently a fractured base is associated with a "black eye."

MIDDLE FOSSA.—Hæmorrhage may occur into the mouth and nose, but the most typical is bleeding from the ear. It is, however, only characteristic when there is a steady copious flow, for hæmorrhage from the ear after a blow on the head may be due to the following causes: (1) laceration of the external ear; (2) rupture of membrana tympani; (3) fracture of the bony meatus; (4) fracture of the tympanic plate; when hæmorrhage is associated with a fractured base, hearing on that side is often absolutely lost.

POSTERIOR FOSSA.—The blood may trickle into the mouth and be swallowed, or may pass externally into the muscles of the neck, and appear two or three days later as a bruise just below the mastoid process.

3. *Cerebro-Spinal Fluid*—**ANTERIOR FOSSA.**—Cerebro-spinal fluid may be recognized coming down the nose, but this is rare.

MIDDLE FOSSA.—The cerebro-spinal fluid escapes from the meatus through a rupture of the membrana tympani, but if this membrane is intact, it may escape down the Eustachian tube into the mouth. In a typical case the quantity is large, so that it can be readily collected in a test-tube and examined. It is a watery fluid with specific gravity of 1006 to 1008, containing a faint trace of albumin, a quantity of sodium chloride, and a substance that reduces Fehling's solution. It may be confounded with a serous discharge in serous otitis media and the liquor Cochlearii contained in the labyrinth. The former fluid contains albumin, so that it solidifies on boiling, and stiffens linen, whilst the latter is so small in quantity as to be negligible.

POSTERIOR FOSSA.—Cerebro-spinal fluid may be seen trickling at the back of the pharynx.

Lesions of Cranial Nerves.—The olfactory nerve is frequently damaged in fractures of the **ANTERIOR FOSSA**. Injury to the optic nerve is often associated with injury to the oculi motor nerves, especially the sixth (abducens), and may occur in fractures either of the **ANTERIOR** or **MIDDLE FOSSA**. The seventh nerve (facialis) is the nerve most frequently injured in fracture of the **MIDDLE FOSSA**, and it may be damaged in two ways: (1) By being torn across or bruised at the time of the injury; (2) by being injured later, either by involvement in the process of repair or by a neuritis secondary to inflammation of the middle ear. The prognosis in primary paralysis is bad, but in the cases in which the nerve is involved secondarily, recovery usually occurs within three months.

In fractures of the **MIDDLE FOSSA** the eighth nerve (auditory) is frequently damaged with the seventh. The prognosis is bad.

Injuries of the ninth, tenth, eleventh, and twelfth nerves in fractures of the **POSTERIOR FOSSA** are rare, and, if they occur, the injury to the brain is of such a nature that death almost invariably follows.

PROGNOSIS.—The prognosis in fractured base depends on the amount of damage done to the brain and bloodvessels at the time of the injury and on the question of infection.

If the brain has been seriously damaged, death will occur in a few hours. In other cases the injury may appear to be trivial, and the

patient can, and often does, attend to his ordinary duties within a very short time of the accident. The usual sequelæ of head injury are apt to follow.

TREATMENT.—The usual treatment of concussion, compression, or cerebral irritation should be carried out, and to avoid sequelæ the patient should be kept in bed for three weeks at least, no matter how trivial the symptoms may be. In cases of severe compression the skull should be trephined in the occipital region to relieve pressure, and a small drain inserted.

In cases of fracture of the middle fossa with bleeding or escape of cerebro-spinal fluid from the ear, the external auditory meatus should be carefully wiped out with sterile pledgets of wool soaked in a weak antiseptic, and a sterile pad bandaged over the ear.

The operative treatment of fractures of the skull may be summed up as follows:

Fractures of the Base.—Decompression operation in occipital region if marked symptoms of compression are present.

Simple Fissured Fractures of Vault.—Wait for the onset of symptoms. (Some surgeons advise operation in any case.)

Compound Fissured Fractures of Vault.—Trephine in all cases. (Some surgeons advise waiting for symptoms.)

Simple Depressed Fractures of Vault.—Trephine in all cases, except in very shallow depressions in young infants.

Compound Depressed Fractures of Vault.—Operate in all cases.

Repair of Fractures of the Skull.—The dura mater and the pericranium, which are the periosteæ of the skull bones, have very little osteogenetic powers, so that loss of a portion of the skull—unless it be very small—is permanent, and the gap is filled with fibrous tissue. The younger the subject the greater the growth of bone from the dura mater and pericranium at the margins of the aperture. Fissured fractures may unite by bone, and the line of fracture entirely disappear; but fractures of the base are often only united by fibrous tissue, and in comminuted fractures the line of fracture remains permanently visible. The amount of callus is always very slight, probably owing to the absolute rest between the fragments. Infection, of course, interferes with the process of repair, and necrosis of the bone usually follows. No involucrum is formed, and the separation of the necrosed fragment takes months or even years. Infection of the membranes is very likely to occur.

DISEASES OF THE SKULL

Acute Infective Osteomyelitis.—As in other bones infection by the staphylococcus or streptococcus, or both, may occur—

1. By direct infection through a wound of the scalp or a compound fracture of the skull-bones.
2. By extension from surrounding structures, such as the middle ear or frontal sinus.
3. By infection from the blood-stream.

PATHOLOGICAL ANATOMY.—In infection of the bone through wounds of the scalp, the outer table only of the skull-bones is affected, and the sequestrum may include only that table and a portion of the diploe, so that there is no actual loss of continuity of the bone after separation of the sequestrum. In other cases, and also in the case of infection through the blood, both tables are affected, and the whole thickness of the bone separates as a sequestrum. Owing to the low osteogenetic powers of the pericranium and dura mater, no involucrum is formed, and the separation of the necrosed portion is exceedingly slow. After separation, the gap is filled with dense fibrous tissue, which causes the scalp and the dura mater to become firmly adherent to one another. Infection of the dura mater and extension of the inflammation to the pia mater and brain are common, as well as infective thrombosis of the venous sinuses in the dura mater. Septico-pyæmia is a common sequel.

CLINICAL FEATURES.—Clinically there are the usual features of an acute inflammation of bone. The general symptoms are well marked, and there is intense pain, redness and swelling of the scalp. After drainage has been established, a sinus forms, which leads down to the necrosed portion of the bone, and continues discharging until the sequestrum separates or is removed. In many cases the symptoms of the inflammation of the bone are masked by the symptoms of meningitis or those of increased cerebral pressure, from the accumulation of pus between the bone and the dura mater.

TREATMENT.—The first step in the treatment is to establish free drainage, and to do this it may be necessary to make multiple incisions in the scalp. If the infection is from the blood, or if in direct infection there is evidence of pus forming on the inner table of the bone, the skull should be trephined and bone removed as far as the limits of infection. After the acute symptoms have subsided, and a sinus has formed, healing may be hastened by removing the necrosed bone instead of waiting for the sequestrum to separate spontaneously. The bone should be removed with rongeur forceps until it bleeds readily. The gap left may be filled by (1) an osteoplastic operation, (2) by bone-graft, or by (3) covering it with a silver or celluloid plate. The gap may also be allowed to close by fibrous tissue, and when healing is complete, the brain is protected by wearing a shield over the hole in the skull.

Tuberculous Osteomyelitis.—Tubercular infection of the skull-bones occurs most commonly in children, the disease originating in the centre of the bone. As a consequence, a sequestrum is formed (caries necrotica), which involves the whole thickness of the skull, but there is no involucrum or surrounding sclerosis. The tubercular granulation tissue spreads externally under the pericranium or between the dura mater and the bone. A tuberculous abscess forms over the diseased bone, and when this bursts, a sinus results and persists until all the necrotic tissue is removed.

CLINICAL FEATURES.—The disease is very insidious in its onset, and the only symptoms and physical signs are the formation of a

painless, soft, fluctuating swelling, or swellings, on the scalp. When an abscess has formed, the skull is usually already perforated.

The usual differential diagnosis from syphilis has to be made, and an X-ray photograph will show the extent of the necrosis.

TREATMENT.—The abscess or sinuses (if they are present) should be thoroughly opened, and all the diseased bone removed. The granulation tissue should be scraped away from the surface of the dura mater, so that only healthy tissue is left. Healing will occur by the formation of fibrous tissue, so that a large defect in the skull will be left, and the brain must be protected by a suitable plate or shield.

Syphilitic Disease.—Syphilitic disease of bones has already been described (p. 495) and special reference made to the skull-bones. Acquired syphilitic diseases of the skull is most common in the tertiary stage, and the following varieties may be distinguished:

1. Syphilitic periosteitis resulting in the formation of nodes on the skull, which, if treatment is neglected, will break down and form sinuses, leading to necrosis of the bone. In some cases extensive new formation of bone occurs.

2. Syphilitic osteomyelitis with sclerosis of the whole thickness of the skull-bones, so that the diploë disappears, and the bone becomes of ivory denseness. In other cases necrosis of the whole thickness of the skull occurs.

3. The disease may chiefly affect the inner table, or spread between it and the dura mater. As a result, there may be considerable thickening on the inner aspect of the skull, with no external signs, or gummata may form between the dura and the bone, and exert considerable pressure on the brain.

TREATMENT.—The usual antisyphilitic remedies are given interally. If necrosis of the bone and sinus formation occur, the necrosed bone must be completely removed, and the sinuses rendered as aseptic as possible. Antisyphilitic remedies must also be given.

Sclerosis of the skull-bones may cause persistent headache, and if this is not relieved by iodides and mercury, the bone should be trephined.

The bone lesions of inherited syphilis are described on p. 498.

Pneumatocoele.—A pneumatocoele is a collection of air under the pericranium, and the condition may be due either to trauma or disease.

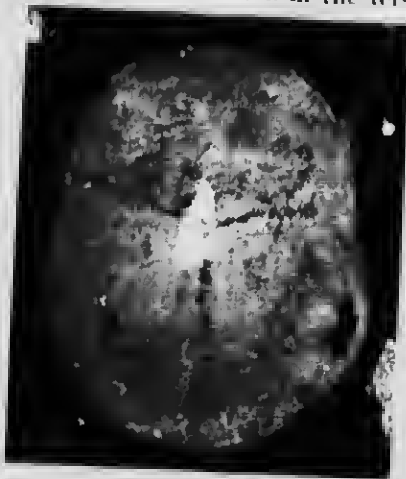


FIG. 376.—GUMMA OF THE SKULL.

Traumatic Pneumatocèle is due to fracture of the bone over the mastoid air cells or frontal sinus, and is very rare.

Spontaneous Pneumatocèle is more common over the mastoid than over the frontal sinus, and is due to an inflammatory lesion of the bone, leading to necrosis and an escape of air under the pericranium.

CLINICAL FEATURES.—There is a slowly increasing painless swelling over the mastoid process, resonant on percussion, and which disappears on pressure, only to reappear when the pressure is removed.

TREATMENT.—The scalp should be incised, and the mastoid process exposed. Any carious bone should be removed, and the skin wound closed, with drainage.

Cephalhæmatocèle.—A cephalhæmatocèle is a collection of blood under the scalp communicating with one of the venous sinuses of the dura mater, usually the superior longitudinal. At first the blood is under the pericranium, but later it lies under the epicranial aponeurosis. The condition may be *traumatic*, a fracture of the skull tearing the wall of the sinus, or may be *congenital* in origin. In the latter case it is probably of the nature of an angioma.

The swellings are usually small, and reducible on pressure, and have an impulse when the patient coughs. Occasionally they pulsate.

TREATMENT.—As a rule no treatment is necessary, but if they are a source of annoyance, they may be removed. They are not sufficiently common, however, for a technique to have been decided upon.

NEW GROWTHS OF THE SKULL-BONES

Innocent

Osteoma.—The osteomata of the skull have already been described on p. 221.

Malignant

Primary Sarcoma.—All the forms of sarcoma may originate in the skull-bones, and may arise from the diploë or from under the pericranium. Usually it is usually impossible to determine the site of origin.

The tumour spreads chiefly externally, but also grows between the dura mater and the bone. It does not tend, however, to infiltrate the brain, being limited by the dura mater; but it may cause serious pressure effects. On the other hand, malignant tumours of the brain and meninges frequently infiltrate the bone.

CLINICAL FEATURES.—The growth is as a rule quite painless in the early stages, the only physical sign being the steadily increasing swelling. In some cases growth is so rapid, and the tumour is so soft and vascular, that it may be taken for an abscess. Later, when it spreads under the dura and the bone, there will be signs of increasing intracranial pressure. Ossification of the tumour is not uncommon. Death occurs from hæmorrhage and sepsis after the tumour has perforated through the skin.

TREATMENT.—The tumour should be removed with a large area of the bone from which it is growing.

The prognosis is unfavourable.

Secondary Sarcoma.—Any form of secondary sarcomatous growth may involve the skull-bones, but the most striking cases are secondary to sarcoma of the suprarenal body.

These growths occur in children, and the primary growth is frequently not discovered till post-mortem examination. Clinically, there are multiple rapidly growing tumours of the skull, and gradual exhaustion. These tumours grow so rapidly that they are often taken for blood-swellings, and considered to be the result of an accident or of some blood disease, such as scurvy or hæmophilia.

There is no treatment.

Secondary Carcinoma.—(Carcinomata of the skull-bones may be secondary to carcinoma in any part of the body, but especially of the breast, thyroid gland, and prostate. The most interesting cases are those secondary to tumours of the thyroid. The original tumour in the thyroid may be obviously malignant, or it may have the characters of an innocent growth. The growths on the skull are multiple, and frequently pulsate. On microscopical examination, they are found to consist of typical thyroid tissue.

There is no treatment.

DISEASES OF THE BRAIN AND ITS MEMBRANES

CONGENITAL MALFORMATIONS

Cephalocele.—A cephalocele is a protrusion of the brain or its membranes through a congenital defect in the bones of the skull, associated with increased intracranial pressure. The cause of the



FIG. 377.—SECTION OF A LARGE CEPHALOCELE.
(London Hospital Medical College Museum.)

condition is quite unknown, and at present it must simply be classed as an error of development, analogous to spina bifida.

PATHOLOGICAL ANATOMY.—Cephaloceles are most common in the middle line in the occipital region. The defect is not at the posterior

fontanelle, but between the foramen magnum and the occipital protuberance, the gap being sometimes termed the "occipital fontanelle." After the occipital region, the protrusions are most common at the fronto-nasal suture, but they may also occur at the lateral fontanelles or project into the mouth, nose, or pharynx. The wall of the sac is formed of the scalp and the meninges. The scalp tissue may be normal or consist of little more than a thin, shiny skin, from which all the hair has disappeared; or there may be a nævoid condition of the skin. Eczema and ulceration of the integument are present in large cephalocele, frequently leading to infection of the cephalocele, and death.

VARIETIES.—According to their contents, cephalocele are divided into—(1) Meningocele, (2) encephalocele, (3) hydrancephalocele.

1. A *meningocele* consists of a protrusion of dura mater lined by the arachnoid and pia mater, and containing cerebro-spinal fluid. It may become shut off from the brain by closure of the opening in the skull to form a cephalhydrocele (see p. 809).
2. An *encephalocele* contains part of the cerebrum or cerebellum in the sac.
3. A *hydrancephalocele* contains part of the cerebrum, including a protrusion of one of the lateral ventricles of the brain.

CLINICAL FEATURES.—The child is born with a spherical tumour, more or less pedunculated, in the middle line either at the occiput or the fronto-nasal junction. The tumour may be larger than the child's head, or so small as almost to escape detection. If it is large, the skin over it is thin and smooth, the hair ill-developed, and a nævoid condition of the skin may be present. The swelling may pulsate, and has an expansile impulse when the child cries. On pressure it can often be partially or completely reduced. This may cause vomiting or convulsions.

The gap in the bone may be felt.

The swelling may remain stationary, but as a rule it gradually increases in size, ulceration of the skin over it occurs, and it bursts. Death then results from loss of cerebro-spinal fluid or infective meningo-encephalitis.

*Meningocele*s are generally small, translucent, and do not pulsate.

*Encephalocele*s are non-translucent, and usually pulsate. They are commoner than meningocele.

*Hydrancephalocele*s are very large, and have a broad base, and are mostly incompatible with life. They may be translucent, and do not as a rule pulsate.

The diagnosis has to be made from cephalhæmatoma, dermoid cyst, and nævus.

PROGNOSIS.—The majority of cases die from ulceration of the skin and meningo-encephalitis in the first few months of life.

TREATMENT.—When very small, nothing is necessary beyond shielding the swelling. When very large, nothing else can be done.

Small cephalocele should be operated upon, especially if they are increasing in size, but the results are unsatisfactory. In many

cases removal of the cephalocele is followed by secondary hydrocephalus, cerebral compression, and death, as the cause of the increased intracranial pressure is not removed by the operation. The nature of the operation depends on the condition present, and it may be necessary to remove the protruding brain matter.

Hydrocephalus

Hydrocephalus is the accumulation of an excess of watery fluid in the cranial cavity. As a result of this accumulation, the skull in a young child becomes expanded. In adults hydrocephalus may be present without expansion of the skull.

If the fluid collects in the pia-arachnoid membrane, it is termed *external* hydrocephalus, and if in the membranes of the brain, *internal* hydrocephalus. The condition may be congenital or acquired.

Congenital Hydrocephalus.

—The causes of this condition are unknown, except that it is frequently associated with **hydramnios**. The fluid is usually found in the lateral and fourth ventricles, which become enormously distended; or it may even be found in one horn of the lateral ventricle, the aqueduct of Sylvius being closed. Occasionally marked external hydrocephalus is present as well.

The condition may be prenatal, and the enlarged head interfere with labour, necessitating puncture or crushing of the head; or it may first show itself in the early weeks of life.

On dissection of the skull, it will be found that the cranial bones have become separated, and the fontanelles enormously increased in size. The bones are thin, and a number of **Wormian bones** may be found in the sutures round the parietal bones.

CLINICAL FEATURES.—The vault of the skull is usually enormously increased in size, and as the bones of the face retain their normal size, they appear to be small. The eyes are pushed downwards and forwards, and the patient is frequently unable to support the head properly on the spine.

The children are generally irritable, but they may be dull and

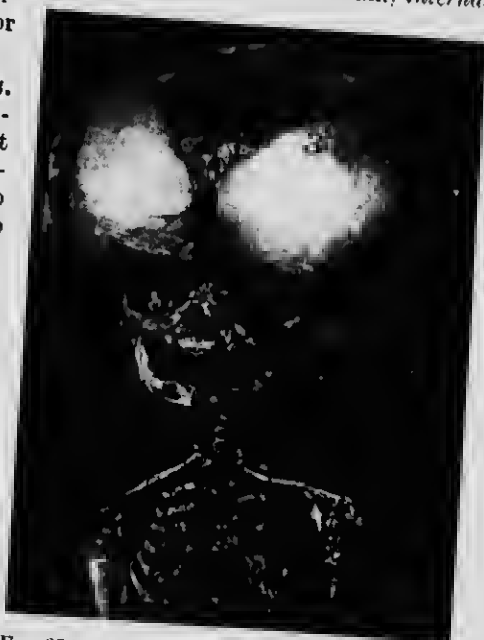


FIG. 378.—DRIED SKULL OF A CASE OF HYDROCEPHALUS.

(London Hospital Medical College Museum)

apathetic. The intellectual faculties are impaired, although in some cases the child may be fairly intelligent. Fits are common. The head as a rule enlarges gradually, few of the children reaching adult life. Optic atrophy is common.



FIG. 379.—CAST OF A CASE OF ADVANCED HYDROCEPHALUS. The skull of the patient was translucent.

(London Hospital Medical College Museum.)

Acquired Hydrocephalus.—Acquired hydrocephalus may be acute or chronic.

Acute Hydrocephalus is due to inflammation of the meninges, usually tubercular. The excess of fluid is found both in the pia arachnoid membrane (external hydrocephalus) and in the ventricles (internal hydrocephalus). The condition is usually fatal.

Chronic Hydrocephalus.—External chronic hydrocephalus is associated with tubercular and other forms of meningitis, intracranial tumour, or atrophy of the brain.

Chronic acquired internal hydrocephalus is due to inflammatory conditions of the base of the brain, such as tubercular meningitis, and chronic inflammatory processes of the choroid plexuses causing obstruction to the outflow of blood by the veins of Galen, or to the circulation of the cerebro-spinal fluid between the ventricles and the subarachnoid space through the foramen of Majendie. It may also be associated with rickets, cerebrial or cerebellar tumour. In these cases the fluid in the skull often contains a large quantity of albumin, and is inflammatory in origin.

The CLINICAL FEATURES and the PROGNOSIS of these cases are similar to those of congenital hydrocephalus. The mild cases associated with rickets, syphilis, or tubercle, frequently recover.

TREATMENT.—Any underlying disease, such as syphilis, rickets, tubercle, or tumours of the brain, should receive appropriate treatment. For the actual accumulation of fluid the following treatments may be tried:

1. Aspiration of the lateral ventricles. The fluid usually soon collects again, and the aspiration must be regularly repeated. A few successes have followed this method of treatment. The aspirating needle is thrust through the anterior fontanelle to one side of the superior longitudinal sinus.
2. Continuous drainage. The fluid is either drained externally into dressings or into the subarachnoid space. There is often temporary improvement, and in some cases apparent cure; but the results, on the whole, are unsatisfactory.

3. Lumbar puncture. This may be frequently repeated, or persistent drainage into dressings or into the peritoneal cavity (Curling) may be established.
4. Ligation of the common carotid artery, to limit the blood flowing through the brain, may be followed by improvement, but is dangerous.

In the mild cases associated with rickets no treatment beyond treatment of the rickets is necessary.

Microcephaly.—Microcephalic idiots may be divided into two groups:

1. The condition is congenital, and the brain shows no pathological change; it is only of a low type of development.
2. The condition is due to injury or disease of the brain, which may be atrophic, sclerosed, or cystic (porocephaly).

Assuming that in microcephalic idiots a premature synostosis and want of growth of the cranial bones was the cause of the non-development of the brain, Lamelongue devised the operation of **craniotomy**. A long strip of bone is cut away from the cranial bones, so that the brain can expand by pushing the bones still farther apart.

At the present time it is believed that the primary defect is in the brain, and if this is so, the operation of craniotomy is useless, and certainly no permanent good results have followed.

Oxycephaly.—This condition is characterized by a peculiarly shaped skull, exophthalmos, and degeneration of the optic nerves, leading in many cases to complete blindness.

It is more common in boys than girls, and may either be congenital or appear in the first few years of life. The cause is unknown.

SHAPE OF THE HEAD.—The forehead is high and slopes gradually up to the vertex, which is pointed instead of being rounded or flattened. The superciliary and temporal ridges are not well marked, and the hair has the appearance of being perched on the top of a cone.

EXOPHTHALMOS is present, and the protrusion may be unequal on the two sides. The patients are usually mouth-breathers, but may be quite intelligent. Smell is often completely lost as well as sight. The condition may not shorten life.

On examination of the dried skull premature synostosis is found at the sutures, especially the coronal and sagittal. The sella turcica is widened and deepened in the middle.

TREATMENT.—Trephining is advised in cases with swelling of the optic discs, if secondary atrophic changes are not present, as the optic atrophy is believed to be due to pressure of the growing brain in the prematurely synostosed skull.

INFLAMMATORY CONDITIONS OF THE BRAIN AND THE MENINGES

ACUTE inflammation of the brain and meninges is due to infection with micro-organisms, chiefly the staphylococcus and streptococcus, but in some cases the pneumococcus, the *Diplococcus intracellularis*.

or other organisms. The tubercle bacillus may occasionally cause an acute meningitis. The methods of infection are—

1. Direct infection through compound fractures, bullet wounds, and operation wounds.
2. Extension from the surrounding tissue—*e.g.*, infection of the middle ear; suppuration in the frontal and ethmoidal sinuses; erysipelas and cellulitis of the scalp, the infection spreading along the emissary veins; acute osteomyelitis of the skull-bones; etc.
3. Infection of the blood-stream as a part of a septic-pyæmia.

Of these causes the most important, because the most common, are infection from suppurative conditions of the middle ear and direct infection through compound fractures.

Pathologically it is possible to divide the inflammatory conditions into—(1) Pachymeningitis externa with extradural abscess; (2) Pachymeningitis interna and Leptomeningitis (meningo-encephalitis) with intradural abscess; and (3) Encephalitis with cerebral abscess. Clinically, it is often exceedingly difficult to distinguish between these conditions, and they are not infrequently associated with one another.

Pachymeningitis Externa.—Inflammation of the outer layer of the dura mater is usually due to infection from compound fractures or to spread of the inflammation from suppuration in the middle ear. The inflammation is generally localized, and gives no direct evidence of its presence until an extradural abscess has formed. When pus is present between the dura mater and the bone, in addition to the usual symptoms of infection there may be a localized œdema of the scalp due to the spread of inflammation through the bone. This swelling was first described by Percival Pott, and is generally known as "Pott's puffy tumour." It is not present in all cases, and is usually absent in those in which the extradural abscess is secondary to compound fracture of the skull-bones. Signs of compression of the brain are not present as a rule, as the abscess is usually small, but with rapidly spreading inflammation or when the inner layer of the dura is also involved, the usual symptoms and signs of cerebral pressure become marked.

TREATMENT.—All the bone over the abscess cavity should be removed so that there is free exit for the pus, and the abscess drained. It is understood that the primary focus of inflammation such as the mastoid antrum or the frontal sinus must be thoroughly treated at the same time.

Acute Pachymeningitis Interna.—Inflammation of the inner layer of the dura is associated with leptomeningitis (inflammation of the pia), and may be either localized or diffuse.

Localized Leptomeningitis is only of clinical importance when an intradural abscess has formed. The symptoms of an intradural abscess are similar to those of extradural abscess, but the signs of cerebral compression, both general and localized, are commonly more marked. It is generally impossible to make a differential diagnosis until operation.

TREATMENT.—After proper treatment of the primary source of infection, the bone over the abscess is removed, and the cavity thoroughly drained.

Acute Diffuse Leptomeningitis (Meningo-Encephalitis)—**PATHOLOGICAL ANATOMY.**—The bloodvessels of the surface of the brain and membranes are congested, and there are punctiform hæmorrhages in the pia mater. A rapid effusion of lymph occurs over the surface of the brain and into the subarachnoid space. This effusion is at first clear, but later becomes turbid, and finally purulent. Pns is also seen lying in the sulci of the brain along the bloodvessels. The brain is softer than normal, cedematous, and owing to the congestion, the intracranial pressure is raised and the convolutions flattened.

SYMPTOMS.—The general symptoms are those of any acute infectious disease. The temperature is high (104° F.), and there is frequently a rigor at the onset of the disease.

The localizing symptoms of the acute inflammation of the brain may be divided into two stages, a stage of irritation and a stage of paralysis.

Stage of Irritation.—The patient is restless and delirious, and complains of severe headache. The special senses are hyperacute, so that he dislikes bright lights and loud noises. Spasms and twitchings of the muscles are present; general convulsions may also occur. Persistent vomiting is often a marked feature, and the bowels are constipated. In those cases in which the base of the brain is chiefly affected, the head is retracted, optic neuritis is early and intense, and there is squint caused by spasm or paralysis of the ocular muscles.

Stage of Paralysis.—The general symptoms of infection are still present, but the patient becomes comatose and the muscles are paralyzed. At first there may be monoplegia or hemiplegia, but later, the paralysis is general. The pupils are dilated and fixed, and the pulse is at first slower, but towards the end rapid and irregular. Death occurs within a week of the onset of the disease.

At any stage of the disease the cerebro-spinal fluid obtained by lumbar puncture may show a leucocytosis or be actually purulent. Bacteriological examination will demonstrate the organism present.

TREATMENT.—As infective leptomeningitis is nearly always fatal, only drastic measures are likely to be of any use. The source of infection in the middle ear, the frontal sinus, or a compound fracture, must be treated radically, and an attempt made to drain the subarachnoid spaces. This may be done by frequent lumbar puncture, but it is more satisfactory to drain by a large opening in the skull below the tentorium cerebelli in cases of basal meningitis, or at the site of the original source of infection. These operations are rarely successful, but are the only rational methods of treatment. After drainage is established, venesection and brisk purging may be used to lower the intracranial pressure.

Vaccine therapy may also be used.

Cerebro-Spinal Meningitis.—This is an infective epidemic disease associated with an acute inflammation of the meninges of the brain

and spinal cord due to the *Diplococcus intracellularis*. The symptoms are similar to those already described, and the diagnosis is made by finding the diplococcus in the fluid removed by lumbar puncture. On post-mortem examination, the brain and spinal cord are covered with a thick fibrino-purulent exudate.

Surgical Treatment.—This consists of repeated lumbar puncture or drainage of the subarachnoid spaces through the occipital bone.

Tubercular Meningitis.—Tubercular inflammation of the meninges is most common in children, and the infection is usually blood-borne, but it may be due to direct extension from tuberculous osteomyelitis or tuberculous otitis media. The base of the brain is most affected, and the pia mater becomes studded with small grey tubercles most numerous along the bloodvessels. There is usually excess of fluid in the subarachnoid space and in the ventricles of the brain (secondary hydrocephalus).

CLINICAL SYMPTOMS.—For a detailed account of the clinical manifestation of tubercular meningitis, a textbook on medicine must be consulted, but the symptoms may be divided into two stages:

1. Signs of irritation of the brain—viz., headache, photophobia, restlessness, crying, alterations in size of the pupils, retraction of the head, vomiting, and convulsions. The abdomen is retracted, there is obstinate constipation, and Koenig's sign is obtained.
2. Signs of cerebral compression, drowsiness developing into coma, muscular paralysis, Cheyne-Stokes respiration, rapid pulse, and optic neuritis. In young children the fontanelles may bulge.

The cerebro-spinal fluid withdrawn by lumbar puncture may show an increase in mononuclear leucocytes, and the tubercle bacillus may be found. In other cases the fluid is sterile.

SURGICAL TREATMENT.—Attempts have been made to drain away the fluid collecting at the base of the brain through an opening in the occipital region, but with very little success. At the present time the only operation to be contemplated is repeated lumbar puncture, and this is of doubtful value.

Syphilitic Meningitis.—Inflammation of the meninges of the brain is most commonly seen within two or three years of the primary infection, but it may occur as late as twenty years after. It is always accompanied by syphilitic changes in the bloodvessels of the brain and spinal cord.

The onset is gradual as a rule, and the early symptoms are recurrent headache, restlessness at night accompanied by dreams, and hallucinations. Later, there may be a sudden onset of localizing signs, such as transverse myelitis, ocular paralysis, and pupillary changes. In some cases the patient has convulsions or paralysis of the cranial nerves. Wassermann's serum reaction is positive, and the spirochete is found in the exudate.

TREATMENT.—Salvarsan or neo-salvarsan should be given intravenously. There is no surgical treatment.

Cerebral Abscess

CAUSES.—1. Extension of suppuration from surrounding structures, particularly the middle ear. Otitis media is by far the commonest cause of abscess of the brain. The abscess may be situated in the cerebrum or cerebellum, the proportion being about three to one. The most frequent situation of the cerebral abscess is in the temporo-sphenoidal lobe, and it is rather more common on the right side than on the left.

Abscess of the brain may also follow inflammatory conditions of the cranial bones.

2. Direct infection through a compound fracture.

3. Blood infection (pyæmia), especially in cases of suppuration in the chest, such as empyema and bronchiectasis, but also in cases of general infectious diseases, such as influenza, enteric fever, or smallpox.

PATHOLOGY.—The abscess may be acute, subacute, or chronic. Acute abscess usually follows direct infection. The disease is therefore part of an acute meningo-encephalitis, and has the same symptoms as this condition. The abscess cavity has no distinct wall, and the surrounding pia mater is soft and oedematous, and shows petechial hæmorrhages.

In subacute and chronic abscess—the form that is most common as a complication of otitis media—the slow-spreading infection obliterates the arachnoid space, and the cortex of the brain, pia mater, arachnoid mater, and dura mater all become adherent. Infection spreads along the lymphatic vessels to the white substance of the brain, and an abscess forms. The abscess has a distinct capsule of fibrous tissue separating it from the rest of the brain substance, and if very chronic may remain quiescent for months or even years. Extension of the abscess may cause it to burst into the ventricles of the brain or on to the surface, causing an acute leptomeningitis, or very rarely it may burst externally through the middle ear.

SYMPTOMS.—1. *Acute Abscess.*—The symptoms of acute abscess are those of acute leptomeningitis. There are the usual general symptoms of infection with rise of temperature and delirium. Signs of compression of the brain supervene, and the patient dies in a comatose condition. A differential diagnosis can only be made on operation or post-mortem examination, and the two conditions are often associated.

2. *Subacute and Chronic Abscess.*—In cases of very chronic abscess of the brain the symptoms are those of cerebral tumour. The chronic abscesses associated with tubercle and syphilis (gummata), and also some of the chronic pyogenic forms, are described with cerebral tumour (p. 854), and require the same treatment. The symptoms are similar to those of cerebral tumour, as in both cases there is a slowly increasing cerebral pressure; but in subacute abscess a differential diagnosis can often be made. For the sake of description it will be convenient to consider the symptoms of subacute abscess secondary to otitis media.

INITIAL STAGE.—A patient who is known to have an otitis media develops the symptoms of an infectious fever. There is headache, vomiting, a rise of temperature, increase in pulse-rate, and general



FIG. 380.—DIAGRAM OF THE PATH OF THE PUS INTO THE BRAIN FROM SUPPURATION IN THE MASTOID ANTRUM.

malaise, the otorrhœa being diminished, or ceasing entirely. This stage lasts for a few hours, or one or two days, and is due to a sub-acute infection of the brain substance. In chronic cases it is absent.

SECOND STAGE.—The general symptoms of slowly increasing intracranial pressure develop as the signs of infection diminish:

Headache is present, and may be localized to the side of the abscess. It is not influenced by medical treatment.

Vomiting occurs without nausea and without relation to food.

Optic Neuritis may be present, but is a very variable sign, and often misleading. It may be absent during the whole course of the disease, and it is present in other conditions besides cerebral abscess.

Temperature.—The typical temperature is subnormal, but there may be an occasional rise, often associated with a rigor.

Pulse is slow and full (50 to 60).

Respiration slow and deep. Sighing or yawning may be present.

Constipation may be marked.

Mental Condition.—The patient is usually conscious, but takes little notice of what is going on around him. If spoken to, he answers correctly and intelligently, but usually after a long pause, and very slowly and briefly. Movements of the limbs are also sluggish.

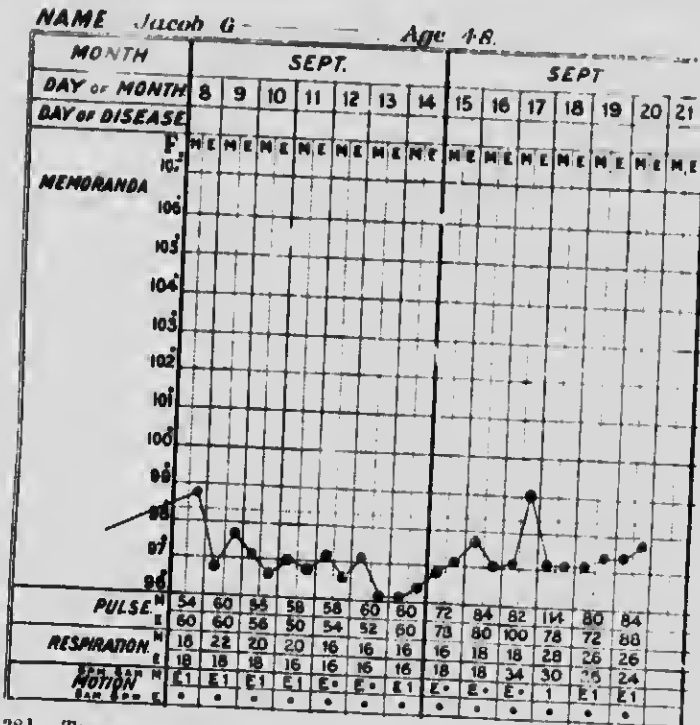


FIG. 381.—TEMPERATURE CHART OF A PATIENT WITH A CHRONIC ABSCESS IN THE TEMPORO-SPHENOIDAL LOBE.

THIRD STAGE.—The patient may simply have increasing coma until death occurs, or there may be a return of the febrile condition, owing to the abscess bursting into the subarachnoid space or into the ventricles of the brain. In the first case the symptoms are those of acute leptomeniingitis, and death occurs in one or two days. If the abscess bursts into the ventricles of the brain, there is a sudden rise of temperature (105° to 106° F.), rapid pulse (130 to 140), stertorous or Cheyne-Stokes respiration, delirium, followed by rapidly deepening coma and death in a few hours.

LOCALIZATION.—Coma and death may occur without localizing symptoms, but when these are present, they are indicative of the situation of the abscess.

Temporo-Sphenoidal.—Increase in size of a temporo-sphenoidal abscess may cause pressure on the fibres of the internal capsule, or on the cortex of the brain in the Rolandic area. If the pressure is

on the internal capsule, the lower extremity on the opposite side of the body first becomes paralyzed, then the upper extremity, and lastly the face; but in the case of cortical pressure, the paralysis occurs in the reverse direction—viz., face, arm, leg. If the abscess is on the left side, there may be motor aphasia from involvement of Broca's area. Squint and a fixed dilated pupil may be present on the same side as the abscess, due to pressure on the third nerve.

Cerebellar Abscess.—With abscess in the cerebellum, the optic neuritis is usually early and intense, and vomiting is very marked. "The patient can walk, there is a staggering gait, and he tends to fall toward the opposite side to the abscess. Vertigo is common. Later, there may be retraction of the head and neck, and alteration in the pulse and respiration rate, caused by pressure on the medulla oblongata.

Further evidence of the localization of an abscess in the brain will be considered under Intracranial Tumour (p. 858).

PROGNOSIS.—The prognosis of cerebral abscess is always grave, and even when the abscess is localized and opened and drained, the result is not always successful, for complications, such as sinus thrombosis, meningitis, and rupture into the ventricles, may occur. Drainage is also difficult, and a hernia cerebri may develop.

TREATMENT.—The treatment consists of opening and draining the abscess thoroughly. In cases of suppuration in the brain secondary to middle-ear disease, the rule for treatment is to "follow the pus." A complete radical mastoid operation should always be performed first and the tract of the pus carefully followed. In this way the abscess in the brain is opened along the path of infection, and there is less likelihood of infecting the meninges and causing acute meningoencephalitis.

If after a radical mastoid operation there is no indication of the path taken by the pus, and the clinical signs of intracranial abscess are marked, the bone should be chiselled away until the dura mater is thoroughly exposed. If a temporo-sphenoidal abscess is indicated by the symptoms, the bone should be removed above and slightly behind the external auditory meatus; while in the case of a cerebellar abscess the bone to be removed lies below and behind. The lateral sinus is examined for thrombosis during removal of the bone. When a sufficiency of bone has been removed, the dura is incised, and a sinus forceps is passed into the brain substance in various directions, until the abscess is found or it is decided that it is not present. If the abscess be found, the forceps are opened, the pus evacuated, and a drainage-tube passed into the abscess cavity. A drain of worsted or strands of silkworm gut may be used instead of the drainage-tube, which is difficult to retain in position in a cerebral abscess. The after-treatment is that of abscess elsewhere.

Thrombosis of the Sinuses of the Dura Mater

Thrombosis of the sinuses of the dura mater may occur (1) from altered blood conditions, such as profound anemia or marasmus; and (2) from infection of the walls of the sinus (infective sinusitis).

The former condition is not amenable to surgical treatment, and it is the latter which will be described here.

Infective Sinusitis (Infective Sinus Thrombosis).—Infective sinusitis in the great majority of cases is due to spread of infection from the surrounding structures, and by far the commonest is infection of the lateral sinus from the middle ear. The infection may extend through the bone until it reaches the wall of the sinus, or it may spread along one of the veins emptying into the sinus. Other causes of infection are—Infective conditions of the bones of the skull, erysipelas, and cellulitis of the scalp, extension from suppuration in the frontal and ethmoidal sinuses, and infected compound fractures of the skull.

PATHOLOGY.—The pathological changes in the wall of the sinus and the formation of a thrombus in the vessel are similar to those present in other veins (see Phlebitis, p. 327). Inflammatory exudates occur between the wall of the sinus and the surrounding bone, and the condition ends either in suppuration and separation of the sinus wall from the bone, or in fibrosis, the sinus being more firmly adherent than usual. The thrombus in the sinus may become organized, so that the sinus becomes a fibrous cord—a condition which is only discovered on post-mortem examination; or it may disintegrate and the sinus become filled with infected blood-clot and pus. This is carried into the general circulation, and septic-pyæmia results, metastatic abscesses being chiefly found in the lungs.

Locally, the infection may spread from the sinus to the bone, meninges, and brain, causing infective osteomyelitis, with subsequent necrosis if the patient lives, or meningitis and meningo-encephalitis.

CLINICAL FEATURES.—The symptoms of infective sinusitis may be grouped as follows:

1. General symptoms of an infective disease.
2. Symptoms of septic-pyæmia.
3. Local symptoms pointing to the sinus affected.

(1) The general symptoms are—Rise of temperature, increase of pulse and respiration rate, vomiting, headache, and general malaise.

(2) The symptoms of septic-pyæmia only occur when the blood-clot has disintegrated and the infective particles are being carried throughout the body. They are—Inflammation of serous and synovial membranes, rashes, usually hæmorrhagic, and evidence of metastatic abscesses. There is generally a succession of rigors. If the condition is not recognized and treated before blood-infection occurs, the prognosis is nearly hopeless.

(3) The local symptoms vary with the sinus affected.

A. LATERAL SINUS.—This is the sinus most usually affected, owing to its proximity to the middle ear. Thrombosis of this sinus should always be suspected if a patient with otitis media has an increase in the general symptoms, without any signs of meningitis or cerebral abscess. *When this sinus is first thrombosed, and when treatment is of most avail, there are no definite symptoms of the condition. There may be headache on that side, or tenderness over the mastoid process,*

with dilatation of the superficial veins; but these occur equally with mastoiditis, and are not of much value, but if present, should always lead to an examination of the sinus during the operation on the mastoid antrum.

The diagnostic physical sign of lateral sinus thrombosis is extension of the thrombosis into the internal jugular vein, which, when thrombosed, feels like a tender cord in the neck. Occasionally the veins of the posterior cervical plexus are also thrombosed. Unfortunately, by the time this sign is present, general infection has often occurred, and this late diagnosis accounts for the bad prognosis in cases of lateral sinus suppuration.

B. CAVERNOUS SINUS.—Thrombosis of this sinus most commonly follows suppuration in the orbit, and extension of the inflammation along the ophthalmic veins. It may also be secondary to suppuration in the ethmoidal cells, sphenoidal sinus, or superior maxillary sinus.

The local symptoms are—Proptosis, with œdema of the eyelids, forehead, and cheek, and chemosis of the conjunctiva. The oculomotor nerves are also pressed upon, causing squint and interference with the movement of the pupils. The condition is at first unilateral, but later it commonly spreads across the middle line, and the physical signs are then bilateral.

C. SUPERIOR LONGITUDINAL SINUS.—Infection of this sinus is usually due to infective inflammation of the scalp and skull-bones. The local symptoms which may be present are œdema of the scalp, with dilatation of the veins, general convulsions, and paralysis; but frequently all these are absent.

TREATMENT.—The first step in the treatment is as far as possible to eradicate the primary source of infection. For example, in lateral sinus thrombosis secondary to mastoiditis, a radical mastoidectomy is absolutely imperative, and in the case of cavernous sinus thrombosis following suppuration in the antrum of Highmore, that cavity must first be thoroughly opened and drained.

Lateral Sinus.—If the internal jugular vein is thrombosed so that the diagnosis is certain, this vein should be at once ligatured in the neck below the thrombus, and a ligature also placed on the lingual and facial veins to prevent spread of the thrombus into them. If, on the other hand, the diagnosis is only tentative, after a radical mastoidectomy has been performed, the opening in the bone should be enlarged backwards, and the sinus exposed and examined, and if it is found to be thrombosed, the veins should then be ligatured. The sinus should be thoroughly exposed by removing sufficient bone, then laid open, and all the clot removed, so that the sinus bleeds freely. The internal jugular vein may be cut across, and the sinus very thoroughly syringed through. The hæmorrhage, which looks alarming, may readily be checked by packing with gauze.

Cavernous and Superior Longitudinal Sinus.—Beyond dealing with the primary source of infection, there is little to be done for thrombosis of these sinuses; but an attempt may be made to remove the infective clot and establish drainage, especially in the case of the longitudinal sinus.

INTRACRANIAL NEW GROWTH (CEREBRAL TUMOUR)

The term "cerebral tumour" is used clinically to include a number of conditions that are not usually classed as tumours, such as syphilitic gummata, masses of tubercular granulation tissue, hydatid cysts, blood-cysts, etc. The term also includes tumours growing from the meninges and cranial bones, which are not, strictly speaking, cerebral tumours. The reason for the broad application of this term is that the condition has to be diagnosed *clinically* by the symptoms it causes, and not by the physical signs of the tumour itself, and there is no difference between the symptoms caused by a slowly increasing gumma or hydatid cyst and those caused by a true neoplasm of the brain.

CLINICAL FEATURES.—The symptoms of intracranial tumours may be divided into four groups:

1. General symptoms which indicate that there is a slow, steady increase of intracranial pressure.
2. Localizing symptoms, indicating the situation in which the tumour is growing, which are chiefly the effects of pressure on or destruction of specialized portions of the brain.
3. Interference with the cranial nerves.
4. Symptoms which indicate the nature of the tumour present.

I. GENERAL SYMPTOMS OF INTRACRANIAL TUMOUR.—These are—Headache, vomiting, dyschromatopsia, and choked discs.

Headache.—The headache is persistent, intense, and unrelieved by drugs. It may be localized over the site of the tumour.

Vomiting.—The vomiting is effortless, has no relation to food, and is unaccompanied by nausea.

Dyschromatopsia—*i.e.*, an inversion of the colour fields shown by the perimeter, and affecting the blue more than the other colours.

Choked Discs.—This condition, commonly spoken of as "optic neuritis," is not an inflammatory condition of the optic nerve, but a mechanical blocking in the bloodvessels of the retina, due to the increased intracranial pressure. In other words, it is an œdema of the optic disc, with congestion and finally rupture of the veins, followed later by optic atrophy. In many cases it is not to be distinguished from the so-called "albuminuric retinitis." This sign is the most important one of all the general pressure phenomena, and is usually most marked on the side of the intracranial tumour.

Other general symptoms are—Vertigo, dizziness, general convulsions, a slow pulse and respiration, and mental hebetude.

Although these are the general symptoms of increased intracranial pressure, intracranial tumour may be present for years without them, and it may be broadly stated that they are more likely to be indefinite than all to be present.

The following types of cases are seen: (1) Patient without any typical clinical, general, or localizing symptoms, the tumour being discovered post mortem; (2) patient with general and without local-

izing symptoms; (3) patients with localizing, but without general symptoms; (4) patients with both general and localizing symptoms.

These general symptoms may also be present in other conditions than intracranial tumour, the most common sources of error being chronic nephritis with renal insufficiency; disseminated sclerosis; hysteria; lead-poisoning; general paralysis of the insane; and pseudo-tumour of the brain.

2. LOCALIZING SYMPTOMS.—The majority of localizing symptoms are due to local pressure or destructive effects on specialized parts of the brain, but the following signs may also help localization: The headache may be most marked over the site of the lesion, and the scalp over it may be tender and oedematous; occasionally a tumour grows through the skull, and can be felt under the scalp. Radiography may show a shadow in the situation of the tumour. In children, bulging of the skull may be present, especially in the occipital region, with cerebellar tumours.

The most important and well-recognized pressure or destructive symptoms are—

Rolandic Area.—If the tumour is growing in or pressing on the cortex of the brain lying in front of the fissure of Rolando, there may be Jacksonian epileptic fits, the aura starting in the group of muscles corresponding to the area of brain chiefly affected. As the cortical cells are destroyed by the tumour growth, these irritative symptoms give place to paralysis of the muscles on the opposite side of the body to the brain lesion. The highest centres in the Rolandic area are for the movements of the vagina and anus, and then in order from above downwards come the centres for movements of the ankle, knee, hip, body, arm, neck, tongue, mouth, and eyes. If the tumour encroaches on the ascending parietal convolution behind the fissure of Rolando, there is alteration in sensation as well.

Subcortical Tumours in the centrum ovale cause a wider spread motor paralysis than cortical tumours, and Jacksonian fits do not occur.

Frontal Region.—The higher intellectual centres of ideation, judgment, memory, and attention, are believed to be in the frontal areas; and tumours in this situation may cause insanity without any general symptoms or other localizing signs. Tumours in this region may also cause ataxia.

At the posterior end of the third left frontal convolution is Broca's area—the motor speech area—and lesions here cause motor aphasia—*i.e.*, the patient knows what he wants to say, but is unable to say it, although the muscles of the larynx are not paralyzed, and the vocal cords are normal. Situated just above Broca's area is the writing centre, a lesion of which causes agraphia—*i.e.*, a patient is unable to write what he wishes. These areas are situated on the right side in left-handed people.

Parietal Area.—The parietal lobe is chiefly concerned in muscular and cutaneous sensibility. With tumours growing in this region of the brain, there may be an inability to recognize the position of the limbs

in space, and to estimate to what extent a limb is moved. When the eyes are shut, the sense of touch may be lost. There may also be loss

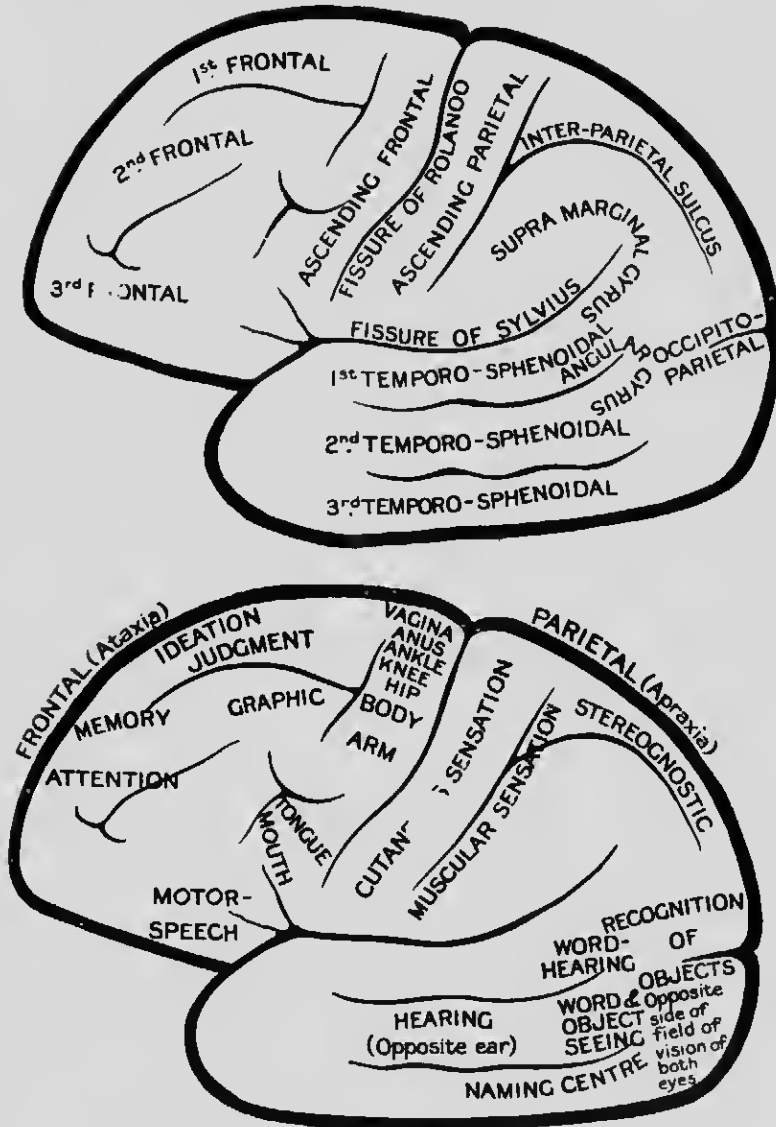


FIG. 382.—DIAGRAMS SHOWING CEREBRAL LOCALIZATION.

of the stereognostic sense—i.e., that sense which enables one to recognize the form, spacing, location, and relative position of objects. At the upper end of the first temporo-sphenoidal convolution is the

angular gyrus, the situation of the centre for word-hearing. Destruction of this centre causes word-deafness—*i.e.*, a sensory aphasia in which there is inability to understand spoken words, although there is no deafness.

A lesion in the parietal area may also cause *apraxia*. A patient in this condition is unable to perform a movement he wishes to, though he knows perfectly well what he desires to do.

Occipital Lobe.—The cortex of the outer aspect of the occipital lobe is chiefly concerned with the higher centres of sight—that is to say, that it is here that objects are *recognized*. Lesions of this part of the brain will therefore not lead to blindness, but to inability to recognize the object seen. If the centres are stimulated by the tumour instead of being destroyed, there may be hallucinations of sight.

The centre for the retina is situated on the under surface of the occipital lobe round the collateral sulcus. A tumour growing in this situation on one side will cause blindness of the opposite half of the field of vision of both eyes—*i.e.*, hemianopsia.

Tumours in the occipital lobe may cause pressure on the cerebellum, with symptoms of cerebellar tumour, the differential diagnosis being made by recognition of the defects in vision.

Temporo-Sphenoidal.—Tumours growing in the upper part of the temporo-sphenoidal lobe may cause absolute deafness in the opposite ear. The uncus is situated in the anterior inferior part of the temporo-sphenoidal lobe, and a tumour of this part of the brain causes defects in taste and smell.

Pituitary Body, or Hypophysis Cerebri.—Tumours growing in the interpeduncular space and involving the pituitary body may be associated with the clinical symptoms of acromegaly and loss of sexual desire. They also cause direct pressure on the optic nerve, and give rise to bilateral temporal hemianopsia. Later, there is complete optic atrophy, without the primary condition of choked disc.

A tumour growing in many parts of the brain gives no localizing symptoms, these parts being known as the "silent areas" of the brain. It must be clearly understood that localizing symptoms are only of value when they occur early in the course of the disease, for, later, they may be due to metastatic growths or to secondary pressure effects.

Cerebellar Tumours—**SYMPTOMS**—The general symptoms of increased intracranial pressure are present, and choked discs usually occur early.

Eye Symptoms.—These are:—nystagmus, weakness of conjugate movements, and skew deviation of the eyes. They are all more marked on the side of the lesion.

Muscle Symptoms.—The following muscular defects may also be present, the symptoms being more marked on the side of the cerebellar lesion:

Gait is staggering, like that of a drunken man, and there is a tendency to fall away from the side of the lesion.

Ataxia, with inco-ordination of the movement of the arms.

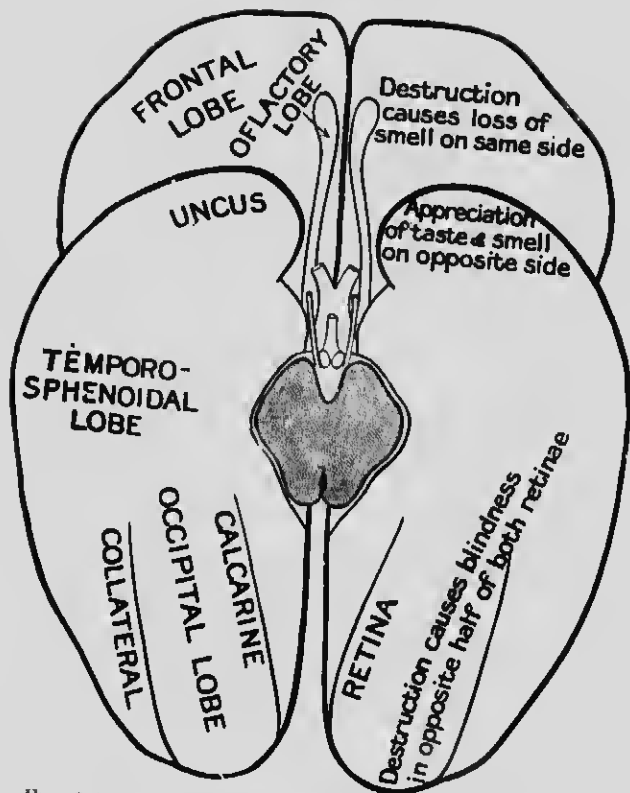


FIG. 383.—DIAGRAM SHOWING CEREBRAL LOCALIZATION.

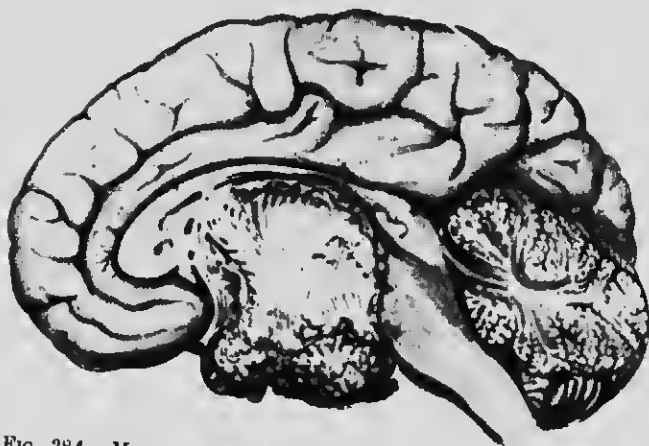


FIG. 384.—MALIGNANT TUMOUR IN THE INTERPEDUNCULAR SPACE.
(London Hospital Medical College Museum.)

Dysdiakokinesis—i.e., the patient cannot perform rapidly alternating movements (e.g., pronation and supination of the forearm) with precision.

Inability to move two joints at the same time.

Hypotonicity and paresis of the muscles on the side of the lesion.

Deep Reflexes, especially the knee-jerks, are altered, sometimes being increased, sometimes diminished. They may, however, be normal.

If pressure from a cerebellar tumour occurs on the pons, there may be hemiplegia on the opposite side of the body, the paresis chiefly affecting the leg and the arm. Alteration in respiration and pulse rate, due to pressure on the medulla, may also be present. It is important to bear in mind this pressure on the medulla, for sudden alteration of it brought about by operation may cause cessation of breathing or the heart-beat.

3. PRESSURE ON CRANIAL NERVES.—Pressure on the cranial nerves may give valuable localizing symptoms. In cases of cerebellar tumour, the nerves likely to be affected are from five to twelve, and especially the sixth (abducens), which is a small nerve with a long intracranial course. In cases of interpeduncular tumours, optic atrophy from pressure on the second nerve has already been mentioned. In tumours in the frontal region there may be loss of smell, caused by pressure on the olfactory bulbs, and in the temporo-sphenoidal lobe deafness from pressure on the eighth nerve, or facial paralysis from pressure on the seventh.

4. NATURE OF TUMOUR.—It is rarely possible before operation to diagnose the nature of the tumour present. The following summary is given by Harvey Cushing of seventy-one cases submitted to operation or post-mortem examination:

Gliomata	..	..	..	..	..	47*
Endotheliomata	..	..	..	..	..	5
Sarcomata (metastatic)	..	..	..	..	..	1
Carcinomata (metastatic)	..	..	..	..	..	3
Primary epithelial tumours	..	..	..	..	..	3
Gummata	..	..	..	..	..	3
Tubercular masses	..	..	..	..	..	4
Dermoid cysts	..	..	..	..	..	1
Angioma	..	..	..	..	..	1
Osteochondroma	..	..	..	..	..	1
Osteoma	..	..	..	..	..	1
Unclassified	..	..	..	..	..	1

—
71

Other tumours which have been described are fibromata, fibrosarcomata, simple cysts, hydatid cysts, and psammomata.

* Including 11 cysts.

Gliomata are the commonest of the cerebral tumours, and are usually slow-growing. In some cases the patient has presented symptoms of intracranial growth for as long as twenty years. They may be either encapsuled or diffuse, and are apt to undergo cystic degeneration. Hæmorrhage may occur into them, causing a sudden increase in the general pressure symptoms.



FIG. 385. — GLIOMA OF THE BRAIN, WITH HÆMORRHAGE INTO THE GROWTH.

(London Hospital Medical College Museum.)

Gummatous tumours in the brain

are said to be rebellious to anti-syphilitic treatment, and early operation is advised if the symptoms do not quickly subside under the administration of salvarsan or mercury and potassium iodide. The diagnosis is made from the history, presence of other syphilitic lesions, and a positive Wassermann's reaction.



FIG. 386. — SOLITARY TUBERCULAR MASS IN THE BRAIN.

(London Hospital Medical College Museum.)

Localized tuberculous masses may form definite tumours in the brain. They always arise in connection with the meninges, and even when found deeply embedded in the brain, have developed on the sheath of the bloodvessels derived from the pia mater. They are rounded and encapsuled, and may grow as large as a hen's egg. They may be solitary or multiple. They are most common in children, and after causing symptoms, may become quiescent for years. They may be associated with other signs of tuberculosis in the body, and tuberculous meningitis is apt to complicate the clinical picture.

Osteoma, Osteochondroma, and Osteosarcoma arising from the cranial bones, and causing symptoms of intracranial tumour, may be detected by radiography.

COURSE OF INTRACRANIAL TUMOUR.—As a rule the course of the disease is steadily downhill, and there is a steady march of symptoms to a fatal termination. There may, however, be intervals of relief from symptoms, with disappearance of the physical signs. This is particularly apt to occur in cases of tuberculosis and syphilis, but may also occur in gliomata and cystic tumours. There is no

evidence that a true neoplasm of the brain ever disappears spontaneously.

TREATMENT.—In all cases an examination of the blood should be made for Wassermann's reaction, and even if this is negative, and there is any possibility of the condition being syphilitic, a course of mercury and iodides or salvarsan should be given. Improvement in the symptoms does not necessarily indicate that the condition is due to a gumma, as other forms of intracranial tumour may be temporarily relieved by iodides, whilst non-improvement does not always mean that the condition is not syphilitic. If there is no improvement, the question of operation must be at once considered.

The cases fall into the following groups:

1. *General Symptoms without Localizing Symptoms.*—In these cases, if the general symptoms are not relieved by drugs, and especially if the condition of choked discs is advancing so that the patient is growing blind, a decompression operation should be per-

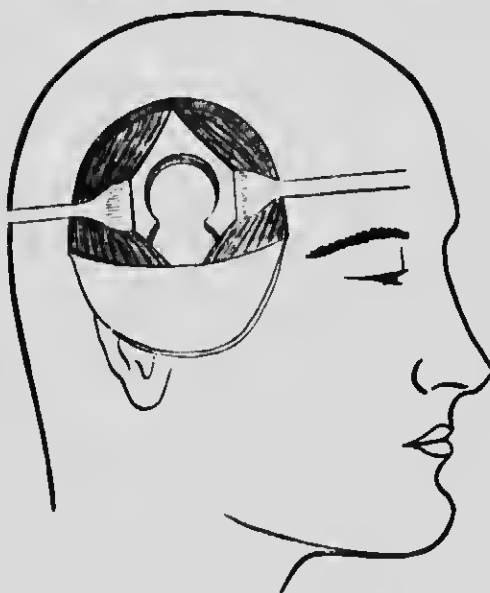


FIG. 387.—SUBTEMPORAL DECOMPRESSION.

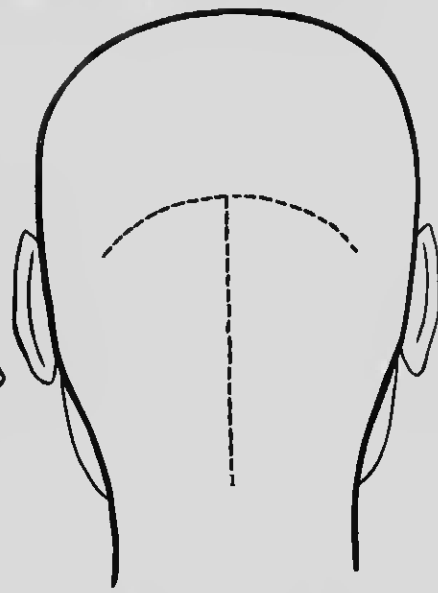


FIG. 388.—INCISION FOR EXPOSING THE SUBTENTORIAL REGION.

formed. This allows the brain to bulge through an opening in the skull, and so relieves the intracranial pressure. *No patient with intracranial tumour should be allowed to become blind.*

In the case of cerebral tumour, a *large* area of bone should be removed from under the temporal muscle on the right side (subtemporal decompression), and for a cerebellar tumour the whole of the occipital bone below the lateral sinuses should be removed (subtentorial decompression). The dura must be incised so that the brain can

protrude, and the wound carefully closed without drainage. Small openings are worse than useless.

2. *General Symptoms with Indefinite Localizing Symptoms.*—As early diagnosis of intracranial tumour gives the best chance of permanent cure, exploratory craniotomy is justifiable if there is a reasonable hope that the tumour can be discovered and removed. Even if the tumour is not found, the operation will be of benefit by causing decompression.

3. *General Symptoms with Localizing Symptoms.*—In this case, the skull should be opened over the supposed site of the tumour, and an attempt made to remove it, *unless* the situation is such that removal is clearly impossible without destroying life or causing complete aphasia. In every case of operation the patient and his friends should be warned that, even if the operation is successful and the tumour removed, paralysis will often be present afterwards, and may even be increased by the operation. It may be stated generally that about 5 to 10 per cent. of intracranial tumours are capable of being removed.

4. *Sudden Increase in the Symptoms.*—Sudden increase in the general symptoms is usually due to hæmorrhage occurring into the tumour, and a decompression operation is urgently needed if life is to be prolonged. This may be done with success, even after cessation of respiration from pressure, if the heart is still beating.

To sum up: Operation in cases of intracranial tumour is indicated to remove the tumour completely and cure the patient; to prolong life, and relieve symptoms, especially blindness; and to ascertain the nature and situation of the tumour, with a view to removal.

LUMBAR PUNCTURE may be tried in cases where the pressure is excessive before operation is performed, but it is not without danger of causing sudden death.

Pseudo-Tumour of the Brain.—This is a condition the pathology of which is obscure. The patient presents all the characteristic signs of intracranial tumour, but on operation or autopsy, no tumour is found. At the operation the brain may bulge considerably through the trephine opening, showing the increase of intracranial pressure. The condition is probably due to an œdema of the brain.

Hernia Cerebri.—A hernia cerebri is a protrusion of the brain through an acquired aperture in the skull and membranes, the protruded portion remaining connected with the rest of the brain. It may follow a compound fracture or an operation, but will not occur unless there is an increase in the intracranial pressure as well as the defect in the skull. This increase of pressure is due to inflammatory exudates, hæmorrhage, œdema of the brain, or the presence of an intracranial tumour.

When a hernia cerebri first appears, it has the characteristic appearance of brain matter, and pulsates; but being pressed upon by the edges of the opening (especially if this is small), the circulation is interfered with, causing it to become congested and œdematous.

This interference may be so great as to cause sloughing of the hernia. Infection of the hernia is common. At first the hernia pulsates and increases in size with forcible respiratory efforts, such as coughing or crying, and it may be possible to press it back in the cranial cavity. Later, these symptoms are lost, and the hernia becomes fixed by adhesions to the scalp.

TREATMENT.—The first step in the treatment consists of removing the cause of the increased intracranial pressure, and if this cannot be done, the only treatment possible consists of keeping the hernia aseptic and free from injury. If the opening in the skull is small, it should be enlarged, as the formation of the hernia is beneficial to the patient in relieving pressure. Strangulation of the hernia is less apt to occur with a large opening than with a small one.

When the hernia has ceased to grow, it may be painted with 4 per cent. formalin. This causes a dry crust to form, which can be removed, and the process may be repeated till all the herniated brain has been taken away. The defect in the skull may then be closed by a plastic operation, or the brain protected by wearing a shield over it.

CRANIO-CEREBRAL TOPOGRAPHY

There are many methods of marking on the outer surface of the skull the situation of the underlying convolutions of the brain and the bloodvessels. None of them are absolutely exact, but they are sufficiently accurate for the purposes of operative surgery.

1. **Reid's Base-Line.**—This is a straight line drawn from the lower margin of the orbit backwards through the centre of the external auditory meatus. It is used as a line from which measurements may be taken.

2. **Fissure of Rolando.**—A line is drawn from the root of the nose to the external occipital protuberance, and a point taken $\frac{1}{2}$ inch behind its midpoint. From this point a line is drawn downwards and forwards at an angle of 67.5 degrees (three-quarters of a right angle), with the horizontal for $3\frac{3}{4}$ inches. In children the angle is a little smaller (about 60 degrees), and the fissure is situated a little more forward, owing to the relatively small development of the frontal lobes.

3. **Fissure of Sylvius.**—To find the point of bifurcation, draw a line $1\frac{1}{2}$ inches above and parallel to the zygoma. Draw a vertical line $\frac{3}{4}$ inch posterior to the frontal process of the malar. These two lines cross at a point corresponding to the bifurcation of the Sylvian fissure.

CHIENE'S METHOD.—Identify the external occipital protuberance and the root of the nose, and take the midpoint C, the three-quarter point D, the seven-eighths point E. Take also the external angular process M, the root of the zygoma L. Join ML, LE, MD. Bisect ML, LE, and HS at S, F, and I, and draw IK parallel to HC. The pentagon HISFLG, corresponds to the temporo-sphenoidal

lobe, CFIK, corresponding to the Rolandic area, and contains the fissure of Rolando and the ascending parietal and ascending frontal convolutions. H is over the anterior branch of the middle meningeal artery and the bifurcation of the Sylvian fissure, and

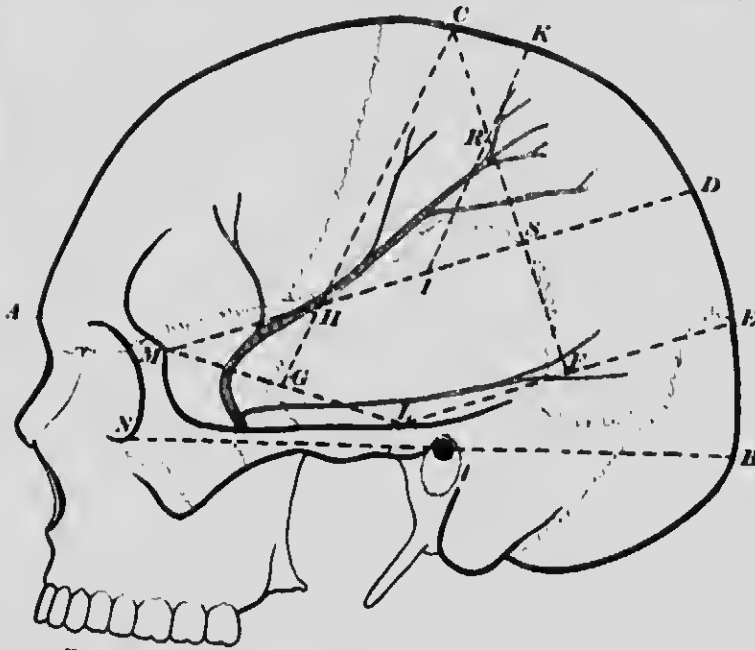


FIG. 389.—CHIENE'S METHOD OF INTRACRANIAL LOCALIZATION.

HS follows the posterior branch. The lateral sinus at its highest point touches the line LE at F. CH corresponds to the procontral sulcus. The supramarginal gyrus lies in the triangle ISR, and the angular gyrus is at S.

4. Parietal-Occipital Fissure.—The external limb of this fissure lies about $\frac{1}{2}$ inch in front of the lambda—i.e., the junction of the occipite-parietal sutures. This can usually be felt through the scalp. It is situated $2\frac{1}{2}$ inches above the external occipital protuberance.

5. Middle Meningeal Artery.—This artery, a branch of the internal maxillary, enters the skull through the foramen spinosum in the sphenoid bone, and at once divides into an anterior and a posterior branch.

ANTERIOR BRANCH.—This branch is usually wounded as it crosses the anterior inferior angle of the parietal bone, and this point lies $1\frac{1}{4}$ inches behind the external angular process of the frontal bone and $1\frac{1}{2}$ inches above the zygoma. From this point the artery runs upward and backwards, and its course may be followed by cutting away the bone with rongeur forceps.

POSTERIOR BRANCH.—The posterior branch runs almost horizontally backwards after the division, crossing the squamous portion of the temporal bone and the occipital bone. It may be looked for by trephining at a point about 1 inch above the centre of the external auditory meatus.

Lateral Sinus.—The descending portion of the lateral sinus lying in the mastoid process lies $\frac{3}{4}$ inch behind the centre of the external auditory meatus. Its posterior end where it joins the torcular Herophili lies just above the external occipital protuberance. Between these two points the sinus runs in a curve with the convexity upwards, the highest point of the curve lying $\frac{3}{4}$ inch to 1 inch above Reid's base-line.

Tapping the Lateral Ventricle of the Brain.—1. From the side. A point is taken $1\frac{1}{2}$ inches above the centre of the external auditory meatus.

2. From above. A point is taken 2 centimetres from the middle line and 3 centimetres from the precentral fissure, and the needle thrust downward and backwards for about 6 centimetres.

3. From behind. A point is taken 4 centimetres above the external occipital protuberance and 3 centimetres from the middle line, and the needle thrust forwards and slightly upwards.

Lumbar Puncture.—The patient should be in the sitting position, with the spine well flexed, or lying on the left side, the spine being flexed by approximating the knees and shoulders. A horizontal line is drawn between the highest points of the crests of the ilia, and this crosses the upper edge of the fourth lumbar vertebra. A point about $1\frac{1}{2}$ inches below this and $\frac{3}{4}$ inch from the middle line is chosen, and the needle thrust forwards and slightly upwards, so as to enter the space between the fourth and fifth lumbar vertebrae. When the needle is in position, there is an escape of cerebro-spinal fluid.

Uses—A. DIAGNOSTIC.—(1) The degree of intracranial pressure can be estimated. If this is normal, the fluid escapes drop by drop, but when the pressure is raised, it escapes in a stream.

(2) *Condition of the fluid*, as to whether it contains blood, pus, inflammatory exudates, or other abnormal constituents. Normal cerebro-spinal fluid is a clear, colourless fluid, of a specific gravity of 1004 to 1008. It contains a trace of albumin, chlorides, and a copper salt reducing body. There are also a few large endothelial cells and some leucocytes.

(3) *Bacteriological examination* of the fluid.

(4) *Cytological Examination.*—In cases of acute inflammation there are polynuclear leucocytes. In the chronic inflammations of tubercle and syphilis lymphocytes are in excess. In some instances tumour cells may be found in the fluid.

B. THERAPEUTIC.—Puncture may be used as a temporary measure to relieve severe symptoms in cases of intracranial pressure due to intracranial tumour, chronic meningitis, or cerebral hæmorrhage. Its use is not without danger of sudden death. Repeated puncture or

continuous drainage has also been tried for the cure of chronic hydrocephalus.

Lumbar puncture is also used for the induction of spinal anesthesia by stovaine and for the injection of antitetanic serum, and magnesium sulphate in cases of tetanus.

OPERATIONS ON THE SKULL

Skin Incision.—Before making the skin incision, it is advisable to mark on the skull by means of a sharp instrument (the pin of the trephine answers admirably) the spot chosen for trephining. The skin incision should be horseshoe-shaped, the base downwards, and so planned that as few as possible of the main arteries and nerves are cut. If an osteoplastic resection of the brain is intended, the skin incision should be Ω -shaped. The incision is carried right down to the bone. The periannium is turned down with the skin-flap, or removed with a rongeur.

Opening the Skull.—Many excellent electrical machines have been devised for opening the skull, but they are only available in special institutions, and the following methods are generally used:

1. The skull is trephined with a medium-sized trephine, and the opening enlarged with various forms of bone-cutting forceps.

2. The skull is opened by cutting with a chisel and mallet, or with a saw. The first of these methods has the disadvantage that the blows may cause cerebral concussion, and the latter the difficulty of avoiding injury to the dura mater.

3. Osteoplastic resection. After the skin incision has been made, four holes are drilled with a small trephine, one at each corner of the area of bone to be removed. These holes are joined together by cutting through the bone with a mallet and chisel, by sawing with a Hey's saw, or by the use of Gigli's saw, and the whole flap (including scalp and bone) is turned down. The upper bone incision should be cut on the slant, being levelled in such a way that the loose piece cannot slip below the level of the rest of the skull when it is replaced.



FIG. 390.—DIAGRAM SHOWING EXPOSURE OF THE LOBES OF THE CEREBELLUM.

Incision of the Dura Mater.—The dura mater can be opened by a crucial or a horseshoe incision, and the bleeding vessels secured by passing a fine suture round them and tying it.



FIG. 391.—A MALIGNANT GROWTH OF THE MENINGES, SHOWING DEPRESSION IN THE BRAIN CAUSED BY THE GROWTH.

(London Hospital Medical College Museum.)

Brain.—After the brain has been exposed, it should be kept irrigated by normal saline solution at a temperature of 115° F. to prevent cooling. It must be gently handled. Before removing a portion of the brain, all the bloodvessels immediately supplying it should be ligatured, and further hæmorrhage is avoided by flooding the cut surface with hot saline fluid, or by giving oxygen. Drainage should be avoided as far as possible.

Operations on the brain are generally done in two stages. In the first operation all the necessary bone is removed; and at the second operation, performed about five days later, the dura is opened and the cerebral condition dealt with.

It is, however, becoming more the custom to complete the operation at one sitting.

AFTER-TREATMENT.—The immediate after-treatment of cerebral operations follows the lines of after-treatment of operations on other

parts of the body. Rest and quiet are important, and the bowels should be kept open. Alcohol and other stimulants should be avoided.

In the later treatment of operations on the brain, prolonged mental rest is important, especially for those whose work is of a mental character. Reading and writing, and as far as possible thinking, should not be undertaken soon after the operation, and complete change and rest during a prolonged convalescence are important.

CHAPTER XXV

INJURIES AND DISEASES OF THE SPINE

INJURIES OF THE SPINE

Contusions and Sprains of the Spine.—It must be understood that the term "spine," used in a clinical sense, includes the bones, intervertebral discs, articulations, ligaments, and the muscles, inserted into and lying alongside the spinal column.

CAUSES.—Contusions of the spine are usually caused by falls, or blows from heavy masses falling on the back. Sprains are caused by indirect violence, such as falls or blows on the head or buttocks, or by over-flexion, over-extension, or over-rotation, of the spinal column.

PATHOLOGICAL ANATOMY.—In the great majority of cases it is not possible to diagnose the exact condition present, which includes laceration of fascia and muscles, rupture of tendons, stretching and rupture of ligaments, tearing away small pieces of bone or epiphyses, and laceration of the intervertebral discs; but in all severe cases it is of the utmost importance that a good radiogram of the vertebræ at the site of injury should be obtained. Since the routine use of the X rays, many lesions called contusions or sprains of the spine have been discovered to be fractures.

CLINICAL FEATURES.—There is the history of accident and the usual signs of trauma, such as bruising, or laceration of the skin.

The patient prefers to lie curled up on one side, and all movements are painful and the spine is rigid. It is tender on palpation, but the tenderness is as a rule diffuse, and not localized to one spot, and there is no irregularity of the spinous processes. The urine should always be examined, as rupture of the kidney or ureter frequently complicates a contusion of the spine. The main clinical interest, however, of contusions and sprains of the spine is the question of injury to the spinal cord. In the majority of cases this is uninjured, but a contusion of the spine without fracture or dislocation may be associated with a cord lesion of any degree of severity, from a slight hæmorrhago causing a transient paresis to a complete transverse lesion with permanent paraplegia. In all cases a careful examination should be made for any paresis or alteration in sensation indicating a cord lesion.

PROGNOSIS.—If the injury is complicated by a cord lesion, the prognosis depends almost entirely on that lesion, and is considered under

Concussion and Laceration of the Spinal Cord; but even without a cord lesion the prognosis should be guarded. As in sprains of other joints, permanent pain and stiffness may remain, owing to matting of the tendons and muscles in inflammatory adhesions, and osteo-arthritis (spondylitis deformans) of the spine may follow. Injury also predisposes to tuberculosis, and possibly to malignant disease of the spine.

TREATMENT.—If there is no cord lesion, the treatment is conducted on the same principle as contusion and sprain of other joints. Until the acute symptoms have subsided, complete rest is necessary, followed by early massage, passive and active movements, to prevent the formation of adhesions in the damaged muscles and tendons. If the pain persists, the various forms of bath treatment should be tried, and appropriate treatment given for gout and rheumatism if the patient has suffered from these diseases. If the presence of adhesions is suspected, either in the intervertebral joints or in the musculo-sheaths, forcible movements should be carried out under anæsthesia as in other joints, followed by active and passive movements to prevent re-formation of the adhesions.

It is convenient to discuss here two conditions that often follow contusions and sprains of the spine—viz., spinal concussion and traumatic neurasthenia.

Spinal Concussion.—This condition is rare, and is always associated, as far as post-mortem evidence goes, with petechial hæmorrhages into the spinal cord or its membranes. These hæmorrhages are produced in the same way as they are in the brain after head injury, either by direct damage to the cord or to sudden alteration in the pressure of the cerebro-spinal fluid (see p. 810).

SYMPTOMS.—After an injury to the back, the patient has retention of urine, with paresis of the legs, and a feeling of numbness in them. All these symptoms are usually transient and non-progressive, but a certain amount of weakness may be left.

TREATMENT.—The patient should be kept at complete rest in bed until all the symptoms have subsided, and the bladder emptied by catheter. The usual treatment of contusion of the spine (see above) should be carried out.

Traumatic Neurasthenia.—This condition is sometimes spoken of as "railway spine," as it frequently follows injury of the spine received during a railway accident. The term is misleading, and even absurd, for it may follow an accident to parts of the body other than the spine, and have nothing to do—even remotely—with a railway. The reason for its frequent association with railway accidents is probably to be found in the terrifying circumstances under which the injury is received. A railway accident is sufficient in itself to cause the condition, for it may develop in a patient who has received no evident injury at the time of the accident, and it has even been known to occur in people who have merely witnessed a railway catastrophe.

PATHOLOGICAL ANATOMY.—There may be clinical evidence of an injury to the spine, such as bruising and stiffness; or radiography may demonstrate that a process of bone has been fractured; but usually there are no physical signs of contusion, and the condition rarely develops if there is a severe injury, such as a fracture or a dislocation. The condition is a functional disturbance of the nervous system, and is much more concerned with the brain than with the spinal cord, being apt to develop in people with inherited or acquired instability of the nervous system—the so-called nervous or "highly strung" temperament.

CLINICAL FEATURES.—If the patient is in a railway accident, he may suffer from acute hysterical excitement, or be in a semidazed condition, or he may render assistance to others, not complaining about his back till hours, or even days, afterwards. If the accident occurs to the patient alone, he gives a history of a severe shaking which, however, was not too severe to prevent him walking, or even working for a time.

On examination of the back, there is usually nothing to be seen, though occasionally there may be severe bruising, and the patient complains of pain, tenderness, and weakness. The pain tends to radiate all over the back and down the legs. The tenderness is generally excessive, and on examination, the slightest touch will cause the patient to go into contortions, which prove conclusively that there is no rigidity of the spine.

The other symptoms developed by the patient are widespread, and often bizarre. He complains of insomnia, and when he sleeps, of unpleasant dreams. There is frequent loss of the power of attention to business, forgetfulness, and irritability of temper. A feeling of weakness is present, often associated with a fear of complete paralysis; or there may be alteration of sensation in various parts of the body. Pain in the back is an almost constant symptom associated with incontinence or retention of urine, and loss of sexual desire and sexual power.

As soon as this train of symptoms develops, a vicious circle is established; the want of sleep and exercise, the constant brooding over the accident, and the fear of insanity or paralysis, still further lowers the mental tone, and the patient runs the risk of becoming a chronic invalid.

In many of these cases it is difficult to exclude the possibility of the patient being a malingerer, especially as there is frequently a question of compensation for the accident, and there are no objective symptoms by which the truth of his symptoms can be judged.

The question of litigation is, however, a most important one, as the neurasthenic is little likely to improve while he is worrying over the details of a law action for damages, and it is often found that directly the compensation for the accident is settled, the patient begins to improve, even if the verdict has been an adverse one.

DIAGNOSIS.—A most careful examination must be made to exclude

—(1) The possibility of there being any organic lesion of the spinal

column or spinal cord; and (2) malingering. In some cases two or three examinations are necessary before the case can be established as one of neurasthenia.

TREATMENT.—The treatment of this condition concerns the physician rather than the surgeon, all local treatment to the back being contra-indicated as causing the patient to dwell on the accident and its supposed effects. The first indications are to get the patient to sleep and eat well, but hypnotics should be avoided if possible. Litigation should be terminated promptly, in order to remove a potent cause for the continuance of the symptoms.

The patient should be assured that there is no organic lesion, and no fear of paralysis supervening; but his symptoms should not be treated lightly. It may be stated broadly that the most important item in the treatment is the personality of the doctor who is directing it. These cases frequently drift into the hands of Christian Scientists or hypnotists, or go on pilgrimages, and are often examples of the numerous "cures" of paralysis, blindness, etc., brought about by these means.

WOUNDS OF THE SPINE

Wounds of the spine are caused by gunshots or stabs.

Gunshot Accidents are examples of compound fractures of the spine, and their importance lies in the presence of a foreign body and the amount of damage done to the spinal cord. The bullet should be localized by the X rays and removed, and the rest of the treatment is similar to that of fractures of the spine due to other causes (see p. 871).

Stabs of the Spine.—These may be non-penetrating or penetrating.

1. NON-PENETRATING WOUNDS.—These have the usual symptoms of wounds in other parts of the body, but as they often implicate the bones, they may be examples of compound fractures. The spinal cord may be damaged—(1) By the violence of the blow; (2) by pressure of a displaced piece of bone; (3) by hæmorrhage between the bone and the dura.

TREATMENT.—The wound should be thoroughly explored, and if there is depression of one of the laminae, the piece of bone should be elevated and removed. The wound should be treated on the usual aseptic principles, and any damage to the cord treated as described under Fractures of the Spine (p. 871).

2. PENETRATING WOUNDS.—These are wounds in which the instrument has pierced the dura mater of the cord. The diagnosis is made by noting the escape of cerebro-spinal fluid from the wound. The condition is usually complicated by injury to the spinal cord or the nerves of the cauda equina.

TREATMENT.—The wound is treated by the usual aseptic methods. If there is evidence of a cord lesion, the question of laminectomy must be considered. In the case of stabs below the level of the first lumbar vertebra, with a lesion of the cauda equina, laminectomy should

always be performed and primary suture of the nerve carried out; but if the spinal cord itself is damaged, suture is useless, for although it has been performed, no good results have been recorded. Excessive escape of cerebro-spinal fluid after an injury to the dura mater has proved fatal, therefore if this complication is present, the dura should be sutured, and this may necessitate removal of bone to bring the wound into view.

FRACTURE OF THE SPINE

Fractures of the spine are divided into incomplete and complete, the latter being the more common.

Incomplete Fracture.—By this is meant a fracture of one of the processes of a vertebra or a fissured fracture of the body, without solution in the continuity of the spinal column as a whole. Incomplete fracture is more often due to direct than to indirect violence, and the fractures usually involve the spinous processes or the laminae.

SYMPTOMS.—The symptoms of these fractures are those of a severe contusion or sprain of the spine, and the absolute diagnosis is as a rule only made by radiography or the presence of deformity after the bruising and swelling have disappeared. In cases of fractures of the spinous processes, or of both laminae of a vertebra, undue mobility of the fragment, with crepitus, may be elicited, or deformity may be recognized in a recent case.

Fractures of the transverse process and fissured fractures of the bodies of the vertebrae are very rare except from gunshot wounds, and are only to be diagnosed by radiography.

TREATMENT.—The treatment of these fractures is the same as the treatment of contusion and sprain of the spine. If symptoms due to a cord lesion are present, and the radiogram shows displacement of a fragment, causing it to press on the cord, the fragment should be elevated or removed by an open operation.

Laminectomy should also be performed if hæmorrhage is taking place between the dura mater and the bone, causing pressure symptoms.

Complete Fractures of the Spine.—A complete fracture of the spine is a solution of continuity of the spine as a whole, with or without displacement of the fragments on one another. If displacement occurs—as is usually the case—the fracture is always complicated by more or less dislocation of the articulations of the vertebra, and the condition is more correctly spoken of as “fracture dislocation of the spine.”

CAUSES.—Complete fracture of the spine may be due either to direct or indirect violence. If to direct violence, a heavy weight has usually fallen on to the neck, or the patient has been thrown violently against a projecting body, such as a railing. Fractures due to indirect violence are caused by overflexion or overextension of the spine. Fractures are most common in the cervical and upper dorsal region of the spine.

PATHOLOGICAL ANATOMY.—As the body of the fractured vertebra is usually crushed, the fracture is comminuted, and fragments of bone may press directly on the cord. Impaction of the fragments is not uncommon. The intervertebral disc is often partially torn from its attachment to the body. The laminae, transverse process, and spinous processes, may be extensively fractured, or may suffer very little; they are more likely to be damaged in fractures due to direct violence. The ligaments are usually extensively torn, and there is nearly always some dislocation of the intervertebral joints.



FIG. 392.—FRACTURE DISLOCATION OF THE SPINE, WITH DESTRUCTION OF THE CORD.
(London Hospital Medical College Museum.)

The usual displacement is for the upper segment of the fractured spine to be displaced forwards on the lower, so as to cause an angular deformity; but very occasionally with hyperextension of the spine the displacement of the upper fragment is backwards.

The *dura mater* is as a rule intact, but it may be lacerated by displaced fragments of bone. Extravasation of blood between the bone and the *dura* is common.

The *spinal cord* is generally crushed at the site of fracture, and the extent of the crushing largely depends on the amount of displacement, but not always. In some cases, with no displacement, the cord may be extensively

damaged, just as it may be without fracture; while in others with considerable displacement there may be no cord lesion.

The muscles and fasciae round the fracture are extensively lacerated.

CLINICAL FEATURES—A. IMMEDIATE SYMPTOMS.—*Shock* is nearly always severe, and the usual symptoms of this condition are present at first.

Damage to Bone.—When the shock has passed off, the patient will complain of pain in the back, increased on movement. On examination, there is as a rule no deformity. Tenderness and swelling are present, and the tenderness is more or less localized. Crepitus may—exceptionally—be obtained, but should never be sought for on account of the increased damage that may be done. A radiogram will show the site and extent of the fracture.

Cord Lesion.—As a rule there is loss of sensation and complete paralysis of all the parts below the seat of the fracture, and retention of urine. There are exceptions to this rule:

- (1) In cases of fracture without cord lesion, there are no nerve symptoms at first, but they may develop later from effusion of blood between the bone and the dura.
- (2) The paralysis may be partial, especially if the symptoms are due to a fragment of bone pressing on the cord.
- (3) The loss of sensation may not be so extensive as the paralysis.
- (4) Sensory phenomena may predominate if the nerve roots are severely injured.

There is often a band of hyperesthesia between the paralyzed and the non-paralyzed parts, which the patient will describe as a band tied round the chest or abdomen (girdle pain).

Reflexes.—The amount of shock present causes the reflexes to be abolished at first, and their further behaviour depends on the situation and nature of the lesion, and will be described later.

Temperature.—The temperature during the period of shock is subnormal, but the temperature of the paralyzed parts, if taken, is often found to be elevated.

B. LATER SYMPTOMS.—The later symptoms depend on secondary degenerative changes occurring in the tracks of the cord, especially the lateral columns, and vary with the site of the lesion.

(1) *Injury of the Cord in the Upper Cervical Region.*—As a rule injury to the cord in this situation is immediately fatal from cessation of respiration, the diaphragm as well as the intercostals being paralyzed (phrenic nerves, third, fourth, and fifth cervical). The patient may, however, live for a few hours.

(2) *Injury of the Cord in the Lower Cervical Region* (fourth cervical to first dorsal).—The intercostals are paralyzed, but respiration is maintained by the diaphragm. Life is possible for a long period, but as a rule mucus collects in the lungs, owing to the inability to cough, and death from hypostatic pneumonia occurs in a few days or weeks. Hiccough is a common symptom. The pupils are contracted, owing to implication of the cervical sympathetic fibres which run down in the spinal cord to the first and second dorsal segments, and the palpebral fissure is narrowed. All the four limbs are paralyzed, and there is loss of sensation below the second interspace, but the shoulders retain their sensation, being supplied by the descending branches of the cervical plexus (third and fourth). With a lesion at the level of the sixth cervical segment, the attitude of the upper extremity is characteristic. The patient lies with the arm abducted from the side and rotated out, while the forearm and hand are flexed and supinated.

The abdomen is distended from a collection of gas in the intestines, and there is constipation, with incontinence of faeces. The bladder is paralyzed, so that there is retention, with overflow, and the urine sometimes contains sugar. Priapism is present.

Injury of the Cord in the Dorsal Region (second to tenth dorsal).—Respiration is carried on by the diaphragm and the intercostal muscles above the lesion, so that the risk of hypostatic pneumonia is not so great as in cervical lesions, and the patients frequently live for years. There is complete paralysis below the seat of the lesion, at first flaccid, but later spastic, and the legs are often drawn up involuntarily in response to stimuli. The reflexes are exaggerated, and ankle clonus and Babinski's sign are present. Later, contractions may occur, and the knees be drawn up on to the chest. (In one case, to the author's knowledge, a bedsore was produced on the thorax by the knees.) Sensation is lost below the level of the lesion, but at that level a band of hyperæsthesia is often found, the patient complaining of a girdle pain.

At first, retention of urine, with overflow, is present; but later, an automatic action of the bladder may be established so that the bladder fills and empties regularly without the knowledge of the patient. Priapism is common, and may appear directly shock has passed off, or be delayed for a few weeks. Later, it may disappear again. True erection of the penis and ejaculation of semen may follow stimulation of the penis. Parturition may occur in women without consciousness. The abdomen is distended and tympanitic, and constipation, with incontinence of fæces, is present.

Injury to the Cord in the Lumbo-Sacral Region (*Lumbar Enlargement*, eleventh dorsal to first lumbar).—There is complete paralysis of the lower extremity, usually of the spastic type, and loss of sensation below the umbilicus. Retention of urine is followed by a dribbling incontinence with an empty, and later a contracted, bladder. Priapism is not present, but there is incontinence of fæces.

Injury to the Cauda Equina.—Fracture dislocation of the spine below the first lumbar vertebra may cause a lesion of the nerves of the cauda equina. The motor and sensory phenomena that follow vary with the nerves that are injured, but the symptoms are always those of a lower nerve neuron paralysis—i.e., a flaccid condition of the muscles, with wasting and loss of reflexes. A large amount of recovery is possible. The muscles that generally escape are the extensors and adductors of the thigh. The sphincters of the bladder and rectum are usually paralyzed at first, and the incontinence may be permanent, or later it may pass off. Priapism is never present.

COMPLICATIONS.—1. *Hypostatic Pneumonia*, which is the common cause of death in lesions of the cervical and upper dorsal segments has already been referred to.

2. *Acute Ascending or Descending Myelitis*.—Acute myelitis may follow crushes of the spinal cord, especially if the fracture dislocation is compound. The symptoms of paralysis and loss of sensation will spread rapidly, and death follows. Chronic myelitis may also supervene. In compound fracture dislocation, acute meningitis and intra- and extra-dural suppuration may follow.

3. *Extradural Hemorrhage* (*Hæmatorrhachis*).—Hæmorrhage between the dura mater and the bone is most common in the cervical region, and causes symptoms of irritation of the cord—i.e., muscular

cramps and spasms, hyperaesthesia and pain radiating along the nerve pressed upon. Later, if the pressure is much increased, there is paralysis, which comes on slowly, and spreads from below upwards (gravitation paraplegia).

4. *Intramedullary Haemorrhage (Hæmatomyelia).*—If the hæmorrhage is sufficiently large to cause disintegration of the spinal cord, the usual symptoms of a complete transverse lesion are present (see above). Small hæmorrhages with characteristic symptoms are seen, most commonly in the lower cervical region. The onset of the symptoms is sudden, with paresis and loss of sensation in the lower extremities. Other symptoms of a cervical lesion may be present. The symptoms quickly subside, and recovery may be complete, but usually some paresis remains, loss of sensation being more rapidly recovered from than paralysis.

5. *Cystitis, Urethritis, Ascending Pylonephritis.*—The primary cause of the cystitis is infection of the bladder by micro-organisms, commonly introduced by catheterization, but owing to the loss of the trophic nerves, rapid ulceration of the bladder and spread of the infection up the ureters to the pelves of the kidneys are common. On the other hand, a patient with a fractured spine, accompanied by incontinence of urine and cystitis, may live for years without gross damage to the kidneys. Ascending pyelonephritis is, however, a frequent cause of death. The urine becomes diminished in amount, and contains pus, and frequently blood. The tissues round the urethra may slough, and perineal abscesses form.

6. *Bedsore.*—Like cystitis, these may be either acute or chronic. An acute bedsore may develop within a day or two of the fracture. It usually occurs in the sacral region, but sometimes on other parts, rapidly tending to sloughing and destruction of the tissue. Death frequently follows.

Chronic bedsore form at any time, and are due to neglect of necessary details of treatment. These patients are particularly liable to bedsore, owing to the loss of sensation, making it impossible for them to appreciate small injuries, and the paralysis preventing them from moving their position. The incontinence of urine and feces also increases the liability to bedsore.

TREATMENT—Transportation.—The patient is kept flat on his back till a suitable stretcher is obtained. This must be firm and unyielding, as a shutter or door. The patient is lifted by four assistants, two taking the head, and two the lower extremities; and as they lift, they should maintain extension, whilst the surgeon supports the fractured vertebrae with both hands.

The patient is only lifted sufficiently to allow the shutter to be slipped under the body; this is then raised and carried, not wheeled. The stretcher-bearers at the two ends should not walk in step. When the patient has reached the place where he is to be nursed, he is wrapped in blankets and kept warm until the bed is prepared and the surgeon is ready to continue the treatment. Stimulants should not be given, as they tend to increase the amount of bleeding.

The bed should consist of a horsehair mattress, under which a fracture-board is placed, and, if possible, the mattress should be in three segments, and the middle segment in halves, so that it can be removed without disturbing the fracture. A water-bed is not advisable until reduction of deformity and immobilization of the fracture have been accomplished.

The patient must be very carefully undressed, without turning or raising him, the clothes being cut where necessary along the seams.

Reduction of the Deformity.—When the patient is lying flat on the back, the deformity usually disappears, and no traction will be necessary. In a few cases also, with slight deformity, there will be no cord symptoms, and these cases are better left unreduced, and fixed by the plaster of Paris case in the deformed position, for during reduction damage might be done to the cord. In other cases, an anæsthetic is carefully given so that the patient does not struggle, and traction and counter-traction are made by four assistants, the surgeon manipulating the spinous processes into position.

Fixation.—This can be done in two ways—(1) By extension, and (2) by fixation in a plaster of Paris case. The two methods may be combined in muscular subjects.

Fixation in a plaster of Paris case should not be done in the case of fracture in the upper dorsal region, or the respiration will be still further embarrassed, and harm, not good, will result.

1. *Extension* is applied in the same way as for Pott's disease (see p. 885). A weight of 5 to 10 pounds is used for each leg, according to the muscularity of the patient. In some cases suffering great pain from pressure on the spinal nerves the relief given by extension is striking.

There is some danger of sloughing in these cases under the strapping, owing to the defective nutrition of the skin, so the apparatus must be carefully watched.

2. *Plaster of Paris Case.*—This has been applied with the patient suspended by the armpits, or slung by a band passing over the site of the fracture; but a less dangerous method to employ is that recommended by Walker. The patient is washed carefully, sponged over with 1 in 1,000 perchloride of mercury solution, and then dried. A large piece of boracic lint, reaching from the axilla to below the crest of the ilia, is slipped under the back and sewn down the front, great care being taken that there are no wrinkles.

A number of strips of muslin bandage, long enough to encircle the body and overlap in front, are then prepared. They are dipped into a mixture of plaster of Paris, 1 pound; water, 8 ounces; and mucilage of gum acacia, 1 ounce. They are then spread rapidly, to prevent setting, on a board covered with a mackintosh sheet, each overlapping the one below by two-thirds of its width. They are arranged in sufficient width to cover the patient from the axilla to midway between the crest of the ilia and the great trochanter, and enough in number to make the whole about six layers thick.

These preparations are made just before the deformity is reduced.

and the plaster strips are then slipped under the patient, and the ends rapidly folded across the chest, like a army-tailed bandage, more plaster being rubbed in if necessary. A "dinner-pad" is placed over the epigastrium, and removed when the case has set.

AFTER-TREATMENT.—The patient must retain the horizontal position for at least two months, and the plaster case should be re-applied if necessary. In some cases the plaster case cannot be borne, and rest, with or without extension, is all that can be done.

At the end of two months the fragments will have united, and the patient may be allowed to sit up, or get about on crutches if the paralysis of the muscles does not prevent this. Before doing this, he should be fitted with a fresh plaster of Paris case, or a jacket of poroplastic felt or leather, or any other form of jacket or brace used in the treatment of Pott's disease (see p. 886). This should be worn for another four months, or longer, if he should still feel need of support.

In most cases of fracture dislocation above the lower lumbar region the patient remains bedridden for the rest of his life, or at best can only assume the sitting posture.

GENERAL TREATMENT.—The patient should be nursed on a water-bed, and must be kept scrupulously clean. Every precaution must be taken to prevent cystitis. If retention be present, the urine must be drawn off by a sterilized catheter at least twice a day, and the penis should be carefully washed in 1 in 2,000 perchloride of mercury solution, and kept wrapped in antiseptic gauze.

If cystitis should supervene—as it generally does—and retention is present, the bladder should be washed out with boracic lotion every time the urine is withdrawn, and suitable urinary antiseptics should be given.

The bowels are best kept open by enemata, and the food should be concentrated and easily digestible. If respiration is embarrassed, diffusible stimulants, such as carbonate of ammonium, alcohol, and ether, should be given; but the onset of hypostatic pneumonia makes the prognosis practically hopeless.

BEDSORES.—The prevention of bedsores is one of the most important points of treatment in cases of fractured spine.

Prevention.—The bed must be kept clean and dry, and free from all crumbs and wrinkles in the bedding. The back and all parts upon which pressure falls, such as the heels, sacrum, elbows, etc., should be washed with soap and water three times a day, rubbing with a brisk circular movement. The back is immediately afterwards rubbed with methylated spirit (or eau de Cologne, whisky, etc.), and is then thickly dusted with some form of dusting-powder, such as zinc oxide and starch.

The same process should be gone through every time the patient is moved for nursing purposes.

If signs of pressure are seen, the parts pressed upon should be relieved of pressure by a careful adjustment of small cushions or rings made of padding-wool, covered with mackintosh.

The arms should be kept away from the sides, and the legs kept apart by long, narrow pads or pieces of cotton-wool.

The heels should be relieved of pressure by adjusting heel-pads to the hollows just above the os calcis, and the pressure of the bed-clothes should be kept off the toes by means of a cradle.

The feet should rest against a pillow, and be kept at right angles to the body. Special care must be taken to keep the groins and axilla dry and well powdered; and as the pillow for the head is small, care must be taken that the ears are not folded over.

OPERATIVE TREATMENT.—Laminectomy is rarely indicated in the treatment of fracture dislocation of the spine, as no good can result in cases of complete transverse lesions of the cord; but in certain cases benefit may follow. They are—

1. In cases where the paralysis is incomplete, and the nature of the accident and radiography suggests a fragment of bone pressing on the cord.
2. If the paralysis comes on some little time after the lesion, and especially if it is a gravitation paralysis, suggesting hamorrhago between the dura and the bone (hamorrhachis).
3. If the lesion is below the first lumbar vertebra, and involves the cauda equina, operation should follow, as in injuries to other spinal nerves (see p. 369).
4. If the symptoms of paraplegia develop later and are believed to be due to cicatricial contraction or to callus formation.

The operation should never be performed during the period of shock, and it may be weeks before the indications are definite enough to suggest that laminectomy is advisable. Even when a long period of time has elapsed since the accident, good results may be obtained in suitable cases.

Dislocation of the Spine.

Pure dislocation of the spine only occurs in the cervical region, and may be unilateral or bilateral, the former being the more common. The usual situation is between the fifth and sixth cervical vertebra, and the displacement of the upper vertebra is practically always forwards. The causes are the same as those of fracture dislocation.

Unilateral Dislocation—**SYMPTOMS.**—There is local pain and stiffness, and it may be possible to feel the irregularity in the spinous processes. The head is fixed and the chin points towards the shoulder of the opposite side.

Bilateral Dislocation.—In these cases there is pain and rigidity, but the head is carried directly forwards. Cord lesions are more common in the bilateral than in the unilateral dislocations.

Both varieties of dislocation may be associated with the cord lesions already described under Fracture Dislocation, but the cord may escape entirely, especially in unilateral incomplete dislocation. Since the routine use of radiography in injuries, dislocation of the cervical spine without cord injury are found to be more often present than was formerly thought to be the case.

TREATMENT.—Immediate reduction should be carried out under anesthesia unless the patient is moribund. The head should be extended to disengage the articular processes, and then flexed. If the dislocation is unilateral, rotation is also necessary. The movements must be made steadily and without violence, or the cord may be injured. If reduction cannot be effected by manipulation, the question of laminectomy must be considered. In unilateral dislocation without cord symptoms, the condition may be left, and reduction may even occur spontaneously later; but if the dislocation is complete, or if there are pressure symptoms present, and reduction cannot be effected by manipulation, laminectomy should be performed, as otherwise the case is sure to terminate fatally. If there is a complete transverse lesion of the cord, reduction of the deformity will not be followed by improvement of the symptoms. After reduction of the dislocation has been effected, the treatment should be that of a severe sprain. The results of the cord lesion, if present, will require the usual treatment.

Spondylolisthesis.—This deformity consists of a displacement of the body of one of the lumbar vertebrae forwards and downwards, the spinous process usually remaining in its normal position. It is much more common in women than in men.

CAUSES.—In many cases there is a congenital defect in the development of the laminae or pedicles of the fifth lumbar vertebra, but the deformity may develop without this being present.

The immediate exciting causes are pressure from the carrying of heavy weights, or from pregnancy, or occasionally from direct injury.

SYMPTOMS.—The body appears to be unnaturally short in comparison to the legs, and there is a marked lordosis, with backward projection of the sacrum. The abdomen is prominent and the gait awkward, the body being held very stiff and erect. The chief interest of the condition is the difficulty it may cause in childbirth.

TREATMENT.—Treatment is of little use, and, when there is no pain, is unnecessary. When pain is present, or the patient wishes to disguise the deformity, a spinal support accurately adjusted to the pelvis should be worn (see p. 256).

DISEASES OF THE SPINE AND CORD

CONGENITAL MALFORMATIONS

Spina Bifida.—The central nervous system is developed from an involution of the epiblast first as a groove—the medullary groove—which becomes closed over into a canal—the medullary canal. The closure takes place first in the middle of the spine, and gradually proceeds to both ends, the lower part of the groove being the last to close. After closure of the groove, the medullary canal becomes separated from the skin by an ingrowth of mesoblast, which form the

vertebræ, ligaments, and muscles. Development may be arrested at any point, and one of the following varieties of spina bifida result. They are all much commoner in the lumbo-sacral region than elsewhere.

1. *Myelocèle*.—The primary medullary groove does not close, but remains open on the surface of the body as a raw red surface.



FIG. 393.—SPINA BIFIDA.

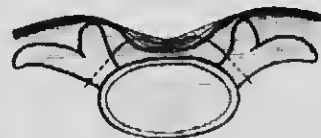


FIG. 394.—MYELOCELÈ.

At the upper end is seen the opening of the spinal canal, from which cerebro-spinal fluid escapes. The condition is incompatible with life.

2. *Syringomyelocèle*.—The medullary groove is closed, but there

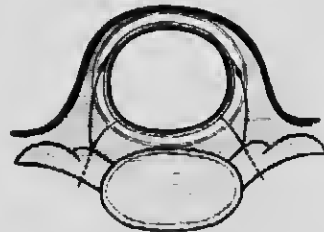


FIG. 395.—SYRINGOMYELOCELÈ.

is great distension of the cavity of the spinal canal, so that a sac protrudes on the back. The tissue of the medullary canal is usually firmly adherent to the skin, and there has been no ingrowth of meso-blast. The spinal nerves travel round the sac to reach the foramina in the vertebræ.

3. *Meningomyelocèle*.—In this variety fluid collects inside the membranes of the cord, which are usually adherent to the skin. The cord or the nerves of the cauda equina run across the sac posteriorly, and the nerves perforate the sac to reach the foramina.

4. *Meningocele*.—The spinal cord and the spinal nerves are normal, but there is a projection of a sac of dura mater filled with cerebro-spinal fluid between the laminae of the vertebræ. The protrusion may be covered with healthy skin, but more commonly the dura mater and integuments are adherent.

5. *Spina Bifida Occulta*.—In this variety the cord and membranes are normal, but the posterior portions of the vertebræ are absent. A

pad of fat or a tuft of hair frequently grows over the site of the defect.

All forms of spina bifida may occur in the cervical region.



FIG. 396.—MENINGOMYELOCELE.

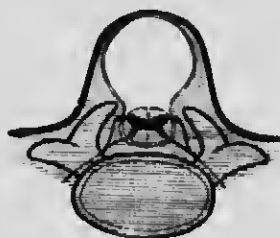


FIG. 397.—MENINGOCELE.

CLINICAL FEATURES.—The diagnosis is usually obvious at a glance. In the lumbo-sacral region of a newly born child there is a cystic tumour, somewhat pedunculated, covered with a thin, semitranslucent membrane, through which it may be possible to see the shadow of the cord or spinal nerves. The swelling increases when the child cries, and may be partially reduced by gentle pressure; if this is maintained, however, it may cause convulsions. The gap in the posterior arch of the spinal column can frequently be felt.

The condition may be present without obvious nervous symptoms, but usually there is paralysis of the lower limbs with talipes, and if the child lives, it will have incontinence of urine and fæces from interference with the nervous mechanism of the sphincters of bladder and anus.

PROGNOSIS.—The majority of cases of spina bifida die within a few weeks of birth. Death occurs from exhaustion following escape of cerebro-spinal fluid, or from spinal meningitis as a result of ulceration of the integument covering the spina bifida. In some cases the patient may reach adult life, but this is rare, and symptoms of paralysis—absent at first—may appear in childhood or adolescence.

TREATMENT.—In the majority of cases there is nothing to be done except to cover the swelling with an aseptic dressing. If the child survive and is robust, the swelling increasing in size, and there are signs of nervous disturbance, operation is justifiable. The swelling is isolated, and the condition dealt with according to what is found, nerve tissue being saved if possible. The parietes are closed by a plastic operation. The immediate results are sometimes good, but many cases die of convulsions soon after the operation, or a secondary hydrocephalus develops, which ultimately proves fatal.

Spina Bifida Occulta.—This condition is only of importance in that it may be associated with paralysis of the lower extremity with talipes, incontinence of urine and fæces, and perforating ulcers. These symptoms may not be present at birth, but occur later owing to the presence of a band of fibrous tissue and fat, stretching from the skin to the lower end of the spinal column, which may exert pressure on the cord.

TREATMENT.—If no nervous symptoms are present, the condition requires no treatment; but if they develop, an exploratory incision should be made to discover if the pressure on the cord can be relieved.

Congenital Sacrococcygeal Tumours.—This term includes a number of tumours of different nature and origin that are found at birth in the sacrococcygeal region. The most important are—

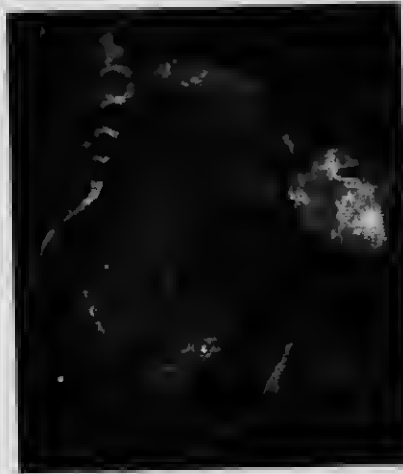


FIG. 398. — SACROCOCYGEAL TUMOUR (TERATOMA).

(London Hospital Medical College Museum.)

1. Dermoid cysts, containing hair and sebaceous material, and having their origin from the epiblast.
2. Tumours arising in connection with the remains of the neurenteric canal—*i.e.*, the original communication between the central canal of the spinal cord and the hind-gut.
3. Lipomata.
4. Unusual forms of spina bifida which have been isolated from the spinal cord.
5. Teratomata—*i.e.*, inclusion of another foetus (see p. 244)—which consists of all three layers of the embryo, and in which tectb, nerve tissue, bone, special sense organs, and tubules with columnar epithelium have been found.

The differential diagnosis of these conditions can often only be made on careful examination during and after removal.

Congenital Post-Anal Fistula.—A post-anal dimple may almost be considered a normal condition, but occasionally the dimples are deep enough to be pathological, and constitute the condition known as "coccygeal fistula." They are more often single than multiple, and if dirt accumulates in them, suppuration may occur so that the condition simulates a fistula *in ano*.

Fistulae also arise in this region from suppurating post-rectal dermoids, or they may be found in connection with the neurenteric canal.

TREATMENT.—The fistula should be completely excised.

INFLAMMATORY CONDITIONS OF THE SPINE

Acute Osteomyelitis of the Vertebrae.—This condition has the same etiology as acute osteomyelitis of the long bones (see p. 485), but is rare. It is most common in the cervical and lumbar regions, and may affect any part of a vertebra.

CLINICAL FEATURES.—The early symptoms are those of an acute infective fever with pain, redness, and swelling over the affected portion of the spine. Pus forms rapidly, and death usually occurs from infective spinal meningitis. If the patient survives, extensive necrosis of the vertebra occurs.

TREATMENT.—The treatment consists of early and free incision to evacuate the pus, and drainage. Sequestra will have to be removed later. During the illness great care must be taken to prevent a spontaneous fracture of the spine.

Tuberulous Osteomyelitis of the Spine (Pott's Disease)

Tuberculosis of the vertebræ may occur at any age, but is most common in children under ten years of age. It has the usual etiology of tubercle in other parts of the body, and is not infrequently associated with tubercular disease of other bones, joints, and lungs. There is often—and especially in adults—a history of definite injury before the onset of the disease.

PATHOLOGICAL ANATOMY.—The disease may affect any part of the spine, but is most common in the lumbo-sacral region.

Occasionally it may occur in two distinct parts of the spine simultaneously. Two types of cases may be distinguished: one starting in the centre of the bone and causing great destruction of it, and the other starting under the periosteum and causing erosion of the surfaces of the bodies of the vertebræ, but not marked destruction. The former is more common in children, and the latter in adults.

When the disease starts centrally, it tends to occur at the junction of the epiphysial plates of cartilage with the rest of the bone, and the intervertebral disc may be destroyed. In other cases the cartilaginous disc escapes, whilst the bodies on either side of it are completely disintegrated. Three types of destruction of the bone can be recognized: (1) The bone undergoes absorption without pus formation (caries sicca); (2) the bone becomes carious and there is abscess formation; (3) large pieces of bone die and separate as sequestra (caries necrotica). New formation of bone from the periosteum is almost entirely absent.

DEFORMITY.—Owing to the destruction of the anterior portion of the vertebræ, combined with the pressure of the weight of the body above the lesion and the pull of the muscles, especially the psoas, the spine becomes bent forwards at the site of the diseased bone. The bend is always angular, but the sharpness of the angle depends on the number of vertebræ involved. If one vertebra is extensively destroyed, the angle is very sharp, but if the disease involves many vertebræ, and more particularly if the periosteum is chiefly involved, the angle is much more rounded. In the early stages of deformity there be may some lateral deviation, but this soon disappears. In order that the body may be maintained upright when there is an angular bend in the spine, compensatory curves develop above and below

the angle. Deformity also follows in the ribs, sternum, and clavicle, which accommodate themselves to the altered condition of the spine.

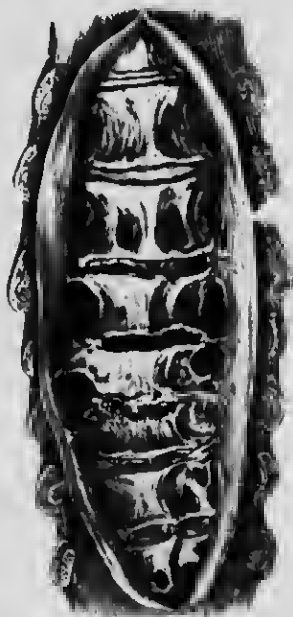


FIG. 399.—TUBERCULOSIS OF THE SPINE, WITH DESTRUCTION OF THE INTER-VERTEBRAL DISCS AND FORMATION OF AN ABSCESS IN FRONT OF THE VERTEBRAL COLUMN.

(London Hospital Medical College Museum.)

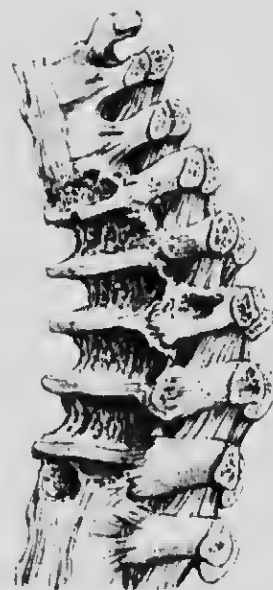


FIG. 400.—TUBERCULOSIS OF THE SPINE, SHOWING DESTRUCTION OF THE BODIES OF THE VERTEBRÆ WITHOUT THE INTER-VERTEBRAL DISCS.

(London Hospital Medical College Museum.)

REPAIR.—Repair occurs, as in other bones, by the formation of granulation tissue in which bone salts are deposited. This bony scar tissue contracts, like other cicatricial tissue, and as a consequence still further deformity occurs, the angle becoming sharper, so that increase in deformity accompanies repair as well as increased destruction of bone.

After repair is completed the actual deformity of the back also tends to increase by the formation of the compensatory curves, which push the angular curve still farther backwards.

EFFECT ON THE CORD.—As the posterior arches of the vertebrae and the articular surfaces are not affected, there is seldom any pathological dislocation of the spine, and the spinal canal is not encroached upon. Pressure on the cord from even a sharp angular deformity is therefore rare, and even when it does occur, the pressure is brought to bear so slowly that the cord accommodates itself to the altered condition. With the sudden production of a sharp curve, bony pressure on the cord may be present.

Pressure on the cord resulting in paraplegia may be due to —

1. Granulation tissue invading the spinal canal.
2. The tubercular process affecting the dura mater causing a pachymeningitis externa.
3. Pieces of necrosed bone slipping into the spinal canal.
4. An abscess forming on the posterior aspect of the vertebræ, and invading the spinal canal.

Paraplegia may also be due to a myelitis and degeneration of the cord, brought about by interference with the blood-supply, owing to contraction of cicatricial tissue in the dura. The spinal nerves may also be pressed upon, as they leave the foramina between the

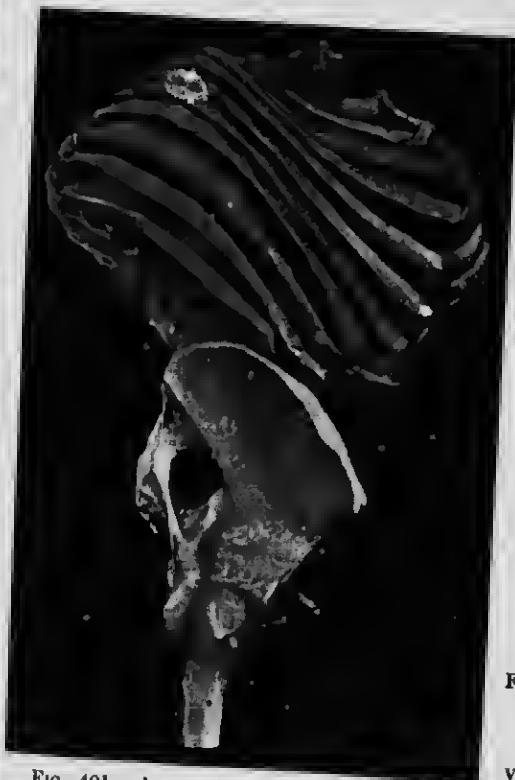


FIG. 401.—ANGULAR CURVE OF THE SPINE (POTT'S DISEASE).

(London Hospital Medical College Museum.)



FIG. 402.—TUBERCULOSIS OF THE SPINE, WITH PRESSURE OF THE CORD.

vertebræ, pain being referred along their course; but marked pressure on the nerves is rare with spinal tuberculosis.

ABSCESS FORMATIONS.—Abscess formation usually occurs on the anterior aspect of the bodies of the vertebræ, and the pus finds its way to the surface along the lines of least resistance. Occasionally, as stated above, the pus will invade the spinal canal. In adults, when the lesion is largely limited to the bone just below the periosteum, very large abscesses may form without any deformity occurring, and the evidence of disease of the bone may be very slight.

As an exception, tubercular inflammation may affect the transverse processes, the laminae, or the spinous processes, and in these cases there is no deformity of the spine. The condition can only be recognized after an abscess has formed and been opened, or by radiography.

CLINICAL FEATURES.—Patients with Pott's disease come under observation for many different reasons, the chief of which are—(1) The child is noticed to be easily tired, and has adopted some awkward position in standing, sitting, or walking; (2) deformity in the back; (3) pain in the chest, abdomen, in both knees, or down the leg—these pains are referred pains along the spinal nerves; (4) limping, due to the presence of a psoas abscess; (5) abscess formation.

For whatever symptoms the patient is brought for examination, there is one constant physical sign which is present in all cases of Pott's disease, and on which chief reliance must be placed for diagnosis before the characteristic deformity is present, and that is *muscular rigidity*. This rigidity shows itself in awkward attitudes and restricted movements.

Attitude.—The attitude adopted is such as will keep the spine at rest and prevent jarring of it, or is due to spasm of muscles inserted into the spine, especially the psoas. The attitude varies with the different portions of the spine affected, and will be discussed later.

Restricted Movement.—The spinal column is made up of a series of joints, and as in other joints, inflammation is associated with loss of movement in all directions. Careful examination of the spine will show that the affected portion does not move with the same freedom as the remainder of the spine. The patient should have the spine thoroughly exposed, and be told to bend it in all directions, the suspected part being carefully examined for rigidity. The muscular rigidity may be most marked after a period of rest, and may disappear after the patient has moved about.

Pain.—Pain may be entirely absent, even when marked deformity has occurred, but there is usually complaint of a dull aching pain in the back, worse while the patient is about, and relieved by recumbency. Pain may also be complained of in the chest, abdomen, pelvis, or lower extremities, being referred along the spinal nerves. The diseased vertebra may be tender on percussion, but this is a sign of little value, and is much more marked in hysterical conditions than in organic disease.

Radiography.—Even before deformity has occurred, a well-taken radiogram may give evidence of bone destruction, and settle the diagnosis in a doubtful case.

Deformity.—The usual deformity is an angular projection of the spine backwards, which is pathognomonic of loss of part of the body of a vertebra, and so may occur in gumma formation and new growth. If one vertebra is mainly destroyed, the angle is sharp, but with destruction of several vertebrae the projection is much more rounded. Lateral deviation occurs in the early stages, but later, the antero-posterior deformity is always the more marked, although the lateral curve may



FIG. 403.—SKIAGRAM OF THE SPINE, SHOWING ANGULAR DEFORMITY DUE TO TUBERCULOSIS (POTT'S DISEASE).

not entirely disappear. Deformity of the chest is always present with deformity of the spine, the sternum and ribs altering their position. The deformity is usually a projection forwards of the sternum, and a lateral flattening of the ribs producing the condition of pigeon-breast.



FIG. 401.—POTT'S DISEASE, SHOWING USUAL DEFORMITY.

COMPLICATIONS — Paraplegia.—Paraplegia may occur early or late in the disease, and in mild or severe cases of deformity. Its causes are given above under Pathological Anatomy.

The early symptoms are motor—viz., fatigue, weakness, dragging of the feet, and incontinence of urine. The muscles are usually spastic, with increased reflexes and ankle clonus, but they may be flaccid. With disease in the cervical region the arms are paralyzed as well as the legs. Later, deformity from contractions of the muscles may occur. The reaction of degeneration is not usually present, but may be so if the lumbar enlargement is involved.

Sensory phenomena are not prominent, but anæsthesia, perversion of sensation, or loss of sensibility to pain below the level of the lesion, may be present.

Paraplegia occurs in about 7 per cent. of all cases, and recurrence of the paralysis after apparent cure is not an unusual feature.

Abscess Formation.—A large number of cases run their course without abscess formation, especially if they are thoroughly treated; but abscesses may occur in any form of Pott's disease and at any period of the disease, and may be the first symptom bringing the patient under observation. They are relatively more common in adults than in children. In many cases they reach an enormous size, and may become infected with other organisms. Abscess formation is the most serious complication of tuberculosis of the spine, and frequently leads to death of the patient from long-continued suppuration, exhaustion, and lardaceous disease.

The following table shows the position in which abscesses usually point in the different regions of the spine:

Upper Cervical	.. ..	In posterior wall of pharynx (retro-pharyngeal abscess).
Lower Cervical	.. ..	1. In the trachea, œsophagus, or through an intercostal space.
		2. Laterally into the posterior triangle of the neck, or even passing with the nerve trunks into the axilla.

- | | | |
|--------------|-------|---|
| Upper Dorsal | .. .. | <ol style="list-style-type: none"> 1. Posteriorly near the spine, passing with the posterior primary divisions of the dorsal nerves. 2. Laterally and anteriorly, passing with the anterior primary divisions of the dorsal nerves. |
| Lower Dorsal | .. .. | <ol style="list-style-type: none"> 1. As upper dorsal. 2. In the psoas sheath, passing under Poupart's ligament into Scarpa's triangle. |
| Lumbar | .. .. | <ol style="list-style-type: none"> 1. Psoas sheath. 2. Iliac fossa. 3. Lumbar region outside the erector spinae. 4. Gluteal region, passing through the great sacro-sciatic notch. |

TREATMENT.—The *General* treatment of tuberculosis, including injection of tuberculin, should be carried out, and is of the utmost importance in obtaining cure of the disease.

Local.—The general principles which govern the local treatment are *absolute rest* and *the avoidance of interosseous pressure*.

Under normal conditions the weight of the head and of the abdominal and thoracic organs tends to bend the spine forwards and downwards, and this pressure on the bodies of the vertebræ is increased when the body is bent forward in the stooping position. On the other hand, the pressure on the bodies of the vertebræ is lessened in the erect and extended position, as it is transferred to the articular processes. In Pott's disease, therefore, the body should be kept at rest in the extended position, so as to reduce the pressure on the diseased vertebral bodies.

Recumbency.—During the active progress of the disease the patient should always be kept recumbent, as no form of mechanical support can effectively remove the weight of the body from the diseased vertebræ. In young children recumbency should be maintained until the disease is cured, for they do not suffer from the confinement, and it is extremely difficult—if not impossible—to fit them with an efficient jacket.

It is not, however, sufficient to keep the patient recumbent in bed, but various forms of apparatus must be used, so that the recumbency and rest are efficient. The most efficient means are—

1. *Extension.*—It is during the acute stages, and when inflammation of the psoas muscle is present, that extension is particularly valuable. The patient is placed flat on the back in bed, and children are best secured in a box-splint. The usual extension apparatus is applied to the legs, and a weight of about 3 pounds is applied to each, the limb being kept in a position of slight abduction. Counter-extension can be applied in two ways: (1) The patient is slung to the head of the bed with well-padded straps running round the chin and occiput, and in cases of lower spinal disease, round the axillæ, and the bed then tilted (Gorham bed); (2) a weight extension of 3 pounds is fixed to the head by means of the straps, and passes over a pulley at the head of the bed.

If the patient is not in a splint, a fracture-cloth, secured at the sides by sandbags, passes across the chest.

The extension is maintained for about six months, and then the treatment is continued in a Phelps's box, a Thomas's double splint, or some form of jacket, according to the age of the patient.

2. *Thomas's Double Splint*.—The double splint used in the treatment of tuberculosis of the spine is similar to that described in the treatment of tubercular arthritis of the hip (see p. 596), but it is provided with an extension to support the feet in the right-angled position. The legs are bandaged to the splint, and a flannel bandage encircles the chest. This is a very convenient splint for the treatment of young children, especially in the out-patient department, as it is easily made, is fairly cheap, and the child can be readily carried about in it. As the treatment may extend over years, it is made so that it can be lengthened to accommodate the growing child. To remove it for washing, the child is turned over on to the face, and the splint lifted off.



FIG. 465.—THOMAS'S DOUBLE SPLINT.

3. *Phelps's Box*.—This splint consists of a wooden trough, in which the child lies, and which at its lower end is prolonged into two narrow troughs for the lower limbs. The box is about 6 inches deep, and it is lined with a horseshair mattress, covered with soft leather, and suitably padded on the sides. The sides are cut away opposite the arms, so that they can be comfortably passed outside for playing, etc., and opposite the buttocks the bottom of the box and mattress are cut away to allow defecation.

If necessary, a bandage is secured round the chest to keep the child recumbent, and the feet are bandaged to uprights at the ends of the leg troughs. This box-splint is easily carried by the parents, and can be placed on any bed or couch, and has the additional advantage that extension can be carried out

by fastening the usual extension apparatus to the legs and letting the cord run over a pulley on the uprights of the leg troughs. Counter-extension is made by slinging the head to the top of the trough by well-padded leather straps passing under the chin and occiput. If the box is to be used for extension, it must be about 18 inches longer than the patient. The power of the extension may be increased by tilting up the head of the box, and this also allows the patient to look about him. The patient is kept in the splint day and night.

A child should be kept in a Thomas's double splint or a Phelps's box for two years after his symptoms have disappeared, and is then allowed to gradually resume sitting and walking.

4. *Plaster Jackets*, fitted in one of the methods given below, combined with recumbency.

Ambulatory Form of Treatment.—

Although all cases in the acute condition of the disease should be treated by recumbency, and the patient will at first markedly improve in general health under this treatment, it should not be continued too long in patients who have passed early childhood, if complications are absent and the local condition is improving.

Patients with tuberculosis need all possible help from fresh air and exercise, and this can be more satisfactorily obtained if they are allowed to get about in apparatus, but it must be fully recognized that all apparatus is mechanically inefficient, and fails in wholly relieving the diseased vertebrae of all their weight-bearing function, so that recumbency is essential until the process of cure is well advanced.

The object of a support is to maintain the extended position of the spine so as to lessen the pressure on the bodies; to keep the various parts of the spine at rest; and in a less degree to transfer the weight of the body above the diseased part to the pelvis, so as to reduce the pressure on the inflamed vertebrae. The pelvis must therefore be the base of support for all efficient forms of jackets, and they must all take a firm grip of the iliac bones. It follows that the ordinary poroplastic jackets, with or without chin supports and with softened places to fit over the crests of the ilia, are of little value in the treatment of this disease. They lessen the movement of the spine to some extent, and so give a little rest, but they do not maintain the extended position which is necessary, nor do they transmit any of the weight to the pelvis.

The following forms of apparatus are suitable for ambulatory treatment:

1. *Plaster Jackets (Sayre's Method).*—This is most suitable for adults; but it can be applied to children, who should be held by an assistant in the upright position, with the arms above the head, the tripod and pulleys not being used.

The patient is suspended by means of chin, occiput, and axillary straps to a pulley fixed at the apex of a tripod stand, so that his toes



FIG. 400.—PHELPS'S BOX.

rest on the ground, and the spine is extended as much as possible without discomfort. The body is covered with a closely woven,

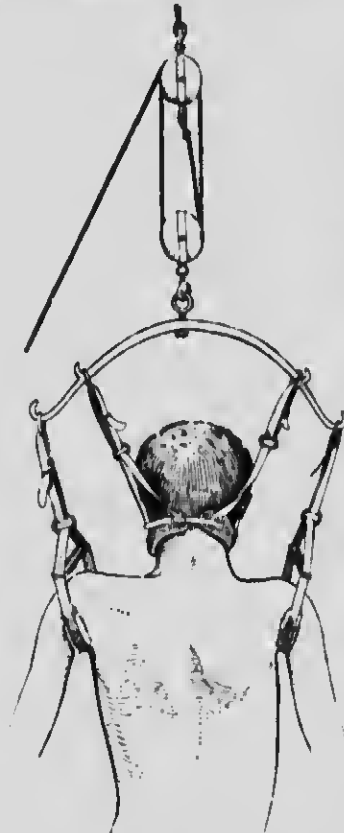


FIG. 407.—SLINGS FOR APPLYING A PLASTER JACKET.

seamless jacket without arms, which is stretched to lie smoothly over the body, and fastened between the legs to prevent it from wrinkling during the application of the plaster.

Before applying the plaster, the anterior superior spinous processes are protected by padding with cotton-wool. In adults a pad, consisting of a folded towel, is placed under the vest over the epigastrium to form a "dinner-pad." This is to be drawn out after the plaster has hardened, and provides room for distension of the stomach after a meal. It is not needed in children, as the plaster always shrinks a little away from the body.

Plaster of Paris bandages are carefully applied round the body from immediately above the great trochanter to the axilla, and strips of perforated tin can be incorporated in the jacket to prevent cracking. The jacket should be from $\frac{1}{4}$ to $\frac{1}{2}$ inch thick, and should have the plaster evenly applied all over. The plaster should dry in about five minutes, and the patient can be suspended while drying; but if he complains, he should be placed

flat on his back, and in this condition the case is carefully moulded to the crests of the ilia by firm pressure with the hands.

When dry, the "dinner-pad" is removed. The edges of the plaster are trimmed, so that it is comfortable when the patient is sitting; but care should be taken to leave it as long as possible, so that the abdomen is well covered. A second vest, with neck and short arm-pieces, should be worn over the jacket, to keep it clean and to prevent crumbs, etc., passing in between it and the skin.

A well-made jacket can be worn from three to six months without being changed, but if it becomes softened or broken, it must be renewed at once.

APPLICATION OF PLASTER DURING RECUMBENCY.—This is most suitable for children. The patient is laid face downwards, with the arms extended above the head, on a hammock made of stout cotton-

cloth a little wider than the patient, and stretched over the ends of a rectangular gas-pipe frame. The hammock may be made tight or allowed to sag to any extent, so that hyperextension of the spine may be made. The cloth is cut along the sides of the body where the plaster will be, so that the bandage can be passed round, including the chest and the hammock.

Just before finishing the jacket the hammock should be cut across above the top of the jacket and the child suspended by the arms by an assistant, and the upper turns of the bandages put on with the spine hyperextended (Brailford and Lovett).

The other details are the same as when the plaster is applied during suspension.

2. *Jackets and Braces.*—Jackets are most suitable in the treatment of older children and adults, for they allow of the patient taking exercise and obtaining fresh air, or even following his employment if it be a suitable one. In all cases, however, it is probably best to keep the patient in the horizontal position during the first few months of the disease, and only to allow him up with a jacket after the acute symptoms have subsided.

In children they are of use during convalescence.

Jackets are made of poroplastic felt, leather, and plaster of Paris, moulded to the patient's body while he is suspended or in the semi-prone position, so that the spine is extended as far as is comfortable to the patient. They must be worn day and night, but are removed daily so that the patient may be bathed and the back rubbed with alcohol and powdered. When removed, the patient must be in the recumbent position, and not allowed to sit up or stand until the jacket is replaced.

If a pressure sore forms, the jacket must be removed, and the patient kept in the recumbent position until it is healed. In all cases he should rest flat on the back for an hour or two in the middle of the day.

In cases with disease high up in the cervico-dorsal region, the head should be held supported in the upright position by chin and occipital supports fastened to the jacket or brace. The jury-mast is obsolete. Jackets should be worn for two years after all symptoms have ceased, and should be discarded gradually, at first being left off at night, and then for a few hours a day, until in about three months they are no longer worn.

Taylor's Brace.—This supports the spine in the extended position, and is to be preferred to all forms of jackets for efficiency and comfort. It consists essentially of two steel uprights, placed one on each side of the spine, going as high as the second dorsal vertebra and firmly secured to a steel pelvic band. The trunk is secured to the brace by means of an apron, which covers the front of the abdomen and chest, and is fastened to the brace by non-elastic straps and buckles. Padded leather bands also pass round the axillæ, and are fastened to the uprights.

The rules for applying and wearing a jacket equally apply to the

use of the brace, and a head support can be applied for disease of the cervical region.

LENGTH OF TIME NECESSARY TO REMAIN RECUMBENT OR WEAR APPARATUS.—It may be taken as a general rule that recumbency or

splint treatment must be continued for two years after all the symptoms have disappeared. As there is no absolute criterion by which it can be ascertained that the disease is cured, the cessation of treatment must always be regarded as an experiment, and therefore it should not occur suddenly. When the disease is considered cured, the patient should

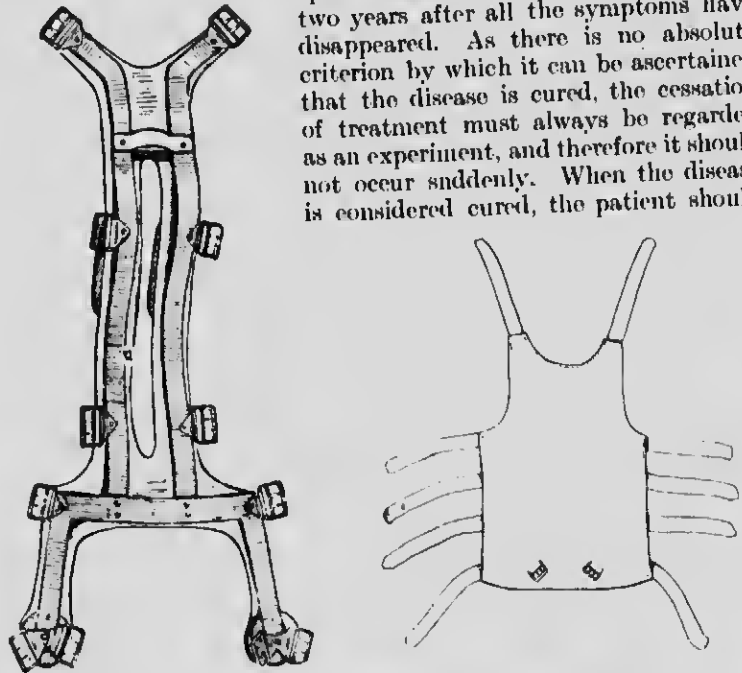


FIG. 408.—TAYLOR'S BRACE.



FIG. 409.—FRAME FOR THE TREATMENT OF POTT'S DISEASE, WITH EXTENSION OF THE SPINE.

be allowed to discard treatment at first for an hour or two a day, increasing the intervals till in about three months all apparatus is dispensed with. Should the symptoms return, the patient must be placed in the recumbent position for another six months.

TREATMENT OF ABSCESS WITH POTT'S DISEASE.—This follows the principles of treatment of abscesses with tubercular arthritis and osteitis.

When the abscess is deep-seated it may be aspirated, the aspiration being repeated if necessary; or it may be opened by a small incision, the contents evacuated, and the wound closed. When secondary infection has occurred or the skin is involved, incision and drainage will be necessary. Should a radiogram show loose sequestra of bone, the incision should be so planned that the diseased vertebra can be reached, the sequestra removed, and the walls of the abscess cavity well scraped. These abscesses frequently continue to discharge for years.

TREATMENT OF PARAPLEGIA.—If the patient is being treated by the ambulatory method, this should be given up at the earliest symptoms of paraplegia supervening, and the patient kept strictly in the recumbent position with extension applied to the lower extremities. The position of recumbency with fixation of the spine must be maintained for months after the paraplegia has disappeared. The usual precautions against bedsores and cystitis occurring in a paralyzed patient must be carried out.

The **PROGNOSIS** of this complication is good, the majority of cases recovering with rest and extension, but in a small minority of cases operation is necessary. Operative treatment is indicated in the following conditions:

1. In those cases in which a radiogram shows sequestra displaced into the spinal canal.
2. When, in spite of careful rest and extension, the symptoms progress.
3. If there is reason to suspect that an abscess is forming in the spinal canal.
4. If, during the process of cure, paralytic symptoms arise, probably due to cicatricial contraction of a previously inflamed dura.
5. If the onset of the symptoms are sudden, and radiographic evidence proves that the cause of the paraplegia is bone pressure (2 per cent. of cases).

The operation performed is that of **costo-transversectomy**. One or two of the transverse processes at the site of the disease are removed, together with the heads and necks of the corresponding ribs. This allows of free exploration of the diseased bodies of the vertebrae and at the same time does not destroy the posterior vertebral arch, which would still further weaken the spine.

Laminectomy should be performed if the posterior vertebral arch is the seat of the disease, and all the diseased bone freely removed.

TUBERCULOSIS AFFECTING VARIOUS PORTIONS OF THE SPINE

Cervical Region—Occipito-Axoid Disease.—*Pain* is referred over the back and side of the head along the course of the auricular and occipital nerves.

Attitude.—The neck is held stiffly, and usually inclined to one side, and the chin is often supported by the hand. Movements of the

head are impossible, and the eyes or the whole body are moved instead of the neck.

Abscess.—If an abscess forms, it points behind the pharynx into the mouth, and may cause trouble in respiration.

Paraplegia, if present, involves the arms as well as the legs. The diagnosis has to be made from torticollis due to other causes. The prognosis is not good, and sudden death from dislocation of the atlo-axoid articulation may occur.

TREATMENT.—Extension should be applied to the head, and lateral movements prevented by placing the head between sandbags. In the ambulatory form of treatment, which should not be attempted until cure is well advanced, the head and neck must be supported by a collar reaching to the chin and the external occipital protuberance, and also restricting movements of the dorsal spine.

Retro-Pharyngeal Abscesses should be opened by an incision at the posterior border of the sterno-mastoid.

Lower Cervical.—*Pain* radiates down the arm and over the shoulders.

Attitude as in the upper cervical region; the angular curve is usually well marked.

Abscess points in the posterior triangle of the neck, passing along the path of the brachial plexus. Treatment as in the upper cervical region.

Dorsal Region.—*Pain* is referred along the intercostal nerves, and the patient complains of "chest-ache" or "belly-ache."

Attitude.—The patient leans forward, and often supports the spine by leaning the arm on a chair, or by resting the hands on the knees with the hips flexed. If told to stoop, the back is kept rigid and the knees and hips flexed, and in regaining the upright position the patient often "climbs up his legs."

The angular deformity is usually well marked, and causes changes in the shape of the chest, the patient becoming "pigeon-breasted." He is sometimes brought to the surgeon for the deformity of the chest.

Abscess.—This usually follows the course of the posterior primary divisions of the dorsal nerves, and points on the back near the spine. The abscess may also follow the course of the anterior primary division of the dorsal nerve, and come to the surface in the position of the lateral cutaneous nerve at the side of the chest, or even point in front at the situation of the anterior cutaneous branch. Occasionally the pleuræ may be perforated and an empyema result.

In the lower dorsal region the pus may pass under the internal arcuate ligament and enter the psoas sheath.

Other symptoms sometimes present in diseases of this region of the spine are grunting respiration and cough. Paraplegia is more common with disease of the dorsal spine than elsewhere.

There are no special remarks to be made on treatment

Lumbar Region.—*Pain* is referred to the back, along the inguina region or down the legs, sometimes simulating sciatica.

Attitude.—There is frequently lordosis in the early stage, and to

compensate for this the patient holds himself "over-erect" and walks with a "waddling" gait, carefully balancing the spine; the abdomen is prominent. Later the lordosis disappears, and gives place to the

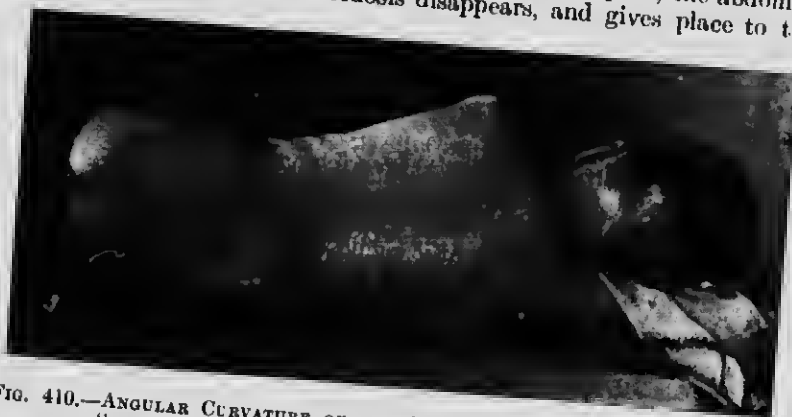


FIG. 410.—ANGULAR CURVATURE OF THE SPINE IN THE LUMBAR REGION, WITH SECONDARY PARTIAL OBLITERATION OF THE DORSAL CURVE.

angular curve backwards. All movements are restricted, and if the patient is laid on his face and the lower limbs lifted, the lumbar spine does not move, but the body is raised stiffly from the couch.

Abscess—Psoas Abscess.—These abscesses pass downwards in the sheath of the psoas muscle, entirely destroying it. They leave the abdomen under Poupart's ligament on the outer side of the femoral vessels, and then usually pass beneath the vessels to point on the inner side of the thigh. The swelling in the thigh has an impulse on coughing, and gets smaller when the patient lies down, so that it may be mistaken for a femoral hernia. Careful examination, however, will reveal a deep-seated swelling in the abdomen, and a wave of fluctuation will pass between it and the swelling in the thigh. The abscess may also point in the iliac fossa, simulating an appendix abscess, or on the outer side of the femoral vessels. These abscesses may hold one or two pints of pus.

Lumbar Abscess.—The pus may pass backwards along the posterior primary divisions of the lumbar nerves, and form a lumbar swelling simulating a perinephritic abscess, or occasionally it may leave the psoas sheath to pass backwards through the great sacro-sciatic notch, forming a "gluteal abscess."

Paraplegia cannot occur with disease below the first lumbar vertebra, but there may be involvement of the nerves of the corda equina with referred pain along their distribution.

In the lower lumbar and sacral region there is usually no deformity, and this part of the spine is only affected in adults.

Syphilitic Disease of the Spine.

Authentic cases of this condition are rare, but when present the condition may imitate all the symptoms of tuberculosis of the spine.

It occurs in both congenital and acquired syphilis, but is more common in the latter, and therefore usually met with in adults. It is most common in the cervical region of the spine, affecting the bodies of the vertebrae, but two regions may be affected simultaneously, and the progress of the disease is generally rapid.

The local features of the condition resemble those of Pott's disease, but evidence of syphilis elsewhere in the body is frequently present, and the Wassermann reaction is positive. Radiography will show the destruction of the bodies of the vertebrae, and the diagnosis may also be made by the effects of treatment.

TREATMENT.—The *General* treatment is the giving of antisyphilitic remedies. The *Local* treatment is similar to that for tuberculosis of the spine, but need not be continued for such long periods.

Typhoid Spine.—Occasionally after typhoid fever the patient complains of pain and stiffness in the back, and the spine may be excessively tender. The condition simulates Pott's disease except that there is no deformity and no abscess formation. It is believed to be

due to inflammation of the periosteum of the vertebrae, due to infection with the typhoid bacillus. The course of the disease is chronic.

TREATMENT.—The patient should be kept at rest whilst there is pain and stiffness of the spine. The prognosis is good.

Gonorrhoeal Arthritis of the joints of the spinal column occasionally occurs as part of a general gonorrhoeal arthritis.

Osteo-Arthritis of the Spine (Spondylitis Deformans).—Osteo-arthritis of the spine is most common in elderly men who follow laborious occupations, especially if exposed constantly to damp and cold, but it may occur in a limited degree in any of the varieties of osteo-arthritis (see p. 569). The changes in the articular surfaces of the vertebrae are similar to those in osteo-arthritis of other joints, but the osteophytic outgrowths invade the intervertebral discs, and a true bony ankylosis of the intervertebral joints occurs, and the spine may become an absolutely rigid column of bone. Similar changes occur in the joints between the vertebrae and the ribs, so that the chest is fixed.



FIG. 411.—OSTEO-ARTHRITIS OF THE SPINE, WITH BONY ANKYLOSIS (SPONDYLITIS DEFORMANS).

(London Hospital Medical College Museum.)

SYMPTOMS.—The patient complains of pain in the back, which is worse in damp weather, and gradually the spine becomes stiffer and stiffer, until movement is impossible. The lumbar curve tends to

disappear, and there is usually marked kyphosis in the dorsal region, and the patient walks bending well forwards, and in stooping the movement is entirely from the hips.

Pain from pressure on the spinal nerves as they leave the intervertebral foramina may be present.

The course of the disease is very chronic, the cases lasting for years. Death usually occurs from pulmonary complications.

Radiography is of value in the diagnosis.

TREATMENT.—The treatment is conducted under the general principles that govern the treatment of osteo-arthritis (see p. 573).

Traumatic Spondylitis.—Occasionally after injury to the spine, when fracture has not been suspected and the patient has soon returned to his occupation, a train of symptoms occurs closely simulating Pott's disease. The patient complains of pain and stiffness in the back, the pain radiating round the body and down the legs. Later, an angular deformity occurs at the site of the injury.

Recovery takes place, but a certain amount of deformity and rigidity are permanent.

This condition is believed to be due to an unrecognized fracture of the spine resulting in softening of the bone and callus formation, and is therefore analogous to traumatic coxa vara. On the other hand, it is extremely difficult to differentiate the condition from Pott's disease following an injury.

Hysterical Spine.—This condition, like other forms of hysteria, is most common in females between the ages of fifteen and thirty. The disease most frequently simulated is Pott's disease in the cervical region, as the vertebra prominens is frequently the peg on which the symptoms are hung, but the symptoms may be referred to the lumbar region. The most prominent symptom is an intense hyperaesthesia of the spine, the patient frequently wincing when the skin over the vertebrae is touched, a symptom which is entirely absent in tuberculosis of the spine. Passive movement of the spine is resisted, but active movement, especially when the skin is touched, is usually free. In some cases an hysterical paraplegia is present.

The treatment is that of hysteria in general.

Coccydynia.—The term indicates a pain and tenderness referred to the coccyx, the pain usually being increased by prolonged sitting and constipation.

Two types can be distinguished. In the first there is no apparent cause and no physical signs, and in the second there is a history of accident or child-birth, and on examination, the coccyx may be more movable or fixed than normal, dislocated, fractured, or have a projection forwards.

The pain in both cases is usually acute and paroxysmal, and radiates over the coccygeal region and down the legs. Examination by the rectum should always be made to discover any pathological condition of the coccyx. The condition may be simulated by piles, anal fissure, fistula, and other diseases of the anus and rectum.

TREATMENT.—If the coccyx appears on rectal examination to be normal, the usual treatment of neurasthenia should be carried out; but if a distinct pathological condition is found, and the condition does not quickly yield to simple remedies, the coccyx should be excised.

NEW GROWTHS OF THE SPINE

Innocent Tumours of the spine are the same as those growing from other bones—viz., **osteoma, chondroma, and fibroma**. They are all extremely rare, and are treated on general principles.

Malignant Tumours are primary or secondary, the primary tumours being sarcoma and the secondary tumours carcinoma and sarcoma.

Primary Sarcoma of the Spine generally occurs in adult life, and may be endosteal or periosteal. The dorsal region of the spine is most frequently affected, and the condition is fatal.

SYMPTOMS.—The early symptoms are similar to those of Pott's disease—viz., aching pain over the site of the growth, rigidity, and some tenderness. The diagnosis is only possible at this stage by X-ray examination and the exclusion of tuberculosis and syphilis. Later an angular curve develops, and the growth may be recognized on examination. Pressure on the nerves as they pass out of the spinal foramina is an early symptom, and there is persistent neuralgia along the course of the nerves, with or without anaesthesia. Pain, referred along the nerves, is the most important clinical sign, but later in the disease it may disappear.

Paraplegia from extension of the growth into the spinal canal is common, and may be associated with intense pain in the lower extremities (paraplegia dolorosa).

An irregular temperature is present in some cases.

Secondary Carcinoma is most common after carcinoma of the breast in women and of the prostate in men. The symptoms are similar to those of primary sarcoma of the spine, but retrogression of the symptoms may occur for a time.

TREATMENT.—No treatment is of any avail, and the only thing to be done is to give morphia to relieve the pain.

DISEASES OF THE CORD AND MENINGES

INFLAMMATORY CONDITIONS

1. **Acute Spinal Meningitis.**—This may be due to—

- (1) Direct infection from without by means of stab, gunshot wounds, or infection of a spina bifida.
- (2) Extension from the bones or the brain and its membranes.
- (3) Infection from the blood-stream, as in cerebro-spinal meningitis.

CLINICAL FEATURES.—The general symptoms are those of any infective disease. The early localizing symptoms are due to irritation

of the spinal centres and nerves. They consist of pain in the back radiating round the body and down the limbs, cramps, muscular spasms, and hyperæsthesia. Later, the symptoms are those of paralysis, and there is paraplegia, with acute bedsores and incontinence of urine and fæces.

TREATMENT.—The condition is usually fatal, and the only treatment is careful nursing, the prevention of bedsores, and repeated lumbar punctures.

2. **Chronic Meningitis.**—This condition is most common in the lower part of the spinal cord, but it may spread upwards as far as the middle dorsal region. It is a chronic pachymeningitis with thickening of the dura, and may follow an acute attack of spinal meningitis or be due to syphilis. The pia and arachnoid membranes are usually affected as well as the dura.

CLINICAL FEATURES.—The patient is as a rule an adult, and the disease starts with pain and rigidity in the back, muscular cramps, and hyperæsthesia. Later, there is paresis ending in paraplegia, with incontinence of urine and fæces and some degree of anaesthesia. The knee-jerks are exaggerated, and ankle clonus is frequently present.

TREATMENT.—Mercury and iodides should be given in the syphilitic cases, but if these fail to cure, the spinal canal should be opened and the dura incised. The wound is then closed without drainage. The prognosis is bad.

3. **Spinal Myelitis.**—Inflammation of the spinal cord may follow traumatism associated with fracture dislocation of the spine, direct extension of inflammation from the meninges, or punctured wounds of the spine. Other cases are due to infection by the organisms of syphilis, pneumonia, influenza, etc.

The symptoms have already been given under the heading of Fracture Dislocation of the Spine. For further details the reader is referred to works of Medicine.

NEW GROWTHS OF SPINAL CORD AND MEMBRANES

Three varieties may be distinguished: (1) **EXTRADURAL**, growing from the connective tissues between the meninges and the bone (*lipoma*, *sarcoma*) or from the bones themselves (*osteoma*, *chondroma*, *sarcoma*, and *secondary carcinoma*); (2) **INTRADURAL**, growing between the dura mater and the cord (*sarcoma* and *fibroma*); (3) **SPINAL**, growing from the pia mater, the nervous tissue of the cord itself, as from the neuroglial supporting elements (*glioma*, *sarcoma*). Hydatid cysts, tubercle, gummata, and other chronic inflammatory lesions may be classed amongst tumours of the spinal cord, as they give the same symptoms as true neoplasms. *False neuromata* may also develop from the sheaths of the nerve roots and the nerves of the corda equina, and are usually multiple.

SYMPTOMS.—The symptoms are mainly due to pressure on the spinal cord. The early symptoms are pain in the nerves coming from the seat of the lesion, modification of sensation (formication,

tingling, numbness, and girdle pain) and spasms of the muscles supplied by the segment of cord affected.

Later, there is gradual paresis of the parts below the lesion, loss of sensation, vaso-motor disturbance, and incontinence of urine and faeces. Bedsores, cystitis, and ascending pyelitis may develop, as in cases of injury to the cord and transverse myelitis.

TREATMENT.—In all doubtful cases antisyphilitic treatment should be tried. If the growth is in the spinal cord itself, or if it is a secondary malignant growth, no treatment is of any value. In extra- and intradural growths, if an attempt may be made to remove the tumour pressing on the spinal cord, it should be remembered that the lesion is always two or three segments higher than the pain would indicate. Operation should be performed as soon as the diagnosis is made, as delay diminishes the chance of obtaining a cure, owing to secondary changes occurring in the cord.

CHAPTER XXVI
SURGERY OF THE NECK

INJURIES

Cut Throat.—The throat is usually cut with a sharp instrument, such as a razor or a pocket-knife, in an attempt to commit suicide or homicide. The wound varies in severity from one almost severing the head and proving rapidly fatal, to an incision into the skin and subcutaneous tissue, which does not damage any of the important structures.

If an attempt has been made to commit suicide by a right-handed person, the incision is firmest and deepest on the left side of the neck and tails off as it reaches the right side. The obverse is the case if the patient is left-handed.

A suicide, before attempting to cut his throat, throws his head backwards. This causes the larynx and trachea to become prominent, and protects the big vessels of the neck; therefore, injury to the trachea and larynx is more common than damage of the carotid artery or internal jugular vein, and the suicide is seldom immediately successful.

In a case of homicide, usually attempted from behind by a right-handed man, the wound is more directly transverse than in suicide, and runs from left to right. It is generally larger and deeper than in suicide, and may sever all the structures in the neck, and even notch the vertebræ. A homicidal wound is therefore more often immediately fatal than a suicidal.

The following clinical varieties will be considered:

1. *Wounds not involving the Air Passages.*—The only dangers of these wounds are hæmorrhage and infection. They have the clinical features and require the same treatment as wounds in other parts of the body.

The hæmorrhage should be arrested by ligaturing the severed arteries and veins, and any muscles cut across should be sutured. Nerves of importance are rarely divided, but if division of a nerve is recognized, the two ends should be sutured together.

The Prognosis is good if the patient is found soon after the injury, and treatment promptly carried out.

2. *Wounds above the Hyoid Bone opening the Mouth.*—These are rare. If the tongue is divided, there is danger of asphyxia, partly from blood running into the larynx, and partly from the base of the tongue falling backwards and obstructing the opening of the glottis.

TREATMENT.—Hæmorrhage should be stopped, and the divided parts accurately sutured in layers. In all cases of cut throat the head should be kept flexed during the healing process.

3. *Wounds through the Thyro-Hyoid Space.*—This is the most common seat of the injury, the pharynx being opened and the epiglottis frequently severed. Hæmorrhage occurs from the facial, lingual, and superior thyroid arteries, and may prove fatal from blood flowing into the larynx and causing suffocation. The hypoglossal nerve may be divided, and cause paralysis of the muscles of the tongue on that side. Swallowing is interfered with, and food and saliva may run out of the wound. Phonation remains normal.

TREATMENT.—After the hæmorrhage has been arrested, the wound should be closed by accurate suturing, and a small drainage-tube inserted. Tracheotomy is seldom necessary; if advised, the high operation should be performed.

4. *Division of the Larynx.*—The thyroid cartilage is the structure most commonly cut, and the division is usually incomplete. The vocal cords may be injured, or the recurrent laryngeal nerve divided. The voice is hoarse, or the patient may only be able to speak in a whisper. Considerable dyspnoea is often present, owing to the entrance of blood into the air passages. If the external wound is small, surgical emphysema of the neck may follow.

TREATMENT.—After all hæmorrhage has been arrested, the divided tissues, including the severed cartilage, should be closed layer by layer, the divided mucous membrane being first accurately sutured with catgut. If the wound is clean cut, and is treated soon after being inflicted, tracheotomy is unnecessary; if, however, the wound is dirty and ragged, a high tracheotomy should be performed.

5. *Division of the Trachea.*—The hæmorrhage in these cases is usually severe, as the carotid artery or jugular vein may be severed at the same time. Copious hæmorrhage may also follow division of the thyroid gland. The recurrent laryngeal nerve may be divided, causing complete paralysis of the vocal cord on the same side. Asphyxia may follow entrance of blood into the trachea, and if the external wound is small, surgical emphysema may occur. Persistent coughing is very common.

TREATMENT.—If the trachea is severed, one or two catgut sutures should be used to hold the portions together, and a tracheotomy tube introduced. When the wound in the trachea is small and clean cut, it may be sutured, or a tracheotomy tube may be introduced for a few days.

COMPLICATIONS OF CUT THROAT—1. *Lung Complications.*—Bronchitis and broncho-pneumonia often ensue, and may cause the patient's death. The entrance of blood into the air passages, and later into the larynx, during attempts to swallow, predisposes to these complications, the sensibility of the mucous membrane being diminished. They are more common if a tracheotomy tube has been inserted. The treatment follows the usual lines.

2. *Surgical Emphysema.*—As the external wound is generally large, surgical emphysema is not a common complication. The emphysema

may be limited to the part immediately round the wound, or it may extend over the whole body.

No treatment is necessary, and the air disappears in a few days.

3. *Infection* of the wound and suppuration and cellulitis of the neck, with the usual complications, may follow. Oedema of the glottis may necessitate tracheotomy.

4. *Delirium Tremens* is not an uncommon complication, for attempts at suicide often follow drinking-bouts.

5. *Aerial Fistula*, or a communication between the air passages and the skin, occasionally results, especially if the thyro-hyoid membrane has been divided. The skin and mucous membrane are continuous at the opening.

The treatment is plastic operation to close the opening.

6. *Stenosis of the Air Passages* occurs if they have been badly incised. It may necessitate the wearing of a permanent tracheotomy tube.

7. *Aphonia* may follow injury to the vocal cords or division of the recurrent laryngeal nerve.

Fractures of the Hyoid Bone.—Fractures of the hyoid bone are due to direct violence, such as blows or kicks, hanging or garrotting, and occasionally to muscular violence. The part fractured is usually the body or the great cornu.

CLINICAL FEATURES.—After an injury to the neck there is difficulty of breathing, dysphagia, pain on moving the jaws and tongue, while speech is as a rule hoarse and difficult. The neck is bruised and swollen, and hæmorrhage may occur into the larynx. The patient complains of a feeling similar to that of a large fish-bone stuck in the throat.

On examination, the displacement of the fragments can as a rule be easily felt either from inside the mouth or in the neck. Crepitus can be obtained. The bone unites by callus in the usual manner.

TREATMENT.—The fragments should be replaced in position by manipulation, and the head and neck fixed in a plaster of Paris or poroplastic collar. If the dyspnoea becomes urgent, tracheotomy will be necessary. The food should be fluid, nasal or pharyngeal feeding being carried out for the first few days to avoid the entrance of any into the trachea.

Fractures of the Laryngeal Cartilages.—The cartilage usually fractured is the thyroid or cricoid. The injury is due to direct violence.

CLINICAL FEATURES.—The neck is swollen, and the deformity of the larynx is readily seen from the outside. Dyspnoea, spasms of coughing, and loss of voice, are present. Hæmorrhage may occur into the trachea, and cause instant asphyxia, or later there may be aspiration broncho-pneumonia. Surgical emphysema is common. The **PROGNOSIS** is very grave. *Union*, if the patient survive, takes place by the formation of a small amount of bony callus.

TREATMENT.—Immediate tracheotomy, for the dyspnoea, if not at first urgent, may become so at any time. During the operation the

fragments of the cartilage should be manipulated into position, and so maintained by suturing if necessary. The feeding for the first few days should be nasal or pharyngeal.

Fractures of the Trachea.—These are rarer than fractures of the hyoid bone and larynx, and are usually due to "run-over" accidents. The most prominent symptoms are urgent dyspnoea and surgical emphysema.

TREATMENT.—Immediate tracheotomy should be performed.

CONGENITAL MALFORMATIONS

Branchial Fistulæ.—The neck is developed from the lower three visceral arches, between which lie the branchial clefts, the first visceral arch forming the lower jaw. These lower visceral arches should completely coalesce by the end of the second month of fetal life, or branchial fistulæ will result. Two varieties may be distinguished—*median* and *lateral*.

MEDIAN FISTULÆ are very rare, but may be complete, blind internal, or blind external, and cause air tumours in connection with trachea or larynx.

LATERAL FISTULÆ may be complete. In such cases the internal opening is always into the larynx, while the external opening is variable in position, but most commonly found near the sterno-clavicular articulation at the anterior border of the sterno-mastoid. Incomplete fistulæ form narrow canals, with an internal or external opening. The internal openings are into the pharynx, never into the larynx; while the external fistulæ open near the anterior or posterior border of the sterno-mastoid muscle.

CLINICAL FEATURES.—As a rule these fistulæ cause little inconvenience. The secretion from them is usually slight, clear, colourless, and odourless. Food and fluids may escape along complete fistulæ. Incomplete internal fistulæ may give rise to air tumours of the neck. Not infrequently these fistulæ are associated with such other congenital deformities as cervical auricles.

TREATMENT.—The treatment is complete extirpation, which in the case of complete fistulæ may be a difficult and tedious task. Small, blind internal and external fistulæ may be left untouched, as they cause little inconvenience. If the lining membrane of the fistula is not completely removed, recurrence is certain.

CYSTS OF THE NECK

1. Branchial Cysts.—Branchial cysts are due to non-obliteration of the branchial clefts, and are most frequently associated with the third cleft lying between the thyroid cartilage and the anterior border of the sterno-mastoid.

They may be divided into two groups:

- (1) Cysts arising from the outer part of the branchial clefts, and containing a thin, opaque secretion which, on casual examination, looks like pus.

It contains epithelial cells, cholesterol, and sebaceous matter, and the cyst wall is lined with a squamous epithelium.

- (2) Cysts arising in connection with the internal portion of the branchial clefts, and containing a clear, glairy fluid. These cysts are as a rule lined with a squamous, though occasionally with a columnar or even ciliated, epithelium.

CLINICAL FEATURES.—Although congenital in origin, the cysts are not often recognizable until adolescence. They grow slowly without symptoms. *On examination*, a thin-walled fluctuating swelling is found in the neck, situated anteriorly to the sterno-mastoid muscle and behind the muscles of the tongue or the infra-hyoid group. Occasionally the cyst may project into the floor of the mouth, and simulate a ranula.

The cyst is not fixed to surrounding structures and there is no enlargement of the cervical glands. The diagnosis has to be made from other cystic swellings, and from a tubercular abscess arising in the glands of the neck.

TREATMENT.—The cyst should be removed by dissection.

2. Dermoid Cysts.—These occur in the middle line of the neck at any position between the chin and the episternal notch. They are not attached to the skin, but are superficial to the deep cervical fascia. They contain epithelial debris and hairs, and are lined with a squamous-celled epithelium. They are congenital in origin, and grow slowly. Suppuration may take place in them.

TREATMENT.—The cyst should be removed by dissection.

3. Sebaceous Cysts may occur anywhere in the neck. They have the same characters as sebaceous cysts elsewhere. They are definitely in the skin.

4. Cysts of the Thyro-Glossal Duct.—The thyro-glossal duct, which should normally become obliterated, starts from the foramen cæcum in the tongue, and passes through the substance of the tongue between the genio-hyo-glossal muscles until it reaches the hyoid line. It continues through or behind the hyoid bone and over the front of the larynx, ending in the isthmus of the thyroid gland. Cysts may arise in any part of the duct. Those in the portion above the hyoid bone (lingual duct) are described under Cysts of the Tongue (p. 980) as lingual dermoids. They chiefly project into the mouth.

Cysts arising in the lower part of the duct form cystic swellings in the median line of the neck. The cysts are situated in the superficial



FIG. 412. — DIAGRAM SHOWING FORMATION OF THYRO-GLOSSAL CYST AND FISTULA.

fascia, and are at first free from the skin, though they may become attached to it. They contain a glairy mucoid fluid. A cyst attached to the skin may burst, leaving a **median cervical fistula**, which constantly discharges a mucoid fluid. These fistulæ are usually situated in the lower part of the neck, and a probe passed into them runs upwards towards the hyoid bone.

TREATMENT.—The fistulous tract must be dissected out. This may involve a dissection continuing up behind or through the hyoid bone. If all the tract is not removed, recurrence is certain.

5. **Cystic Hygroma.**—Cystic hygromata, which are congenital in origin, are most commonly met with in the neck. They are described under Diseases of the Lymphatics (p. 341).

6. **Bursal Cysts.**—The various bursæ in the neck may become enlarged, and give rise to cystic swellings. The infra-hyoid bursa situated between the posterior aspect of the hyoid bone and the thyro-hyoid membrane is the one usually affected. Other bursæ are the supra-hyoid bursa and the thyroid bursa in front of the median protuberance of the thyroid cartilage (pomum Adami). These enlarged bursæ occur in the middle line, and the diagnosis is rarely certain until they have been removed.

TREATMENT.—They should be removed by dissection.

7. Cysts in connection with the **thyroid gland** and **accessory thyroids**. These cysts are considered on p. 965.

8. **Blood-Cysts.**—Blood-cysts of the neck are very rare, but four kinds are distinguished:

- (1) Blood-cysts due to a lateral diverticulum from a vein, the cyst either communicating with the vein through a small opening, or being entirely detached from it.
- (2) Varicose dilatation of a vein.
- (3) Cavernous angioma, in which the vessels have coalesced to form one large vessel.
- (4) Blood-cysts formed by degeneration of **endotheliomata**. These cysts grow slowly, and if they communicate with a vein, can be emptied by pressure.

TREATMENT.—The cysts should be removed by dissection, and if communicating with a vein, the vessel should be tied above and below the opening.

9. **Echinococcus Cysts.**—The cysticercus stage of *Tænia echinococcus* may occur in the neck. These cysts are described on p. 246.

10. **Malignant Cysts.**—These are formed in malignant tumours of the neck, primary or secondary, which have undergone degeneration.

AIR SWELLINGS IN THE NECK

The following swellings containing air are met with in the neck:

1. **Dilatations of the Ventricle of the Larynx.**—These swellings appear at the side of the thyro-hyoid membrane, and may be unilateral or bilateral.

2. Congenital or Acquired Herniæ of the trachea, or tracheoceles. These are true herniæ of the mucous membrane between the cartilaginous rings, and are due to increased respiratory pressure.

3. Herniæ of the Lungs.—These are generally bilateral, and appear in the supraclavicular fossæ. They are nearly always associated with emphysema, and swell during a respiratory effort with a closed glottis, such as coughing.

SOLID TUMOURS OF THE NECK

1. Tumours in connection with the lymphatic glands. These are—Tubercular glands, syphilitic glands, Hodgkin's disease, primary and secondary sarcoma, and secondary sarcoma. Their clinical features and treatment are described elsewhere.

2. Innocent New Growths.—The innocent neoplasms, lipomata, circumscribed and diffuse; fibromata; neurofibromata, and occasionally cartilaginous tumours in connection with the visceral arches.

3. Branchiogenic Carcinoma.—Carcinomata may originate in connection with the remnants of the branchial clefts, especially the second. The type of growth is a squamous-celled carcinoma presenting all the usual features of a malignant swelling.

CLINICAL FEATURES.—Branchiogenic carcinoma is more common in men than in women, and is mostly seen in middle life. It forms a hard, fixed swelling at the anterior or posterior border of the sternomastoid muscle at the level of the larynx, and becomes fixed to surrounding structures. Obstruction in the trachea or œsophagus and glandular infiltration occurs later. Metastases are rare. Cystic degeneration of the tumour, which is of low malignancy, often ensues.

TREATMENT.—The growth should be freely removed, but, unfortunately, owing to the absence of local symptoms and non-interference with the general health, advice is not usually sought until the tumour is of large size.

4. Carcinoma of Accessory Thyroids.

5. Tumours of the Carotid Gland.—The carotid gland is about the size of a grain of wheat, and is situated at the bifurcation of the common carotid artery. It may be the site of origin of a curious form of tumour formation that has been termed the *potato-like tumour* of the neck.

CLINICAL FEATURES.—These tumours as a rule first appear in adult life, and grow slowly. For a long time they remain encapsuled, but later break through their capsule and infiltrate the surrounding structures. They form firm, smooth or lobulated tumours in the neck at the level of the bifurcation of the carotic, and are at first freely movable. They cause few or no symptoms until they are very large, but on operation, are found to surround the carotid arteries, and to be attached to the internal jugular vein. Later, they cause pressure on the sympathetic and vagus nerves, and obstruct the arteries and

veins. Pulsation from the carotid artery is usually transmitted through them.

PATHOLOGY.—These tumours are believed to be endotheliomata arising in the carotid body.

TREATMENT.—The treatment is free excision, and this generally involves ligation of the common carotid artery and the internal jugular vein. Secondary degenerative changes in the brain often follow.

6. Congenital Sterno-Mastoid Tumour.—This is a hæmatoma of the sterno-mastoid muscle, caused by partial rupture of the muscle during birth. It is more common on the right side than on the left, and most commonly follows breech presentations.

CLINICAL FEATURES.—The swelling is noticed at birth, or a few days later. It is situated in the middle (approximately) of the sterno-mastoid muscle, and is at first soft, but later becomes firmer and more definite. It is painless, and causes no symptoms.

PROGNOSIS.—If left alone, the swelling gradually disappears in about three months. Congenital torticollis may occasionally develop. In the majority of cases of congenital torticollis, however, there is no history of congenital sterno-mastoid tumour.

TREATMENT.—No treatment is necessary, but the child should be watched for the onset of torticollis.

Cervical Ribs.—A cervical rib is a rib which arises in connection with the seventh cervical vertebra, and since the introduction of the X rays in diagnosis, cervical ribs have been found to be a common congenital deformity. Two types may be distinguished: (1) A rib made of bone and cartilage, articulating with the transverse process of the seventh cervical process—*true cervical rib*; and (2) a mass of bone or cartilage growing from the transverse process—*false cervical rib*. This distinction is probably artificial, and of little use clinically. The condition may be unilateral or bilateral, the latter being the more common. The rib may end in one of the following ways: (1) It may be joined to the sternum by cartilage and exactly simulate the first rib; (2) it may end freely in a cartilaginous process; (3) it may become fused with the first rib; (4) it may end in a tense fibrous band, which is attached to the sternum or to the first rib.

CLINICAL FEATURES.—The condition may give rise to no symptoms, and be accidentally discovered on radiographic examination, or the patient may notice the swelling after an illness that has led to loss of subcutaneous fat. If symptoms do arise in connection with the rib, they are seldom present before young adult life. Two groups of symptoms may be recognized—vascular and nervous.

Vascular Symptoms.—The subclavian artery passes over the rib, and may be pushed forwards and pressed upon.

The vessel becomes prominent in the neck, and the condition may be mistaken for an aneurysm. When the arm hangs down, the pulse is weak; but when the arm is raised, the pulsation at the wrist may be normal. Gangrene of the extremities of the fingers has been known.

Nerve Symptoms—Sensory.—The nerves pressed upon are the eighth cervical and the first dorsal. Tingling pain and numbness, chiefly on the ulnar side of the forearm, and dulness to light touch over the same area, are present.

Motor.—The hand is weak, the muscles chiefly affected being the muscles of the thumb, which are paretic, and undergo atrophy.

The **DIAGNOSIS** is made by X-ray examination, which must be carried out by an expert, for the radiogram is not easy to read. A stereoscopic view is a great help.

TREATMENT.—Treatment is only necessary if pressure symptoms are present. In this case the extra rib should be removed by an incision in the posterior triangle of the neck. The dissection presents considerable anatomical difficulty.

Torticollis, or Wry Neck

The term "torticollis" is applied to an abnormal attitude of the head, which is inclined to one side. The condition may be congenital or acquired.

CONGENITAL TORTICOLLIS.—The wry neck may be noticed soon after birth, but more commonly the patient is not brought for treatment until four or five years old.

The cause of the condition is unknown. The following theories are held:

1. It is due to intra-uterine contraction, probably associated with malposition *in utero*—i.e., it is an ischæmic contraction of the muscles from pressure on the bloodvessels.
2. It is dependent upon a nerve lesion.
3. It is a syphilitic myositis. There is, however, seldom any evidence or history of congenital syphilis.
4. The condition follows rupture of the sterno-mastoid during delivery (congenital sterno-mastoid tumour). A certain number of cases do occur after this accident, but it is more likely that the rupture was brought about by an intra-uterine contraction than that the contraction follows the rupture.

CLINICAL FEATURES.—The child persistently holds its head to one side, generally the right.

On examination, the head is found to be flexed towards one shoulder, with the chin slightly elevated, and turned to the opposite side. If an attempt is made to straighten the head, the sterno-mastoid muscle stands out as a rigid bar. If the muscle is examined, it is found to be smaller and firmer than normal, the clavicular head being chiefly affected. The face is asymmetrical, the half on the affected side being smaller than the other. The measurement from the angle of the mouth to the external canthus is smaller, the side of the face is flattened, the eye is more oblique, and the eyebrow less arched. The deep cervical fascia is shortened, and if the defect is of long standing, the trapezius, scalene muscles, levator anguli scapulae, and the other

muscles on the side of the neck, are also shortened. The cervical vertebrae become wedge-shaped, and compensatory lateral curves and scoliosis develop in other parts of the spine. In very old-standing cases the head is markedly asymmetrical.



FIG. 413.—CONGENITAL TORTICOLLIS, SHOWING OBLIQUITY OF THE FACE (MR. OPENSHAW'S CASE.)



FIG. 414.—POSTERIOR VIEW OF CONGENITAL TORTICOLLIS, SHOWING DEVELOPMENT OF SCOLIOSIS. (MR. OPENSHAW'S CASE.)

TREATMENT.—If the condition is noticed early in infancy, prolonged massage and stretching of the muscle, combined with careful training, when the child is old enough to understand, may be sufficient to correct the deformity. In the majority of cases, however, tenotomy of the sterno-mastoid is necessary.

An incision is made *below* the clavicle, and the skin pulled up until the wound is about $\frac{1}{2}$ inch above that bone. Both heads of the sterno-mastoid are then divided, together with the deep cervical fascia, and, if necessary, the omohyoid muscle. The skin incision is allowed to fall back, and is closed with sutures. The after-treatment consists of massage and stretching of the divided muscles. The child must be carefully trained to hold his head erect, and if these directions are thoroughly carried out, no retentive apparatus is necessary. Movements should be begun as soon as the wound is healed. The results, if the operation is done early in life, are excellent.

ACQUIRED TORTICOLLIS.—The following varieties must be distinguished:

1. **Rheumatic Torticollis.**—This condition appears suddenly, often after sitting in a draught, and is believed to be a rheumatic myositis

of the sterno-mastoid muscle analogous to lumbago. The condition frequently disappears suddenly after a few days or weeks.

TREATMENT.—Aspirin and salicylates should be given, and the neck rubbed with a rubefacient liniment.

2. **Inflammatory Reflex.**—This variety occurs with inflamed glands of the neck, tuberculosis of the cervical spine, gumma in the sterno-mastoid, etc.

The **DIAGNOSIS** and **TREATMENT** are that of the cause.

3. **Paralytic.**—The muscles commonly affected are the trapezius and the sterno-mastoid, the usual cause being division of the spinal accessory nerve and the third and fourth cervical nerves in the operation for tubercular glands of the neck.

4. **Cicatricial.**—This is generally produced by a burn of the side of the neck, but cicatrization of a gumma of the neck or the scar of a tubercular abscess may produce the deformity. The treatment consists of plastic operations and skin-grafting.

5. **Hysterical.**—Hysterical wry neck is not uncommon in very young subjects. The diagnosis is made by the absence of any cause, and by the sudden disappearance of the deformity under the influence of strong suggestion.

6. **Spasmodic.**—Spasmodic wry neck is a condition in which there are clonic spasms of the muscles of the neck, chiefly the sterno-mastoid, trapezius, and the posterior rotators, so that the head is jerked into a position of wry neck. The cause of the condition varies in different cases, the following being the most common: (1) A habit of spasm, originated by some movement habitually made in the course of a patient's work—*i.e.*, analogous to writer's cramp; (2) an irritative lesion in the cortical centres presiding over the movements of the muscles; (3) errors of refraction; (4) peripheral irritation—*e.g.*, from carious teeth, or suppuration in the antrum of Highmore.

The condition is generally met with in young adults, and becomes worse when the general health is depressed. The spasms may be more marked in movements of excitement.

The **PROGNOSIS** is bad.

TREATMENT.—Sedative drugs and the use of massage and electricity may be tried, but they are seldom of value.

The operative measures that have been carried out are—

1. Stretching or neurectomy of the spinal accessory nerve
2. Neurectomy of the posterior primary branches of the upper five cervical nerves.
3. Division of all the muscles affected and retention in apparatus.
4. Operation on the cortical centres in the Rolandic area.

These operations may be combined, but no operative measure is invariably successful, and relapses and post-operative deformities are common.

CHAPTER XXVII

INJURIES AND DISEASES OF THE NOSE

INJURIES

Fracture of the Nasal Bones—**CAUSE**.—Fracture of the nasal bones is due to direct violence, usually from a blow with the fist. The fracture is always compound into the nose, the mucous membrane being lacerated. Epistaxis is invariably present. The fracture occurs as a rule at the lower end of the bones, but in the case of severe violence it may be at the upper end, and involve the nasal process of the superior maxillary bone. In these severer accidents the nasal septum, both cartilage and bone, is usually fractured or deformed, and a characteristic deformity is left—"boxer's nose." The cribriform plate of the ethmoid is very rarely broken.

CLINICAL FEATURES.—Owing to the great swelling of the nose, the symptoms of fracture are difficult to obtain, unless the case is seen early, though obvious deformity may be present, and crepitus may be felt on manipulation. Hemorrhage from the nose is invariable, and there may be surgical emphysema, especially if the patient sneezes or blows his nose. After the swelling due to the blow has disappeared, the deformity may be very obvious.

TREATMENT.—The patient should be warned against blowing the nose, and if sneezing is inevitable, he should be directed to sneeze through the mouth, and not through the nose. If any deformity is present, an anæsthetic should be given, and no pains spared to restore the nose to its original shape. This may be done by introducing a pair of padded forceps into the nose, one blade on each side of the septum, and manipulating the nose from the outside. Should there be no tendency for the deformity to recur after reduction, no treatment beyond warning the patient not to touch the nose is necessary. Union occurs rapidly.

If the deformity persists, or recurs after reduction, satisfactory results are very difficult to obtain. The following methods are used:

1. The nose is plugged with strips of gauze, a small tube being introduced into each nostril to allow breathing.
2. An external splint, consisting of moulded gutta-percha or leadfoil, is fixed with strapping to the outside of the nose.

3. The fragments may be fixed in position by thrusting steel pins through them, the pins being removed in four or five days.
4. Various special spring splints of more or less ingenuity have been devised.

The nose should be kept clean by spraying, and all blood-clots should be removed. A little vaseline introduced into the nostril will prevent the formation of crusts.

Foreign Bodies in the Nose.—Foreign bodies are frequently introduced into the nostrils by children, lunatics, and hysterical patients. An *Ascaris lumbricoides* occasionally wanders into the nose from the alimentary canal.

SYMPTOMS.—The chief symptom is the presence of a blood-stained purulent discharge from one nostril. This should always lead to examination of the nose for a foreign body. The diagnosis is made by seeing the foreign body by means of a nasal speculum and a head mirror, though it may be so covered by mucus and blood that its detection is difficult. It lies usually in the inferior meatus. Radiography will show metallic foreign bodies.

TREATMENT.—The foreign body should be removed with a looped hook introduced behind it, and gently drawn forward. An anæsthetic is seldom necessary. If a foreign body has been forced into the nose, Rouge's operation, which consists of turning the nose upwards by means of an incision between the upper lip and the jaw, may be necessary.

Rhinoliths.—A rhinolith is a calculus formed from a pathological secretion from the nose, due to a chronic inflammation of the mucous membrane. The nucleus may be a foreign body, a piece of food that has regurgitated into the nose, or a fragment of necrosed bone. The salts present are the phosphates and carbonates of calcium and magnesium.

CLINICAL FEATURES.—Rhinoliths are met with at all ages and in any part of the nose, but most commonly in the inferior meatus. Occasionally they cause perforation of the septum by pressure. They then lie in both nostrils, but the presence of more than one rhinolith is very rare.

The symptoms are those of a foreign body in the nose, and one rhinolith may grow large enough to fill both nostrils.

TREATMENT.—The rhinolith should be removed with a hook in the same way as a foreign body, but if it is very large, it should be first broken up. In a few cases Rouge's operation is advisable.

Epistaxis.—The CAUSES of hæmorrhage from the nose are—

1. Injuries, including fractures of the nasal bones and fractures of the base of the skull.
2. Ulceration of the nose, septic, syphilitic, carcinomatous, etc., opening a bloodvessel.

3. Degeneration of the bloodvessels and high blood-pressure, especially in chronic interstitial nephritis. The hæmorrhage usually occurs in the anterior part of the septum.
4. Congestion of the nasal mucous membrane in mitral disease the specific fevers, cirrhosis of the liver, etc.
5. The presence of neoplasms in the nose.
6. Operation on the nose and naso-pharynx.

A nasal speculum should be introduced, and the local condition examined. In cases associated with high arterial tension, the bleeding artery is often seen on the septum near the anterior end, and the hæmorrhage can be arrested by touching the artery with the actual cautery at a dull red heat. If the hæmorrhage is associated with malignant new growth in the nose, it may be necessary to tie the external carotid artery, but this should only be done at the request of the patient or his friends. Other methods of arresting hæmorrhage from the nose are given on p. 197.

TREATMENT.—As the treatment depends on the cause of the epistaxis, this should be carefully investigated before any measures are adopted.

DEFORMITIES OF THE NOSE

Congenital deformities of the nose, apart from hare-lip and cleft palate, are so rare that a special description is unnecessary.

Acquired deformities are most commonly due to injury or syphilis. Deformity owing to fracture of the nasal bones and septum has been referred to under Fracture of the Nasal Bones. It should be corrected immediately after the injury, but if the fracture has united, a plastic operation will be necessary. Unfortunately, these operations are not very successful. The nasal bone has to be refractured in several pieces, which are then moulded into shape.

Saddle-Nose is the deformity most frequently met with in syphilis. It may be due to periostitis of the nasal bones in infancy leading to non-development of the bridge of the nose, or to necrosis and removal of the nasal bones. The latter condition may occur in both congenital and acquired syphilis, but is more common in the acquired variety. The bridge of the nose is sunken and flattened, and the nostrils look more forward than normally, the tip of the nose being turned up.

TREATMENT.—A modern treatment of this condition is the injection of paraffin at a melting-point of 110° F. into the subcutaneous tissue of the nose. The paraffin is injected slowly with full aseptic precautions, and then moulded into the shape of the nose by external manipulation. This operation is not as a rule permanently successful. From time to time various plastic and osteoplastic operations have also been tried, with more or less success.

Loss of Part of the Nose may be due either to injury or disease, and the loss may be remedied by plastic operations of various kinds. The deformity may also be hidden by the wearing of an artificial nose adjusted with spectacles.

Rhinophyma.—Rhinophyma is a condition of diffuse sebaceous adenoma of the skin of the nose. It generally occurs in elderly men, and is associated with acne rosacea. The patients are often accused of chronic alcoholism, but there is not necessarily any connection between the two conditions.

CLINICAL FEATURES.—The end of the nose is bulbous, and has excrescences on it. The skin is greasy, and dilated veins are seen over the nose. If the nose is squeezed, sebaceous matter oozes out from many points.

TREATMENT.—The best method of treatment is to pare the nose down to its original size with a sharp scalpel. The bleeding is slight, and the surface soon heals by granulation tissue. This operation must be repeated from time to time. Another method of treatment is to "skin" the nose, and remedy the defect with skin-grafts, but the nose so obtained is exceedingly ugly.

INFLAMMATORY CONDITIONS OF THE NASAL MUCOUS MEMBRANES

Acute Rhinitis.—Acute inflammation of the mucous membrane of the nose is due to a variety of causes, but in every case infection soon occurs, even if it is not the primary cause of the inflammation. The following varieties are the most important:

1. **SIMPLE ACUTE RHINITIS.**—By this term is meant the ordinary "cold in the head," an affection of medical rather than surgical interest during the acute stage. The chief surgical interest lies in the predisposing causes, such as adenoid growths, deflections of the septum, polypi, sinus suppuration, etc., all of which should be remedied in order to avoid recurrence of the condition.
2. **TRAUMATIC RHINITIS.**—This follows the introduction of foreign bodies into the nose. The foreign bodies may be gross, as pieces of pencil, rhinoliths, etc., or minute in the form of dust, common in such occupations as metal-workers, brush-makers, poulterers, millers, etc.
3. **DRUG RHINITIS.**—Acute rhinitis and conjunctivitis may follow the administration of potassium iodide.
4. **SPECIFIC RHINITIS.**—Acute rhinitis may be due to infection with the specific organisms, such as the gonococcus, glanders bacillus, diphtheria bacillus, *Spirochaeta pallida*, or the streptococcus of erysipelas. In all cases of acute rhinitis of doubtful origin, especially if there is a purulent discharge from the nose, a bacteriological examination of the discharge should be made in order that specific serum or drug treatment can be carried out.
5. **SYMPTOMATIC RHINITIS.**—Acute rhinitis may be symptomatic of a general infectious disease such as scarlet fever, measles, or influenza.

TREATMENT.—In all cases the general treatment of an infectious disease should be carried out. Specific treatment should be given for

such conditions as diphtheria, syphilis, etc. *Locally*, the nose should be kept clean, especially if the discharge is purulent, by irrigation with a mild antiseptic, such as weak boracic lotion. A little mercurial ointment should be put round the nostrils to prevent excoriation. The mucous membrane may also be sprayed by Ol. Menth.

CHRONIC RHINITIS

Apart from syphilis and tubercle, chronic rhinitis follows repeated attacks of acute rhinitis, or it may supervene on a severe acute attack due to the gonococcus or the organisms of one of the specific fevers. It may also be due to continued exposure to such unhealthy hygienic conditions as living in damp, cold houses, or working in ill-ventilated, dust-laden workshops. The condition is also frequently associated with adenoid growths, deflection of the nasal septum, and chronic suppuration in the accessory cavities of the nose. Three types may be recognized, but it is difficult to say how far each depends on the other. They are—

1. **Chronic Hypertrophic Rhinitis**—(CLINICAL FEATURES.—The patient complains of nasal discharge and obstruction, often more marked at night. The obstruction is first greater on one side, and then on the other. The *nasal obstruction* is associated with headache, mental lassitude, impairment of the sense of smell, and a "thick" method of talking. The tongue in the morning is usually dry. The patient's sleep is not refreshing. The *nasal discharge* may be thin and mucoid, or purulent. Subacute attacks of rhinitis are often recurrent.

On examination, the mucous membrane is pale and œdematous or congested, but its chief feature is swelling, specially marked over both ends of the inferior turbinate bones. The swelling feels spongy, and if cocaine and adrenalin are applied, it subsides rapidly, especially if the disease is recent. In the more chronic cases the swelling is firmer and paler, and does not shrink so much when astringents are applied. Deflections of the septum are often present.

PATHOLOGICAL ANATOMY.—The swelling in the early cases is due to dilatation of the veins in the mucous membrane, and exudate of serum into the submucous tissue. Later, the connective-tissue elements in the submucosa are increased, and hyperplasia of the lymphoid tissue is present. The inferior turbinate bones are not increased in size.

TREATMENT.—All the predisposing causes must be removed as far as possible, especially those that cause nasal obstruction, as adenoid growths, enlarged tonsils, and septal deflections, for cure is impossible unless the nasal respiration is free.

The nose should be kept clean with a mild antiseptic lotion, such as 10 grains of potassium carbonate with 2 minims of carbolic acid in 1 ounce of water, or an astringent lotion containing hazeline may be used. The lotion should be comfortably warm.

The patient should live under good hygienic conditions, and a holiday in a dry, pure climate will often effect a cure.

If the swelling is marked, the mucous membrane may be touched with the galvano-cautery in order to produce scarring, or such caustics as chromic acid, nitrate of silver, or nitric acid, may be used. If the enlargement is excessive, the anterior or the posterior ends of the inferior turbinate bones should be removed.

2. Rhinitis Sicca—(CLINICAL FEATURES.—The patient complains of dryness and tickling in the *throat* and nose, headaches, and frequent attacks of slight epistaxis. There may be an acrid nasal discharge. On examination, the mucous membrane is either pale or congested. It is also shrunken, with dark crusts of dried secretion upon it. If these crusts are removed, the mucous membrane is found to be reddened and excoriated. It is from these patches that the bleeding takes place. The mucous membrane of the pharynx is congested and glazed (dried secretions may be present on it), the uvula is thickened, the tongue furred, and the breath somewhat offensive. Later in the disease the mucous membrane under the crusts may become definitely ulcerated, and perichondritis with perforation of the septum may result.

TREATMENT.—All the predisposing causes must be carefully treated, and the patient's general health improved in every possible way, special attention being given to any anaemia which may be present.

Local.—The nose should be kept clean of crusts by the use of a warm alkaline lotion. After each cleansing, an oily preparation (oil of eucalyptus 20 minims, and oil of almonds 1 ounce) or an ointment (nitrate of mercury 40 grains, oil of almonds $\frac{1}{2}$ ounce, and paroline 1 ounce) should be applied to the mucous membrane of the anterior part of the nasal cavity, especially the septum, in order to prevent the adhesion of crusts. The post-nasal space and the pharynx should also be kept clean by syringing with an alkaline lotion night and morning. In obstinate cases, plugging the nose with strips of gauze soaked in oil may be necessary before the formation of crusts is prevented, the patient in the meantime having to breathe through the mouth.

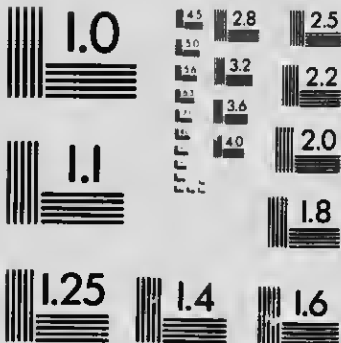
3. Atrophic Rhinitis (Ozena).—The term "ozena" has been used to designate any evil-smelling discharge from the nose, but the condition to be described here is a clinical entity, the cause of which is not known. The disease commences in early childhood, and is characterized by a foetid discharge from the nose and the formation of crusts on the mucous membrane. It is more common in females than in males, always occurs before the age of eighteen, and is not infrequently associated with the infectious diseases of childhood. In many of the cases the patient presents a peculiar physiognomy, consisting of a broad face, prominent cheek-bones, a flat, broad nose, with the nostrils looking forward. The disease often runs in families, and a history of syphilis is present in a certain number of the cases.

(CLINICAL FEATURES.—The patients or their friends complain of a very disagreeable fetid odour from the nose and of a thin, acrid discharge.



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On examination of the nose, it is seen to be very "roomy," the turbinate bones being shrank against the lateral wall. The mucous membrane is thin, pale, and dry, and on it are dark crusts, from which the odour comes. The smell is due to decomposition of the retained secretion in the nose. If the crusts are removed, a raw surface is left, and ulceration of the mucous membrane occurs in the later stages of the disease. The inferior turbinate bones are small, but there is no evidence that they atrophy, and the middle turbinates are often enlarged. The pharynx and posterior nasal spaces are as a rule chronically inflamed, and infection of the middle ear, resulting in deafness, is a common complication. The general health suffers, and a well-marked anæmia is common.

TREATMENT.—The general health should be improved in every way, special attention being given to the anæmia and indigestion which so often accompany this disease.

Locally.—The nasal cavity must be kept clean by frequent douching with an alkaline, antiseptic fluid, and the surgeon should satisfy himself that this is effected. If any crusts resist the douche, they can be removed if rubbed with pieces of lint held in forceps. The nose must be thoroughly cleaned at least twice a day, and to prevent the formation of crusts it should be packed with strips of iodoform gauze moistened with oil. This is very uncomfortable at first, but if the patient will persevere, the discomfort passes off, and as the disease is most objectionable, he will usually carry out any treatment which holds out a prospect of cure.

The packing and the cleaning must be continued until the smell disappears, and the formation of crusts is replaced by a thin discharge without smell. The packing can then be discontinued, but the douching must still be done, or the crusts and the smell will return.

The length of time the packing must be worn can be determined only by experiment, but in a moderately severe case it will be about three months. Any sinus suppuration and the inflamed condition of the mucous membrane of the pharynx must be treated at the same time.

Injections of paraffin under the mucous membrane of the nose to diminish the "roominess" of the nasal cavity have been advised.

PROGNOSIS.—Although the disease cannot be said to be ever completely cured in the sense that relapses will not occur, the careful carrying out of treatment will prevent any smell or the formation of crusts. The turbinates will remain small and the nose "roomy," and any interruption of the douching is liable to be followed by a relapse.

SYPHILIS

Primary Syphilis of the Nose is uncommon, though it has followed the use of infected instruments, or picking the nose with an infected finger. The diagnosis and treatment are those of primary sores elsewhere.

Secondary Syphilis causes similar lesions to those found in the mucous membrane of the mouth and pharynx. Mucous patches and

superficial ulcerations are the most characteristic, but they often pass unnoticed on account of the more evident secondary lesions in other parts of the body.

No local treatment beyond the application of an alkaline lotion is necessary.

Tertiary Syphilis.—The most common tertiary lesion is a gummatous inflammation of the mucous membrane, ending in ulceration, perichondritis, and periostitis, with necrosis of the cartilage and bones of the nose. This ulceration usually occurs within four years of the primary infection, and the destruction of the nose is rapid.

CLINICAL FEATURES.—The patient complains of nasal obstruction and discharge, the discharge being purulent, and often blood-stained.

On examination, ulceration is seen on the septum and lateral wall of the nose. In the floor of the ulcers dead bone or cartilage may be exposed. Perforation of the septum or of the hard palate is common, and large pieces of necrosed bone may be removed from the nose. Ulceration of the alae nasi is also common.

After healing, the nose is broad and flat, and there may be loss of substance round the nostrils, which are tilted forwards. Suppuration may take place in the accessory sinuses of the nose, and the necrosis may involve the base of the skull, meningitis or cerebral abscess probably ensuing.

The diagnosis has to be made from lupus, which, however, seldom destroys the nasal bones, and takes months to accomplish what syphilis will do in weeks. A Wassermann serum reaction or the effects of treatment will as a rule definitely settle the diagnosis.

TREATMENT.—General antisyphilitic treatment must be given.

Locally, the nose should be kept clean by antiseptic douches, any dead bone being removed as soon as it is loose. Granulation tissue should be destroyed by application of the actual cautery, or by caustics.

The after-deformities may be remedied by plastic operations, or by injections of paraffin wax.

Inherited Syphilis is considered under Syphilis (p. 144), and Deformities of the Nose (p. 912).

TUBERCULOSIS

Tuberculous ulceration of the nasal mucous membrane is rare, and is usually secondary to pulmonary or laryngeal tuberculosis. It may lead to necrosis of the underlying bone, but the destruction is not so extensive as in syphilis.

The treatment follows the usual lines of tuberculosis of other mucous membranes.

Adenoids

Adenoid growths are due to hyperplasia of the lymphoid tissue of the nose-pharynx, especially that mass of tissue which is known as the pharyngeal or Luschka's tonsil.

CAUSE.—A definite cause for adenoids cannot be given, but the following are important etiological facts: Adenoids commonly occur in children under ten, and are most prevalent among the children of the poor living under bad hygienic conditions. Sometimes they are congenital. They are more general in cold and damp than in dry climates, and in races with high, narrow noses than in the flat-nosed races. Inherited syphilis, with its liability to inflammation of the mucous membrane of the nose, is said to be a predisposing cause, while some authorities have thought the condition to be tubercular.

PATHOLOGICAL ANATOMY.—Adenoids generally grow from the vault of the naso-pharynx. They may, however, be more numerous in the lateral recesses of the pharynx (fossæ of Rosenmüller), and be attached to the tip of the Eustachian tube. The growth consists of soft lymphoid tissue covered by epithelium; but if the condition is neglected, adenoids become firmer and more fibrous.

They are frequently associated with chronic hypertrophy of the tonsils, and the patients are liable to post-nasal inflammation and chronic inflammatory changes of the nose and pharynx.

CLINICAL FEATURES.—The chief symptom of adenoid growths is nasal obstruction, and this in turn leads to various symptoms and important consequences. The symptoms are—Inability or difficulty in breathing through the nose. This difficulty is increased from time to time by slight attacks of inflammation. It is often most marked during sleep. The patient snores, and sleeps with the mouth wide open. The respiration may be embarrassed, and the child become cyanosed. This cyanosis leads to night terrors, headache, lassitude in the morning, and sometimes nocturnal enuresis. The child is restless, anæmic, and mentally dull.

As a consequence of mouth-breathing (aprosœxia), the patient develops a characteristic facies; the mouth is held open, with the lower jaw hanging, and the expression of the face is dull. The bridge of the nose is widened, while the alæ nasi are pinched. During the day there is constant sniffing and noisy respiration; and at night the child snores. The speech is thick, and there is some loss of the sense of smell.

When the Eustachian tube is pressed upon, or the mucous membrane is inflamed, deafness is a symptom, and adds to the stupidity of the expression.

The arch of the palate becomes raised and narrow, and the teeth are often deformed and misplaced, owing to defective development of the jaws. The upper lip is everted and pulled upwards.

The chest also becomes deformed, especially if the lungs are not properly aerated, owing to bronchitis or broncho-pneumonia. The chest is flattened, the shoulders rounded, and a permanent furrow (Harrison's sulcus) forms over the lower part of the sternum and the lower ribs at the attachment of the diaphragm. In other cases the deformity known as "pigeon-breast" develops.

The patient is liable to chronic inflammation of the upper air passages, in addition to chronic bronchitis and broncho-pneumonia.

The glands in the posterior triangle of the neck are usually enlarged. Reflex disturbances of the nervous system are not infrequently associated with adenoid growths, and the patient may suffer from laryngismus stridulus, spasmodic cough, asthma, and hay fever. The general health always suffers, and the patients are spoken of as "weakly" or "delicate."

On examination with a posterior rhinoscope, the adenoids may be seen; but this examination is very difficult in the case of a child. The better method, therefore, is to examine the posterior nasal space with the finger, and to feel the adenoids. The conditions simulating adenoids are naso-pharyngeal sarcomata, enlargement of the posterior ends of the turbinates in hypertrophic rhinitis, and nasal polypi. A careful examination of the nose and pharynx and post-nasal space should always be made before an opinion is given or treatment proposed.

TREATMENT.—In very mild cases the child should be taught to breathe through the nose, and the general health and hygienic surroundings must be improved. If, however, any of the sequelæ of mouth-breathing are present, or if there is chronic bronchitis, frequently recurring nasal catarrh or deafness, the growths should be removed.

The patient is anesthetized, and the growths removed by means of a curette, Lowenberg's forceps, a ring knife, or a scraping instrument fixed to the finger-nail.

The hæmorrhage is usually slight, and can always be stopped by sponge pressure. Hypertrophied tonsils should be removed at the same operation.

No local after-treatment is necessary, but it is absolutely essential to establish good habits of nose-breathing by careful exercises, or no good will result from the operation, and relapse will occur.

Deviation of the Nasal Septum.—Deviations of the septum are exceedingly common, occurring in 80 per cent. of adults in the civilized races. Marked degrees of deviation are uncommon in children, although it is possible that some cases are of congenital origin. Spurs and thickenings of the septum often accompany deviation. They may be of no clinical importance.

CAUSES.—The cause of deviation of the septum has been a matter of much dispute, and two views are held by rhinologists: (1) The deviation is due to trauma, especially to the frequent falls of childhood, and is one of the penalties incurred by man when he assumed the upright position; and (2) the deviation depends on nasal obstruction. This last view was based on the assumption that nasal obstruction causes a high arch to the palate, and so diminishes the vertical measurement of the nose. As a consequence, the nasal septum is bent to accommodate itself in a smaller space. Rhinologists, however, are not agreed that this arching of the palate does follow nasal obstruction.

CLINICAL FEATURES.—In the great majority of cases, deviation of the septum and spurs give rise to no symptoms, and though the

deformity may be marked, the patient may be quite unconscious of it. When it does cause symptoms, they are those of unilateral, nasal obstruction and its attendant evils (see p. 918).

On examination, the nose is seen to be deflected to one side, and when the interior is examined with a speculum, the deviation of the septum is seen. The whole nasal cavity and the naso-pharynx must be carefully examined, for other causes of nasal obstruction more important than a slight deflection of the septum may be present.

TREATMENT.—Treatment is only necessary when the deviation is associated with symptoms, and if it is discovered during the routine examination of the nose, no notice need be taken of a slight deviation.

If treatment is desirable, the operation advised is a **Submucous Resection of the Septum**. A flap of mucopariosteum is turned up on the convex side of the deflection and the deviated portion of the septal cartilage, and, if necessary, a portion of the vomer removed. The flap is then placed back in position. The results are excellent.

Nasal Polypi.—The term "nasal polypus" has been used to indicate any pedunculated growth within the nose, but it should be limited to the soft, gelatinous masses of oedematous mucous membrane and granulation tissue which occur with disease of the ethmoid bone.

CAUSE.—The cause of nasal polypi is a rarefying osteitis of the ethmoid bone, particularly the middle turbinate; but the cause of the osteitis is unknown. In some cases it is associated with suppuration in the accessory sinuses of the nose, but suppuration is a super-added phenomenon due to infection with one of the pyogenic organisms.

PATHOLOGICAL ANATOMY.—The ethmoid bone undergoes a slow disintegration (rarefying osteitis) and absorption, accompanied by oedematous infiltration of the mucosa and submucosa. Actual necrosis of the bone is rare, and when a sequestrum is present, it is probably always due to a secondary infection. Spontaneous cure is possible in the early stages, with sclerosis of the bone, but is very rare in the later stages of the disease.

The disease may be unilateral or bilateral, and the polypi single or multiple. They vary in size from a pea to a walnut, and may distend both sides of the nasal cavity, causing great widening of the nose. In many cases they are pedunculated, or they may be attached to the bone, particularly the middle turbinate, by a wide stalk. They very rarely grow from the septum or the inferior turbinate. Nasal polypi sometimes undergo cystic change, and when occurring in the antrum of Highmore, form one of the causes of hydrops of the cavity.

CLINICAL FEATURES.—Nasal polypi are most common after the age of twenty-five, and are rare in children. They are rather more common in men than in women. The patient complains of nasal obstruction and its usual attendant symptoms, and a mucous discharge from the nose. The sense of smell is lessened; the voice has "nasal twang"; and deafness, owing to Eustachian obstruction, often present.

On examination, the nasal polypi are seen as smooth, glistening, greyish-pink tumours filling up the air-way. By the use of a probe it can be ascertained that they are growing from the lateral wall of the nose, and they do not shrink markedly after cocaine is applied to the nose. The latter fact is used to differentiate between nasal polypi and hypertrophic rhinitis, but the diagnosis is seldom in doubt if the polypi are seen.

TREATMENT. — This must be considered according to the severity of the disease.



FIG. 415.—NASAL POLYPI.

1. If there are only one or two polypi, and the bone disease is not active, the polypi should be removed with the snare; but the operation may have to be repeated many times, for rapid recurrence is common.
2. The polypi may be removed with a snare, and the underlying bone scraped or removed with cutting forceps, the operation being conducted under cocaine.
3. The piece of the turbinate bone from which the polypi are growing may be excised, and in this way the whole of the disease eradicated.
4. If there is extensive bone disease and many polypi, the underlying diseased bone must be thoroughly removed. The patient is given a general anaesthetic, and the middle turbinate bone is removed, together with the polypi hanging on it. The ethmoidal region is then vigorously scraped with a ring knife, removing all the diseased bone and numerous polypi. Care must be taken not to scrape away the cribriform plate of the ethmoid, but if the orbit is invaded, little harm is done. The haemorrhage is profuse at first, but there is no danger, and the bleeding can always be arrested by plugging the nose.

The after-treatment consists of keeping the nose clean.

Recurrence is possible, but on the whole the results of this operation are good, and it is to be preferred to repeated removal of the polypi with the snare.

If suppuration in the accessory sinuses is present, it should receive appropriate treatment.

NEW GROWTHS

Innocent

Papilloma.—Papillomata of the nose are rare, and seldom grow to a large size. They first attract attention by causing nasal obstruction, or by appearing at the anterior nares, and are diagnosed on inspection.

The TREATMENT is removal.

Osteoma.—Osteomata may grow from the ethmoid bone, or encroach on the nasal cavity from one of the accessory sinuses. The symptoms are those of nasal obstruction and pressure symptoms, the latter being due to invasion of the surrounding cavities, such as the orbit or cranial cavity. Severe neuralgic pains may be present, owing to pressure on the nerves.

The TREATMENT is removal.

Chondroma.—Chondromata are much rarer than osteomata. They produce the same symptoms and require the same treatment.

Fibroma.—True fibromata do occur in the nose, but are very rare, the majority of the tumours described under this name being fibrosarcomata.

Fibro-Angioma.—Fibro-angiomata occur in adults and cause gradually increasing nasal obstruction and attacks of epistaxis.

On examination, a small vascular pedunculated tumour is seen attached to the cartilage of the septum. These tumours bleed readily on examination, and have been mistaken for sarcomata.

TREATMENT.—Removal must be thorough in order to prevent recurrence.

Malignant

Sarcoma.—The most common form of sarcoma of the nose is a slowly growing spindle-celled growth, sometimes called a "fibroma" and sometimes a "naso-pharyngeal tumour." These fibro-sarcomata spring from the periosteum of the base of the skull and grow downwards and forwards into the nose and naso-pharynx.

CLINICAL FEATURES.—The tumours generally develop in the first two decades of life, and are more common in boys than in girls. The early symptoms are those of nasal obstruction, and the condition is not infrequently diagnosed and treated as adenoid growths. The tumour grows steadily, and causes great deformity of the face. The nose is widened and the superior maxillary bones are forced forwards and apart. The orbits are separated and the deformity is spoken of as "frog-face." The palate is depressed, and the growth may sometimes be seen hanging down behind it. Repeated attacks of epistaxis occur, one of which may be fatal.

On inspection, the growth is firm, pinkish in colour, and bleeds on manipulation.

Although these tumours grow slowly as a rule, they may take on a more malignant nature, and invade the cranial cavity and the orbit, causing death by ulceration, hæmorrhage, and pressure.

TREATMENT.—The treatment of these growths is free removal if possible.

Other forms of sarcomata met with in the nose are **small spindle-celled sarcomata** and **round-celled sarcomata**.

CLINICAL FEATURES.—Nasal obstruction is present, and as the growth breaks down and ulcerates early, there is a blood-stained nasal discharge or repeated attacks of epistaxis. Pain is also present from pressure on the nerves, and this is an important point in the differentiation of sarcomata from polypi of the nose. The tumour spreads rapidly into the surrounding cavities—viz., the cranium, the orbits, and the antra.

On inspection, a soft fleshy mass is seen in the nostril, which bleeds readily on examination, and is often ulcerated and necrotic on the surface. The side of the face and the nose are often enlarged.

TREATMENT.—The only treatment is thorough removal, and the prognosis is bad.

Carcinomata.—Both squamous-celled and columnar-celled carcinomata occur in the nose.

Squamous-Celled Carcinoma is usually seen as an ulcer with hard everted edges, which develops at the anterior end of the nasal septum. It grows slowly, metastases are rare, and involvement of glands takes place late. The symptoms are those of nasal obstruction and unilateral nasal discharge. The diagnosis is made on inspection, and, if necessary, by removing a portion of the edge of the ulcer for microscopic examination.

The **TREATMENT** is removal with the glands in the anterior triangles of the neck.

Glandular Carcinomata occur more frequently in the upper part of the nose. They cause the same symptoms and have the same clinical features as the sarcomata, and are only to be diagnosed on microscopic examination.

The **TREATMENT** is removal, together with the glands in the neck.

METHODS OF REMOVAL OF NASAL AND NASO-PHARYNGEAL TUMOURS IN ORDER OF SEVERITY

1. Removal through the nose by means of the snare, or galvanocautery, or excision of the structure from which the tumour is growing.
2. *Rouge's Operation.*—This consists of detaching the upper lip from the upper jaw by an incision extending from the bicuspid teeth on one side to the bicuspids on the other. The cartilaginous septum is detached from the nasal spine and the alæ cartilages from the superior maxillary bone. The detached nose is turned upwards against the forehead. After the operation it is replaced.
3. *Nélaton's Operation.*—The uvula and soft palate are split in the middle line, and the incision carried along the hard palate and outwards to the teeth. A flap of muco-

periosteum is turned up on each side, and as much bone as necessary is removed in order to give a clear view of the attachments of the tumour.

4. *Resection of the Nose.*—Various incisions are used, the nose being turned upwards, downwards, or laterally.
5. *Resection of the Upper Jaw.*—The jaw may be excised or turned outwards by an osteoplastic resection, and replaced in position after the tumour has been removed.

In the last three methods of operation, it is an advantage to perform a preliminary laryngotomy and to plug the pharynx.

ACCESSORY SINUSES OF THE NOSE

The accessory sinuses of the nose are—The antrum of Highmore, the frontal sinus, the ethmoidal cells, and the sphenoidal sinus. The sinuses are lined by a mucous-periosteum, directly continuous with the mucous-periosteum lining the nasal cavity, with which they communicate

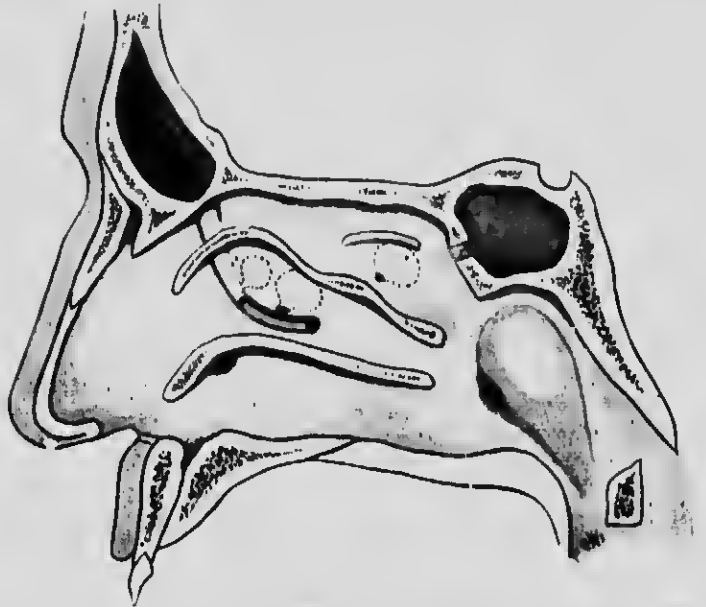


FIG. 416.—DIAGRAM OF THE OPENINGS OF THE SINUSES INTO THE LATERAL WALL OF THE NOSE.

by their various openings; therefore inflammatory conditions of the nose easily spread to the accessory sinuses. New growths may also arise in the accessory sinuses, and, if malignant, tend to invade the nose and cause a nasal discharge.

Inflammation of the Accessory Sinuses—**CAUSE.**—The cause of inflammation of the accessory sinuses of the nose is invasion of the

muco-periosteum with micro-organisms, and this invasion is due to the following causes:

1. Direct extension from the nose during the course of an acute rhinitis, either the ordinary cold in the head or one of the specific forms of rhinitis, such as influenzal, pneumococcal, scarlet fever, measles, etc. If nasal obstruction is already present, spread of the inflammation to the accessory sinuses is more likely to follow.
2. Direct extension from the nose of inflammation due to infection after operations on the nasal cavity, such as the removal of polypus.
3. Direct extension from the various forms of chronic rhinitis, especially ozæna.
4. Direct infection following the introduction of foreign bodies or injury.
5. Extension from carious teeth, the infection spreading through the bone.
6. Extension of the inflammation from one sinus to another—*e.g.*, infection of the antrum of Highmore from suppuration in the frontal sinus.
7. Extension from the bone when this is the site of an acute osteomyelitis, the organism being blood-borne.

The inflammation may be acute or chronic, but the majority of the chronic cases follow an acute attack. The tendency for the acute cases to become chronic depends upon the difficulty of the escape of inflammatory exudates owing to the small size of the openings, and to their situations being badly placed for drainage. Other causes for chronicity are—The continuation of the cause, such as the presence of a foreign body in the cavity, or the presence of chronic suppuration in the nose; the presence of necrosed bone owing to severity of the inflammation of the muco-periosteum; the presence of polypoid granulation tissue.

PATHOLOGY.—The pathology is that of acute or chronic inflammation, which in the majority of instances ends in suppuration. As the inflamed tissue is a muco-periosteum, caries or necrosis of the underlying bone is almost inevitable if suppuration takes place, and the suppuration will continue until the dead bone has been removed. If suppuration does not occur, sclerosis of the bone may follow a chronic inflammation; but this is not so common in the accessory sinuses of the nose as in the mastoid antrum.

CLINICAL FEATURES—Acute Inflammation.—The patient, who is suffering from an acute rhinitis or suppuration round a tooth or from any of the conditions given above, complains of throbbing pain over the affected sinus. His temperature rises, and the general malaise increases. The sinus is tender on palpation, and if suppuration is present, the skin over it is red and œdematous, and finally the pus may point. On inspection of the nose, the mucous membrane is found to be red and œdematous, and there is marked swelling round the orifice

of the affected sinus. After a few days the pus points externally, or is discharged down the nose. Relief at once follows.

The discharge of pus may be followed by cure, or the suppuration and discharge may become chronic; or there may be recurrent attacks of the inflammation, with renewed pain and discharge.

TREATMENT.—In the early stages the treatment should be directed towards removal of the cause, and any rhinitis that may be present should receive appropriate treatment; a carious tooth should be removed. The pain should be relieved by hot fomentations applied over the affected sinus, or if very severe, morphia may be given.

Menthol inhalations to cause shrinking of the mucous membrane round the opening of the sinus are valuable.

As soon as the sinus is believed to contain pus, it should be aspirated, and the cavity washed out. The methods of doing this in the various sinuses are—

1. *Maxillary Antrum.*—If a carious tooth is present, it should be removed, a hole made in the socket, and the antrum drained. If there is no carious tooth, the antrum should be aspirated through the inferior meatus of the nose. Irrigation should be carried out daily until the discharge ceases.
2. The *Ethmoidal Cells* should be opened by breaking through the lateral wall of the nose.
3. The *Frontal Sinus* must be approached through the infundibulum after cutting away the anterior end of the middle turbinate bone. If a canula can be passed through the opening, the sinus should be washed out; if this is not possible, the pus may be left to find its way down into the nose.
4. Acute suppuration in the *Sphenoidal Sinus*, even if recognized, is better left to open into the nose.

Chronic Suppuration.—Clinically, chronic suppuration in the accessory sinuses of the nose may be divided into two groups; (1) With the opening into the nose patent, (2) with the opening closed.

With the Opening Patent.—The patient will complain of a unilateral discharge from the nose, which may be continuous or intermittent.

In some cases, as in suppuration in the antrum, it occurs in gushes in certain positions, as in stooping forwards with the head lowered. The sense of smell is often lost, and pain is felt over the affected sinus. The patient may also complain of general malaise, anæmia, and dyspepsia, owing to the constant swallowing of pus.

On examination, there is evidence of nasal catarrh, with œdema and polypoid growths round the opening of the affected sinus. Although the pus is discharging down the nose, it may also be spreading into the surrounding tissue; and abscess in the cheek, orbital cellulitis, meningitis, sinus thrombosis, etc., may supervene at any time. These cases may pass unnoticed for months.

With the Opening closed.—There are the usual general symptoms of septic absorption, with headache and pain over the sinus. The bone over the sinus is tender, and the skin becomes red and oedematous. In the cases of the antrum and the frontal sinus, the pus points externally as a rule; with the ethmoid sinuses, the pus may burst into the orbit; and with the sphenoidal sinus, meningitis and cavernous sinus thrombosis are apt to occur.

The signs of pus are—

1. *In the Antrum of Highmore.*—The pus runs out of the nose when the patient is stooping or turns on the sound side. The pain is over the cheek or in the back of the upper jaw, and the bone is tender. On inspection of the nose, the pus is found to come from the posterior part of the middle meatus. Oedema and polypi are common in this situation. Transillumination by a small electric light in the mouth shows that the affected side is opaque. The final diagnosis is made by aspiration. The sinus may be aspirated (1) through the socket of a carious tooth, (2) through the alveolar margin in edentulous patients, (3) through the anterior part of the inferior meatus of the nose.
2. *In the Ethmoidal Cells.*—After antral suppuration has been relieved, if the pus still continues to come from the nose and there are polypi round the middle meatus, it is probable that there is suppuration in the ethmoidal cells. The only means of diagnosis is exploring the cells from the nose. The pus may point on the inner wall of the orbit, and if it bursts, causes orbital cellulitis.
3. *In the Frontal Sinus.*—The pain is supra-orbital, and the discharge from the nose is usually continuous and not affected by position. Antral and ethmoidal suppuration should be excluded by exploration. The pus may point on the forehead. The diagnosis can only be rendered certain by exploring the sinus through the frontal bone.
4. *In the Sphenoidal Sinus.*—The pus comes from the upper and back part of the nose. The mucous membrane in this part is tender and oedematous. The diagnosis is largely made by exclusion, the pus continuing to exude after the antrum, frontal sinus, and ethmoidal cells are pronounced free from suppuration.

TREATMENT OF CHRONIC SUPPURATION.—The first step in the treatment is to remove any cause of continued suppuration in the nose, such as polypi, exuberant granulation tissue, and in the cases of suppuration in the antrum of Highmore, to remove a carious tooth.

As far as possible, the opening of the sinus into the nose should be cleared in order that free discharge can occur. The further treatment is thorough drainage or obliteration of the sinus.

The methods of carrying this out are:—

1. *Antrum of Highmore*.—(A) In early cases the antrum should be punctured through one of the situations given above, a small silver tube introduced, and the antrum washed out twice daily.

If the puncture is made through the inferior meatus of the nose, the opening cannot be maintained by a tube, and repeated puncture is necessary; but this difficulty may be overcome by making a large, permanent opening into the antrum through the inferior meatus.

(B) **RADICAL CURE**.—This is indicated (a) in old-standing cases, (b) when puncture and irrigation have failed, (c) if necrosed bone and polypi are present, (d) when the walls of the antrum are distended with the pus, (e) when a foreign body is present in the antrum. A large subperiosteal opening is made into the antrum through the outer alveolar wall, so that the cavity can be explored, and carious bone and polypi or foreign bodies removed. A large counter-opening should then be made into the inferior meatus of the nose, the anterior end of the inferior turbinate bone being first removed, and the cavity packed with gauze. The gauze is removed on the second day, and the cavity washed out two or three times daily until all discharge has ceased. The results are excellent.

2. *Ethmoidal Cells*.—The ethmoidal cells may be opened from the nose, and the cavities irrigated, but in the majority of cases a radical operation is necessary. This operation consists of thoroughly curdletting the ethmoidal region in a similar manner to that described in the treatment of polypi (p. 920).

In the after-treatment the nose should be kept clean, but packing with gauze should be avoided as far as possible. The results are good, but the operation is not without danger of severe hemorrhage or death, owing to damage to the cribriform plate and subsequent meningitis and thrombosis of the cavernous sinus.

When the pus is already pointing in the orbit, an external operation is necessary. An incision is made on the inner side of the orbit, the periosteum reflexed, and the abscess opened. The ethmoid cells should be thoroughly opened up, and a free opening made into the nose. A rubber tube is passed from the internal wall of the orbit into the nose, being replaced in a few days by a silver tube. Irrigation is continued until the discharge ceases.

3. *Frontal Sinus*.—In the first place, an attempt should be made to establish free drainage into the nose by removing the anterior end of the middle turbinate bone, and opening up the lacrymo-ethmoidal and anterior ethmoidal cells. Careful irrigation of the sinus should then be carried out twice daily.

If this method fails, or if the sinus is bulging, or an external fistula is present, an external operation is necessary.

An incision is made parallel and just below the supra-orbital margin, and the sinus opened by removing the anterior wall. The lower wall of the sinus is then cut freely away, so that the infundibulum is opened up, and a large opening established into the nose.

The sinus can either be obliterated or drained.

Obliteration is the more certain method of cure, but the resulting deformity is greater than if drainage is carried out. The operation is not without danger of necrosis of the skull and meningitis, for the diploë of the frontal bone is opened up.

4. *Sphenoidal Sinus*.—Under cocaine anæsthesia this sinus can be thoroughly exposed by cutting away the anterior wall, the posterior ethmoidal cells being opened up at the same time. The operation is one requiring care, but if the lateral and posterior walls are not encroached upon, it is quite safe. Irrigation is carried out daily, and the suppuration usually ceases in a month to six weeks.

Although the various sinuses have been considered separately, it is—as a consideration of the causes would lead one to suspect—by no means rare to have more than one sinus affected, and in some instances suppuration may be present in all the sinuses. In these cases, if the pus is coming from the anterior set of sinuses, the antrum should be first opened up, then the anterior ethmoidal sinuses, and lastly the frontal sinus. If the pus is coming from the posterior set, the posterior ethmoidal and the sphenoidal sinuses may be opened by one operation.

CHAPTER XXVIII
AFFECTIONS OF THE LIPS, MOUTH, SALIVARY GLANDS,
GUMS, AND JAWS

LIPS

Hare-Lip and Cleft Palate—FORMATION OF THE FACE.—The face is formed in early fetal life by the coalescence of certain processes which grow from the frontal portion of the skull, together with the first or mandibular arch, which forms the lower jaw. These processes are the fronto-nasal process and the two superior maxillary processes.

The fronto-nasal process grows downwards from above between the two superior maxillary processes, and divides into a median process



FIG. 417.—DIAGRAMS SHOWING FORMATION OF THE FACE IN THE FETUS
(His's MODELS).

and two lateral processes, the median being separated from the lateral processes on each side by a furrow. The median process is again divided into two by a median fissure.

The superior maxillary process grows inwards on each side from the mandibular arch, and meets the fronto-nasal process to form the face, the line of meeting being the naso-facial furrow, and running through the upper lip, cheek, and eyelids to the external angular process of the orbit.

The *upper lip* is formed by the median portion of the fronto-nasal process coalescing with the superior maxillary process, the lateral fronto-nasal process taking no part in its formation.

The *lower lip* is formed by the coalescence of the two mandibular arches on each side.

Hare-Lip.—Hare-lip is due to the non-union of those various processes, the cause of this failure of union being unknown.

It will be seen that the following varieties may occur:

1. Single lateral hare-lip. This will be due to non-union on one side of the median fronto-nasal process and the superior maxillary process. It is most common on the left side, and is more often seen in boys than in girls.
2. Double lateral hare-lip is due to non-union of the median fronto-nasal process with the superior maxillary process on both sides.

The degree of hare-lip in both these cases varies with the amount of union. It may be anything from a slight notch to complete non-union.

3. Median hare-lip. Two varieties are distinguished:
 - (1) A median notch, due to imperfect closure of the cleft in the median fronto-nasal process.
 - (2) A wide gap due to non-development of the lower end of the fronto-nasal process, so that the middle part of the lip is missing. This is always associated with cleft palate.

Lateral hare-lip is much more common than median.

Cleft Palate.—To understand this deformity, a brief description of the formation of the palate must be given.

FORMATION OF THE PALATE.—In early fetal life the nose and mouth form one cavity—the primitive buccal cavity or stomodaum—and the separation of this into two cavities is brought about by the formation of the palate.

The main part of the palate—*i.e.*, that part lying behind the anterior naso-palatine foramen—is formed by the coalescence of two processes growing inwards from the superior maxillary processes. These processes, meeting in the middle line, form the great part of the hard palate and the soft palate. The small triangular part of the hard palate lying in front of the naso-palatine foramen is termed the "premaxilla." It is formed by two processes on each side, one growing from the median fronto-nasal process, and one from the lateral fronto-nasal process, and each process bears an incisor tooth. Non-union of any of these processes gives the various forms of cleft palate.

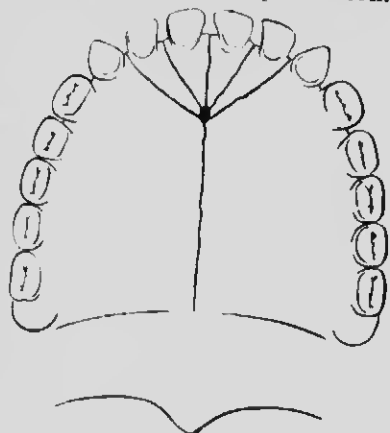


FIG. 418.—DIAGRAM SHOWING FORMATION OF THE HARD PALATE.

Cleft palate is divided into the following degrees:

1. Bifid uvula.
2. Cleft of the soft palate.
3. Median cleft of the hard and soft palate, the cleft stopping in front at the naso-palatine foramen.
4. Median cleft of the hard and soft palate, and extension of the cleft forwards on one side between the premaxilla and maxilla.
5. Median cleft in the hard and soft palate, with extension of the cleft forwards on both sides between the premaxilla and maxilla.

The two last conditions are probably brought about by suppression on one or both sides of the segment of the premaxilla derived from the lateral fronto-nasal process. They are always combined with hare-lip.

In the fifth degree of cleft palate the premaxillary segment remains attached to the vomer, and is generally pushed forwards so as to form a protrusion on the front of the face. Clinically, this segment, which as a rule carries two incisor teeth, is spoken of as the *os incisivum*.

HEREDITARY NATURE OF HARE-LIP AND CLEFT PALATE.—Hare-lip and cleft palate tend to run in families, but the deformity soon dies out, and in many cases no family history of the deformity can be obtained. One of the parents of a child with cleft palate is sometimes found to have imperfect development of one of the lateral incisor teeth, or this deformity may be found among its brothers and sisters.

CLINICAL FEATURES.—The diagnosis of hare-lip and cleft palate is made at a glance, but a careful examination of the nature and extent of the deformity, especially of the width of the cleft in the hard palate, is necessary before the best form of treatment can be decided upon.

In slight degrees of hare-lip the child is able to suckle, but in the more severe degrees, especially if cleft palate is also present, suckling may be impossible unless some form of mechanical contrivance, such as a large india-rubber teat, is provided, so that the cleft may be filled. Children with marked deformity may be fed from a spoon, the milk being poured well back into the pharynx. Fortunately, however, many of these children do not thrive, but gradually become marasmic and die.

Death from broncho-pneumonia is also common.

Speech is little affected by hare-lip, but with cleft palate of any degree, except bifid uvula, the voice has a harsh nasal sound, and the pronunciation of the palatal consonants is indistinct, so that it is difficult for strangers to understand what the patient is saying. This difficulty can only be overcome to a certain extent by wearing an obturator and training the voice.

The special senses of taste and smell are defective, and the breath is often offensive, owing to the collection of particles of decomposing food in the mouth and nasal cavity. Adenoids and inflammation of the pharyngoal and nasal mucous membranes are common.

TREATMENT—1. Hare-Lip without Cleft Palate.—A hare-lip should be operated upon soon after birth, provided the child is in a healthy condition. The closing of the gap enables the child to take food more easily, and also relieves the mind of the mother, who as a rule is more concerned about the obvious deformity of hare-lip than the hidden deformity of cleft palate.

The operation performed depends upon the variety and extent of the gap, but all the operations have the following common points: (1) The lip must be freely separated from the jaw; (2) the flaps cut

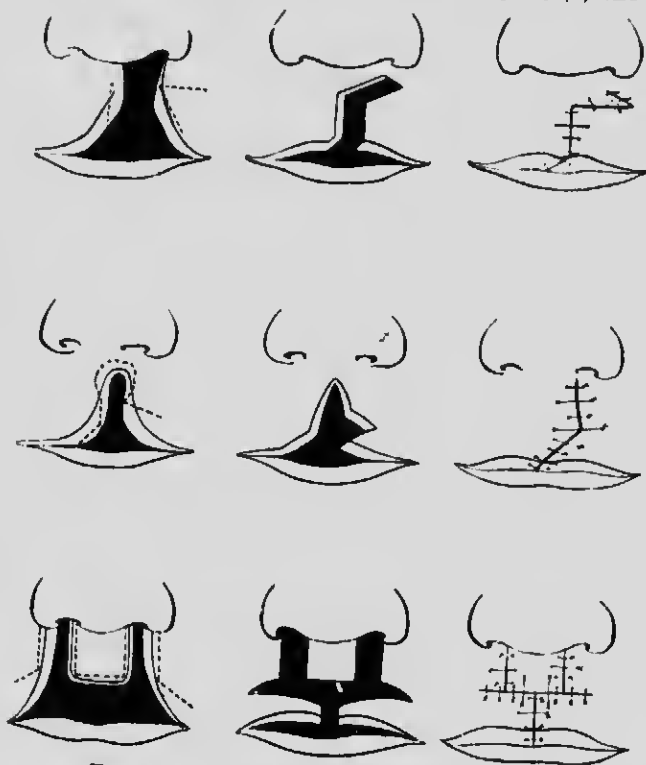


FIG. 410.—METHODS OF REPAIRING HARE-LIP.

must be thick; (3) the red margin of the lip on each side must correspond; (4) the lip, after the operation, must be fuller than necessary, as some contraction is certain to occur; (5) each case must be carefully examined, and the operation adapted to the particular case.

2. Hare-Lip with Cleft Palate.—Surgeons may be divided into two schools on the subject of the time to operate on cleft palate—(1) Those that advise early operation, and prefer to use the gap given by a hare-lip to make closure of the palate easier; and (2) those that defer operation on the palate until the child is about three years old, and close the hare-lip soon after birth.

The advantages claimed for the early operation are—(1) The better nutrition of the patient if the gap is closed; (2) that the operation is easier, especially if hare-lip is also present; (3) speech is better after early than after later operation; (4) the apposition of the upper and lower teeth is more perfect if the gap is closed early.

The advantages claimed for the later operation are—(1) The child is stronger and more able to stand the shock of the operation; (2) the closing of the hare-lip tends to diminish the gap in the palate; (3) the child has more control, can be more easily kept quiet, and can be prevented from sucking at the stitches; (4) speech is not interfered with if the operation is done before the third year.

Operations.—The early operations may be divided into two groups: (1) BROPHY'S OPERATION; (2) DAVIES-COLLEY'S OPERATION.

1. Brophy recommends that the operation should be performed at some time between two weeks and three months after birth, and that

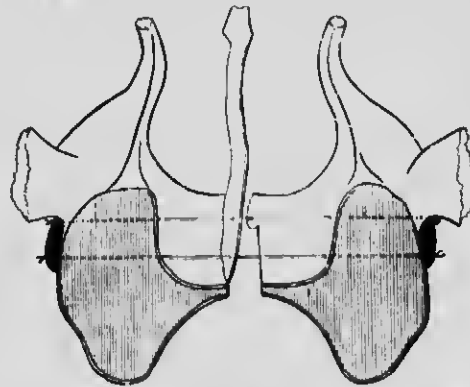


FIG. 420.—BROPHY'S METHOD OF REPAIRING CLEFT PALATE.

the palate should be closed before the hare-lip. The operation consists of paring the edges of the cleft, and then forcing the two superior maxillary bones together, so that they meet in the middle line. The bones are kept together by silver wires, which are fixed to leaden plates lying between the bones and the cheeks (see Diagram).

This operation, which has been very successful in the hands of Brophy,

has not met with general acceptance in this country. The operation is severe, and necrosis of the superior maxillæ has followed.

2. **Davies-Colley's Operation** is also performed in the first few weeks of life, and consists of raising a muco-periosteal flap from each side of the cleft, and placing this over the gap. The flaps are so arranged that one presents the mucous membrane to the nasal cavity, and its raw surface downwards, whilst the second has the raw surface upwards opposed to the raw surface of the first flap, and the mucous membrane portion to the buccal cavity. The flaps are sutured into position.

Two or more operations may be necessary to close a large gap, especially anteriorly.

The operation usually performed at the later period is **Langenbeck's**. The edges of the cleft are carefully pared, and muco-periosteal flaps are then raised on each side of the cleft. The flaps are pulled inwards in order to meet in the middle line, lateral incision being

made near the alveolar border to relieve tension. The muco-periosteal flaps are carefully sutured together, silkworm gut or fine wire being

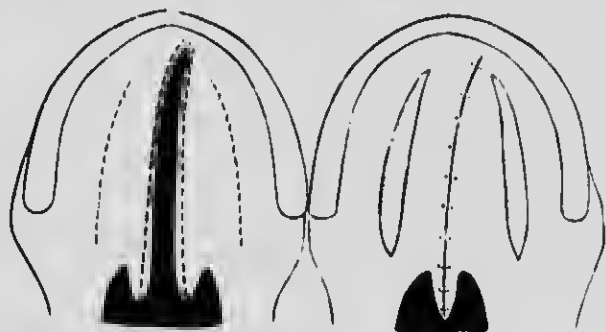


FIG. 421.—LANGENBECK'S METHOD OF REPAIRING CLEFT PALATE.

used for the hard palate, and silkworm gut for the soft palate. Before the suturing is begun, the two halves of the soft palate must be freely separated from the palato bene.

Treatment of the Os Incisivum.—If the os incisivum is lying flush with the superior maxillary bones, its presence does not affect the operation for hare-lip or for cleft palate; but when it is pushed forwards, as is commonly the case, it must be dealt with before either operation can be performed. The following methods are used:

1. The piece of bone with the incisor teeth is removed. This allows easy closure of the hare-lip, but the front of the face is flattened, giving the child the appearance of a "rag doll."
2. A triangular piece of bone is removed from the vomer, and the os incisivum pushed backwards. It may remain loose, and be a great source of annoyance.
3. The os incisivum may be forced back into position.

The part of the hare-lip attached to the os incisivum should always be utilized either in forming the lip or the nose; but it should not take part in forming the red margin of the lip, or the tip of the nose will be unduly depressed.

TREATMENT BEFORE OPERATION.—No special preparation is necessary for these operations, but they should not be performed if the child is not in a good state of health. If the palate is to be operated upon, and the child is two or more years old, the mouth should be syringed before the operation to accustom the child to the manipulation.

AFTER-TREATMENT.—When the operation is finished, the child should be placed with the head well to one side, so that the saliva and blood may run out of the mouth; and if the patient is an infant, the nurse should be instructed to keep it in her arms for a time, with the mouth directed downwards. As soon as the child expresses a desire for drink, a sip of water, hot or cold, may be given him from a spoon.

Feeding should be begun from six to eight hours after the operation, milk and water being given; and as soon as the child can swallow—i.e., about twenty-four hours—beef-jelly may be given. In the course of a day or two, if the child be of a suitable age, fish or meat run through a fine sieve, bread and milk, or soft custard pudding, may be given.

Care of the Mouth.—If the child will readily allow it—and it will as a rule if syringing has been practised before the operation—the mouth should be syringed with a weak solution of boracic lotion every four hours, and after the taking of food; but it must not be done if the child is frightened or repels it. There is no necessity to inspect the palate, and all unnecessary manipulations should be avoided.

If the patient is an infant, the field of operation can be gently brushed over with a camel-hair brush dipped in warm boracic lotion when it opens its mouth to cry.

Instructions should be given to the nurse to keep the child amused and quiet, in order to prevent crying. An older patient must be cautioned not to talk, and a slat should be provided so that he can make his wants known.

In some cases after the operation for hare-lip, the breathing may be embarrassed, owing to the nostrils becoming blocked with dried mucus and blood. The nostrils must be kept clear by gently wiping them; but if the dyspnoea continue, the nurse should be instructed to depress the lower lip, so that the child can breathe through the mouth.

In the case of a hare-lip some of the sutures may be removed on the third day, and the rest on the fifth. If they give way before this, the lip should be bathed with warm boracic lotion, and an attempt made to keep the flaps together with a gauze and collodion dressing. If the sutures in cleft palate do not work out, they should be removed on the seventh or eighth day.

It is frequently found after the wound has healed soundly that small gaps are present in the palate, particularly at the anterior end and at the junction of the hard and soft palates. These may be closed by a subsequent operation, or the patient may be fitted with an obturator.

A patient who has been operated on for cleft palate must be carefully trained to enunciate properly, voice training being an essential part of the treatment, and it is often necessary to carry this out for years. The important point is to teach the patient to allow the sounds to come out of the mouth, the nasal cavity being shut off by raising the soft palate, and not through the nose.

Obtulators.—Adult patients with cleft palates are best treated by fitting a false roof to the mouth, the aid of a dentist being sought. In these patients it is very difficult to bring about closure of the gap, and even if successful, there is little or no improvement in the voice. Cases in which operative treatment has failed must also be treated by fitting an obturator and carefully training the patient to speak.

OTHER CONGENITAL DEFORMITIES OF THE LIPS

Microstoma (Small Mouth) is brought about by too complete fusion of the superior maxillary processes and the mandibular arch. It is usually associated with smallness of the lower jaw.

Macrostoma (Large Mouth) is the opposite condition in which the coalescence of the processes is incomplete.

Oblique Facial Cleft.—This occurs by non-union of the superior maxillary process and the fronto-nasal process, and may extend from the lip to the external angular process. It may be unilateral or bilateral, and associated with hare-lip, cleft palate, etc. It may be noted here that all these deformities are often associated with other congenital deformities, both of the face and other parts of the body.

Mandibular Cleft arises from imperfect coalescence of the two halves of the mandibular arch, and is a median furrow in the lower lip.

TREATMENT.—The treatment of all these deformities are plastic operation, each of which must be adapted to the deformity present. All the deformities should be over-corrected at the time of operation to allow for subsequent contraction of the scars.

Fistulae of the Lower Lip.—These occur as two small dimples placed symmetrically near the middle line on the mucous surface of the lower lip. Each leads into a small blind fistula which secretes a fluid resembling saliva. They are nearly always associated with hare-lip, and should be removed by dissection.

INFLAMMATORY CONDITIONS

Cracks and Fissures are common in the lips, especially in cold, damp weather, and the condition is spoken of as *chapped lips*. They should be treated by the application of simple ointments, but if they become callous, cauterization may be necessary.

Chronic Inflammation of the Lip (Strumous Lip).—A chronic inflammatory condition leading to thickening of the lip and eversion of the mucous membrane is sometimes present in delicate children. It is most commonly seen in the upper lip, and it may be associated with cracks and fissures.



FIG. 422.—OBLIQUE FACIAL CLEFT.
(London Hospital Medical College
Museum.)

TREATMENT.—Any crack or fissure should receive careful attention, and the general health of the patient should be improved. Later, if the thickening is marked, plastic operations may be advisable.

Cancerum Oris.—This form of infective gangrene is described on p. 177.

Syphilis

Primary Stage.—A primary chancre is most frequently seen on the upper lip, and is more common in women than in men. It occurs on the mucous membrane, and is best seen by everting the lip. The appearance of the sore may be that of a typical Hunterian chancre (see p. 122), but more often it is atypical, and appears more acutely inflamed than the characteristic chancre on the penis. The submaxillary and submental glands are tender and swollen, and may be so enlarged that suppuration may be suspected; but this is rare. Under antisyphilitic treatment the enlargement of the glands subsides.

A primary chancre should be suspected in every ulcer occurring without cause on the upper lip, especially if the patient is a woman,

and the diagnosis should be established by discovering the spirochæto. In many cases the cause of the sore is unsuspected until secondary symptoms appear.

Secondary.—*Mucous patches* and small superficial ulcers are common on the lips in secondary syphilis as a part of a general stomatitis.

Tertiary.—Gummatous ulceration is uncommon on the lips, but is of importance for its liability to be mistaken for carcinoma, which is by far the more common disease. The diagnosis is established by the history, Wassermann's serum reaction, and the effect of anti-syphilitic treatment.

Inherited.—The most characteristic lesions of the lips of inherited

syphilis are cracks and ulcers (rhagades) radiating from the angles of the mouth during the first two years of life. When they heal, they leave characteristic scars which are stigmata of syphilis.



FIG. 423.—SYPHILITIC ULCERATION OF THE LIP.

TREATMENT.—The usual general antisyphilitic treatment and keeping the local lesion clean is all that is necessary in all forms of syphilis of the lips.

Tuberculosis

Tuberculous ulcers may occur on the lips in patients suffering from advanced tuberculosis of the lungs and larynx. They have the same clinical characteristics as tuberculous ulcers of the tongue (see p. 970), and are often very painful.

TREATMENT.—This is usually palliative on account of the condition of the lungs. Dusting the ulcer with orthoform may relieve the pain and enable the patient to eat in comfort.

NEW GROWTHS

1. Innocent

The innocent new growths of the lips are angiomas (*naevi*) and papillomata.

Angioma.—These tumours occur either on the inner or outer aspect of the lip, and are best removed by excision. Small *naevi* may be treated by electrolysis or the application of carbon dioxide snow.

Papilloma.—Papillomata are most common on the lower lip near the angle of the mouth, and are usually seen in elderly people. As a carcinoma of the lip often first shows itself as a warty growth, and papillomata not infrequently become carcinomata, any wartlike growth on the lip should be removed as soon as possible, and its base carefully examined with the microscope.

Macrocheilia.—This term is applied to a congenital enlargement of the lips, in many respects similar to macroglossia, and believed to be due to a new formation of lymphatic vessels (plexiform lymphangioma). One or both lips may be affected, and the muscular movements are lost, so that suckling, eating, and talking are made difficult.

TREATMENT.—Plastic operations should be carried out on the lips to reduce their size and restore their shape.

2. Malignant

Carcinoma.—Carcinoma of the lip is more common in elderly men than in women, the lower lip near the angle of the mouth being most frequently affected. It is rare on the upper lip. A predisposing cause is probably the habit of smoking short clay pipes, the growth originating at the place where the mouth-piece rests against the lip. The tumour is invariably a squamous-celled carcinoma, and as a rule slowly growing. The glands involved are the submental and submaxillary, and later the parotid glands lying along the internal jugular vein. Metastases in distant organs are rare.

CLINICAL FEATURES.—Carcinoma in the early stages appears as (1) a small warty growth, (2) a subcuticular nodule, (3) a fissure or ulcer, or (4) as an indurated patch of epithelium. The growth is at first slow, and causes the patient no inconvenience; but later there is severe pain spreading along the branches of the fifth nerve.



FIG. 424.—SQUAMOUS-CELLED CARCINOMA OF THE LOWER LIP.

The tumour extends as an indurated papillary growth or as a carcinomatous ulcer, with raised, everted edges, a sloughing floor, and an indurated base. During its spread it destroys the whole of the lip, and becomes attached to the lower jaw.

The glands, which are affected early, are enlarged, hard, matted together, and fixed to the surrounding tissues. Later, they may become cystic from chronic suppuration, and burst, leaving large carcinomatous ulcers with foetid discharge. Death occurs from exhaustion, sepsis, pain, and hæmorrhage, in about three years.

DIAGNOSIS.—The diagnosis is rarely in doubt, the most likely causes of error being primary chancres on the lip and gummatous degeneration. The usual differential diagnosis is made.

TREATMENT.—The modern treatment of carcinoma of the lip is free removal of the growth and removal of the connective tissue containing the lymphatics and lymphatic glands in the submaxillary and submental triangles on both sides of the neck, no matter how small the growth may be, or how early the patient comes for treatment. It is seldom the old V-shaped incision allows of sufficient removal, and the incisions must be planned so that after a free removal of the growth, the lip may be restored by tissue taken from the cheek or from under the chin. These incisions may also be made in such a way that removal of the lymphatic area may be carried out at the same time. In advanced cases it may be necessary to remove part of the jaw with the lip.

Inoperable cases may be treated by the X rays or radium.

Carcinoma of the upper lip has the same clinical characteristics as carcinoma of the lower, and demands similar treatment. It is equally common in men and women.

CYSTS

Mucous Cysts occur chiefly on the inner aspect of the lower lip. They are small, elastic, rounded swellings of a bluish colour, and contain a clear, mucoid fluid.

TREATMENT.—A part of the cyst wall should be excised, and a caustic, such as pure carbolic, chromic acid, or silver nitrate, applied.

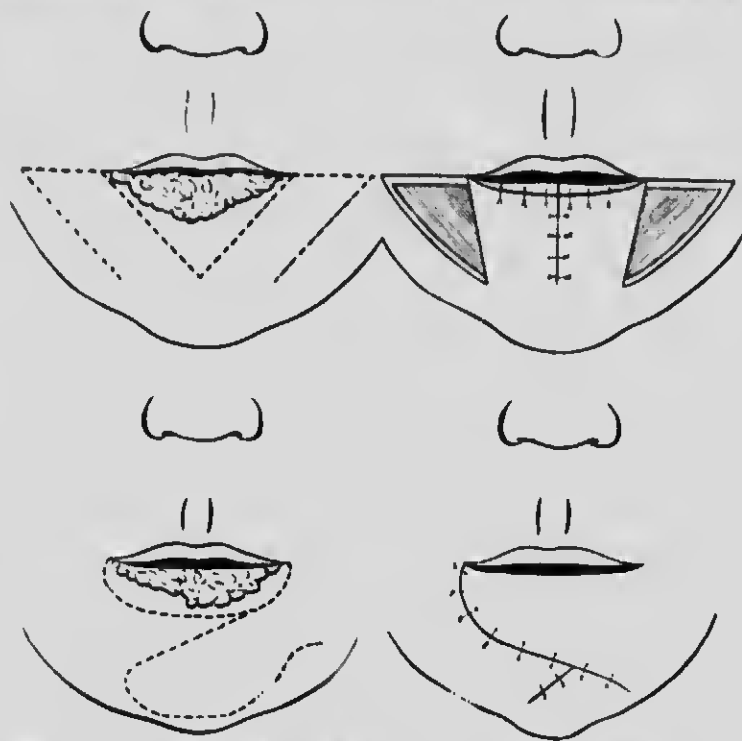


FIG. 425.—PLASTIC OPERATIONS AFTER REMOVAL OF CARCINOMA OF THE LOWER LIP.

WOUNDS OF THE LIPS AND FACE

Wounds of the lips and face, even if extensive, usually heal well, although it is difficult to keep an aseptic dressing in place if the mouth and nose are involved. Severe suppuration or sloughing is uncommon. This is no doubt owing to the very extensive blood-supply and the very free anastomosis between the branches of the two external carotid arteries.

In treating a wound of the face, no part of the skin should be cut away. The suture material should be fine silkworm gut, and the sutures may be removed as early as the third or fourth day in order to avoid stitch marks. Subcutaneous suturing may also be used.

If the mucous membrane of the mouth or nose is involved, the

edges should be approximated with a separate row of sutures to the skin suture, and for this purpose catgut sutures are preferable, as it is not necessary to remove them.

Infected Wounds of the Face.—Infections of wounds of the face are similar to those in other parts of the body; but infection from special organisms, as tetanus and anthrax, is more common in the face than elsewhere, except the hand, owing to the fact that the face is exposed. The clinical course of these infectious diseases and their treatment are the same as in other parts of the body, but infection of the brain and its membranes through the communicating vessels is a special complication to be feared.

NEW GROWTHS OF THE FACE

Innocent.—The innocent new growths of the face include angiomas, lipomata, neuro-fibromata, and dermoid cysts. They require no special description or treatment.

Malignant.—The malignant new growths are squamous-celled carcinoma, rodent ulcer, and melanoma.

Squamous-Celled Carcinoma usually occurs in men over forty, and in clinical features resembles similar growths elsewhere. After ulceration of the growth has occurred, the ulcer tends to assume a rounded form with deep indurated edges and base. Such an ulcer has been termed a **crateriform ulcer**, but there is no necessity for a special name (see Diseases of the Skin, p. 402).

TREATMENT.—The growth and about $\frac{3}{4}$ inch of apparently healthy tissue round it should be excised, and the gap closed by a plastic operation. At the same time, or soon after, the whole lymphatic area into which the part drains should be removed.

Rodent ulcer and melanoma are described elsewhere (p. 401).

MOUTH

INFLAMMATORY AFFECTIONS—STOMATITIS

1. **Catarrhal Stomatitis** may be due to superficial burns, carious teeth, specific infectious foci, operations on the mouth, wounds of the cheeks, etc. The mucous membrane is swollen and hyperæmic, and there is increased mucous secretion.

Eating is painful, and small superficial ulcers may be present on the mucous membrane.

TREATMENT.—The mouth should be kept clean by simple non-irritant mouth-washes, and a painful ulcer touched with chromic acid or silver nitrate. The general health of the patient should receive attention.

2. **Aphthous Stomatitis.**—The cause of this condition is unknown, but it is met with in underfed children in bad health. There is a rise of temperature and general symptoms associated with the appear-

ance of white patches on the mucous membrane, which break down into small superficial ulcers.

TREATMENT.—Attention should be given to the general health of the patient, and the mouth kept clean.

3. **Thrush** occurs in infants, and is due to the growth of a fungus, the *Oidium albicans*, which is found in sour milk. It appears as white patches on the mucous membrane.

TREATMENT.—The mouth should be kept clean, and great care taken that the milk is fresh, and that the utensils in which it is kept are clean.

4. **Mercurial Stomatitis**.—Patients who are taking mercury may develop an ulcerative stomatitis associated with salivation, which, if the mercury is continued, may lead to loss of the teeth and necrosis of the jaw. It is of chief importance in the treatment of syphilis, as the ulceration may be considered due to the disease, and the mercurial treatment pushed with disastrous results. The patient will complain of a metallic taste in the mouth, and the breath is particularly offensive.

TREATMENT.—The administration of the drug should be stopped, and the mouth kept scrupulously clean. Chlorate of potash, both internally and as a mouth-wash, is particularly effective in relieving the condition.

5. **Cancerum Oris** (gangrenous stomatitis) is described on p. 177.

6. **Syphilitic Stomatitis** (see p. 133).

7. **Erysipelas** of the buccal mucous membrane is described on p. 78.

NEW GROWTHS

Adenoma of the Soft Palate.—This is a form of new growth most commonly met with in young subjects between puberty and thirty years of age, which grows in the submucous tissue of the soft palate.

CLINICAL FEATURES.—There is a slowly growing encapsuled tumour to one side of the middle line in the submucous tissue of the soft palate, or very rarely of the hard palate. It may grow to the size of a walnut, and causes little inconvenience. If, however, it is not removed, it is liable to infiltrate the surrounding structures, and be locally malignant.

PATHOLOGY.—Various views are held:

1. That the tumour is an adenoma of the palate glands, which may undergo carcinomatous or sarcomatous change.
2. That it is an endothelioma.
3. That it is a mixed tumour similar to those in the parotid and submaxillary glands.

TREATMENT.—The tumour should be shelled out as soon as diagnosed through an incision in the mucous membrane. If untreated, an extensive operation may be necessary.

Carcinoma of the Palate.—A squamous-celled carcinoma may originate in the soft or hard palates, or spread to this structure from

other parts. The growth has the usual features of a carcinomatous ulcer in other mucous membranes, and the glands on both sides of the neck are liable to be affected.



FIG. 426.—GROWTH OF THE HARD PALATE.

external carotid artery is ligation of the artery, and injection of boiling water into its branches. Complete disappearance of the growth has followed this operation, and some arrest of the rate of growth is usual.

Carcinoma of the Floor of the Mouth.—Carcinoma of the floor of the mouth is much more common than carcinoma of the palate. It generally originates at the reflexion of the mucous membrane of the tongue on to the inner aspect of the jaw. It is a squamous-celled carcinoma.

CLINICAL FEATURES.—The onset is insidious, and when the case first comes under observation, the growth is as a rule advanced. There is an ulcer with the usual carcinomatous features fixing the tongue to the floor of the mouth, so that it cannot be protruded. Pain is absent in the early stages, but later is intense, and is referred to the ear. Salivation is present. The glands on both sides of the neck are affected early.

TREATMENT.—Radical treatment involves removal of the floor of the mouth, part of the tongue, a segment of the lower jaw, the sublingual and submaxillary salivary glands, and the glandular area in

TREATMENT.—The growth should be freely removed as soon as diagnosed, a part of the superior maxilla and the vomer being excised if necessary. An extensive removal of the lymphatics of the neck should also be carried out, and this is conveniently performed before removal of the primary growth, as the hæmorrhage can be controlled by temporary or permanent ligation of the external carotid or its branches. **Mikulicz's operation** (see p. 987) is an excellent method for removal of these growths.

If the condition is inoperable when first seen, X-ray treatment or exposure to radium may be tried.

Another method of treating inoperable growths in the area supplied by the

both anterior triangles of the neck. The prognosis is very bad, and early local recurrence is the rule.

In inoperable cases exposure to the X rays and radium may be tried, but this treatment will sometimes increase the rate of ulceration.

CYSTS

1. **Mucous Cysts.**—These are seen as small, translucent, bluish swellings in the mucous membrane. They contain a mucoid fluid, and should be treated by removal of the anterior wall of the cyst.

2. **Dermoid Cysts.**—See Diseases of the Tongue (p. 981).

3. **Ranula.**—A ranula is a cystic swelling in the floor of the mouth formed in connection with one of the glands situated there.

CLINICAL FEATURES.—The patient shows a cystic swelling under the tongue to one side of the frenum, bluish-coloured, and painless. It causes little inconvenience unless it is allowed to grow to a very large size. If pricked, a glairy mucoid fluid escapes, and the cyst collapses, but gradually fills up again.

Wharton's duct can usually be identified running along the outer surface of the cyst.

PATHOLOGY.—Ranula is generally due to a degeneration of one of the glands in the floor of the mouth or under surface of the tongue, such as the mucous glands, the glands of Blandin-Nuhn, and the incisive glands. In a few cases a ranula results from blocking of Wharton's duct, or one of the ducts of Rivini of the sublingual gland.

TREATMENT.—The cyst should be dissected out, or its anterior wall freely removed, and the cyst cavity swabbed with pure carbolic acid or chromic acid.

The wound is allowed to heal by granulation.

AFFECTIONS OF THE SALIVARY GLANDS

Injuries.—Injuries of the salivary glands require no special mention but to point out that if one of these glands is injured, and the wound becomes infected, a salivary fistula may result.

Wounds of Stenson's Duct.—The duct of the parotid gland—Stenson's duct—runs from the anterior border of the gland across the masseter muscle, pierces the buccinator, and opens on the inner aspect of the cheek opposite the second molar tooth in the upper jaw. Its course is indicated by a line drawn from the lobule of the ear to a point midway between the ala nasi and the margin of the upper lip; it lies above the facial nerve. The duct may be wounded from within or without. Wounds from within are of little importance unless they cause stenosis of the duct, for a salivary fistula on to the inner aspect of the cheek causes no inconvenience. Wounds from without may result in the formation of an external fistula, which will be a serious source of annoyance to the patient.

TREATMENT.—When the whole thickness of the duct is divided, the skin wound should be very carefully sutured.

The wound of the mucous membrane should not be sutured; the saliva, therefore, can escape freely into the mouth. It is not necessary to attempt to suture the duct.

If there is an external wound only, an attempt to suture the duct may be made; but it is probably better to make an opening into the mouth, and suture the external wound only, so that if a fistula forms it is more likely to be an internal one.

Salivary Fistulae.—Salivary fistulae nearly always occur in connection with the parotid gland, and are only of importance if the fistulous opening is on the outer aspect of the cheek. They may be divided into two groups—fistulae of the gland and fistulae of the duct.

1. *Fistulae of the Gland*—**CAUSE.**—The causes of this condition are wounds of the gland that have been infected and have suppurated, and abscesses in the gland which have burst externally. These abscesses not infrequently form round salivary calculi.

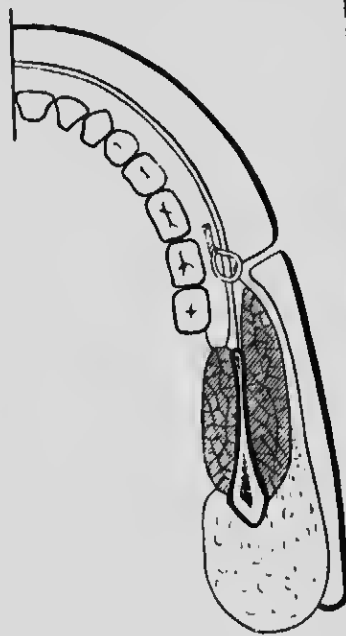


FIG. 427.—METHOD OF TREATING PAROTID FISTULA.

CLINICAL FEATURES. There is a constant but slight discharge of saliva from the fistula, the amount being increased when eating.

TREATMENT.—If spontaneous closing does not take place, the edge of the fistula should be touched with the galvano-cautery. Should this fail to bring about closure of the fistula, the tract should be dissected out, and the wound closed by careful suturing.

2. *Fistula of the Duct.*—A fistula of the duct is due to a wound dividing it or to suppuration round a calculus.

CLINICAL FEATURES.—The fistula may be situated on the masseter or on the buccinator muscle, and its opening is usually surrounded by exuberant granulations. The discharge is constant and profuse, and increased by the taking of food. The cheek in the neighbourhood usually becomes eczematous. Spontaneous closure is the exception.

TREATMENT.—An attempt may be made to obtain healing by cauterization of the opening, though this will mostly end in failure. If the opening is in the buccinator, the duct may be slit up from the natural opening in the mouth to the fistula, and an internal fistula established instead of an external. Another method is to pass a silver wire through the fistula opening into the mouth at two points about $\frac{1}{4}$ inch apart. The ends in the mouth are then tied tightly together.

so that the piece of mucous membrane between them becomes necrotic, and a fistulous opening into the mouth is established. The edges of the external fistula can then be pared, and the wound closed by suturing.

If the opening is on the masseter muscle, a more elaborate method of closing the fistula is required, and it may even be necessary to remove as much of the parotid as feasible without injuring the important structures running through it, for a persistent salivary fistula makes life almost intolerable.

Salivary Calculi.—Salivary calculi are composed of phosphate and carbonate of lime, and are chiefly found in the ducts of the submaxillary and sublingual glands, but they may also be found in the parotid duct or in the substance of one of the glands. They are usually small, solitary, and yellowish-white.

CLINICAL FEATURES.—Four types of case may be recognized:

1. The patient complains of a hard swelling in the floor of the mouth without symptoms.
2. The gland is acutely swollen and painful, the patient seeking relief a few hours after the onset of the symptoms. Spontaneous evacuation of the stone sometimes occurs.
3. There are recurrent attacks of swelling of the gland, usually during eating, the gland becoming tender and painful, but the patient may have freedom from symptoms for weeks.
4. Suppuration occurs round the stone, and an abscess forms, which may discharge into the mouth or externally, resulting in the formation of a fistula.

The **DIAGNOSIS** is made by feeling the stone, but if it is in the substance of the gland, this may be impossible. A radiogram in this case may be of assistance.

TREATMENT.—When the stone can be felt in the duct, the mucous membrane over it should be incised and the stone removed. Local anaesthesia with cocaine is sufficient.

If the stone is in the substance of the submaxillary gland, excision of the gland is the best treatment; but in the case of the parotid gland, the stone should be excised, care being taken to secure union of the wound by the first intention, or a fistula may result.

INFLAMMATION

Inflammation of the salivary glands is most conveniently divided into—(1) Primary inflammation, (2) ascending secondary inflammation, and (3) inflammation round calculi.

1. Primary Inflammation—Epidemic Parotitis, or Mumps.—This is an acute specific infectious disease of unknown cause, usually occurring in children. The parotid gland is more often affected than the other salivary glands, but inflammation of the submaxillary gland without the parotid may arise, and even the complication of orchitis may occur in a patient during the course of an epidemic, without the salivary

glands being obviously involved. The incubation period is about three weeks.

CLINICAL FEATURES.—There are the usual general symptoms of any infectious disease. The parotid glands are inflamed, swollen, and tender, one being as a rule affected a day or two before the other. Inflammation of the submaxillary glands, the sublingual glands, and the lymphatic glands of the neck may be present at the same time. Inflammation of the ovary and testis may also occur and lead to atrophy of these organs.

Suppuration is rare, the inflammation ending in resolution. The disease lasts from one to two weeks.

TREATMENT.—The patient must be isolated and kept warm. No other treatment is necessary. Hot fomentations may be applied if there is much pain.

2. Ascending Secondary Inflammation.—This condition is almost entirely limited to the parotid gland, and in surgery is most often seen after abdominal operations in which rectal feeding is necessary. It also occurs during the course of the specific fevers, such as scarlet or typhoid fever, and in the various forms of stomatitis, especially mercurial. The inflammation is due to infection of the gland by various bacteria spreading along Stenson's duct from the mouth.

CLINICAL FEATURES.—There are the usual general symptoms of infection, and the gland on one or both sides becomes acutely swollen and tender. Suppuration is a common result, and after the abscess has burst or been opened, a fistula may result. As the abscess lies under the layer of deep cervical fascia enclosing the gland, extensive burrowing may occur if it is not opened early.

TREATMENT.—The mouth should be kept very clean after all abdominal operations, and during the course of any of the infectious diseases.

Before suppuration has taken place, fomentations should be applied; but directly the presence of pus is suspected, an incision should be made behind the jaw parallel with the facial nerve, and the abscess opened by Hilton's method. Free drainage must be established.

3. Suppuration round a Calculus.—The ordinary signs of an abscess situated in one of the glands will be present, and the abscess should be incised. If no cause is obvious, a calculus should be searched for, and removed if found.

Tuberculous and Syphilitic Inflammations of the salivary glands are so rare as to require no special mention.

Mikulicz's Disease.—This is a condition of unknown pathology in which the salivary glands and the lacrymal glands undergo a chronic enlargement, beginning in early adult life. The only inconvenience is the disfigurement.

TREATMENT.—No medical treatment is of any avail; if the glands become inconveniently large, they should be excised.

NEW GROWTHS

Innocent.—**Adenomata** and other innocent growths are sometimes met with in the salivary glands, but are so rare as to be clinical curiosities.

Malignant.—**Carcinomata.**—Carcinomata of the salivary glands are rare; they have the usual characters of glandular carcinomata elsewhere. They may be encyphaloid or scirrhus. In the case of the sublingual gland, they ulcerate rapidly into the floor of the mouth, and then have the appearance of a carcinomatous ulcer.

Sarcomata.—Round and spindle-celled sarcomata occur in the salivary glands, but are rare. They rapidly infiltrate the surrounding structure, and, in common with the carcinomata, cause facial paralysis if they are situated in the parotid gland.

TREATMENT.—Early and complete removal with the lymphatic glands is the only treatment. In the case of the submaxillary glands, this operation can easily be carried out, but removal of the parotid is a most difficult operation. No effort should be made to save the facial nerve or any other of the important structures lying in the gland, the sole aim being as complete removal as possible, regardless of the deformity caused. The prognosis is bad, local recurrence being the rule. Many cases are inoperable when first seen, but a trial of X rays and radium, or, in the case of sarcomata, Coley's fluid may be made.

Mixed Tumours.—This term has been applied to a variety of tumour met with chiefly in the parotid gland, but sometimes in the submaxillary, and which has a complicated structure.

They are at first encapsuled tumours, and, on microscopic examination, are seen to contain immaturo cartilago, myxomatous tissue, fibrous tissue, and a cellular element which has been described as glandular and endothelial. Their exact pathology is not yet decided, the following views being held:

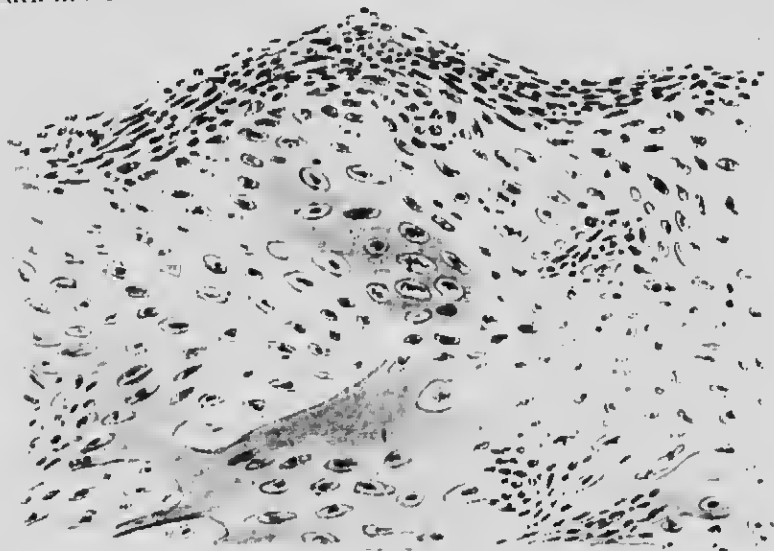
1. They are endotheliomata, the columns of cells being endothelial, and the cartilago and myxomatous tissue being degeneration of the gland substance.
2. They are tumours arising in embryonic remnants of the branchial arches, the cartilage arising from misplaced cartilage cells of Meckel's cartilage.
3. They are slowly growing adenomata which ultimately become carcinomata, or whose ground substance undergoes sarcomatous change.
4. They are malignant teratomata. This is the most modern view (see p. 244).

CLINICAL FEATURES.—Two clinical types may be distinguished:

1. The usual clinical type is a very slowly growing tumour arising in young adult life, generally situated in the parotid gland near the angle of the jaw, but sometimes occurring in the submaxillary gland and growing outward. The tumour is firm and freely movable; it

causes neither pain nor facial paralysis. After growing slowly for years, the growth somewhat suddenly assumes malignant characters. It infiltrates surrounding structures, causes facial paralysis, and gives rise to secondary growths in the lymphatic glands and in distant organs.

2. The growth may be malignant from its first appearance; it rapidly infiltrates the surrounding structures, ulcerates, and causes death in a few months.



Colman, p. 10

FIG. 428.—SECTION OF A MIXED PAROTID TUMOUR, WITH CARTILAGE.

TREATMENT.—Tumours of the slowly growing type occurring in the parotid should be excised, the capsule being removed with the tumour. The incision should be made horizontally across the neoplasm, and care should be taken to avoid injury of the facial nerve and Stenson's duct. Similar growths in the submaxillary gland should be treated by complete extirpation of the gland, the facial artery being divided between ligatures.

Rapidly growing tumours of the second variety, and tumours of the first variety that have begun to grow rapidly, must be treated like other malignant tumours by free and complete removal with the lymphatic area into which they drain, important structures being sacrificed to thorough extirpation.

GUMS

Inflammation of the Gums (Gingivitis).—Inflammation of the gums is generally due to septic infection spreading from carious teeth, but it is not infrequently part of a general stomatitis due to thrush, syphilis mercurial poisoning, etc.

CLINICAL FEATURES.—The gums are swollen, and bleed readily when touched; the tongue is furred and the breath offensive; superficial ulceration is frequently present, being most marked, perhaps, in cases of mercurial poisoning. Salivation is also common. If the condition does not clear up rapidly, the teeth become loose.

TREATMENT.—The cause should be removed at once, and careful attention given to the teeth. Locally, the treatment consists of removing carious teeth, and giving astringent antiseptic mouth-washes, which should be used frequently. One of the best is chlorate of potash, which may also be applied to the gums as a paste.

Pyorrhœa Alveolaris ("Riggs Disease").—This affection is a chronic suppurative inflammation of the gums and the periodontal membranes, due to pyogenic infection, which may affect the whole of the teeth.

CLINICAL FEATURES.—The gums are swollen and bleed readily. Pressure on them causes pus to well up between them and the teeth, which may be carious or appear perfectly sound. The breath is offensive, the tongue coated, and symptoms of dyspepsia are often present, as the food is not chewed properly and the patient is constantly swallowing pus. After a time the gums shrink away from the teeth, the roots are uncovered, and the teeth grow loose and drop out; cure of the condition follows loss of the teeth. Alveolar abscesses (gumboils) often form during the course of the disease.

TREATMENT.—All carious teeth should be removed, and the teeth sealed to remove the tartar under which the suppuration may be continuing. Antiseptic mouth-washes should be used freely, and the teeth kept scrupulously clean. In some instances sound teeth must be removed before healing will take place, and in exaggerated cases natural cure must be anticipated by removal of all the teeth. Vaccine treatment may be tried.

Dental Cysts.—Dental cysts are cystic swellings occurring in connection with carious teeth, usually the molars or bicuspids. They are by no means uncommon, and occur in both the upper and lower jaws.

CLINICAL FEATURES.—A painless swelling forms slowly in connection with one of the teeth, the bone of the jaw being gradually expanded. After a time eggshell crackling is present, and a bluish, cystic swelling appears under the gum. This swelling in the upper jaw may project into the cavity of the antrum, and the condition be diagnosed as hydrops of that cavity. The fluid is mucoid, contains cholesterolin, and is sterile.

PATHOLOGY.—Two views are held as to the origin of these cysts:

1. That they are very chronic, inflammatory swellings at the root of a tooth—*i.e.*, they are chronic abscesses.
2. That the irritation of the infected tooth causes development of a cyst in certain embryonic remnants at the root of the tooth.

DIAGNOSIS.—The diagnosis has to be made from a dentigerous cyst (see p. 903), which is a follicular odontome. A dental cyst is always found in connection with a carious tooth; while with a dentigerous cyst the corresponding secondary tooth has never erupted. A radiogram may show the unerupted tooth.

TREATMENT.—The carious tooth should be extracted, and the cyst opened freely into the mouth. The wall of the cavity should be scraped and allowed to close by granulation. Mouth-washes should be used during healing.

JAWS

Fractures of the Upper Jaw.—Fractures of the upper jaw always result from direct violence, and it is impossible to give any systematic description of these fractures, as no two of them are quite similar. The following points should be noted:

1. Loosened teeth should be carefully placed in position and secured, the aid of a dentist being obtained if possible.
2. The fractures are frequently comminuted, but the fragments should always be preserved, as they are almost sure to unite.
3. The fractures are usually compound, and severe hæmorrhage may occur from the branches of the internal maxillary artery. If the wound becomes infected, secondary hæmorrhage may follow.
4. Other bones of the face, such as the malar, the zygomatic arch, the nasal bones, and the opposite superior maxilla, are often fractured by the same accident.
5. If the outer wall of the antrum is depressed, it should be elevated; and if the alveolar margin is fractured, the fragments should be retained in position by a dental splint.
6. The mouth should be kept thoroughly clean, and the patient fed through a tube if necessary.
7. Injury to the infra-orbital nerve may be present, causing anæsthesia of the cheek.

Fractures of the Lower Jaw.—Fractures of the lower jaw are caused by direct violence, and in over 90 per cent. of the cases the fracture is of the body of the jaw. The injury is most commonly situated anteriorly near the mental foramen, and both sides of the jaw may be fractured. Fractures of the ramus, the coronoid process, and the neck of the condyle also occur.

CLINICAL FEATURES.—The fractures are most common in adults, and there is frequently a history of fighting. The face is swollen, and the patient dribbles blood-stained saliva, the fracture being compound into the mouth.

Deformity.—If the fracture is under cover of the masseter and the internal pterygoid, there is often no deformity; but with the usual fracture the anterior fragment is displaced *downwards*, and the posterior fragment is pulled up by the masseter and displaced *outwards*.

The fragments frequently overlap. In the case of fractures on both sides of the symphysis, the downward displacement of the anterior fragment may be very considerable.

With fracture of the neck of the condyle, the jaw is displaced towards the opposite side, while the condyle itself is drawn inwards and forwards by the external pterygoid muscle.

The mobility of the fragments varies with the position of the fracture. In the usual fracture of the body mobility is well marked, and the line of the teeth is irregular; but with fractures of the ramus very little mobility may be present.

Crepitus is as a rule readily obtained.

A radiogram is useful in difficult cases to demonstrate the presence of a fracture and show its extent and direction.

COMPLICATIONS.—Fractures of the lower jaw are generally compound into the mouth, and infection of the wound occurs readily. The bone may be infected and an abscess form round the site of the fracture, the abscess in most cases pointing beneath the jaw. Necrosis of part of the bone may follow, with separation of a sequestrum.

Severe hemorrhage is rare, and the inferior dental nerve generally escapes serious injury.

TREATMENT.—In the modern treatment of fracture of the lower jaw the aid of a dentist is almost a necessity. A plaster cast is made of the jaw and teeth, and the fracture reproduced in the cast. The fragments are then replaced in position, and from this cast a dental splint is made which is then fitted over the patient's teeth, so that the apposition of the fragments is exact, and the line of the teeth strictly preserved. Loosened teeth should not be removed unless they are lodged between the fragments and are preventing reduction of the deformity.

The mouth must be kept cleaned by the use of hydrogen peroxide or some other antiseptic mouth-wash, and the teeth should be scaled if necessary, and carious teeth removed.

Other methods of treatment are—

1. The application of a four-tailed bandage, thus keeping the lower teeth firmly pressed against the upper, care being taken that the line of the teeth is preserved. The bandage may be supported by—

2. Splints made of cardboard, poroplastic, or gutta-percha, and fitted as shown in Fig. 429.

If either of these methods is used, the patient must not be allowed to eat solid food for four weeks, and talking should be reduced to a minimum. The food must be fluid, or semifluid, and given through



FIG. 429.—SPLINT APPLIED FOR FRACTURED JAW.

a feeder, the tube being introduced through the nose, or behind the last molar teeth, or through a gap from which a tooth has been extracted. If there is no tendency to reproduction of the deformity, a little more laxity in feeding and talking may be given, but no mastication of solid food should be allowed. Splints, if used, must be kept clean, being removed and readjusted every two or three days, for fragments of food and saliva are apt to collect between the chin and the splint.

3. Hammond's interdental wire splint is useful if the fragments cannot be retained by the above simple means. The splint is made on a plaster cast as described above, and the aid of a dentist is necessary.

4. Wiring the Fragments.—This method is very seldom necessary, especially if the assistance of a skilled dentist is obtained in the treatment; but if the fragments cannot be retained in position in any other way, wiring should be tried. It is most commonly called for in double fractures with marked displacement downwards and backwards of the anterior fragment. The jaw is drilled below the sockets of the teeth on each side of the fracture, a stout silver wire is introduced and the ends twisted together until absolute apposition of the fragments is obtained. Unfortunately, necrosis of the jaw commonly follows this operation. The wire suture should always be removed in three or four weeks.

UNION.—Union is usually firm in four to six weeks unless inflammation and necrosis of the bone occur. Non-union is very rare, even if suppuration follows the operation of wiring.

INFLAMMATORY CONDITIONS OF THE JAWS—PYOGENIC INFECTIONS

Infections of the jaws by pyogenic organisms do not differ from similar infections in other bones; in the majority of cases the infection spreads from a carious tooth. The following clinical varieties may be distinguished:

1. **Internal Alveolar Abscess (Gumboil).**—The infection travels from the carious tooth to the periodontal membrane, causing a *periodontitis*, and then spreads through the alveolar margin. If suppuration takes place, an abscess forms under the gum (gumboil), which discharges into the mouth. As a rule necrosis of the bone does not occur. Recurrence is common unless the tooth is removed or stopped.

The TREATMENT is that of the carious tooth—*i.e.*, removal or stopping.

2. **External Alveolar Abscess.**—In these cases the pus forms under the external periosteum of the jaw, and the cheek becomes adherent to the gums and jaw. The pus points on the skin over the lower jaw, and when the abscess bursts, a sinus is formed, leading down to the bone. As a rule a small sequestrum is found at the bottom of the sinus, and this must be removed before the sinus heals. The sinus may remain open for months.

The final result is a depressed scar firmly adherent to the lower

jaw, usually situated just below and in front of the attachment of the masseter. Similar abscesses in the upper jaw are much rarer, but the pus may spread into the antrum of Highmore and cause suppurative sinusitis (see p. 942).

TREATMENT.—The carious tooth should be extracted and if the abscess does not discharge freely through the socket, it should be opened into the mouth in order to avoid an external scar. If the case is not seen early and the abscess is already pointing externally, or if drainage into the mouth is not sufficient, an external opening must be made, care being taken to avoid wounding the facial artery. Later, it may be necessary to scrape away carious bone, or a definite sequestromy may be unavoidable.

3. Acute Periosteomyelitis.—This may be due to extension from a carious tooth, the pus spreading widely under the periosteum, and causing necrosis of the bone; or the infection may be blood-borne and due to the same causes as acute periosteomyelitis in other bones. Not infrequently the condition follows the acute exanthemata, especially scarlet fever and measles.

CLINICAL FEATURES.—The general symptoms are those of any acute infection. Locally, there is redness and great swelling over the jaws, usually the lower, and in two or three days fluctuation is present. When the abscess is opened, a large area of bone is found to be bare and necrosed. Sinus formation follows.

TREATMENT.—As soon as the diagnosis is established, incisions should be made into the inflamed area. These incisions should be made, if possible, through the gums in order to avoid an external scar. In many cases, however, free incision from the outside is necessary. If there are any carious teeth, they should be removed; the mouth must be kept clean by antiseptic mouth-washes, and free drainage must be carried out until the sequestrum separates.

Sequestra in the Jaws.—Necrosis of the jaw may follow any of the infective processes in the same way as in other bones, but the separation of the sequestra and the reproduction of the jaws after necrosis require special mention.

The reproduction of new bone in the jaws, especially in the upper jaw, is very imperfect; and for practical purposes it may be stated that no formation of an involucrum or reproduction of the bone occurs in the **UPPER JAW**. Defects left by necrosis of the bone are permanent. For example, necrosis of the hard palate leaves a permanent opening between the mouth and nose, and the necrosis of one side of the upper jaw, owing to carious teeth, that side of the face falls in.

In the **LOWER JAW** the formation of new bone depends on the cause of the necrosis and the age of the patient. In young subjects an involucrum may be formed, although it is seldom as perfect as in other bones, and after separation of the sequestrum an imperfect new lower jaw may be formed. In a case cited by Wood, a new lower jaw was present in a girl of nineteen three years after complete

removal for phosphorous necrosis; and Waren Tay quotes the case of a boy who was able to crack a walnut with the jaws ten years after removal of the lower one. Of course, the teeth are not reproduced. In elderly people there may be no formation of an involucrum or regeneration of the bone, and the lower jaw will be replaced by a dense fibrous mass. In a case of an elderly woman, under the care of the author, the whole of whose lower jaw became necrosed and was removed, no involucrum was present at the time of the operation, and a year later there was no attempt at new bone formation.

The operation of sequestrotomy in these cases is quite simple, and it may be possible to remove the necrosed bone from inside the mouth, thus leaving no external scar. It has been stated that new bone, formed after necrosis of the lower jaw, may be absorbed.

Phosphorous Necrosis.—Since the substitution of red amorphous phosphorus for yellow phosphorus in the manufacture of matches, this disease has become almost extinct in England. It formerly occurred in those people with carious teeth who worked in match



FIG. 439.—NECROSIS OF THE JAW IN A WORKER IN A MATCH FACTORY (PHOSSY JAW).

factories. It is believed to be a pyogenic affection of the jawbones after their vitality has been lowered by the action of phosphorus fumes.

The condition is a chronic, suppurative osteomyelitis leading to extensive necrosis of bone, lasting in the majority of cases for years. The sequestra are spongy and grey in colour. In the upper jaw no involucrum is formed, and there is no reproduction of bone; but in the lower jaw a soft porous involucrum is present, and after removal of the jaw, reproduction of the bone may occur.

TREATMENT.—The prophylactic treatment consists of the use of amorphous phosphorus in the manufacture of matches, cleanliness on the part of the workpeople, and strict attention to the teeth. The treatment of the necrosis is the same as for that due to other causes.

Actinomycosis.—Infection of the jaw with the actinomyces is due to carious teeth, in the sockets of which the organism has been found. The lesion is a very chronic osteomyelitis ending in suppura-

tion and necrosis of bone. The only certain method of diagnosis is discovery of the actinomyces in the pus discharged from the sinuses. The infection is mixed, other pyogenic organisms being always present.

CLINICAL FEATURES.—The disease begins as a firm swelling in the jaw near a carious tooth, the lower jaw being more frequently affected than the upper. This swelling is tender, and increases steadily in size. Finally it involves the skin, which becomes red and œdematous, and fluctuation is present. The condition may be exceedingly difficult at first to diagnose from a sarcoma. The abscess may burst through several openings, leading to the formation of numerous sinuses.

The general symptoms are mild, and the disease runs a very chronic course, the chief danger being the formation of actinomycotic abscesses in the lungs owing to inhalation of the pus and organisms.

TREATMENT.—*Locally*, the treatment consists of thorough eradication of the disease with the sharp spoon, gouges, and scissors; or, if extensive, removal of a part of the bone with mallet and chisels. The *General* treatment is the administration of large doses of iodide of potassium.

Syphilis.—Spirochæte infection of the jaws takes place in the secondary and the tertiary periods. It is most common in the upper jaw in the tertiary period, leading to necrosis of the hard palate and the formation of a permanent opening between the mouth and the nose.

In the lower jaw gumma formation rarely occurs. It is possible to mistake it for sarcoma, therefore syphilis should always be definitely excluded before removal of the lower jaw for a tumour is contemplated.

TREATMENT.—The general treatment is antisyphilitic. Necrosed bone should be removed when the sequestrum is loose, and the mouth should be kept clean with mouth-washes. Osteoplastic operations to close defects in the palate are mostly unsatisfactory.

Tuberculosis.—Tuberculosis is more common in the upper jaw, and occurs in the malar bone or in the orbital margin of the superior maxilla. A swelling, which becomes red and fluctuating, forms under the lower eyelid, and the abscess bursts near the lower margin of the orbit. A sinus forms which, on healing, leaves a characteristic depressed scar. Tuberculosis of other parts of the upper jaw or of the lower jaw is rare.

TREATMENT.—If an abscess forms, it should be opened and the bone thoroughly scraped. Sinuses should be treated in the same way. The general constitutional treatment of tuberculosis should be carried out.

NEW GROWTHS OF THE JAWS

New growths of the jaws may be divided into—(1) Tumours of the alveolus, (2) tumours of the body of the jaws.

TUMOURS OF THE ALVEOLUS

The general name given to these tumours is *epulis*, but this term has no pathological significance, and merely means "situated on the gums." Histologically and clinically the epulides are—

1. **Granulomata**—*i.e.*, masses of granulation tissue associated with carious teeth, inflammatory conditions of the alveolar margin, and sinuses. These granulomata are most common in children, and the treatment consists of removing the cause and scraping away the granulation tissue.

2. **Fibromata**.—These grow from the periosteum of the jaw or from the periodontal membrane, and are firm, slowly growing tumours which do not bleed on examination. A fibroma is the rarest form of epulis, and is only to be differentiated from sarcoma by careful microscopical examination. It should be treated as the fibrosarcomata.

3. **Sarcomata**.—The majority of epulides are sarcomata. Two kinds may be distinguished:

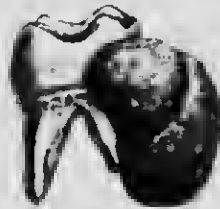


FIG. 431.—TOOTH WITH
EPULIS ATTACHED.
(London Hospital Medi-
cal College Museum.)

- (1) A slowly growing fibro-sarcoma of the spindle-celled type, originating from the periosteum or the periodontal membrane.
- (2) A more rapidly growing, round-celled sarcoma which may originate in the periosteum or in the interior of the bone.

These tumours form firm or soft swellings on the gums, hugging the teeth closely. The soft varieties bleed readily, but they cause little inconvenience unless ulceration occurs.

TREATMENT.—The treatment consists of removing a wedge-shaped piece of the alveolar margin from which the tumour is growing. The whole depth of the alveolar margin must be removed, and the teeth near the growth sacrificed. If the teeth are sound, they should be preserved and lifted by a dentist to a tooth-plate. The more rapidly growing and vascular the tumour, the more freely should the alveolar margin be removed. In all cases the prognosis is good, and recurrence or metastasis in distant organs is rare.

4. **Myelomata**.—Giant-celled growths also occur in the alveolar margin, chiefly in the upper jaw, but are only to be distinguished from the sarcomata on microscopical examination. The treatment is the same as for the sarcomata, among which they are frequently classed (see p. 23).

5. **Carcinomata**.—Carcinomata may secondarily invade the alveolar margin from carcinoma of the gums, lips, or floor of the mouth. If operation is contemplated, a large piece of the jaw must be removed.

TUMOURS OF THE BODY OF THE JAWS

UPPER JAW.—**Innocent Tumours** of the upper jaw may arise in the periosteum, the bone, the lining membrane of the antrum, or in connection with the teeth.

- (1) **Fibromata** originate from the periosteum or the lining membrane of the antrum, and are rare. Those arising from the antrum, after filling the cavity, may cause absorption of the bony walls, and push the cheek outwards, causing considerable deformity.
- (2) **Chondromata** are rare, and give much the same clinical features as the fibromata.
- (3) **Osteomata** may be ivory or cancellous, and may grow on the outer surface of the jaw or invade the antrum. They grow slowly, but may reach a very large size.

Leontiasis Ossea.—This is a rare disease of unknown pathology—though probably inflammatory in nature—found in young subjects of both sexes. The disease generally originates in the malar bones, and spreads slowly. It affects both upper and lower jaws. The chief feature is the formation of masses of new bone on the jaws, leading to hideous deformity, and interfering with sight, smelling, and the movements of the jaws.

The disease is long-drawn out, lasting for twenty or thirty years and no treatment has proved of the slightest use.

Malignant Tumours occurring in the upper jaw are **sarcomata**; **columnar-celled carcinomata**, arising in the lining membrane of the antrum; and **malignant odontomata**. Of these tumours the sarcomata are the most common, but a differential diagnosis is as a rule only possible on microscopical examination after removal. The sarcomata may be periosteal or endosteal, and may be associated with a large amount of new bone formation, a condition that does not occur in the carcinomata, which, on the other hand, are more likely to cause secondary growths in the lymphatic glands. **Squamous-celled carcinomata** may secondarily invade the upper jaw from the gums or the mucous membrane of the hard and soft palate.

CLINICAL FEATURES.—The clinical features of malignant disease of the upper jaw vary with the primary situation of the growth and the main direction in which it grows. For clinical description the condition may be divided into—

1. *Growths from the Outer Surface of the Jaw.*—These tumours grow outwards on to the cheek, and their most important feature is the deformity they cause. The cheek is pushed forwards, and later invaded by the growth which can also be detected by examination between the cheek and the bone above the alveolar margin. Neuralgia due to involvement of the dental nerves may be a symptom. These tumours are frequently sarcomata.
2. *Growth invading the Antrum or growing from its Lining Membrane.*—The early symptom of this growth is an intractable neuralgia

affecting the superior dental nerves, and spreading to the other branches of the second division of the fifth cranial nerve. In elderly people this symptom should always lead to a careful examination of the antrum. After the antrum is filled with the growth, it begins to invade surrounding structures, and according to the direction of its spread, the following symptoms appear :



FIG. 432. — MALIGNANT DISEASE OF THE UPPER JAW.

- (1) A bulging of the cheek, which becomes adherent to the upper jaw.
- (2) Obstruction of one nostril and nasal discharge. On examination, the growth is found spreading into the nose.
- (3) Diplopia and proptosis due to invasion of the orbit through the orbital plate.
- (4) Epiphora from obstruction of the nasal duct.
- (5) Depression of the alveolar margin and the hard and soft palates from extension of the growth downwards.

- (6) Neuralgic pains along all the branches of the second division of the fifth cranial nerve owing to invasion of the sphenomaxillary fossa.

When the growth ulcerates into the nose or naso-pharynx, severe hæmorrhage may result. Ulceration may also occur on the cheek, usually just below the orbital margin. On transillumination, the antrum is found to be dark, and in some cases eggshell crackling of its walls is present. These growths are frequently beyond radical cure when they are first seen, but operation may ameliorate the symptoms.

3. *Tumours Springing from the Posterior Wall of the Maxilla.*— These tumours grow into the sphenomaxillary fossa and then invade (1) the pterygo-maxillary fossa, causing a swelling in the temporal region; (2) the orbit from behind, causing proptosis; (3) the cranial cavity through the foramina rotundum and ovale, causing symptoms of intracranial tumour; (4) and the naso-pharynx.

The earliest symptom is, as a rule, neuralgic pain along the branches of the second division of the fifth cranial nerve. Later, a swelling forms in the temporal region.

In all tumours of the upper jaw X-ray examination may give valuable information.

DIAGNOSIS.—Malignant tumours of the upper jaw must be carefully distinguished from the various forms of innocent odontomes (see p. 964), and from trigeminal neuralgia. It is also important to distinguish tumours arising in the upper jaw from tumours invading it from the nose, naso-pharynx, and bones of the skull.

PROGNOSIS.—This is bad, early recurrence being the rule.

TREATMENT.—The radical treatment of malignant disease of the upper jaw is complete removal of the superior maxilla, and in the case of carcinoma, removal of the lymphatic glands of the neck. It may be stated as a rule that if the growth has spread beyond the limits of the superior maxilla, it is unsuitable for radical cure, although operation with removal of part of the cheek, the contents of the orbit and part of the nose, may be considered as a palliative measure if the pain and discomfort are severe.

The preparations for the operation are similar to those adopted before removal of the tongue (see p. 977).

The incision runs from the external earthus just below the margin of the orbit to the side of the nose; then along the junction of the nose and face, curving round the lower margin of the nose to the middle line. It is continued directly downwards to the centre of the upper lip, the red margin of which is divided.

The flap of skin marked out is rapidly turned up and the bleeding arrested. The superior maxilla is separated from its connection with the malar bone, the nasal bone, and the nasal process of the frontal bone, by sawing into the orbit, the eyeball being protected by a spatula. The nasal cartilage is afterwards separated.

The central incisor tooth is then removed, the hard palate divided by a saw introduced into the nose, and the soft palate separated from the hard. The maxilla is seized with lion forceps and forced away from its further connections. The cavity left is packed with gauze. The skin flap is sutured back into position.

The after-treatment and the complications to be feared are the same as those that follow excision of the tongue (see p. 978). The gauze should be removed at the end of forty-eight hours, and as a rule the face wound heals well.

After the operation the eyeball may drop, although it is usually kept in position by the suspensory ligament of Lockwood. To prevent this, as well as a troublesome œdema of the lower eyelid, the orbital plate may be left, but complete removal of the growth is the first consideration. When the wound has healed soundly, a plate should be fitted by a dentist to cover in the gap left in the palate.

LOWER JAW—I. *Innocent*.—**Osteomata, chondromata, and fibromata** all occur in the lower jaw, but are rare. They have the usual

clinical features of these tumours elsewhere, and demand the same treatment.

Myeloma.—Myelomata may arise in the body of the lower jaw as well as on the alveolar margin, forming a central growth which gradually expands the jaw, causing eggshell crackling or spontaneous fracture of the bone. They are slowly growing tumours, seldom forming metastases, and are treated by excision of the part of the jaw in which they are growing.

X-ray examination is valuable in the diagnosis of these tumours. The prognosis is good.

2. **Malignant.**—**Sarcomata** of the lower jaw may be either periosteal or endosteal, round-celled or spindle-celled.

The clinical feature is the presence of a rapidly enlarging swelling on the lower jaw, displacing the teeth, and becoming adherent to the



FIG. 433.—SARCOMA OF THE LOWER JAW.
(London Hospital Medical College Museum.)

surrounding parts. The diagnosis has to be made chiefly from the innocent odontomata, which should always be carefully excluded.

The TREATMENT is excision of the lower jaw.

Carcinoma, usually squamous-celled in type, may invade the lower jaw from growths of the tongue, floor of the mouth or the lips. If radical cure is contemplated, a large piece of the jaw must be removed (see p. 977).

Malignant Odontomata also occur in the lower jaw, but are not to be distinguished from the sarcomata on clinical examination. The treatment is the same as for sarcomata.

EXCISION OF THE LOWER JAW.—The preparations for removal of the lower jaw are similar to those for removal of the tongue (see p. 977).

The incision runs from the attachment of the lobule of the ear (if the incision is carried higher than this there is danger of cutting the facial nerve) downwards to the angle of the jaw, along its lower margin to the middle of the chin, and from this point it turns upwards, terminating just below the red margin of the lip. The facial artery

and vein are ligatured before being divided. The soft parts are then separated from the bone, unless they are already invaded by the growth, in which case free removal of them is necessary. This must be done, even if the facial nerve has to be sacrificed. The cavity of the mouth must be opened. An incisor tooth is removed, and the lower jaw sawn through near the symphysis. The temporo-maxillary articulation is reached by depressing the bone strongly, the ligaments are cut with stout scissors, and the jaw disarticulated. The chief dangers are wounding the facial nerve and the internal maxillary artery. The after-treatment and the complications are similar to those after removal of the tongue (see p. 978).

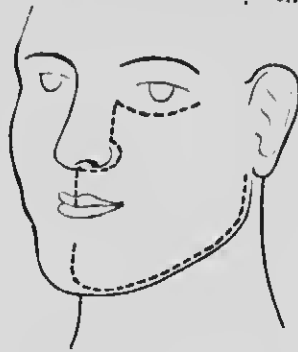


FIG. 434.—INCISION FOR REMOVAL OF UPPER AND LOWER JAW.

ODONTOMA

The odontomata are tumours arising in connection with the permanent tooth germs. They originate from any of the parts of one germ, or from the whole germ or several germs. The following varieties are recognized according to their origin:

1. **Epithelial Odontome or Fibro-Cystic Disease of the Jaw.**—This variety arises from the enamel organ—*i.e.*, it is epithelial in origin. It occurs most frequently in the lower jaw, and on macroscopic section, appears as a collection of cysts lined by epithelium and containing a glairy fluid.
2. **Follicular Odontoma (Dentigerous Cyst).**—In this form the tooth sac of the unerupted permanent tooth becomes distended with fluid, forming a large cyst, which contains the tooth, usually one of the molars. The condition has to be diagnosed from a dental cyst, which is inflammatory in origin, and occurs round the root of a carious tooth. A radiogram will often show the unerupted tooth.
3. **Fibrous Odontome.**—If the tooth sac is thickened by fibrous tissue, instead of giving way and allowing the tooth to erupt, a fibrous odontome is formed, the tooth remaining buried in a mass of fibrous tissue.
4. **Radiolar Odontome.**—These are tumours arising from the root of a tooth. They may cause great obstruction to extraction.
5. **Cementome.**—A cementome arises from the cement substance of the tooth, and is a very rare form of tumour.

6. **Composite Odontome.**—This tumour arises from the whole of the tooth germ or from several tooth germs which have fused together, and consists of a mass of enamel, dentine, and cement.

7. **Malignant Odontome.**—Malignant tumours of the jaws have been described which, on section, contained elements closely resembling the developing tooth. They have been designated "malignant odontomes," but their pathology is doubtful, and they cannot be distinguished clinically from other varieties of malignant tumours of the jaws. The treatment is excision of the jaw from which they are growing.

CLINICAL FEATURES OF SIMPLE ODONTOMATA.—These tumours most commonly occur in young subjects and form slowly growing, localized neoplasms of the jaws, which are often diagnosed as osteomata, fibromata, or sarcomata. On examination, it will be found in the majority of cases that a tooth is missing over the site of the tumour, or that one of the milk teeth is persisting, and an X-ray examination may reveal the unerupted tooth buried in the jaw. The first intimation of the presence of an odontome may be suppuration occurring round it. This frequently happens between the ages of twenty to twenty-five, and the presence of the odontome may only be recognized after the abscess has been opened.

Dentigerous cysts, the most common form of odontome, appear as a smooth, rounded, painless swellings under the gum. When large, they are bluish in colour, and eggshell crackling of the bone over them may be obtained. The cyst is filled with mucoid fluid, and may contain one or more unerupted teeth.

TREATMENT.—The treatment of simple odontomata is thorough local removal. A dentigerous cyst is treated by freely removing its outer wall, scraping its interior, and allowing the cavity to granulate from the bottom. An unerupted tooth, if present, should be removed.

CHAPTER XXIX

AFFECTIONS OF THE TONGUE, PHARYNX, TONSILS, AND ŒSOPHAGUS

INJURIES AND DISEASES OF THE TONGUE

Wounds of the Tongue are most frequently made by the teeth, especially during epileptic fits. The hæmorrhage may be profuse.

TREATMENT.—If the wound be far back and large, the bleeding should be arrested for the moment by pressure with a piece of lint in the wound, while the proper instruments are obtained for giving an anæsthetic, arresting hæmorrhage, and suturing. The patient being anæsthetized, the mouth is opened with a gag, a stout silk ligature passed through the tip of the tongue, and then pulled upon in order that the wound is well exposed. The bleeding vessels should be seized—the wound being enlarged if necessary—and ligatured. If the bleeding be venous or capillary oozing, suture of the wound is all that is required. The wound should be sutured with chromicized catgut, for then there will be no need to remove the stitches.

In wounds of the point of the tongue an anæsthetic is not necessary, but in all cases where there is difficulty in stopping hæmorrhage it is advisable to administer one, in order that the bleeding can be securely arrested.

SECONDARY HÆMORRHAGE is not common from wounds of the tongue unless they are complicated by the presence of a foreign body or with malignant ulceration.

In all cases an anæsthetic should be given, the wound well exposed and cleaned, and a thorough search made for a foreign body. The bleeding-point, if it can be seen, should be ligatured; in other circumstances it will be necessary to tie the lingual artery in the neck. If the wound is a large one, involving the tonsil or other parts, it is probably better to tie the external or common carotid.

After suturing wounds of the tongue, a weak antiseptic mouth-wash should be used frequently. Healing as a rule occurs readily.

Stings on the Tongue may prove fatal in a few minutes, the patient collapsing from failure of pulse and respiration. In other cases acute œdema of the glottis follows upon the swelling of the tongue, and tracheotomy is necessary to save the patient's life.

TREATMENT.—If the patient is collapsed, stimulants should be given, and artificial respiration performed if necessary. Incisions

are rarely necessary into the tongue, unless the swelling is very marked in this or in any other form of acute glossitis. The incisions should be two in number, one on each side of the middle line, and should be $1\frac{1}{2}$ to 2 inches long and $\frac{1}{4}$ inch in depth. Cocaine may be applied first.

The hemorrhage is free, but not severe, and is decidedly beneficial. Suppuration is less likely to occur if the incisions are made early; the relief given is striking.

The mouth should be frequently washed out with an alkaline solution (Pot. bicarb., grs. x. ad \mathfrak{z} i.) or a weak solution of ammonia, and ice may be sucked. Should the breathing become embarrassed, tracheotomy should be performed early.

CONGENITAL ABNORMALITIES

1. **Aglossia** (complete or partial absence of the tongue) is exceedingly rare.

2. **Extreme Length of Tongue and Frenum.**—This condition may be congenital and a patient be able to touch the sternum with the tongue. A complication is tongue-swallowing, the tip of an extremely long tongue being caught by the fauces and involuntarily swallowed, death resulting from suffocation. The condition may also be acquired in one of two ways: (1) After division of the frenum for alleged tongue-tie, the front part of the tongue may become too mobile, and the patient—usually an infant—may swallow the tongue; (2) with certain chronic affections of the pharynx and naso-pharynx a patient may acquire the habit of licking those parts with the tongue, the tongue becoming unduly mobile.

3. **Bifid Anterior Portion of the Tongue.**—This can be remedied by a plastic operation at the wish of the patient.

4. **Tongue-Tie.**—Shortness of the frenum of the tongue is more often diagnosed by the parents or midwife than seen by the surgeon, and is to be considered a rare congenital deformity. Division of the frenum linguae should never be done unless such a definite degree of tongue-tie is present as to prevent the infant sucking or protruding the tongue beyond the gums.

TREATMENT.—The shortened band of the frenum is snipped with a pair of scissors, and the wound widened by pressing the tongue back with the thumb. Too free division leads to the danger of tongue-swallowing.

5. **Macroglossia.**—This condition will be considered under Tumours of the Tongue (p. 972).

INFLAMMATIONS OF THE TONGUE

Acute Superficial Glossitis.—Acute inflammation of the epithelium of the tongue is generally associated with an acute stomatitis due to mercurial poisoning, secondary syphilis, burns of the mouth, aphthous stomatitis, etc. The treatment is that of stomatitis.

Acute Parenchymatous Glossitis.—Acute inflammation of the tongue, apart from the stings of insects, is due to infection of the tongue, usually by a streptococcus. The causes are—Inflammation of the surrounding structures, especially the tonsils in the acute infectious fevers; any form of ulceration of the tongue, including mercurial poisoning; wounds of the tongue, especially if associated with the presence of foreign bodies; infection of the sublingual tissue; and infection from animals suffering from "foot-and-mouth disease." In some cases no cause can be assigned.

CLINICAL FEATURES.—The patient, who is often under treatment for some inflammation of the tonsils or pharynx, complains of great swelling of the tongue and difficulty in breathing. In many instances the symptoms become urgent in a few hours. The tongue is firm and swollen, protrudes from the mouth, and is covered with a thick white fur. The breath is fetid, and when the swelling is considerable, the patient has great difficulty in speaking, swallowing, and breathing. Salivation is a marked feature, and there is great pain. The lymphatic glands of the neck are as a rule enlarged. The inflammation may involve one-half of the tongue only, the condition then being termed *hemiglossitis*.

The general symptoms are those of a severe infection.

RESULTS.—*Resolution* is the commonest termination, the inflammation disappearing in about a week. *Fibrosis* is rare, though occasionally a hard fibrous nodule is left in the tongue. *Suppuration* may result in the formation of a localized abscess, or be diffuse through the tongue, the latter condition being serious, and not infrequently associated with septic broncho-pneumonia. Gangrene occasionally occurs, especially in cases of "foot-and-mouth disease."

TREATMENT.—The general treatment of any infective condition should be carried out. Locally, the mouth and tongue should be kept clean by antiseptic mouth-washes. The swelling may be lessened by placing pieces of linen soaked in glycerine on the tongue. If this treatment is not adequate, a longitudinal incision should be made on each side of the middle line, and the tongue allowed to bleed freely, the muscular tissue being incised. Tracheotomy is only occasionally necessary, and should not be performed early, for resolution is the common sequel, and tracheotomy greatly increases the liability of broncho-pneumonia. Abscess of the tongue must be treated by incision.

Chronic Superficial Glossitis.—Chronic superficial glossitis is a chronic inflammation of the epithelium and subepithelial tissue of the tongue, usually associated with a similar condition on the inner surfaces of the cheeks near the angles of the mouth.

A chronic parenchymatous glossitis may be present at the same time.

CAUSES.—Syphilis is believed to be the most important predisposing cause, although a history or evidence of the disease is not always obtained. The exciting causes generally alleged are smoking, irritation of carious teeth or ill-fitting tooth-plates, excessive use of hot

condiments, spirit-drinking, etc.; but in many cases all these causes are absent, and the reason for the disease is obscure.

CLINICAL FEATURES.—The patient may complain of burning and itching of the tongue, especially when taking hot or spiced food, salivation or dryness of the mouth, and loss of taste. In many instances, however, it is the appearance of the tongue that brings the patient to the surgeon. The symptoms may be so insignificant that no advice is sought until carcinoma has developed.

On examination, various appearances of the tongue may be seen, and two or more of them may be present at the same time on different parts of the tongue and the inner sides of the cheeks. The tongue should always be carefully dried before the examination is made.

1. The tongue may be red and swollen, and indented by the teeth, and the papillæ over the anterior two-thirds hypertrophied, and this hypertrophy so marked that the tongue appears shaggy.
2. White patches are present, which on examination are found to consist of heaped-up epithelium which has undergone keratinization. These patches may be small or may cover the whole surface of the tongue, and be so dense as to give the appearance of white plaques on the tongue; or the epithelium may be so heaped up that the condition is spoken of as warty. If these patches are peeled off, they leave a raw, bleeding surface. When the white patches are well marked, the condition is sometimes called *leucoplakia lingualis*.
3. The tongue may present glazed, smooth, red patches, over which the papillæ have disappeared. The epithelium is thinner than normal, and the subepithelial tissue is dense. This smooth, glazed appearance may extend over the whole organ, which is much drier than normal.
4. Furrows, not due to ulceration, are often present in the tongue, and when the furrow is opened, the epithelium at the bottom is found intact, and the lingual papillæ are present.
5. Cracks and small ulcerations, callous and healing slowly, often develop in the later stages of the disease. After they have healed, their cicatrices remain and cause additional furrows.

If chronic parenchymatous glossitis is present at the same time, the tongue is smaller and harder than normal, and distorted in shape.

PROGNOSIS.—If the disease is once thoroughly established complete cure is impossible, but the symptoms may be relieved and an increase of the condition checked.

RELATIONSHIP TO CARCINOMA.—A large proportion of cases of chronic superficial glossitis (Barker, 43 out of 110 cases) end in carcinoma; and it has been termed a "precancerous condition." The

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PLATE VII



Chronic superficial Glossitis (*Chenopodiata buccalis*).

glossitis, however, may remain for years without malignant change supervening; and, on the other hand, many cases of carcinoma develop in the tongues of patients who have never suffered from superficial glossitis.

TREATMENT.—An isolated white or warty patch on the tongue should be excised, and excision of the epithelium or “skinning of the tongue” should be carried out in advanced cases, a careful microscopical examination of the part removed being made to determine the presence of malignant change.

Milder cases should be treated by removal of the cause, such as smoking, spirit-drinking, carious teeth, etc., and the giving of such soothing antiseptic mouth-washes as bicarbonate of soda with a little carbolic acid, or borax. Butlin recommended the application of a lanoline ointment to the tongue each night. General antisyphilitic treatment may be tried, though it usually has little effect.

Cracks and ulcers of the tongue should be treated by the application of chromic acid (gr. v. ad ʒi.) or some other caustic, a few applications only being made, for the continued use of caustics in chronic superficial glossitis is one of the great causes in determining the onset of carcinoma. If the ulcer or crack is persistent, it should be excised and microscopically examined.

“**Smoker's Patch.**”—This is a localized form of chronic superficial glossitis which develops at the place on the tongue where the mouth-piece of the pipe or cigar-holder rests. It consists of a red patch on the tongue covered by a yellowish crust of sodden epithelial cells, and over which the papillæ are wanting.

TREATMENT.—Smoking should be discontinued, and the patient given a mouth-wash. The patch, if irritable, may be painted a few times with 5 per cent. solution of chromic acid.

SYPHILIS OF THE TONGUE

Primary.—Primary sores are generally met with on the anterior part of the tongue, and are most commonly due to smoking infected pipes. The chancre is atypical in appearance, and there is more induration than in tubercular or tertiary syphilitic ulceration. The submaxillary glands on both sides are swollen and painful, but suppuration is uncommon.

Secondary.—The lesions in the secondary stage are superficial, subacute inflammations, and the following manifestations may be seen:

1. Mucous patches of beaped-up epithelium.
2. Condylomata on the dorsum, in which the epithelium may be so heaped up as to form a “Hutchinson's wart.”
3. Small superficial ulcers, snail-track or semilunar in shape.

All these lesions may be present simultaneously on the same tongue.

Tertiary.—The following lesions are met with during the tertiary period:

1. Chronic superficial glossitis.
2. Chronic sclerosing parenchymatous glossitis, in which fibrous tissue forms in the substance of the tongue, squeezing the muscular tissue into round, firm elastic nodules, which may be mistaken for new growths. The tongue is harder than normal, does not move so freely, and is furrowed.
3. Gumma formation. A *gumma* of the tongue usually develops on the dorsum near the middle line, and therefore does not interfere with the movements of the tongue, which can be freely protruded. Two or more gummata may be present, and the swelling may be superficial or deep. *On examination*, there is found an elastic, painless swelling in the substance of the tongue, either just under the mucous membrane or situated deeply. It increases in size slowly, but ultimately breaks down, forming a gummatous ulcer.
4. Gummatous ulcers of the tongue are generally situated on the dorsum near the middle line. They are rounded, or have a serpiginous outline with a sloughing floor and a foul secretion. The edges are sharply cut or undermined, and the surrounding tissue is indurated; but the induration is not so marked as in carcinoma or primary sores. Pain is not such a prominent feature as in malignant disease and tuberculous ulcers. Carcinoma may develop in a syphilitic ulcer. When the ulcer heals, a permanent fissure, which may give valuable evidence of past syphilis, is left in the tongue.

TREATMENT.—At all stages of the disease the mouth must be kept clean by the use of mouth-washes, of which the most valuable are chlorate of potash, lotio nigra, and borax. General antisyphilitic treatment should be given, and if mercury is employed, the course of treatment should be continued for months after the lesion has healed. Mercurial stomatitis must not be mistaken for syphilis, and the mercurial treatment pushed. As soon as there is a suspicion that a gummatous ulcer is becoming carcinomatous, it should be excised and examined microscopically.

TUBERCULOSIS OF THE TONGUE

Tuberculosis rarely, if ever, occurs in the tongue as a primary infection; in the great majority of cases it is secondary to tuberculosis of the lungs or larynx, the tongue being probably infected from the sputum.

CLINICAL FEATURES.—The disease is most common in young adults, and affects the dorsum of the tongue near the tip and to one side. It appears first as a submucous nodule or nodules, which breaks down into a tuberculous ulcer with the following characteristics: The outline is irregular, with sharply defined edges and an uneven sloughing

floor. The base is not indurated, and the tongue can be freely protruded, but small nodules of tuberculosis are usually present round the primary focus. The ulcer is as a rule extremely painful, and interferes with eating to a very serious extent; the discharge is thin and sanieus. The submaxillary glands are not often affected.

The Prognosis is very bad, and even if healing takes place, the scar is very apt to break down.

TREATMENT.—The treatment of tuberculosis of the tongue is **excision**, but this operation may be contra-indicated by the general condition of the patient, or by that of his lungs or larynx. The focus should be completely excised and the gap in the tongue sutured. If the operation cannot be undertaken, the mouth should be kept clean, and the pain allayed by the application of etherform or some other local analgesic. The principal trouble is the pain caused by eating; therefore the anæsthetic should be applied just before food. The ulcer should be thoroughly cleaned after each meal, and, if necessary, more of the analgesic applied. Cauterization of the ulcer or excision of the lingual nerve may also be useful for the relief of pain.

Dental Ulcer.—This variety of ulceration is due to the rubbing of the tongue against a sharp carious tooth or on an ill-fitting tooth-plate.

CLINICAL FEATURES.—The ulcer is situated on the side of the tongue, and lies opposite the tooth which causes it. The ulcer is irregular in outline, with sharp-cut edges and a sloughing floor. There is often distinct induration of the base, especially if the ulcer is neglected. The surrounding portion of the tongue is inflamed, so that it does not move freely; salivation is usually present. The submaxillary glands are often enlarged and tender. The condition may persist for weeks or months, and in these old-standing cases the resemblance to carcinoma is very exact.

TREATMENT.—The tooth should be removed or the sharp edge filed down, and the ulcer, after being cleaned and dried, painted with chromic or carbolic acid. The patient should use a solution of potash mouth-wash, and the ulcer ought to show signs of healing in a few days. If this does not take place, the question of carcinoma should be considered, and part of the edge excised and examined microscopically.



FIG. 435.—SIMPLE (DENTAL) ULCER OF THE TONGUE.

Dyspeptic Ulcer.—Small superficial ulcers of the tongue and inner aspect of the lips are frequently met with in badly nourished children and in adults who suffer from indigestion. They should be touched with solid silver nitrate, and the stomæhic condition treated.

Ulceration in Whooping-Cough.—A small ulcer is met with under the tongue of patients with whooping-cough, due to the tongue rubbing against the lower teeth during the paroxysms of coughing.

Herpes.—The vesicles appear in the back and sides of the tongue, and break down into small superficial ulcers. A mouth-wash is all that is necessary.

Annulus Migrans (Geographical Tongue).—This condition occurs in ill-nourished children, and is very rare and intractable to treatment. Small red patches appear, and spread in an annular fashion, clearing up in the centre as they spread at the periphery. The rings coalesce, so that a well-outlined figure appears on the tongue, which changes in shape from day to day (geographical tongue). There is little pain, but the tongue burns, and there is some salivation.

The TREATMENT consists of giving a mouth-wash, and in time the condition disappears.

NEW GROWTHS

Innocent

Papillomata occur in the form of warts, and require excision.

Angieomata are not uncommon, and are usually of the cavernous type (see p. 333). They grow rapidly, and are difficult to remove completely, several operations being necessary. Small nævi may be treated with the actual canter, the application of carbon dioxide snow, or by electrolysis.

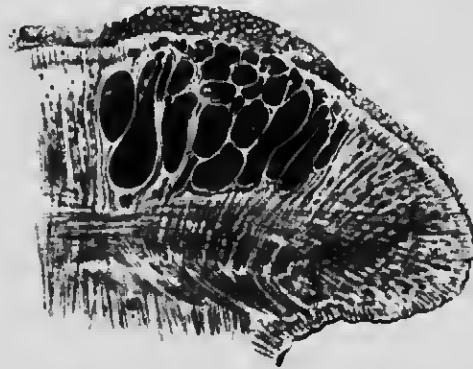


FIG. 436.—ANGEOMA (NÆVUS) OF THE TONGUE.
(London Hospital Medical College Museum.)

Macroglossia.—This is a congenital enlargement of the tongue implicating the anterior two-thirds. It increases steadily in size as the patient grows older. In marked cases the tongue protrudes from the mouth, causing deformity of the lower jaw

and teeth. The tongue becomes dry and scaly, and superficial ulcers develop on it. Two pathological varieties are distinguished:

1. The condition is a plexiform lymphangioma, analogous to the plexiform angiomata, the tumour being diffuse through the substance of the tongue.
2. It may be a condition of neuro-fibromatosis (see p. 218) of the lingual and hypoglossal nerves.

TONGUE, PHARYNX, TONSILS, AND OESOPHAGUS 973

TREATMENT.—As the tongue enlarges, a large wedge-shaped portion should be excised, and the edges of the incision brought together.

Lipomata may occur in the substance of the tongue, and require removal.

Malignant

The malignant new growths of the tongue are sarcoma and carcinoma.

Sarcoma of the tongue is extremely rare, and is generally seen in children. The tumour grows steadily, and the diagnosis is rarely made until a portion is excised for microscopic examination.

Histologically it is as a rule a round-celled growth.

The **TREATMENT** is the same as for carcinoma.

Carcinoma.—Carcinoma is the commoner form of malignant new growth of the tongue, and is usually seen in patients over forty.

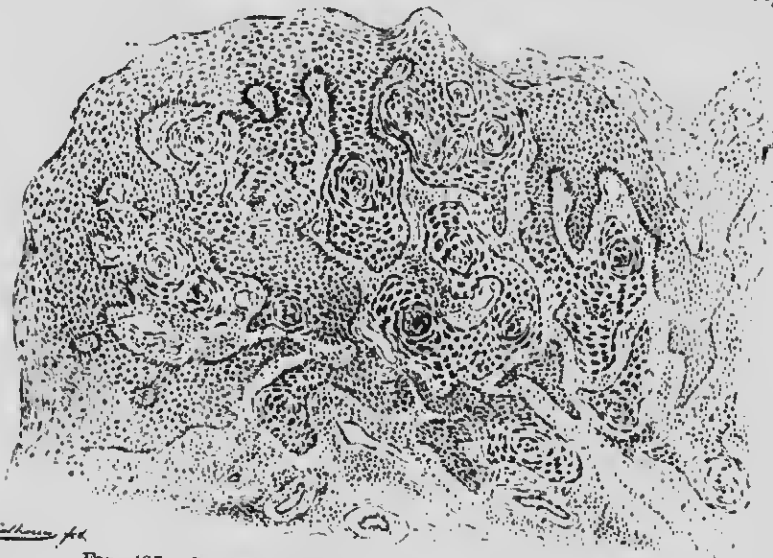


FIG. 437.—SQUAMOUS-CELLED CARCINOMA OF THE TONGUE.

It occurs occasionally, however, at an earlier age, one case being seen by the author at the age of eighteen. It is more common in males than in females. This is probably accounted for by the habits of smoking and spirit-drinking, and the greater prevalence of syphilis and chronic superficial glossitis in men. The irritation of a carious tooth constantly rubbing against the tongue, and the habit of smoking a short clay pipe, the mouth-piece of which rests against the tongue, predispose to carcinoma. Tertiary syphilitic ulceration of the tongue may also develop into carcinoma.

The type of growth is a squamous-celled carcinoma, and there is usually extensive keratinization of the cells, so that cell-nests are

well marked and abundant. The lymphatic glands are affected early, but the first enlargement is inflammatory, owing to infection from the ulcer.

The growth is usually situated on the anterior two-thirds of the tongue on one side of the middle line, but it may invade the tongue from a carcinoma situated in the floor of the mouth.

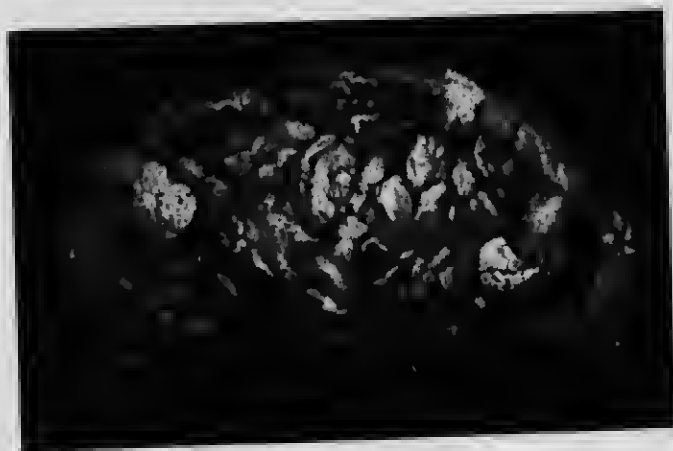


FIG. 438.—CARCINOMA OF THE TONGUE: LATERAL VIEW.

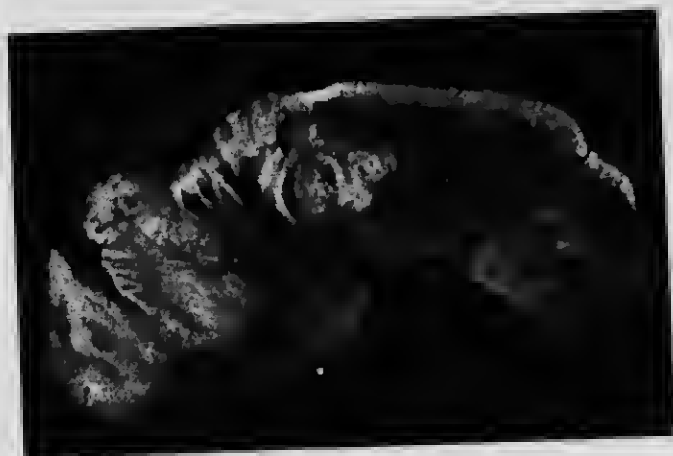


FIG. 439.—CARCINOMA OF THE TONGUE IN LONGITUDINAL SECTION.

CLINICAL FEATURES.—The disease starts in one of the following ways:

1. As a small warty growth.
2. As a small subepithelial nodule.
3. As a thickening in a patch of chronic superficial glossitis.

TONGUE, PHARYNX, TONSILS, AND ŒSOPHAGUS 975

In any case, sooner or later the condition develops into a carcinomatous ulcer with thick everted edges; a sloughing floor on which small, warty projections are often visible; a hard, indurated base, which becomes fixed to surrounding structures; and a foul secretion. The patient complains of the ulcer in the mouth, salivation, and pain, which is referred to the corresponding ear. The speech is somewhat slurring, and if the patient is asked to protrude the tongue, it is found to be somewhat fixed in the mouth, and deviates towards the side on which the growth is situated. In the later stages, the patient may be unable to protrude the tongue between the teeth.

The growth spreads steadily and invades the floor of the mouth, the lower jaw, and the fauces.

The glands affected are the sublingual, submaxillary, and the glands lying along the internal

jugular vein (superior and inferior carotid set). Although the growth may be apparently limited to one half of the tongue, the glands on both sides of the neck are often affected, owing to the anastomosis of the lymphatic channels.

As stated above, the first enlargement of the glands is inflammatory, and it is not a contra-indication to operation. The submaxillary and sublingual salivary glands are involved, as the lymphatic glands lie in the same covering of deep cervical fascia, and should always be removed. After the lymphatic enlargement has become carcinomatous, chronic suppuration is apt to occur in the glands, which become soft and fluctuating. If these abscesses burst or are opened, a fungating ulcer appears in the neck. Secondary growths in distant organs are rare. The causes of death are exhaustion, hæmorrhage from the opening of large bloodvessels, septic broncho-pneumonia, and suffocation owing to the pressure of the enlarged lymphatic glands.

DIAGNOSIS.—The differential diagnosis has to be made from syphilitic ulceration in the tertiary period, callous dental ulcers,



FIG. 410.—CARCINOMA OF THE TONGUE.
(Note the patient is unable to protrude the tongue from the mouth.)

induration of patches of leucoplakia, primary chancres, and any other form of ulceration of the tongue. All these conditions may terminate in carcinoma, and unless they improve *rapidly* under treatment, a portion of the ulcer wall should be excised and submitted to microscopic examination, for the only hope of radical cure is early and complete removal of the growth. Papilloma may simulate carcinoma, but as the growth should always be removed immediately, and submitted to microscopical examination, the diagnosis is soon settled. Occasionally the normal ridge of papillae foliatae situated on the sides of the tongue are mistaken for an early carcinoma. No stress should be laid on the absence or presence of enlarged glands in the neck in the early diagnosis of carcinoma.

PROGNOSIS.—The prognosis of carcinoma of the tongue is bad on account of the late period at which the patient comes for radical operation. As carcinoma is the most common disease occurring in the tongue in patients over forty, every ulcer or nodule in the tongue of a patient over this age should be regarded with grave suspicion, and every means taken to establish an accurate diagnosis. The mortality immediately after operation is about 10 per cent., and it may be stated generally that it is uncommon to see a patient alive three years after the tongue has been removed, especially patients of the poorer classes. Cases that are not operated upon rarely live for more than a year after the disease first comes under observation.

TREATMENT.—The modern operation for carcinoma of the tongue, even in the earliest stage, is removal of the growth with $\frac{1}{2}$ inch of apparently healthy tissue round it—no matter if this encroaches over the middle line—and the whole of the fascia containing the lymphatic glands and lymphatics lying in the anterior triangles on both sides of the neck. This fascia should be removed as far as possible in one sheet, starting from below.

The operation includes removal of the submaxillary and sublingual salivary glands.

The method of performing this operation varies considerably. That advocated by the author will be first described:

An incision is made along the margin of the jaw from one angle to the other, and a second incision is made extending the whole length of the middle line of the neck. The triangular flap of skin and fascia marked out on this side of the growth is then dissected back until the sterno-mastoid muscle is thoroughly exposed. Beginning at the sternum, a clean dissection is made of the anterior triangle. The lingual and facial arteries are tied at their origin from the external carotid artery, and the lingual and facial veins are ligatured as they enter the internal jugular. The submaxillary and sublingual glands are removed in the sheet of fascia.

A similar operation is then performed on the other side of the neck, and the neck wound closed with drainage. The mouth is then opened, and the whole or a large portion of the tongue freely excised. The wound in the mouth is closed as far as possible by suturing.

TONGUE, PHARYNX, TONSILS, AND OESOPHAGUS 977

This operation takes from one hour to one hour and a half, and the advantages claimed are—

1. The amount of bleeding, especially at the second part of the operation is slight, as the lingual and facial arteries are ligatured on both sides.
2. The operation is completed under one anaesthesia.
3. The removal is very thorough.
4. There is no need for a preliminary laryngotomy or tracheotomy, steps that increase the risk of broncho-pneumonia.
5. The wounds heal well, there is little discharge from the mouth, and the resulting deformity is slight.

OTHER METHODS.—1. The tongue may be removed by **Whitehead's operation**, and the glandular operation done nine or ten days later. Whitehead's operation is an intrabuccal method, the tongue being cut away with scissors, and the lingual arteries ligatured on the face of the stump.

2. When the floor of the mouth is extensively involved, a preliminary laryngotomy is advisable to prevent blood entering the trachea, as this is a common source of broncho-pneumonia.

3. **Syme's operation** and its modifications. In this operation, which is reserved for extensive cases, the lower jaw is split at the symphysis, and the two halves forced widely apart. This gives a good view of the tongue and floor of the mouth, and the tongue can be removed right back to the epiglottis and the pillars of the fauces. After removal, the two halves of the jaw are wired together. A preliminary laryngotomy is usually advisable.

4. In advanced cases it may be necessary to remove part of the jaw, and the operation must be modified accordingly.

5. With involvement of the posterior part of the tongue, the glands in the posterior triangle must also be removed, and with well-marked glandular involvement it is advisable to remove the whole of the sterno-mastoid muscle and the internal jugular vein.

In these extensive operations the external carotid artery should be tied.

6. If these operations are not considered advisable, the lingual artery may be ligatured in the submaxillary triangle before removal of the tongue.

Before operations on the tongue, very careful preliminary treatment is necessary to diminish the risk of infection. For at least three days before the operation the patient should wash out the mouth every few hours—and always after taking food—with some such antiseptic mouth-wash as carbolic acid and water (1 in 80), warm peroxide of hydrogen, or permanganate of potash solution. The teeth should be attended to, all carious stumps removed, the healthy teeth scaled, and carious teeth stopped temporarily. They should be brushed night and morning, a carbolic tooth-powder being used. The mouth, tongue, and ulcer should be cleaned twice daily with great care. Pieces of lint soaked in 1 in 1,000 biniodide of mercury, or perchloride

of mercury should be gently pushed into all cracks and pockets, and the ulcer itself painted with a camel-hair brush dipped in the solution.

If the patient is in a good state of health, there is no need to keep him in bed, and he can continue his ordinary occupation till the day before the operation. Elderly, feeble patients who have been half-starved beforehand on account of the pain, salivation, and septic condition of the mouth, require rest in bed and careful feeding for a few days before being operated upon. The cleaning of the mouth will enable the patient to take food more easily. Fluids and soft food should be given freely, the food being first sterilized. If sufficient food cannot be taken by mouth, nutrient enemata must be given.

In all cases the method of taking food after the operation should be explained to the patient, who should practise it, so that no difficulty may be experienced.

The patient should be shaved, and if the glands are to be removed, the whole of the front and both sides of the neck should be prepared to well below the clavicles. The chin, lips, and face should also be rendered as nearly aseptic as possible.

AFTER-TREATMENT.—The patient is kept in bed, lying on one side, with the head low, so that blood and mucus can readily escape from the mouth, and not be swallowed or inhaled. He may be nursed in that position throughout; but if shock passes off in twelve hours, he may with advantage be propped up with pillows, and the after-treatment carried out in that position.

During the first day or two ice may be sucked. If the pain is severe, morphia should be given. The mouth must be cleaned every two hours with the same antiseptic as was used before the operation. In a day or two the patient will be able to assist in this. If gauze has been packed into the mouth during the operation, it should be removed after twenty-four to forty-eight hours.

The **COMPLICATIONS** of the operation are—

1. Asphyxia from the stump of the tongue falling back, or blood entering the trachea.
2. Hemorrhage from the lingual arteries, especially if they have been ligatured on the face of the stump.
3. Septic broncho-pneumonia from inhaling pus. This complication usually occurs on the third day, and the symptoms are rising temperature, cough with difficulty of expectoration, cyanosis, and increased pulse and respiration rate. It is generally a fatal complication.
4. Heart failure.

EFFECTS OF REMOVAL OF THE TONGUE.—Speech and deglutition are but little interfered with if the anterior part of the tongue is removed, but after extensive operations on the base of the tongue and the floor of the mouth, speech is impaired. After a short period, however, the patient can make himself easily understood by his friends, and with a little difficulty, by strangers. Deglutition is also interfered with in these cases, the food tending to collect between the teeth and the cheeks; but the patient, even after extensive operations only

leaving the epiglottis, can take food readily. The swallowing of saliva is difficult, and the patient has constantly to wipe it away, as it runs from the corners of the mouth. Its flow may be diminished, if necessary, by giving small doses of atropine.

PALLIATIVE TREATMENT OF CARCINOMA OF THE TONGUE—

1. *Prevention of Sepsis.*—All the symptoms of the malignant disease are increased by sepsis; therefore, by preventing septic decomposition in the mouth, the acuteness of any of the symptoms—such as pain, salivation—and the danger of hæmorrhage is diminished. The teeth should be scaled, septic fangs extracted, and carious teeth temporarily stopped. Aseptic mouth-washes should be used freely, and the malignant ulcer carefully cleaned and painted with perchloride of mercury (1 in 1,000).

2. *Pain.*—This can be relieved by the insufflation of such powders as orthoform or boracic, 4 grains; iodoform, 1 grain; and morphia, $\frac{1}{4}$ grain. The ulcer should be dried with a small piece of lint or blotting-paper, and the powders then blown in with an insufflator. This can be repeated two or three times a day. Cocaine may also be sponged over the ulcer.

The best treatment for deep ulcers is careful cleaning and spraying with 10 per cent. cocaine, and then packing with strips of soft iodoform gauze. This should as a rule be changed every other day, though in some cases it can be left for three or four days.

The application of the actual cautery, followed by aseptic mouth-washes, may give relief, but is not without danger, owing to hæmorrhage when the slough separates.

Excision of a portion of the lingual nerve just behind the last molar tooth will occasionally relieve the pain, but it may return after being absent for some time.

Directly it is necessary to procure relief, morphia and opium should be given freely enough to diminish pain and to procure sleep at night.

3. *Salivation and Fætor* are relieved by the means given above of preventing sepsis, especially the application of iodoform in powder or gauze. If the smell of the iodoform is much objected to, it may be hidden by a drop of attar of roses to each drachm of iodoform (Butlin). Any antiseptic mouth-wash may be used.

Atropine in doses of $\frac{1}{100}$ grain, or the division of the lingual nerve, tend to diminish the flow of saliva.

4. *Hunger.*—After pain is relieved, food can generally be taken. It should be non-irritating, pepper, spices, etc., being avoided. In the later stages the food should be fluid or semifluid, and given cold or lukewarm.

Nasal feeding can be resorted to if food by the mouth is too painful, and as a last resort rectal feeding may maintain life for some time.

5. *Hæmorrhage.*—Death from hæmorrhage is rare, but it cannot be deplored in inoperable cases. It may be venous or capillary, in which case the only treatment necessary is the application of styptics, such as adrenalin; or it may be arterial, and demand more energetic treat-

ment. It is rarely, if ever, possible to apply a ligature to the bleeding-point, on account of the sloughing condition of the ulcer. The lingual or external carotid must be tied, according as the hemorrhage is definitely from the lingual or from an artery in the floor of the mouth. It should only be done at the urgent request of the patient or his friends.

6. *Suppurating Malignant Lymphatic Glands.*—This complication is prevented by reducing the septic condition of the mouth, but it is a common sequel to cancer of the tongue. The suppuration is usually mild, and the pain not great. Even if fluctuation is present, it is better not to interfere with the glands until the abscess is about to burst. The incisions will not heal, and a large malignant ulcer will soon appear, and must be kept clean and aseptic in the usual way.



FIG. 441.—FUNGATING CARCINOMA OF THE GLANDS OF THE NECK SECONDARY TO CARCINOMA OF THE TONGUE.

7. *Asphyxia*, due to the presence of malignant glands in the neck pressing on the trachea, may be the direct cause of death. It may be possible to do a low tracheotomy, and so maintain life for some time longer; but the difficulty of finding the trachea and of introducing a tube which will relieve the breathing is sometimes very great.

THYROID TUMOURS AND CYSTS OF THE TONGUE

These tumours and cysts arise in aberrant thyroid tissue lying in the middle line of the tongue. This thyroid tissue is the remains of the thyroglossal tract, from which the middle lobe of the thyroid is developed.

Thyroid tumours occur chiefly at the back part of the tongue, and on microscopical section, closely resemble normal thyroid tissue. The cysts are formed from degeneration of the tumour in the same way as they are formed in goitres (see p. 1047).

TONGUE, PHARYNX, TONSILS, AND OESOPHAGUS 081

CLINICAL FEATURES.—The patient complains of a swelling in the tongue, which may be large enough to interfere with deglutition. It is sometimes accompanied by severe attacks of hæmorrhage. The tumour may enlarge suddenly, owing to internal hæmorrhage, and if not previously noticed, the sudden onset of the symptoms is very puzzling.

On examination, a bluish-red swelling, situated deeply in the back of the tongue and near the middle line, is seen. The swelling slowly increases in size.

These tumours may become malignant, and then have the usual clinical characteristics of carcinomata.

TREATMENT.—The tumour should be shelled out of its capsule in a similar manner to that employed in removing adenomata of the thyroid.

Lingual Dermoids.—Lingual dermoids arise in connection with the lingual duct, and are situated in the middle line of the tongue between



FIG. 442.—SUBLINGUAL DERMOID.
(London Hospital Medical College Museum.)

the genio-hyoid muscles, often protruding into the floor of the mouth. In some instances they are so large as to protrude between the lips.

Their walls are composed of fibrous tissue, lined with a squamous epithelium, and they contain hairs, sebaceous matter, and cholesterolin.

CLINICAL FEATURES.—Although congenital in origin, they may not be noticed before adult life. They then present themselves as painless, slowly growing tumours, lying just under the mucous membrane of the floor of the mouth, and projecting under the chin. They are exactly mesial in position, yellow in colour, and opaque. The cyst may grow to a very large size without interfering with speech or deglutition. Suppuration may occur.

TREATMENT.—The cyst should be dissected out of its capsule. In the majority of cases this is done from inside the mouth, but if the cyst projects well under the chin, it can be removed through a median incision extending from the symphysis to the hyoid bone.

TONSILS AND PHARYNX

INFLAMMATORY CONDITIONS OF THE TONSILS

Acute Tonsillitis.—Acute inflammation of the tonsils is due to infection with various micro-organisms, most commonly streptococci, staphylococci, pneumococci, the *Bacillus catarrhalis*, and the pseudo-diphtheria bacillus. These organisms may constantly be found in the pharynx and on the tonsils. Any lowering of the general health, especially if associated with confinement in close, ill-ventilated rooms and exposure to the emanations from bad drains, predisposes to acute infection. Residence in hospital, especially if in attendance on cases infected by the pyogenic organisms, also predisposes to acute tonsillitis, the condition being spoken of as "hospital sore throat." In some of these cases the infection is very acute, and death from general septicæmia may follow in a few days.

Acute tonsillitis also occurs at the onset of any of the infectious fevers, such as scarlet fever, measles, and typhoid; it may also alternate with attacks of acute articular rheumatism.

Acute infection of the tonsils is most commonly met with in young subjects between the ages of fifteen and thirty, and one attack appears to predispose to subsequent attacks. The subjects of chronic enlargement of the tonsils are also more liable to acute infection than individuals with normal tonsils.

Clinically, three varieties of tonsillitis may be recognized: (1) Acute superficial tonsillitis; (2) acute follicular tonsillitis; and (3) acute suppurative tonsillitis. A bacteriological examination should always be made, as many apparently simple cases of tonsillitis and pharyngitis are due to the bacillus of diphtheria.

Acute Superficial Tonsillitis—CLINICAL FEATURES.—The patient complains of general malaise, pain on swallowing, and a constant desire to do so. The temperature is raised (100° to 103° F.), and on examination, the pharynx, soft palate, and tonsils are found to be red and swollen. The patient may also complain of deafness and a feeling of fullness in the ears, owing to the spreading of the inflammatory condition to the Eustachian tubes.

TREATMENT.—The patient should be confined to bed in a well-ventilated room, kept at an even temperature, and the usual general treatment of an infective condition carried out. The throat should be gargled, swabbed, or sprayed with an antiseptic and soothing lotion, or the patient may be given inhalations of steam impregnated with ammonium chloride, carbolic acid, or creosote. Hot or cold compresses to the throat are useful if there is much pain. In rheumatic cases salicylate of soda or aspirin in 10-grain doses should be given.

Acute Follicular Tonsillitis.—The general symptoms are usually more severe in this variety, and in addition to the pain on swallowing, there may be difficulty in opening the mouth (trismus). Some dyspnoea may also be present, especially if the tonsils are abnormally enlarged.

On examination, the tonsils are seen to be greatly swollen, and the crypts contain yellowish plugs of exudate, which project on the surface. Mucus and muco-pus may also be present on the surface of the tonsil, so that the condition somewhat resembles the false membrane of diphtheria. The mucus, however, comes away readily without leaving a bleeding surface, and has not the white appearance of the diphtheritic membrane. An exact diagnosis can only be made by examining a culture from the throat, and this should always be done.

The glands in the neck are inflamed, and suppuration in them may occur after the tonsillar condition has disappeared.

The illness lasts about a week, but recurrent attacks, especially if the patient has chronically enlarged tonsils, are common.

TREATMENT.—The treatment is the same as that for acute superficial tonsillitis.

Acute Suppurative Tonsillitis—Quinsy.—The general symptoms are the same as those mentioned above, but the onset is more sudden, and the symptoms are more severe. There is great pain on swallowing, and some difficulty in opening the mouth. Pain in the ears is also a symptom. The tongue is furred, the breath offensive, and the general malaise well marked. If the patient can open the mouth wide enough, the tonsils are seen to be enormously swollen, the swelling being as a rule more marked on one side, and involving the anterior pillar of the fauces and the soft palate. When suppuration occurs, there is a feeling of softness or fluctuation in the anterior pillar of the fauces, the pus in adults mostly forming in the peritonsillar tissue. In some cases, however, the pus forms in the tonsil itself. If the abscess is not opened, the pus bursts into the mouth, and suppuration in one tonsil is frequently followed by suppuration in the other.

TREATMENT.—The early treatment of this condition is the same as that of the other varieties of tonsillitis. When pus has formed—usually in three to seven days—the abscess should be opened. The best place for the incision is through the anterior pillar of the fauces in a line between the root of the uvula and the last molar tooth, and nearer the palate than the tooth. It should, however, always be made over the most prominent part of the swelling. A tenotome or a guarded bistoury should be used, and the knife directed backwards and a little inwards.

After evacuation of the abscess, bleeding should be encouraged by warm gargling, and the pharynx kept clean by spraying. If suppuration occurs on the other side, the abscess should be opened in a similar manner.

After all the acute inflammation has subsided, tonsillotomy should be performed if the tonsils remain enlarged.

Chronic Enlargement of the Tonsils.—Chronic enlargement of the tonsils is most frequently seen in children between the ages of five and fifteen, but it may occur before these ages, and may persist into adult life. It is often associated with adenoids (post-nasal growths), and the patients are liable to acute and subacute attacks of tonsillitis, which may end in suppuration. The exact cause of the condition is unknown.

CLINICAL FEATURES.—The condition is often discovered during the routine examination of a child patient when the surgeon has been

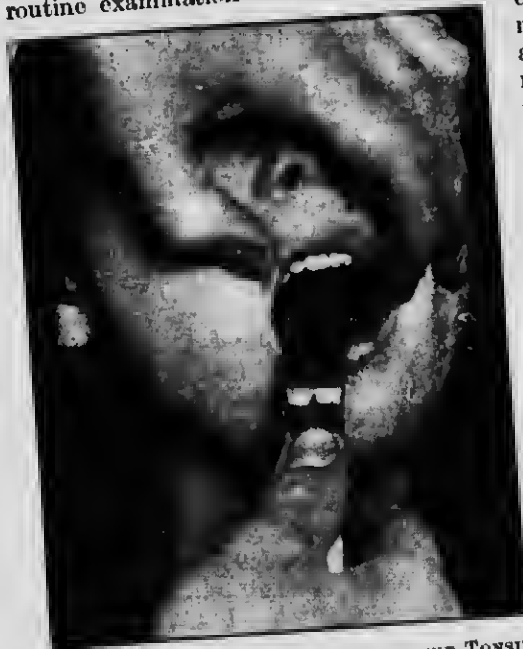


FIG. 443.—CHRONIC ENLARGEMENT OF THE TONSIL.

consulted on account of mouth-breathing, snoring at night, deafness, recurrent attacks of tonsillitis, thickness in speech, or dyspnoea when asleep.

On examination, the tonsils are seen to be enlarged, and may even meet in the middle line, crowding the uvula away. The enlargement is usually bilateral, but may not be symmetrical. The crypts are exaggerated, and may be filled with cheesy masses of exudate mucus, food, and bacilli. Later, calcareous salts may be deposited in the mass, and a calculus form. The lymph follicles are well marked, and if abscesses have formed in the tonsils, their scars

may be apparent. In children the tonsils are soft, but after recurrent attacks of inflammation, they become hard and fibrous. Enlargement of the glands of the neck is often present, and examination of the naso-pharynx usually reveals the presence of adenoids. Deafness, from blockage and inflammation of the mucous membrane of the Eustachian tube, is a common complication.

Inflammatory conditions of the lungs and deformities of the chest often occur in connection with enlarged tonsils owing to defective aeration of the lungs and the habit of mouth-breathing.

TREATMENT.—Slight enlargement of the tonsils should be treated by improvement of the general health, good ventilation in the living-rooms and bedrooms, careful training in nose-breathing, and antiseptic and astringent applications to the pharynx and tonsils. When the enlargement is more advanced, and when nose-breathing is difficult and complications are present, the enlarged tonsils should be removed.

TONGUE, PHARYNX, TONSILS, AND ŒSOPHAGUS 985

Two methods are in vogue—tonsillotomy, and enucleation of the tonsils.

Tonsillotomy.—The projecting part of the tonsils is cut off, either by a guillotine or with a long bistoury, under local or general anaesthesia.

Enucleation.—In this operation the tonsil is completely removed, being enucleated from its bed by blunt dissection. Hæmorrhage is arrested by sponge pressure, but it is rarely severe if the surgeon does not work outside the capsulo of the tonsil.

Enucleation is the better operation, for after tonsillotomy recurrence is possible, necessitating a second, or even a third operation.

Adenoids, if present, should be removed at the same operation.

After-Treatment.—This is almost as important as the operation. The general health of the patient should be looked after and improved in every way, and he must be carefully taught to breathe through the nose. If the habit of mouth-breathing has been established, clearing of the nasal air passages will not be followed by nasal respiration, and training is necessary to re-establish this.

SYPHILIS OF THE TONSILS

Primary.—A primary chancre may occur on the tonsil, and, like other extragenital chancres, may be atypical in appearance, and cause excessive enlargement of the glands of the neck. It is most likely to be mistaken for carcinoma, and the diagnosis is as a rule only made when secondary symptoms appear.

Secondary.—In the early secondary stage general inflammation, with superficial kidney-shaped or snail-track ulcers, is common, the patient complaining of a sore throat. Mucous patches may also be present on the tonsil. Later, more serious ulceration, leading to extensive scarring, may occur in patients who are debilitated in health or who have been improperly treated.

Tertiary.—In the tertiary stage extensive ulceration of the soft palate, fauces, and tonsils may take place, and when healing ensues under antisyphilitic treatment, the scarring may be so extensive as to lead to stenosis of the pharynx. The diagnosis is made in the usual way. A positive Wassermann serum reaction is always present.

TREATMENT.—The usual general antisyphilitic treatment is given and the throat is kept clean with antiseptic mouth-washes.

If stenosis of the pharynx occurs, it should be treated by careful division of bands with the knife, and dilatation of the stenosed orifice by bougies. The occasional passage of bougies will probably be necessary for the rest of the patient's life.

TUBERCULOSIS OF THE TONSILS AND PHARYNX

Tuberculosis of the tonsil and pharynx is invariably secondary to tuberculosis of other organs, especially of the lungs and larynx.

CLINICAL FEATURES.—The patient complains of severe pain on eating, and hoarseness of the voice, and is generally suffering from pulmonary tuberculosis.

On examination, ulceration is seen on the soft palate, tonsil, and posterior wall of the pharynx, and careful inspection will reveal small nodules of tuberculosis round the ulcers, which have ragged, undermined edges. Perforation of the soft palate or the epitonsillar recess is not common, a contradistinction to syphilis, but scarring and contracture occur. The lymphatic glands of the neck usually become tuberculous.

Tubercular ulceration is distinguished from syphilitic ulceration by its great chronicity, its tendency to cause scarring rather than perforation, the presence of nodules round the ulcers, evidence of tubercle in the lungs or larynx, the discovery of the tubercle bacillus, and the absence of Wassermann serum reaction.

TREATMENT.—The *General Treatment* is that of tubercle elsewhere.
Local Treatment.—The ulcers should be destroyed with the galvano-cautery, or cauterized with chromic acid, pure carbolic acid, or silver nitrate. Afterwards the pharynx must be kept clean with weak antiseptic lotions and inhalations. Pain may be relieved by insufflation of orthoform. The prognosis is bad, for tuberculosis of the lungs is nearly always present.

NEW GROWTHS OF THE TONSILS AND PHARYNX

Innocent

Innocent new growths of the tonsil and pharynx are rare, but **lipoma**, **fibroma**, and **myoma** have been described. If diagnosed, they should be removed and microscopically examined.

Malignant

Sarcoma of the Tonsil.—Both lympho-sarcoma and small rounded-celled sarcoma are met with in the tonsil, and are exceedingly malignant growths, rapidly infiltrating the surrounding tissues and the lymphatic glands of the neck.

CLINICAL FEATURES.—The patient complains of a lump in the throat and neck, and difficulty in swallowing. In the later stages dyspnoea is also present. On examination, the tonsil is seen to be enlarged, bluish-red, and soft to the touch. It may be movable, but more commonly is fixed, and associated with enlarged glands of the neck. Ulceration is always present in the later stages, and repeated severe hæmorrhages are a frequent cause of death.

TREATMENT.—The treatment is complete extirpation, if possible.

Carcinoma.—Squamous-celled carcinoma may originate on the pillars of the fauces, soft palate, pharynx, or tonsil, but all these parts are rapidly involved in the growth. It presents itself as a carcinomatous ulcer with raised edges, sloughing floor, and indurated base. The glands of the neck are infiltrated early. The growth is usually painful, and interferes with swallowing and respiration. Pain in the ear is also present.

TREATMENT.—The treatment is extensive excision, with removal of the glands of the neck.

METHOD OF REMOVAL OF MALIGNANT DISEASE OF THE TONSIL AND PHARYNX.—The best method of removal of malignant growths from the tonsil and pharynx is that described by **Mikulicz**. A low tracheotomy is performed some days before the operation. An incision is made from the mastoid process downwards along the inner border of the sterno-mastoid muscle, the glands in the anterior triangle are removed, and hæmorrhage controlled by ligation of the main blood-vessels. The ascending ramus of the jaw is then resected subperiosteally, so that the mouth is not opened. After the field of operation has been well cleared, and all hæmorrhage arrested, the pharynx and mouth are opened, and free excision of the growth made with a pair of stout scissors. Hæmorrhage is arrested, and the cavity plugged with gauze. The tracheotomy tube is not removed for a few days, and the patient is fed by means of a stomach-tube.

The loss of the portion of the jaw is not of serious consequence if part of the insertion of the masseter is saved.

Another method of removing these growths from the outside is by temporary resection of the angle of the jaw, which is put back in position after the growth has been extirpated.

Removal of malignant disease can also be carried out from the mouth, but the removal is always imperfect and recurrence in the glands of the neck inevitable.

Retropharyngeal Abscess.—Two varieties of retropharyngeal abscess occur—acute and chronic.

Acute Retropharyngeal Abscess is due to suppuration in the lymphatic glands in front of the cervical spine between the prevertebral layer of the cervical fascia and the post-pharyngeal fascia. These glands, like all other lymphoid tissue, tend to disappear as we advance; therefore acute suppuration in them is most common in the first few years of life.

CLINICAL FEATURES.—The general symptoms of an acute infection are present. There is pain on swallowing, regurgitation of food, stiffness of the head and neck, and dyspnoea, which may become urgent. On examination, the glands of the neck are often found to be enlarged and tender, and the posterior wall of the pharynx inflamed and pushed forwards. Inspection, however, may be deceptive, and digital examination is the only satisfactory method of making a diagnosis. The mouth is held open with a gag, and the posterior wall of the pharynx examined with the finger. A retropharyngeal abscess declares itself as a tense fluid swelling, usually situated a little to one side of the middle line.

COURSE OF THE PUS.—(1) The abscess may burst into the pharynx, and the pus be swallowed or spat up. In the case of infants, especially if the abscess bursts during sleep, the pus may enter the larynx, and cause instant suffocation or septic broncho-pneumonia. (2) The pus may track outwards and point in the neck, generally behind the sterno-mastoid muscle, but sometimes in front of that muscle in the anterior triangle. (3) The pus may burst into the cellular tissue of the neck,

causing an acute cellulitis, which may spread down into the mediastinum.

TREATMENT.—If the pus is pointing in the neck, the abscess should be opened by Hilton's method, the incision being as a rule at the posterior border of the sterno-mastoid; but if the abscess is entirely retropharyngeal, it should be opened from the mouth. The patient is placed with the head hanging over the end of the table, the mouth is opened by a gag, and the abscess incised with a guarded knife over the most prominent part of the swelling. All the pus is rapidly swabbed away, and the operation is attended with little danger. After the operation, the mouth should be kept clean, and healing occurs rapidly.

Chronic Retropharyngeal Abscess is secondary to tubercular disease of the cervical vertebræ, the pus hurrowing in the retropharyngeal space. The local symptoms are the same as those of acute retropharyngeal abscess, but less severe, and the pus tends to track along the paths already described.

The diagnosis is made by recognizing the disease of the cervical vertebræ and digital examination of the pharynx. Very frequently the first intimation of the condition is a swelling in the posterior triangle of the neck.

TREATMENT.—The abscess should always be opened from the neck in order to avoid secondary infection, and appropriate treatment for the cervical tuberculosis must be carried out.

INJURIES AND DISEASES OF THE ŒSOPHAGUS

Congenital Malformations.—Congenital strictures and congenital diverticula of the œsophagus have been described, but they are exceedingly rare. Abnormal communication between the œsophagus and the trachea is the most common congenital deformity, but as death always occurs soon after birth, the condition has no clinical interest.

A congenital fistulous opening between the trachea and œsophagus is not incompatible with life.

Congenital Dilatation of the whole œsophagus may occur, so that the tube is much wider and longer than normal, but it is of little clinical importance. Localized dilatations may arise, especially just above the place where the œsophagus pierces the diaphragm.

INJURIES

Wounds.—Wounds of the œsophagus from without are usually complicated by wounds of other such important structures, as the trachea and great vessels of the neck, and do not require separate consideration. Injuries from within are caused by the presence of foreign bodies or from the unskilful passage of œsophageal bougies, the œsophagoscope, or the gastroscopé. In the latter case the instrument passes from the œsophagus into the mediastinum or into the

pleura, usually the left, and is followed by cellulitis or empyema. This accident is generally fatal. If an empyema follows, it must be opened and drained in the usual way.

Rupture of the Œsophagus.—This accident occurs in alcoholics, and is due to vomiting after a heavy meal or a drinking-bout. The rupture always takes place near the cardiac orifice, and the contents of the stomach pass into the tissues of the posterior mediastinum or the pleura. Death generally follows within twenty-four hours. This condition must be carefully distinguished from post-mortem digestion of the lower end of the œsophagus.

Burns of the Œsophagus arise from the swallowing of hot liquids (especially in children) or of corrosive fluids, as sulphuric, hydrochloric, or nitric acids, or a caustic alkali. They are followed by necrosis of the mucous membrane, and sometimes of the muscular coat. After the slough separates, ulcers are left. These ulcers heal in the usual way by the formation of scar tissue. Serious stricture of the œsophagus may result.

SYMPTOMS.—In some cases sudden death from shock takes place. If the patient survives, he has pain along the course of the œsophagus, dyspnoea from œdema of the glottis, gagging and vomiting. The vomit contains blood and shreds of altered mucous membrane. Death may occur in two or three days from exhaustion or from cellulitis of the neck or mediastinum.

TREATMENT.—If the corrosive is an acid, it should be neutralized as far as possible by giving chalk, carbonate of soda, or magnesia in large quantities of water; if an alkali, a dilute solution of vinegar should be administered. If carbolic acid has been swallowed, olive oil should be given. The œsophagus should be put at rest, and food administered by nutrient enemata for a time. Afterwards the patient should be put on a bland diet until the œsophagus has healed. Two weeks after the accident, œsophageal bougies must be passed to prevent cicatricial contraction and stricture, and in cases of severe burns the patient will have to pass bougies at stated intervals for the rest of his life in order to keep the œsophagus open.

Impaction of Foreign Bodies in the œsophagus is most commonly met with in children, epileptics, and lunatics, the foreign bodies being as a rule coins and tooth-plates. The impaction usually occurs at one of the three narrowest parts of the œsophagus—viz., at the entrance; where the tube crosses the left bronchus; and at the cardiac



FIG. 444.—FOREIGN BODY PERFORATING THE ŒSOPHAGUS.

(London Hospital Medical College Museum.)

orifice of the stomach. In children coins are seen in a radiogram to lie between the clavicles.

SYMPTOMS.—There is usually a history of the foreign body being in the mouth, and sudden pain and coughing. It is surprising how little inconvenience is caused by a coin or smooth foreign body lying in the œsophagus, for the patient may be able to swallow without pain or difficulty. With irregularly shaped or sharp foreign bodies pain is felt on swallowing, and food and blood-stained mucus



FIG. 445.—FOREIGN BODY IN THE
ŒSOPHAGUS.

may be regurgitated. If the impacted foreign body is opaque to the X rays, its position can easily be seen on the fluorescent screen; or a radiogram may be taken. In any case, its position may be seen by the use of Kilian's œsophagoscope, and this instrument is also exceedingly useful as a means of removing it. It is important to remember that in many cases of supposed swallowing of a foreign body, nothing has been swallowed; and also that most unlikely foreign bodies, such as spoons and very irregular and large tooth-plates, may pass down the œsophagus into the stomach. It is therefore of the utmost importance to be sure that there is an impacted foreign body in the œsophagus before attempts are made to remove it.

A body impacted in the œsophagus may cause ulceration of the wall, and perforate into the air passages, the mediastinum, the pleura and lungs, or the main bloodvessels, as the aorta.

TREATMENT.—The treatment of foreign bodies in the œsophagus depends upon their nature and the length of time they have been impacted.

Coins and similar rounded bodies can as a rule be readily removed with a coin-catcher, and the removal may be aided by working in a dark room with X rays and the fluorescent screen, though in the majority of cases this is unnecessary. Some trouble may occur as the coin passes the upper end of the larynx, and gentleness of manipulation is essential.

Small, Smooth, Foreign Bodies, such as a mass of food, may be

pushed on into the stomach by means of the sponge-covered head of a prebang, while pins, fishbones, etc., may be removed by passing an expanding prebang below them, opening and withdrawing it.

Irregular-Shaped and Sharp Foreign Bodies, such as teeth-plates, may be caught with a coin-catcher, forceps, or a prebang; but if on attempting to withdraw them they do not come up easily, the attempt should be abandoned, and they should be removed by operation. Operation should also be resorted to if the foreign body has been impacted for some time and ulceration of the œsophagus is suspected.

If the foreign body is impacted in the cervical or upper dorsal region of the œsophagus, **œsophagotomy** should be performed. The œsophagus is reached through an incision at the anterior border of the sterno-mastoid, the main vessels of the neck being pulled forwards, and care being taken to avoid the recurrent laryngeal nerve. After removal of the foreign body, the wound should be closed with drainage, and rectal feeding carried out for three days. When the foreign body is lodged at the lower end of the œsophagus, the operation of *gastrostomy* should be performed, the cardiac orifice of the stomach dilated, and the foreign body removed. In some instances the foreign body cannot be reached conveniently either from the stomach or through an œsophagotomy, but such instances are rare. The œsophagus must be reached in these cases through the posterior mediastinum by resecting part of two or three ribs, the anæsthetic being given by the intratracheal method under pressure, so that the lungs do not collapse if the pleura is opened.

Œsophagoscopy.—The introduction of Kilian's œsophagoscope has reduced the number of cases in which œsophagotomy or gastrostomy is necessary. An anæsthetic is administered, and the œsophagoscope passed with the patient's head hyperextended. The foreign body can be seen and removed with suitable forceps.

DIVERTICULA

Diverticula of the œsophagus are pouches formed in the walls, and are due to traction or pressure.

Traction Diverticula are caused by the œsophagus being dragged upon from without. They are most common in the anterior wall, and are generally caused by adhesion of the œsophageal wall to inflamed glands in the neck or mediastinum. As the fibrous adhesions contract, they draw out a funnel-shaped process of the œsophagus, which is firmly fixed to the trachea, bronchi, or remnants of the gland.

These diverticula do not as a rule increase in size, but if a foreign body lodges in one of them, it may be difficult to remove, and, if left, may cause ulceration of the œsophagus, and death.

Pressure Diverticula arise from pressure within the œsophagus, and are generally herniæ of the mucous membrane which is forced out between the bundles of muscular fibres; exceptionally they may be

covered by the muscular coat. The pouch usually appears through the fibres of the inferior conductor of the pharynx, and is therefore really situated in the pharynx just at its junction with the œsophagus. These diverticula as a rule increase steadily in size, and form large pear-shaped sacs, which lie between the œsophagus and the vertebral column, and cause pressure on the œsophagus. They have been known to extend below the bifurcation of the trachea.



FIG. 446.—DIVERTICULUM OF THE
ŒSOPHAGUS.

(London Hospital Medical College
Museum.)

CLINICAL FEATURES.—The condition is far commoner in men than in women, and often first compels attention in middle age, as the pouches increase in size very slowly. The first symptoms that attract the patient's notice are difficulty in swallowing, and regurgitation of food, which may be mere or less decomposed.

On examination, especially after a meal, a swelling in the neck may be found, and there may be evidence of pressure on the great vessels of the neck and the air passages. Pressure on the swelling may cause the contents of the sac to regurgitate into the mouth, and the swelling to disappear. A bougie, when passed, enters the diverticulum, and is arrested, and then it may be possible to pass another bougie into the stomach. Bismuth emulsion should then be given, and a radiogram will disclose the presence of the pouch lying behind the œsophagus. The opening of the pouch may also be seen with the œsophagoscope.

Death from inanition or ulceration of the pouch into the mediastinum occurs if the condition is left untreated.

TREATMENT.—The sac should be exposed by an incision similar to that for performing œsophagotomy, and excised, the opening in the pharynx being closed by sutures. The wound should be drained. If this operation is refused and the condition is becoming serious, the patient must be fed by means of a stomach-tube.

FUNCTIONAL DISORDERS OF THE ŒSOPHAGUS

Œsophageal Spasm.—This condition is most frequently seen in neurotic men and women, and generally occurs when the patient becomes excited or is dining in company. It is a sudden spasm of the muscular tissue of the œsophagus leading to complete closure

the tube, so that swallowing is impossible. A patient seen by the author would suddenly suffer from this spasm during the course of a meal which he was swallowing quite normally, and would have to retire and regurgitate the food that was in the œsophagus at the time of the spasm. A full-sized bougie will pass quite easily or be arrested by the spasm, which will yield to gentle pressure. Dilatation of the œsophagus may occur above the point of spasm.

TREATMENT.—The treatment is that of any other neurosis combined with the occasional passage of a full-sized bougie.

Cardiospasm.—This term is applied to spasm of the muscular tissue at the cardiac orifice of the stomach, and has the same symptomatology as œsophageal spasm. The food regurgitated is alkaline, showing it has not reached the stomach, and the whole of the œsophagus may be dilated. On passage of a bougie the obstruction is felt about 16 inches from the teeth, and yields gradually to pressure. The treatment is the same as the treatment of œsophageal spasm, but the cardiac orifice should be steadily dilated with bougies.

INFLAMMATION OF THE ŒSOPHAGUS

Acute Œsophagitis follows impaction of foreign bodies, burns of the œsophagus from hot fluids, corrosive acids, or caustic alkalies, and extension of inflammation from the throat, such as that due to diphtheria. Of most importance to the surgeon is abscess formation in the submucous tissue, due to the penetration of a small foreign body, such as a fish-bone. In a case under the care of the author, a piece of a tooth of a comb was found in a submucous abscess cavity in the upper end of the œsophagus. The patient suddenly developed dysphagia, and died three days later. These abscesses may burst externally, leading to fistulæ of the œsophagus.

Tuberculous inflammation of the œsophagus is rare, and is usually due to direct extension from the bronchial glands, pharynx, or larynx. There is great pain and difficulty in swallowing.

Syphilitic disease of the œsophagus is also rare, but in tertiary syphilis a gummatous ulceration of the œsophagus may give rise to similar symptoms to carcinoma. In every case of suspected carcinoma of the œsophagus, Wassermann's serum test should be applied, and if it is positive, antisyphilitic remedies must be given. Gastrostomy is usually needed as well on account of the cicatricial contraction which will follow healing of the ulcer.

Varicose Veins of the Œsophagus.—The chief interest of varicose veins of the œsophagus, which mostly occur at the lower end, and are due to back-pressure from cirrhosis of the liver, is their liability to cause severe hæmorrhage. The only symptom, apart from the evidence of fibrosis of the liver, is hæmatemesis, and the condition is likely to be mistaken for gastric or duodenal ulcer. The only treatment is the treatment of the disease of the liver.

Esophageal Obstruction.—Esophageal obstruction may be due to—

1. Obstruction in the lumen of the tube by the presence of a foreign body.
2. Obstruction due to disease of the wall of the œsophagus—*e.g.*, cicatricial contraction, abscesses, syphilitic and tubercular ulceration, diverticula, and neoplasms.
3. Obstructions due to pressure from without—*e.g.*, tumours of the thyroid glands, aneurysms, enlargements of the bronchial glands, and tumours of the mediastinum.



FIG. 447.—SIMPLE ULCERATION OF THE ESOPHAGUS, DUE TO CAUSTICS, CAUSING OBSTRUCTION.

(London Hospital Medical College Museum.)

1. Obstruction from the presence of foreign bodies has already been discussed.

2. Obstruction due to disease of the walls of the œsophagus.

Fibrous Stricture is most commonly due to the healing of ulcers following burns of the œsophagus caused by swallowing one of the corrosive acids or alkalis. The stricture may involve most of the œsophagus, which is transformed into a fibrous canal hardly admitting a probe, or it may be completely annular or involve only part of the wall. The most common situations are the upper or the lower end. The lumen of the œsophagus immediately above the stricture is dilated.

SYMPTOMS.—Difficulty in swallowing first solid food, and finally fluid, increases steadily. The food regurgitates into the mouth, though it may be retained above the stricture for half an hour or more if the obstruction is low down. Emaciation, of course, follows the inability to take food. Ulceration of the œsophagus above the stricture may occur, and lead to suppurative mediastinitis, or the œsophagus may perforate into the trachea, lung, or pleura.

The diagnosis is made by the history, by obstruction to the passage of bougies, and by tracing a draught of bismuth emulsion down the œsophagus by means of the X rays and fluorescent screen.

TONGUE, PHARYNX, TONSILS, AND OESOPHAGUS 1005

TREATMENT.—The method of treatment to be first tried is to keep the stricture dilated by the passage of bougies as often as necessary. The patient should be put to bed and carefully fed for a few days, so that any inflammatory swelling may be reduced, and an attempt then made to pass a bougie. The surgeon should stand in front of the patient, who is seated with the head held a little forwards. The bougie is softened in warm water, the end slightly curved and lubricated with a little glycerine. Two fingers are placed on the patient's tongue, and the bougie is passed to the back of the pharynx, the patient being directed to swallow. As the instrument passes the glottis, it will usually cause retching and dyspnoea, but after it has passed the cricoid, breathing becomes easy and the bougie is passed steadily onwards. When the instrument reaches the stricture it is pressed gently against it until it holds; but if it does not readily do so, smaller and smaller bougies are tried until one passes. The rules of dilatation of the oesophagus are similar to those for dilatation of the urethra (see p. 1143). This method of treatment may be all that is necessary, and a patient may continue for many years keeping the stricture dilated by the regular passage of a bougie.

Continuous Dilatation, as in the case of urethral stricture, may be used for firm strictures. A Symond's tube is passed and left in position for two or three days, and then removed and replaced by a larger one, the patient being fed by fluid poured down the tube. When the stricture is fully dilated, bougies should be passed as often as necessary.

Internal Oesophagotomy.—The stricture may be divided with a guarded knife under full illumination by the oesophagoscope or by means of a silk thread. A bullet carrying the silk thread is swallowed, and the stomach opened and the end of the thread drawn out. The stricture is then divided by sawing the silk thread backwards and forwards. If either of these methods is used, the stricture must be subsequently kept dilated with bougies.

Retrograde Dilatation.—The stomach is opened and bougies passed from below through the stricture, a tube coming out through the mouth is left in position, and the stomach closed. In two or three days the tube is removed, and the stricture kept dilated as usual by bougies.

Gastrostomy.—If the stricture cannot be dilated or kept dilated by any of these methods, a permanent gastrostomy must be used to feed the patient, who may live in comparative comfort for many years.

NEW GROWTHS

All new growths of the oesophagus, except carcinoma, are so rare that they need not be discussed.

Carcinoma of the Oesophagus—Malignant Stricture

Carcinoma of the oesophagus is a squamous-celled growth, the clinical symptom of which is obstruction of the oesophagus. It is much more common in men (7 to 1) than in women, and its usual

position is at the lower end of the œsophagus. The other favourite sites are the upper end at the level of the cricoid cartilage and at the point where the œsophagus is crossed by the left bronchus. These points are 16 inches, 7 inches, and 11 inches, respectively, from the teeth.

The growth is usually circumscribed, and tends to include the whole circumference of the œsophagus, leading to stricture. Ulceration is always present after the early stages, and may lead to perforation into the



FIG. 448.—ANNULAR CONSTRICTING CARCINOMA OF THE (ESOPHAGUS, WITH DILATATION ABOVE.
(London Hospital Pathological Institute.)



FIG. 449.—PAPILLOMATOUS CARCINOMA OF THE (ESOPHAGUS, WITH PERFORATION INTO THE TRACHEA.
(London Hospital Pathological Institute.)

brachi, pleura, or pericardium. The glands affected are the bronchial and the cervical; metastases in other organs are rare.

CLINICAL FEATURES.—The patient complains of increasing difficulty in swallowing, and rapid wasting; pain is as a rule absent. The œsophagus above the growth is dilated, and regurgitation of food and

mucoid viscid saliva, which may be blood-stained or even contain small particles of growth, is present. The dysphagia is often intermittent, and sometimes, after apparently complete closure, a few days' rest in bed and feeding by means of nutrient enemata may allow the patient to swallow again. This return of the power of swallowing is frequently seen after gastrostomy has given rest to the oesophagus. In the cervical portion of the tube the growth may be felt, but the methods of diagnosis are the same as for those of simple stricture—viz., passage of a bougie, the examination of the passage of bismuth emulsion by the X rays, and examination with the oesophagoscope. The chest should always be examined for neoplasm or aneurysm before any instrument is passed down the oesophagus.

Later in the course of the disease there may be pressure and paralysis of the cervical sympathetic and of the recurrent laryngeal nerves, causing contraction of the pupil, hoarseness, and aphonia.

Death occurs within two years of the onset of the symptoms from starvation, cachexia, or perforation of the growth into the trachea, bronchus, or left pleural cavity.

TREATMENT.—In the majority of cases this is symptomatic owing to the late period at which the disease is seen; but attempts may be made to remove the growth in the cervical portion of the tube, and also in the thoracic part, under intratracheal anaesthesia. The reported successful cases are very few in number, and in the case of removal of a cervical growth the patient may have to be permanently fed through an oesophagostomy or gastrostomy opening. The wearing of a short Symond's tube may give relief for a time, but in the majority of instances palliative treatment consists of feeding the patient through a permanent gastrostomy opening. The operation should be performed before the patient is emaciated and exhausted from want of food.

Symond's Tubes are funnel-shaped tubes, about 6 inches in length, and the size of a No. 12 English catheter. To the upper edge of the tube two silk threads are attached, and a pilot is used to pass the tube; but if this is not at hand, an ordinary bougie may be used. The tube is passed through the stricture (usually a malignant one) so that the funnel-shaped top rests upon it, and the silk strings are brought out of the mouth, looped over the ear, and fastened with a piece of strapping. If the tube gets blocked at any time, it can be removed by pulling on the silk thread, but otherwise it may be left in position for two weeks, then removed, cleaned, and replaced. The silk threads should be inspected daily to make sure that they are not cut by the teeth, for if this happens it may be necessary to do oesophagotomy to remove the tube. Any food that will pass through the tube may be given, and one of Symond's cases swallowed easily for eight months after natural deglutition had become impossible.

Gastrostomy.—This operation may be performed in many ways, one of the most successful being the following: The stomach is exposed by a vertical incision through the right rectus, and a portion of the an-

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terior wall of the fundus brought out of the abdomen. Three rows of purse-string sutures, about $\frac{1}{2}$ inch apart, are then passed through the sero-muscular coat. An opening is made in the centre of the smallest purse-string suture, and a No. 8 rubber catheter passed into the stomach. The suture is tightened until it grips the tube, which is then pushed in and the second suture tightened. The stomach is still further invaginated and the third suture tightened, so that a valve is formed (see Fig. 450). The peritoneal surface of the stomach is then sutured to the parietal peritoneum, and the abdominal wound closed. The patient can be fed down the tube as soon as he has recovered from the anæsthetic.

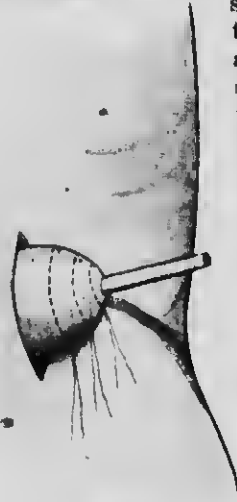


FIG. 450.—METHOD OF PERFORMING GASTROSTOMY.

The patient should be fed every four hours, milk and eggs being given, and the amount of food gradually increased. After the wound has healed and the patient is taking food well, he may be allowed to chew solid food and spit it down the tube.

It will frequently be found that after gastrostomy the patient can take food by the mouth, the rest given to the œsophagus diminishing the ulceration and reopening the channel. There is no reason why the patient should not take as much food by the mouth as possible.

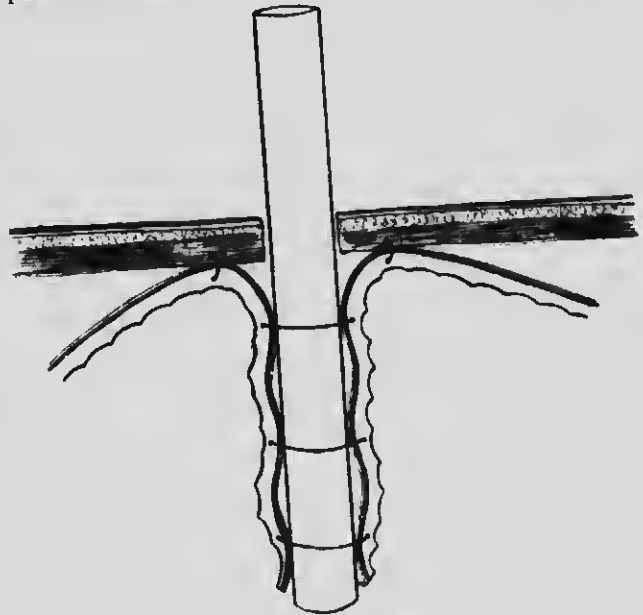


FIG. 451.—METHOD OF PERFORMING GASTROSTOMY.

CHAPTER XXX

AFFECTIONS OF THE ORBIT AND EAR

INJURIES AND DISEASES OF THE ORBIT

Contusions—"Black Eye."—A "black eye" is an extravasation of blood into the eyelid, often accompanied by rupture of some of the conjunctival vessels, so that there is effusion of blood over the "white" of the eye.

It has to be diagnosed from fracture of the orbital plate of the anterior fossa of the base of the skull, and the following are the points of difference between the two conditions:

"BLACK EYE."	FRACTURE OF ORBITAL PLATE.
Extravasation appears directly after the blow.	Extravasation delayed for twenty-four hours or longer.
Extravasation occurs into both lids.	No extravasation into upper lid.
Hæmorrhage is into conjunctiva, and at first bright red.	Hæmorrhage is under the conjunctiva, and dull red.
Hæmorrhage diffused through conjunctiva.	Hæmorrhage triangular in shape, on outer side of the eyeball, and the posterior limit cannot be seen.
No proptosis.	Proptosis present.

It is, however, to be noted that a "black eye" may be associated with fracture of the anterior fossa, and also that, if the frontal plate is broken as well as the orbital plate, extravasation of blood occurs after a little time into the upper eyelid.

TREATMENT.—Immediately after the injury, cold should be applied to lessen the extravasation, or a firm bandage may be tied over a pad of cotton-wool for the same purpose. The blood is always absorbed, a characteristic play of colours preceding its disappearance.

Wounds of the Orbit.—Wounds of the orbit owe their importance to associated wounds of the eyeball and injuries to the base of the skull, which can easily be penetrated through the orbital plate. In cases of stabs into the orbit, the point of the weapon is sometimes left in the wound as a foreign body. Wounds of the orbit should therefore

be carefully examined for these complications, and if there is any doubt as to the presence of a foreign body, an X-ray photo should be taken. The complications and treatment of wounds of the orbit do not differ from those of similar accidents in other parts of the body.

Injuries of the Eyeball.—Injuries of the eyeball may be penetrating or non-penetrating.

Penetrating wounds of the eyeball are treated in the same way as wounds elsewhere, but under the following circumstances the eye should be removed :

1. If there is so much escape of vitreous matter that the eye is collapsed.
2. If the nature of the injury is such that the sight is inevitably lost.
3. If there is a compound dislocation of the lens.
4. If a foreign body is in the eyeball and cannot be removed.
5. If removal of such a foreign body results in complete loss of sight.
6. If severe infection occurs, especially in the ciliary region, as this may ultimately lead to sympathetic ophthalmia and loss of sight in the other eye.

Prolapse of the iris, if an attempt is made to save the eye, should be treated by removal of the prolapsed portion.

Non-Penetrating Wounds and Contusions may result in hemorrhage into the eyeball, detachment of the retina, or dislocation of the lens. The injury itself is treated according to the ordinary rules of surgery.

Orbital Cellulitis is described on p. 83.

Pulsating Exophthalmos.—Protrusion of the eyeball with marked pulsation of the contents of the orbit is seen under the following conditions:

1. Aneurysm of the ophthalmic artery.
2. Aneurysm of the internal carotid artery.
3. Arterio-venous aneurysm following injury involving the internal carotid artery and the cavernous sinus. This is probably the most common cause.
4. Plexiform angioma (cirsoid aneurysm).
5. Thrombosis of the cavernous sinus.
6. Some very vascular tumours of the orbit.

CLINICAL FEATURES.—The eyeball is protruded and pulsates, and the veins of the orbit are distended, pulsation being often present in them. The lids are swollen and œdematous, and the conjunctiva injected. On listening with a stethoscope over the temporal area, an arterial bruit or a venous hum may be heard. Pressure on the common carotid artery lessens the exophthalmos, and the pulsation ceases only to return when the pressure is released. The movements of the eyeball are interfered with, but unless the proptosis is marked, sight is unimpaired.

TREATMENT.—In the majority of cases pulsating exophthalmos should be treated by ligature of the common carotid artery. This operation, in the case of arterio-venous aneurysm, always results in improvement of the condition and often in cure; but when the condition depends on the presence of a plexiform angioma, relapse is certain.

In cases of aneurysm of the ophthalmic artery enucleation of the eyeball may be necessary; pulsating tumours must be excised if possible.

NEW GROWTHS OF THE ORBIT

New growths of the orbit may arise in the eyeball or in the surroundings of the orbit, and may be either innocent or malignant. Hydatids and other cystic tumours will give rise to symptoms very similar to those of the solid tumours.

The most common *innocent* tumour is an **osteoma**, which may occur in the wall of the orbit, but more commonly invades this cavity from the frontal sinus. The tumour is usually of the ivory variety, and is very slowly growing.

The *malignant* tumours are **primary carcinomata** arising in the lachrymal gland; **melanotic sarcomata**, originating in the pigmented layer of the retina; **glio-sarcomata**, which generally occur in children, and may be bilateral; **sarcomata**, arising from the orbital bones; and **chloromata** (see p. 230).

CLINICAL FEATURES OF MALIGNANT GROWTH OF THE ORBIT.—The eyeball is pushed forwards and displaced according to the situation of the tumour, so that double vision results. The eyeball is congested, the lids swollen and oedematous, and if the protrusion is excessive, the cornea becomes inflamed and ulcerates. The movements of the eyeball are limited, and there may be paralysis of the ocular muscles, owing to pressure on the third, fourth, and sixth cranial nerves. As the proptosis increases, sight is lost, owing to pressure on the optic nerve. A malignant tumour of the orbit, if not removed, fungates outwardly; growth inward to the brain is rare.

TREATMENT.—The treatment of growths of the orbit is thorough excision, and in the case of malignant tumours, the eyeball must always be sacrificed and the contents of the orbit completely removed. This operation should be carried out even if early recurrence is to be expected, for it may prevent fungation of the growth and relieve the pain due to pressure on the orbital nerves.



FIG. 452.—TUMOUR OF THE ORBIT DISPLACING THE EYEBALL.

(London Hospital Medical College Museum.)

AFFECTIONS OF THE EAR

AFFECTIONS OF THE PINNA

Congenital Deformities.—**Accessory Auricles** are common, and vary from a small nodular projection to a long, finger-like process. If necessary, they should be removed.

Absence of the Pinna may occur on one or both sides, or the pinna may be excessively deformed. In these cases there is usually gross defect or absence of the external auditory meatus in addition to defects in the internal ear. The shape of the pinna may be improved by plastic operations, but no attempt should be made to fashion a new external meatus, as hearing will not be improved.

Prominent Ears.—This defect may be remedied by wearing an apparatus, or may be treated by excising a suitable piece from the posterior aspect of the ears, and uniting the cut surfaces by sutures.

Injury.—Wounds of the ears should be treated under the usual rules of aseptic surgery. If a portion of the ear is cut off, and treatment can be carried out at once, an attempt should be made to save the separated portion by suturing it into position.

Hæmatoma Auris.—A subperichondrial hæmatoma occurs under two conditions:

1. The most usual cause is a blow on a healthy ear, and the condition is especially common in boxers.
2. It may follow a very slight injury to an ear in which degenerative changes have taken place in the cartilage and perichondrium. This variety is frequently seen in the insane, and is spoken of as "asylum ear." Its presence may lead to unfounded charges of cruelty against asylum attendants.

CLINICAL FEATURES.—The anterior surface of the auricle is swollen, painful, and bluish-red. The blood may be absorbed, but generally the ear remains thickened and deformed. Occasionally suppuration may occur.

TREATMENT.—The ear should be bathed with hot water, and elastic pressure applied; or an incision may be made into the swelling, and the clot removed. The latter treatment should be carried out if appearance has to be studied. If suppuration occurs, the swelling must be incised and drained. If treatment has been neglected, the resulting deformity may to some extent be remedied by a plastic operation.

Cysts of the Auricle.—Small cysts containing clear fluid are sometimes met with under the perichondrium, and are probably forerunners of hæmatoma auris. They should be treated by excision. Sebaceous cysts must be removed. They are most common on the posterior surface of the pinna.

Carcinoma of the Pinna.—A squamous-celled carcinoma on the skin of the pinna is not uncommon; it has the usual characteristics

of a carcinomatous ulcer. The growth may invade the temporal bone, and cause destruction of the middle ear and facial paralysis. The glands affected are the posterior and anterior auricular glands, and the deep cervical glands.

TREATMENT.—The pinna should be completely removed, and all the glands liable to be affected should be excised.



FIG. 453. — SQUAMOUS-CELLED CARCINOMA OF THE AURICLE.

AFFECTIONS OF THE EXTERNAL AUDITORY MEATUS

Eczema, Impetigo, and Boils are not uncommon in the skin of the external auditory meatus, especially if the patient has a purulent discharge from the middle ear. There is nothing special to consider in the clinical features or in the treatment.

Foreign Bodies.—Foreign bodies of the most varied kind have been introduced into the external auditory meatus, chiefly by children, while muggots and insects sometimes find their way into this canal.

CLINICAL FEATURES.—In the case of introduced foreign bodies, information is often given by the child or its parents. The symptoms are pain and discomfort in the meatus, deafness, and noises in the ear. In old-standing cases there is a purulent discharge. The diagnosis is made by careful inspection of the meatus with a speculum, and in the case of young children an anaesthetic may be necessary.

TREATMENT.—The foreign body may generally be removed by syringing, the stream of water being directed along the upper wall of the meatus; but if this fails, it may be removed by introducing a bent hook beyond the foreign body, and pulling it out. In a few cases the foreign body has to be removed by making a curved incision behind the ear and detaching the pinna from the bone.

Cerumen.—Plugs of wax frequently form in the ears of the most cleanly people, and remain quite unsuspected. In many cases they are associated with slight chronic middle-ear suppuration.

The **SYMPTOMS** produced are deafness, tinnitus, vertigo, and vomiting. These may be of very gradual onset, or appear quite suddenly, especially after bathing, for the water may cause the plug of wax to swell suddenly. The diagnosis is made by inspection of the meatus with a speculum. The plug varies in colour from black to light brown.

TREATMENT.—Plugs of wax can always be removed by careful and prolonged syringing, the stream of water being directed along the roof of the meatus. If the plugs have been present for a long period, the patient may complain of the excessive loudness of sounds for a day or two after they have been removed.

Traumatic Rupture of the Membrana Tympani.—Rupture of the tympanic membrane follows blows on the ears, the concussion of firing of heavy guns in enclosed spaces, diving from a height, and high ascents in balloons. It occurs also in cases of fracture of the middle fossa of the skull. The tympanic membrane is occasionally ruptured as a result of such wounds through the external auditory meatus as are produced by incautious efforts to remove a foreign body.

CLINICAL FEATURES.—There is pain and bleeding from the ear, followed by noises in the head, and deafness. *On examination*, blood is found in the external meatus, and the perforation, which has ecchymosed edges, can usually be seen in the membrane.

TREATMENT.—A little boracic powder should be insufflated into the meatus, and all syringing avoided. The ear should then be covered with a pad of aseptic gauze. Healing as a rule ensues, but the prognosis as regards hearing should be reserved until careful tests have been carried out. With fracture of the middle fossa, the seventh and eighth nerves may be injured at the same time, and the prognosis as to hearing is bad.

AFFECTIONS OF THE MIDDLE EAR

Acute Otitis Media.—Acute inflammation of the mucopariosteum lining the cavity of the middle ear is always due to infection by organisms, which reach it in one of the following ways:

1. By extension up the Eustachian tube from the naso-pharynx. This is the most common mode of infection, and the otitis media is secondary to acute inflammations of the naso-pharynx, especially those associated with the specific infective fevers, particularly scarlet fever. Extension along the Eustachian tube is also favoured by the presence of adenoid growths and enlarged tonsils.
2. By extension from the external auditory meatus after rupture of the membrana tympani.
3. By infection through the blood-stream.
4. By extension from the surrounding bone. This is the most common mode of infection in cases of tubercle and syphilis.

Acute otitis media is much more common in children than in adults, and the attacks are very apt to recur, especially if suppuration has taken place.

CLINICAL FEATURES.—The patient, usually a child, is suffering from an infection of the naso-pharynx, and complains of *earache* and *deafness*. The general symptoms of an acute infection are present, and as the patient is often delirious, the condition may be mistaken for acute meningitis. *On inspection*, the drumhead is seen to be reddened and congested, and in the course of a day or two is bulged outwards by the pressure of fluid behind it. In many cases the condition is not recognized until there is a discharge from the ear. The affection may be bilateral, the second ear discharging a day or two after the first.

RESULTS.—After the inflammatory exudate has discharged through the membrane, one of the following consequences ensues:

1. The inflammation may subside, and the hole in the membrane heal—*i.e.*, the condition ends in resolution.
2. The inflammation may subside, but the perforation in the membrane remains. These cases are liable to recurrent attacks and sclerosis of the middle ear.
3. The discharge may continue and the condition pass on to chronic suppurative otitis media.

TREATMENT.—At the onset of the attack the treatment should consist of antiseptic applications to the naso-pharynx. The pain must be relieved by fomentations or by dry heat applied over the ear. Tincture of opium or cocaine may be dropped into the meatus. The external auditory meatus should be thoroughly cleansed, so that if perforation occurs, there is no fresh infection of the middle ear. As soon as bulging of the membrane shows that there is fluid behind it, an incision should be made through the lower posterior quadrant, and the pus evacuated; the incision should run across the radiating fibres. This is as a rule followed by relief of all the symptoms.

After the incision has been made or the membrane has ruptured, the external auditory meatus must be kept clean, and an aseptic gauze pad applied over the ear until the discharge ceases.

Chronic Suppurative Otitis Media.—Chronic suppuration in the middle ear is frequently the sequel to an acute otitis media, or the condition may be chronic from the first, the latter cases generally being secondary to tubercular osteitis of the temporal bone. The causes of the continued suppuration are—

1. Chronic suppurative inflammation of the muco-periosteum lining the tympanic cavity, associated with the formation of granulation tissue.
2. Necrosis of the ossicles, which must be removed or come away before the discharge ceases.
3. Necrosis of the temporal bone, the extent of the necrosis varying from a small spicula to almost the whole of the bone.
4. Suppuration persisting in the accessory sinuses—*i.e.*, the mastoid antrum and mastoid cells—owing to insufficient drainage.

CLINICAL FEATURES.—The main symptom is a chronic purulent discharge from the ear, with an offensive smell. The amount of the discharge varies from a thick, profuse discharge to a quantity so small that it escapes the patient's observation. The amount varies from time to time, and the patient is liable to exacerbations due to fresh attacks of inflammation in the middle ear. Cessation of the discharge is often associated with earache, rise of temperature, and other general symptoms, owing to retention of the pus in the tympanic cavity; with renewal of the discharge, the symptoms abate. The discharge also ceases or becomes lessened when serious complications arise.

Examination.—The nose and naso-pharynx should be first examined as the condition is frequently associated with adenoids, enlarged tonsils, and inflammatory conditions in the nose and throat. If the discharge is profuse, the ear must be carefully syringed before the examination is made; but in cases of slight discharge, this is dangerous, and the meatus should be cleaned with pledgets of cotton-wool. On examination with a speculum and reflected light, one of the following conditions is seen:

1. A round perforation in the tympanic membrane, through which the pus is escaping.
2. The drumhead has been destroyed, and the inner wall of the tympanum, which is red and inflamed, is visible.
3. The meatus is partly or wholly filled out with aural polypi—i.e., masses of granulation tissue.

Careful examination with a fine probe may reveal the presence of carious bone. The degree of deafness present should be estimated by the tuning-fork, though a patient with a perforated drum may be only slightly deaf.

Polytizerization or the passage of a Eustachian catheter may show that the Eustachian tube is closed.

TREATMENT.—The general health should be improved in every way, and any treatment of the naso-pharynx that may be necessary should be carried out. Adenoids and tonsils should be removed, and the patient given an antiseptic gargle.

The external auditory meatus must be kept clean. This is best accomplished, when there is profuse purulent discharge, by syringing with warm boracic or peroxide of hydrogen lotion. If the discharge is slight, syringing may cause an attack of acute otitis, and the meatus must therefore be kept clean by careful swabbing with moist pledgets of cotton-wool. The Eustachian tube should be kept clear by polytizerization, the passage of the Eustachian catheter, or by Val'salva's method.

In a large number of cases this treatment will be successful, although the patient is usually liable to fresh attacks of otitis media, especially if he has inflammation of the nose or naso-pharynx. In a good proportion of cases the discharge continues, and further treatment is necessary. If necrosed bone can be felt with a probe, an attempt should be made to remove it through the external auditory meatus. This can easily be done if the ossicles are at fault (*ossiculectomy*). Polypi should also be removed with a snare at the same time. They consist of masses of granulation tissue springing from the remains of the tympanic membrane, or forming round necrosed bone.

This further treatment will cure the discharge in a number of cases which have proved rebellious to treatment by syringing, but in some patients the discharge will continue.

Although it is possible, and even common, for a patient to have an otorrhœa for twenty or thirty years without suffering from more than slight deafness and the inconvenience of the discharge, the condition

of chronic suppurative otitis media is a dangerous one, for very serious complications may arise at any time. For this reason, if the discharge continues in spite of the above treatment, carried out carefully for a reasonable time (three to six months), more radical treatment should be advised.

This treatment consists of performing complete mastoidectomy.

Complete Mastoidectomy.—A curved incision is made behind the auricle and carried to the bone, and by means of a rongeur the auricle is separated from the posterior margin of the bony meatus. MacEwen's suprimental triangle is sought for, and the bone removed with mallet and gouge until the mastoid antrum is opened. This will be found

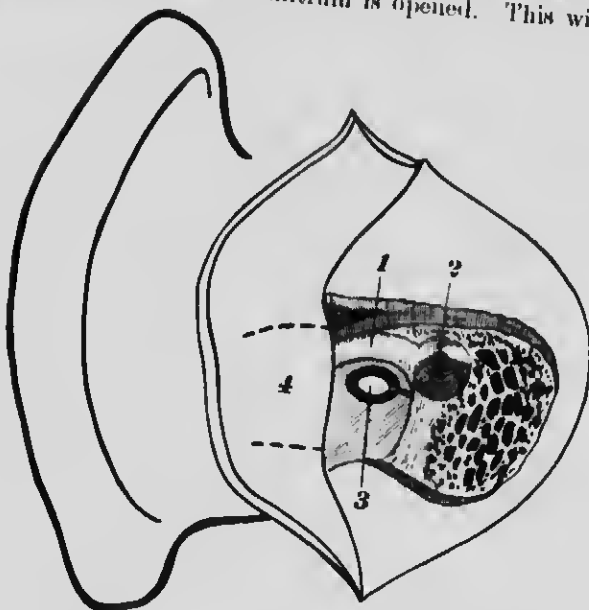


FIG. 454.—DIAGRAM OF THE EAR AFTER RADICAL MASTOID OPERATION.

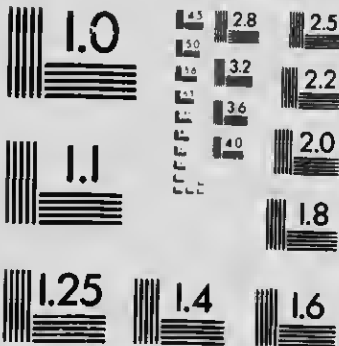
1. Prominence of facial canal; 2. prominence of external semicircular canal; 3. tympanum, with footplate of stapes in position; 4. flap of skin widening the external auditory meatus.

filled with pus. The bone between the antrum and the middle ear is then removed, and all the mastoid cells thoroughly opened up. The malleus, the incus, and the remains of the tympanic membrane, are removed, and the walls of the middle ear thoroughly scraped, an attempt being made to obliterate the opening of the Eustachian tube. The cavity thus formed is carefully examined, and any necrosed bone removed, the tract of the pus being followed until healthy tissue is reached, no matter how far it may go. The cartilaginous meatus is then enlarged, and the cavity in the bone packed with gauze through it, the posterior wound being closed. During the after-treatment the cavity must be kept clean and packed with gauze. Exuberant



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granulation tissue should be destroyed with silver nitrate, and any particles of necrosed bone removed. When healing has taken place, there will be a cavity in the bone lined with a squamous epithelium, and communicating with the exterior by the external auditory meatus. This cavity represents the tympanum, attic, mastoid antrum and mastoid cells.

This operation does not destroy the hearing, but, on the contrary, may improve it. The hearing is preserved as long as the internal ear remains intact. A modification of the operation—though not generally advisable—is to leave the tympanic membrane and ossicles untouched.

The chief danger of the operation is injury to facial nerve, and this should be avoided by careful attention to anatomical details. The anaesthetist should also be admonished to call attention to any twitching of the facial muscles, for this will show that the facial nerve is being touched.

COMPLICATIONS OF OTITIS MEDIA.—The complications of otitis media are—

1. EXTRACRANIAL:

Eczema furuncles, erysipelas, and impetigo of the external auditory meatus.

Arthritis of the temporo-maxillary joint, with or without suppuration (see p. 579).

Necrosis of the temporal bone.

2. INTERCRANIAL:

Necrosis of the ossicles.

Mastoiditis, acute and chronic. *Bezold's mastoiditis*.

Facial paralysis.

Otitis interna; labyrinthine inflammation.

3. INTRACRANIAL:

Subdural abscess, meningitis, and meningo-encephalitis.

Lateral sinus inflammation and thrombosis.

Cerebral and cerebellar abscess.

Mastoiditis.—By this term is understood a suppurative inflammation in the lining membrane of the mastoid antrum and cells with necrosis, more or less extensive, of the mastoid process of the temporal bone. It is almost invariably secondary to suppurative otitis media.

The following clinical varieties must be distinguished:

1. *Acute Mastoiditis Secondary to Acute Otitis Media*—CLINICAL FEATURES.—During an attack of acute otitis media there is exacerbation of the local and general symptoms, with redness, tenderness, and swelling over the mastoid process; the auricle is pushed forwards. If the condition is not treated, an acute abscess forms over the mastoid process.

TREATMENT.—If the symptoms do not subside quickly after perforation of the tympanic membrane, the operation of **partial mastoidectomy** should be performed.

A curved incision is made behind the ear, and the bone exposed

If the pus is seen oozing through a perforation of the bone, this opening should be deepened; in other cases the mastoid antrum should be opened with a gouge, Macowen's supra-mastoid triangle being taken as a guide. The antrum and cells should be thoroughly opened up, but the middle ear should not be touched. Drainage is carried out from

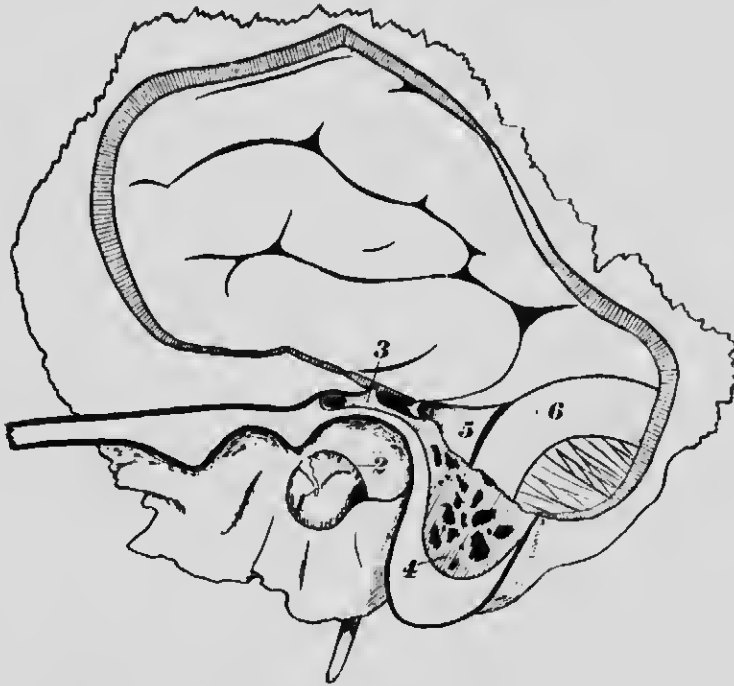


FIG. 455.—DIAGRAM SHOWING RELATIONSHIPS OF THE MIDDLE EAR.

1 and 2, Malleus and tympanic membrane; 3 and 4, mastoid cells; 5, bone over mastoid antrum; 6, lateral sinus.

behind. The operation is usually successful in children, but if a chronic sinus results, it may be necessary to perform complete mastoidectomy later (see p. 1007).

2. *Acute Mastoiditis Secondary to Chronic Otitis Media.*—At any time while a patient has an otorrhœa, acute inflammation of the mastoid may supervene; it often follows bathing or an acute inflammation of the naso-pharynx.

CLINICAL FEATURES.—The discharge from the ear ceases or lessens, and the patient has the general symptoms of an acute infection. There is pain in the ear, redness and swelling over the mastoid process, and later an abscess develops.

TREATMENT.—If the otitis media is of old standing, a complete mastoidectomy should be performed, as the middle ear will be extensively diseased.

3. *Chronic Mastoiditis with Free Discharge of Pus.*—In these cases the only symptoms will be deafness and a chronic otorrhœa, which does not clear up after careful treatment of the middle ear for a reasonable time (three to six months).

TREATMENT.—A complete mastoidectomy should be performed.

4. *Chronic Mastoiditis without Free Discharge of Pus.*—In these cases, although the patient has a chronic otorrhœa, the pus burrows through the mastoid process, and forms a chronic abscess behind the ear. This variety is most common in children, and is frequently tubercular.

TREATMENT.—A complete mastoidectomy should be performed. In cases of mastoid abscess, especially when acute, it may be necessary to drain the cavity through the posterior wound as well as through the external auditory meatus.

5. *Bezold's Mastoiditis.*—This is as a rule a chronic form, but it may also be acute. The characteristic feature is suppuration occurring in a large cell at the inner and lower part of the mastoid process, the pus appearing under cover of the anterior border of the sterno-mastoid muscle, instead of behind the ear over the mastoid bone.

TREATMENT.—A complete mastoidectomy should be performed.

Cholesteatoma.—During an operation on the mastoid antrum and cells a mass of inspissated pus and epithelial débris is sometimes found lying in the mastoid antrum or in one of the cells, which it distends. Such a mass is termed a "cholesteatoma." It is impossible to diagnose its presence before operation.

Facial Paralysis.—Paralysis or paresis of the muscles supplied by the facial nerve may arise in the following ways during the course of otitis media and its treatment:

1. *Before Operation.*—The nerve may be involved in the inflammation of the walls of the tympanum, and paralysis or paresis follow. This complication may arise at any time, and some cases of so-called "Bell's palsy" are due to neuritis of the facial nerve, secondary to middle-ear inflammation. If the nerve is simply inflamed, the prognosis is good; but if it is compressed owing to sclerosis of the temporal bone, the paralysis may be permanent. The condition may be indicative of extension of the inflammation to the internal ear.

TREATMENT.—The onset of facial paralysis indicates the need for a radical mastoid operation. If the paralysis is due to sclerosis and is permanent, the only treatment is a facio-hypoglossal nerve anastomosis (see p. 381).

2. *After Intrameatal Operations.*—During these operations the nerve may be damaged, and the resulting paralysis may be temporary or permanent.

3. *After Radical Mastoidectomy.*—(a) The nerve may be cut across at the time of the operation, and the resulting paralysis will be permanent. A severe twitch of the facial muscles during the operation will indicate this accident.

(b) The paralysis may not occur till two or three days after the

operation; in this case it is due to a neuritis. The muscles are only paretic as a rule, and the condition is temporary. No treatment is necessary.

4. The formation of a cerebral abscess in the temporo-sphenoidal lobe may cause facial paralysis of the supranuclear type by involving the face centre in the Rolandic area. After the abscess has been opened and drained, the paresis will disappear. The extent of the paralysis, when the different parts of the nerve are involved, is given on p. 381.

Otitis Interna (Acute).—Extension of suppuration to the internal ear is not common, but it may occur either through the bone into the external semicircular canal, or through the foramen rotundum or ovale into the cochlea.

CLINICAL FEATURES.—A patient who has acute otitis media or chronic otorrhœa has an increase in the general symptoms of infection, accompanied by severe pain in the ear, nausea, and vomiting. The deafness on the affected side increases and becomes absolute. Although the patient may complain of noises in the ear. Vertigo is present, owing to implication of the semicircular canals, but it is difficult to demonstrate on account of the patient's general condition. Nystagmus is often a symptom.

DIAGNOSIS.—The condition is difficult to diagnose from cerebellar abscess. A differential diagnosis before operation is not, however, of great importance, as the treatment is the same in both diseases.

TREATMENT.—A complete mastoidectomy should be performed, and the path of the pus into the internal ear followed until its limit is reached, all the diseased tissue being removed.

Subacute and Chronic Otitis Interna.—A gradual extension of the inflammation to the internal ear gives the following symptoms: Deafness, with noises in the head and sometimes acoustic hyperæsthesia—i.e., undue sensitiveness to loud sounds; vertigo and disorders of localization; nausea and vomiting. When, however, the internal ear has been destroyed, all the symptoms, except absolute deafness, disappear. The prognosis is bad.

TREATMENT.—If the otitis interna is secondary to a chronic suppurative otitis media, a radical mastoid operation should be performed, and the path of infection into the internal ear followed, all diseased tissue being removed.

Meningitis, Subdural Abscess, Cerebral Abscess, and Cerebellar Abscess are all considered in the section on Diseases of the Brain (p. 835).

In every case of one of these complications following otitis media a complete mastoidectomy should first be performed, and the spread of the pus carefully followed by removing the bone behind the ear. The prognosis of these conditions is bad, owing chiefly to late diagnosis; therefore if there is a suspicion that one of these complications is present, the complete mastoid operation should be performed, and the suspected area definitely explored.

Lateral Sinusitis (Thrombosis of the Lateral Sinus).—Inflammation in the middle ear may extend through the bone until it reaches the wall of the lateral sinus, which may become inflamed. Inflammation of the sinus (sinusitis) is followed by thrombosis of the blood in it, and if the inflammation terminates in suppuration, pus is formed in the sinus, and the clot breaks down. Minute particles of infective clot are then carried into the circulation, and a condition of septico-pyæmia results. On the other hand, suppuration may not occur, and the clot in the sinus becomes organized; the sinus is obliterated, and is represented by a fibrous cord stretching back as far as the torcular Herophili.

CLINICAL FEATURES.—Inflammation, extending back to the sinus, gives no characteristic symptoms, and is only indicated by an increase in the general symptoms of infection. During the course of a radical mastoid operation it is by no means uncommon to find the pus extending to the external wall of the sinus without thrombosis having ensued. Even when thrombosis has occurred, there may be no localizing symptoms, and during the course of a post-mortem examination the sinus may be found to be fibrosed, although the patient has had no definite symptoms pointing to thrombosis of the sinus during life.

Lateral sinus thrombosis only gives the following characteristic symptoms when the condition is advanced—viz.: The appearance of an inflamed cord in the neck, owing to inflammation extending to the internal jugular vein with thrombosis of the blood in it, and the symptoms of septico-pyæmia. The symptoms of the latter condition are irregular pyrexia, often accompanied by rigors, and the appearance of inflammatory foci in various parts of the body, especially in the synovial membranes, serous membranes, and the lungs. When the inflammation extends from the sinus to the meninges, the following symptoms are added: Pain, rigidity of the muscles at the back of the neck, delirium or coma, and optic neuritis. When the sinus becomes inflamed, the discharge from the ear may cease.

DIAGNOSIS.—The diagnosis of lateral sinus thrombosis is most commonly made during the operation of mastoidectomy, when an increase in the general symptoms has led to operation and the sinus has been deliberately exposed. The diagnosis can only be made clinically when general infection has occurred.

PROGNOSIS.—The prognosis is bad, owing to late diagnosis; but if during operation the sinus is found to be thrombosed and general infection has not ensued, recovery is the rule.

TREATMENT.—As soon as the condition is suspected, a radical mastoid operation should be performed, and the temporal bone removed until the sinus is exposed. If it is thrombosed, the internal jugular vein with its tributaries, the lingual and facial veins, should be tied in the neck in order to prevent general infection. The ligatures on the internal jugular must, of course, lie below the thrombus (if one is present), and this may necessitate ligaturing it near its junction with the subclavian. The sinus is freely exposed by removing the bone over it towards the torcular, and when the limit of the throm-

bosis is reached, the sinus is incised and all the infected clot removed. The complete removal of the thrombus is indicated by a rush of blood, but this hæmorrhage is easily controlled by gauze packing. The wound in the neck is drained, and as a rule the cavity behind the ear being left to close by granulation. If general infection has already taken place, the secondary inflammatory foci must be treated as they arise, and the general treatment of septico-pyæmia carried out.

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CHAPTER XXXI

AFFECTIONS OF THE LARYNX AND TRACHEA—INJURIES AND DISEASES OF THE THORAX

THE LARYNX AND TRACHEA

Foreign Bodies in the Air Passages—1. *In the Pharynx*.—The most common foreign bodies to become impacted in the pharynx are large boluses of food or false-tooth plates. Large boluses of food usually cause complete obstruction to the airway, and if the patient is not at once relieved, he dies of asphyxia in a few minutes. False-tooth plates and foreign bodies of a similar nature cause partial obstruction with dyspnoea, and later the obstruction is complete, owing to œdema of the glottis.

TREATMENT.—The foreign body should be immediately removed with the finger, or with a pair of pharyngeal forceps. If this fails and the dyspnoea is urgent, tracheotomy should be performed if the patient is a child, and laryngotomy if an adult. If necessary, artificial respiration must be commenced. The foreign body can be removed later.

2. *In the Larynx*.—Such small foreign bodies as coins, beads, pins, pieces of food, etc., if in the mouth, may be carried down into the larynx during a sudden inspiration on coughing, laughing, or crying. The cases may be divided into two groups: (1) Those with urgent dyspnoea; (2) those without urgent dyspnoea.

(1) The symptoms are those of sudden dyspnoea, and there is usually a history of the foreign body being held in the mouth.

TREATMENT.—Tracheotomy should be performed at once, and the foreign body removed when the urgent symptoms are relieved.

(2) The symptoms are those of dyspnoea, cough, and a senso of suffocation; the difficulty in breathing may suddenly become urgent owing to spasm of the glottis. Very small foreign bodies, after lodging in the larynx for days without causing marked symptoms, may shift their position, and then cause urgent dyspnoea.

TREATMENT.—The larynx should be rendered insensitive by the application of cocaine, and the position of the foreign body ascertained by means of the laryngoscopic mirror. A pair of laryngeal forceps is then introduced, and the foreign body removed under observation. During these manipulations the tracheotomy instruments should always be ready for instant use. If the foreign body cannot be removed by

forceps, it may be removed through a laryngotomy opening; or, if laryngoscopic examination shows that this method of removal is inadvisable, *thyrotomy* should be performed.

3. *In the Trachea.*—Foreign bodies in the trachea are inhaled through the larynx. They may be fixed in the mucous membrane, but more commonly are free to move, and cause violent spasmodic attacks of coughing with frothy expectoration. During such an attack the foreign body may become impacted in the glottis and cause urgent dyspnoea.

TREATMENT.—A Kilian's bronchoscope should be introduced into the trachea, the foreign body located, and removed with the forceps. If this instrument is not available or cannot be introduced, a low tracheotomy should be performed, and the trachea held open. The violent coughing following the opening of the trachea will usually expel the foreign body through the wound; but if not, inversion of the patient can be tried. The foreign body may be seen, and removed with forceps. After successful extraction, the tracheal opening may be closed with sutures, and primary healing will result. If attempts to remove the foreign body fail, the trachea should be kept open. Stitches are passed through each side of the trachea, and fastened together at the back of the neck. If the foreign body is not coughed up in the next twenty-four hours, careful search must be made for it, or inflammatory mischief will be set up in the lungs.

4. *In the Bronchi.*—A foreign body lodges in the right bronchus more frequently than in the left, owing to its larger size. The symptoms are very variable. The foreign body, in some instances, may remain for a long time without causing marked symptoms, while in other cases there is collapse of a portion of the lung, and dyspnoea. On examination of the chest, the usual signs of obstruction to a bronchus will be found—viz., defective air entry into one lung and dullness over the corresponding side of the chest; a radiogram may show the presence of the foreign body. From time to time the foreign body may be expelled into the trachea, and spasmodic fits of coughing occur. During one of these attacks the foreign body may be coughed up or become impacted in the glottis, causing urgent dyspnoea. Sooner or later inflammation and suppuration take place in the lungs, with multiple abscesses, or the patient may develop bronchiectasis. If there is no history of the inhalation of the foreign body, the case may be taken for one of pulmonary tuberculosis.

TREATMENT.—An attempt should be made to remove the foreign body through a Kilian's bronchoscope. If this fails, a low tracheotomy should be performed, and the foreign body removed in any way that ingenuity suggests. The bronchoscope can be passed through the wound in the trachea, and the foreign body may be seen.

Under positive pressure anaesthesia the chest may be opened, and the foreign body removed by an incision into the bronchus.

Injuries of the Larynx and Trachea have been considered under Cut Throat (p. 899).

Inflammation of the Larynx.—Acute and chronic catarrhal laryngitis and diphtheritic laryngitis are of medical rather than surgical interest unless tracheotomy is necessary.

Acute Oedema of the Glottis.—By this is understood an acute serous infiltration of the mucous and submucous tissue of the larynx and its surroundings. It is a secondary condition, the causes being—

1. Acute and chronic inflammations of the larynx.
2. Injury due to the impaction of foreign bodies.
3. Burns and scalds of the larynx, from steam or hot water, or from swallowing corrosive acids or alkalis, especially hydrochloric a. s.
4. Erysipelas spreading from the fauces.
5. Cellulitis of the neck or retropharyngeal abscess.
6. Bright's disease, morbus cordis, and other general diseases causing dropsy.
7. Vasomotor neuroses.

PATHOLOGICAL ANATOMY.—Although the whole of the mucosa and submucosa is swollen, the swelling is most marked in the aryteno-epiglottidean folds, on the epiglottis, and in the false vocal cords. The true vocal cords only swell slightly, owing to the absence of submucous tissue.



FIG. 453. — OEDEMA OF THE GLOTTIS.

(London Hospital Medical College Museum.)

CLINICAL FEATURES.—The chief symptom is dyspnoea, which is at first only noticed on inspiration, but which rapidly becomes so urgent that if tracheotomy is not performed, death ensues. The diagnosis is made by the history of sudden onset of urgent dyspnoea during the course of one of the conditions mentioned above and by laryngoscopic examination.

TREATMENT.—If the dyspnoea is not urgent, the larynx should be sponged with cocaine, and multiple small incisions made into the oedematous tissue; at the same time hot fomentations or leeches are applied to the neck near the larynx. After the incisions are made, the patient is given ice to suck, or he is made to inhale steam. If the dyspnoea increases, tracheotomy should be performed; it is important not to postpone this operation too long.

Syphilis of the Larynx—Secondary.—In the secondary stage of syphilis there is a subacute inflammation of the mucous membrane of the larynx, on which papules and mucous patches are seen. The patient is hoarse and the throat is somewhat painful.

The diagnosis is made from the presence of other secondary syphilitic lesions, and by laryngoscopic examination.

The **TREATMENT** is the general treatment of syphilis. Local treatment is unnecessary.

Tertiary.—In the tertiary stage there may be a general gummatous infiltration of the submucous tissue or localized gummata. In either case ulceration usually occurs, the ulcers being commonly situated near the epiglottis and the aryteno-epiglottidean folds. If the ulcers are deep, suppurative perichondritis may occur, with necrosis of the laryngeal cartilages, especially the arytenoids and the cricoid. As the ulcers heal there is a great liability to contraction and stenosis of the larynx; the obstruction may be so severe as to require tracheotomy.

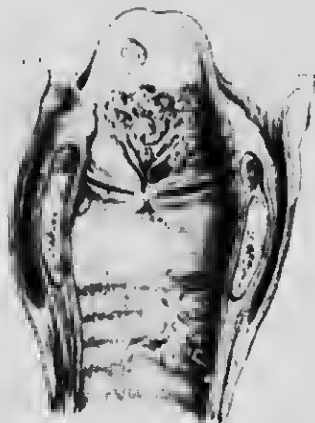


FIG. 457. — SYPHILIS OF THE LARYNX.
(London Hospital Medical College Museum.)

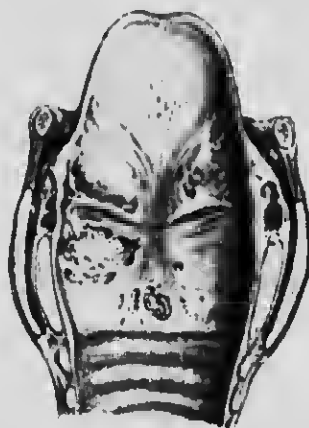


FIG. 458. — TUBERCULOSIS OF THE LARYNX.
(London Hospital Medical College Museum.)

The **SYMPTOMS** are hoarseness and dyspnoea, and the diagnosis is made from the history, the presence of Wassermann's serum reaction, and examination with the laryngoscope.

TREATMENT.—General antisyphilitic treatment should be given, and the ulcers dusted with calomel or painted with a weak solution of perchloride of mercury.

Necrosis of the cartilages is treated by removal of them, and urgent dyspnoea by tracheotomy.

Cicatricial contraction is treated by division of the stricture, either from within or from without, and after the division a cannula must be worn for a time, or in some cases permanently.

Tuberculosis.—Tuberculosis of the larynx is as a rule secondary to tuberculosis of the lungs but it may be primary, in which case tuberculosis of the lungs may follow.

CLINICAL FEATURES.—The patient complains of hoarseness, dyspnoea, and pain on swallowing.

On examination, ulcers are seen situated chiefly on the posterior laryngeal wall and on the interarytenoid space. The ulcers are shallow with undermined edges, and small, yellowish tubercles may be seen round them. The glottis may be occluded by a mass of tubercular granulation tissue or by oedema of the submucous tissue. The absolute diagnosis is made by the discovery of the tubercle bacillus in the secretion taken directly from the ulcers.

The prognosis is bad unless the lungs are unaffected.

TREATMENT.—The *General* treatment is the same as that of tuberculosis in other parts of the body, and is more to be relied upon than local treatment.

The *Local* treatment consists of painting the ulcer with 30 per cent. lactic acid, and if there are exuberant granulations which are occluding the glottis, they should be cut away. The condition may also be treated by opening the larynx and thoroughly scraping the ulcers, but this method of treatment can only be recommended in progressive cases without pulmonary disease. Tracheotomy may be necessary in some instances.

NEW GROWTHS OF THE LARYNX

Innocent

Papilloma.—Papillomata of the larynx are firm, wartlike growths, springing chiefly from the true vocal cords, the false cords, and the aryteno-epiglottidean folds. They are single or multiple, sessile or pedunculated, and are most common in childhood.

CLINICAL FEATURES.—The patient complains of hoarseness, aphonia, and some slight degree of dyspnoea, which may, however, at any moment become urgent. The diagnosis is made by laryngoscopic examination.

TREATMENT.—Papillomata may be removed by endo-laryngeal methods, either being twisted off by forceps or removed with the laryngeal snare. Recurrence is common after this method of treatment, and it is probably better to divide the thyroid cartilage (thyrotomy) and remove all the growths. Carcinoma sometimes supervenes on papilloma.

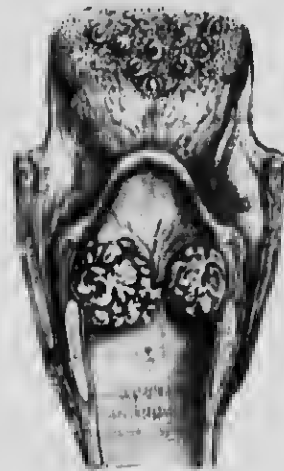


FIG. 459.—PAPILLOMATA GROWING FROM THE TRUE VOCAL CORDS.

(London Hospital Medical College Museum.)

Malignant

Sarcoma of the larynx is rare, and can only be recognized from carcinoma by microscopic examination.

Carcinoma occurs most frequently in men between the ages of forty and sixty, sometimes supervening on a papilloma. The disease is

generally a squamous-celled carcinoma arising from the true vocal cords, and may start as a warty growth or as a small ulcer.

The SYMPTOMS are hoarseness, aphonia, with pain on speaking and swallowing, the pain often being of a most distressing character. The breath is offensive on account of the fetid discharge from the ulcer, and hemorrhage may occur. Urgent dyspnoea may supervene at any time, or the patient may die of broncho-pneumonia or exhaustion from inanition, owing to the inability to swallow on account of the pain. The glands in the neck are affected early.

The DIAGNOSIS is made by laryngoscopic examination and the exclusion of other diseases, especially syphilis and tubercle. A small portion of the growth may be removed for microscopical examination.

The PROGNOSIS is bad.

TREATMENT.—The treatment of carcinoma of the larynx is a complete partial laryngectomy, and, later, removal of the glands in the anterior triangle of the neck. A preliminary tracheotomy is always necessary, and it is usually advisable to perform œsophagotomy at the same time. About three weeks after the operation the patient should be fitted with an artificial larynx. Many patients, however, prefer to wear a simple T-shaped tracheotomy tube, as they can easily make themselves understood without the artificial larynx, although the voice is only a whisper.

If operation is refused or impossible on account of the extent of the growth, the pain should be relieved by injections of morphia, by applying cocaine to the larynx, and by spraying the throat with antiseptic and deodorizing solutions.

When the dyspnoea becomes urgent, a low tracheotomy should be performed.

PRIMARY CARCINOMA may also occur in the trachea, the symptoms being very similar to those of laryngeal carcinoma. There is no treatment.

Operations on the Air Passages

1. **Pharyngotomy.**—Two operations are performed—subhyoid pharyngotomy and transhyoid pharyngotomy. In subhyoid pharyngotomy the pharynx is opened between the hyoid bone and the thyroid cartilage. Transhyoid pharyngotomy is only an extension of this operation, the hyoid bone being divided in the middle line.

Indications.—New growths involving the epiglottis, and foreign bodies lying above the entrance of the larynx.

OPERATION.—A preliminary tracheotomy is advisable, and the pharynx is opened by a median vertical incision. If it is necessary to



FIG. 460.—CARCINOMA OF THE LARYNX GROWING FROM THE FALSE VOCAL CORDS.

divide the hyoid bone, the incision is carried up towards the chin. It is not necessary to wire the hyoid bone after the operation.

2. Thyrotomy.—The thyroid cartilage is split in the middle line.
Indications.—

- (1) Removal of innocent growths that cannot be removed by intralaryngeal methods.
- (2) Removal of foreign bodies that cannot be removed with the laryngeal forceps.
- (3) Stenosis of the larynx.

OPERATION.—A high tracheotomy is performed, and the incision increased upwards. The thyroid cartilage is split by a scalpel or scissors exactly in the median line, and the condition present is treated. The cartilage is then carefully sutured. The tracheotomy tube is removed within forty-eight hours.

3. Laryngotomy.—The larynx is opened between the thyroid and the cricoid cartilages.

Indications.—The operation, only performed in adults, is used in—

- (1) Cases of urgent dyspnoea from inhaling foreign bodies.
- (2) Stoppage of respiration under anaesthesia.
- (3) As a preliminary to tongue, mouth, or jaw operations, especially if much bleeding is anticipated.

OPERATION.—The crico-thyroid space is reached by a median incision, and the crico-thyroid membrane is then divided horizontally. A laryngotomy tube can usually be removed within twenty-four hours of the operation.

4. Tracheotomy.—An opening is made into the trachea above the isthmus of the thyroid—high tracheotomy; or below—low tracheotomy.

Indications.—

- (1) Acute inflammation of the larynx, especially diphtheria, causing urgent dyspnoea.
- (2) Ulceration and stenosis of the larynx.
- (3) Malignant new growths of the larynx.
- (4) Foreign bodies in the air passages.
- (5) As a preliminary to other operations on the air passages.

OPERATION.—In the great majority of cases the *high* operation above the isthmus of the thyroid is chosen on account of its ease and safety. The patient is placed with the head well extended over a sandbag, in order to throw the trachea forward; it is the duty of the anaesthetist to see that the head is kept steady, and that the chin is strictly in a line with the sternum. The incision is about $1\frac{1}{2}$ inches long, and its upper end should be at the upper border of the cricoid cartilage. The surgeon cuts deliberately through the subcutaneous fat and anterior layer of the deep cervical fascia, exposing the interval between the infrahyoid groups of muscles. This interval is opened up, and the layer of deep cervical fascia over the trachea exposed.

Venous hæmorrhage will probably be free owing to the congestion of the veins, but it will cease as soon as the trachea is opened. The fascia is cut through, and the tracheal rings exposed. The sharp hook is then inserted into the lower border of the cricoid cartilage, and this is drawn upwards and forwards by the anaesthetist, putting the trachea on the stretch. The trachea is incised from below upwards. There is at once a rush of air escaping from the trachea, and the patient coughs, expelling mucus and blood. Without removing the hook, the side of the opening in the trachea is seized with forceps held in the left hand, and the tube, with its pilot, introduced with the right. When the tube is in position, the hook is removed, and the tube fastened by means of the tapes passing round the neck. Immediately after the introduction of the tube, the patient may cease breath-

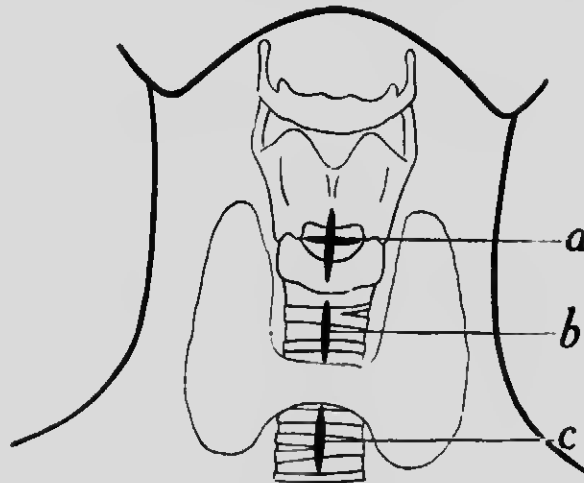


FIG 461.—INCISIONS FOR (a) LARYNGOTOMY; (b) HIGH TRACHEOTOMY; (c) LOW TRACHEOTOMY.

ing, but artificial respiration will quickly restore the act. Venous bleeding as a rule will stop as soon as the trachea is opened and breathing becomes easy.

If the trachea has been opened for diphtheritic laryngitis, it should be held open with the tracheal dilators, and the false membrane gently swabbed away before the tube is introduced. If foreign bodies in the trachea are not coughed up at once, the trachea must be held open while they are removed. In clean cases, after the obstructing body has been removed, the trachea can be closed with fine catgut sutures. The dressing should consist of a piece of berie lint in the form of a collar lying underneath the shield of the tracheotomy tube. If surgical emphysema should occur during the operation, as large a tube as possible should be introduced into the trachea; no further interference is necessary, and the swelling as a rule soon subsides.

Low Operation.—The low operation has the following disadvantages: (1) It is more difficult, as the trachea is deeper, smaller, and more mobile; (2) it is more dangerous, as the innominate veins may come into the field of operation; (3) broncho-pneumonia more often follows; (4) if suppuration of the wound takes place, the pus more readily reaches the mediastinum.

The *indications* are—(1) Malignant growths of the larynx invading the trachea; (2) foreign bodies in the trachea and bronchi which cannot be removed through the bronchoscope; (3) some cases of tumours of the thyroid gland.

The *OPERATION* is performed in much the same way as the high operation, but special care must be taken that no large vessel is divided in the lower part of the incision.

Tracheotomy Tubes.—The majority of these are made of silver, and should be of such calibre that respiration can be carried on through them without effort on the part of the patient. The outer tube should have an opening at the upper part of the bend, so that, with the outer opening of the inner tube closed, the patient can breathe through the larynx. The most commonly used are—

BRYANT'S.—The curve of this tube is about a quarter of a circle, and its lower end tends to press against the anterior wall of the trachea, and cause ulceration. The shield is fixed.

PARKER'S.—This has an angular curve, so that the part in the trachea accurately follows the direction of that tube. It has a movable collar, which is more comfortable to the patient than the fixed shield.

DURHAM'S.—The inner tube and the pilot of this instrument are fitted with lobster-tails, which make them a little dangerous. Its advantage is that it is fitted with a movable collar, which can be fastened at any point on the tube by means of a screw. In this way it can be adjusted to any degree of thickness of tissue between the skin and the trachea.

FULLER'S.—The outer tube is a half-valve, so that it can be readily introduced into the slit in the trachea without a pilot. The shield is fixed.

KÖNIG'S.—This is a very flexible silver tube for introduction when the trachea is constricted low down by a thyroid tumour.

MORRANT BAKER'S.—This tube is made of india-rubber, and has sufficient rigidity to prevent it from collapsing, but not sufficient to cause ulceration. It is used when the tube has to be worn for a long time; it should not be introduced for the first twenty-four hours, a silver tube being used immediately after the operation. It is a single tube, and is easily removed and reintroduced.

After-Treatment of a Case of Tracheotomy performed for Diphtheritic Laryngitis.—The temperature of the room should be kept at 63° to 65° F., draughts being carefully avoided. The use of the steam-tent is of doubtful benefit, but if employed, care must be taken that there is a free exit for the steam, and that the temperature in the tent does not rise above 70° F.

The mouth of the tube should be covered with one or two thick-

nesses of gauze, in order that the air entering into the trachea is to a certain extent filtered.

The inner tube should be removed and cleaned with an alkaline lotion directly it gets blocked, and then replaced; but even if it does not get blocked, it should be removed and cleaned every two hours. All membranes coughed up through the tube should be immediately wiped away with a swab. If the membrane is dry and comes away with difficulty, the inner tube should be removed, and warm alkaline lotion (bicarbonate of potash, 20 grains, to water, 1 ounce) sprayed into the outer tube. This will loosen the membrane, and allow it to be coughed up. If, in spite of the inner tube being clear, the dyspnoea returns, and if the lungs are not affected, it is evident that the membrane is blocking the trachea beyond the tube, and a feather should be used to remove it. Feathers are sterilized by boiling or by dry heat. They are kept in a weak carbolic solution, and should be dipped into the alkaline solution before using. The feather is introduced into the outer tube, turned round, and removed. Violent coughing is often excited, and the membrane ejected. Too frequent use of the feather is to be avoided. If the dyspnoea continues, the outer tube must be removed, the trachea held open by dilators, and the offending membrane sought for and removed.

At the end of twenty-four hours the outer tube should be removed, carefully cleaned, and replaced; and at the end of forty-eight hours steps should be taken to accustom the child to dispense with it altogether. This is done by blocking up the inner tube with a piece of lint for a few minutes at a time, so that the child has to breathe through the larynx and the upper opening in the outer tube; the periods of this natural breathing should be steadily increased. Some tubes have the inner tube fitted with a cap that can be gradually screwed down, and the air-supply through the tube cut off by degrees.

The tube should be removed at the earliest possible date, and this will generally be on the third day. The dilators should be at hand. During removal the attention of the child should be attracted elsewhere, or the tube can be removed while the child is asleep. In some cases removal with the child in the sitting position is successful. When removed, the tube should be cleaned and fitted into its pilot ready for an instant replacement; and the surgeon should not leave the patient until he is breathing comfortably through the mouth. In all cases a competent person who can replace the tube should be left in charge in case dyspnoea again becomes urgent.

Feeding.—The child should be encouraged to take food, and should be fed every two hours, 4 ounces of milk with barley water being given at each feed to a child two years old. In some cases the food will regurgitate through the nose, or it may pass into the trachea and be expelled through the tube or wound. Under these circumstances, it will often be found that if the milk is thickened with arrow-root, it can be swallowed quite easily. If, however, the food still regurgitates and causes coughing, or if there is distaste and resistance to food, nasal feeding must be begun. In a favourable case some

solids can be swallowed on the third day, and the dietary should gradually return to that suitable to the age of the child.

The wound as a rule, under a simple dressing frequently changed, heals rapidly; but if suppuration or diphtheritic infection of the wound occur, appropriate treatment must be carried out.

Intubation of the Larynx.—This measure is employed as a means of dilating a chronic fibrous stenosis of the larynx, and as a substitute for tracheotomy or laryngotomy in certain special conditions. The instruments consist of a set of intubation tubes varying in calibre, corresponding to the size of the larynx; an introducer; an extractor; and a mouth-gag. All are made of metal, and are sterilized by boiling.

THE OPERATION.—The child is wrapped in a blanket, the arms being inside, and is laid on the table, with the head slightly extended over a small pillow placed behind the neck. The assistant stands on the left side of the patient, holds the mouth open with the gag, and steadies the head. The forcing of the mouth open is not without danger, the child sometimes ceasing to breathe. The tube should be warmed and lubricated with a little vasoline before introduction. The operator holds the introducer, with the threaded tube, in his right hand, feels for the epiglottis with the left forefinger, and, pulling this forward, inserts the end of the tube between his finger and the epiglottis. The handle of the introducer is then raised, and the tube pushed on into the larynx between the vocal cords. As soon as the tube is in position, the introducer is removed, the left forefinger holding the tube in position during its withdrawal.

The thread on the tube is brought out of the mouth, fixed to the cheek with a piece of strapping, and left in position until the tube is removed.

Immediately the tube is introduced there will be a violent attack of coughing, and the child should be turned on his side to facilitate the escape of the mucus and membrane that is coughed up; but after a severe bout of coughing the breathing will be easy, and the child will generally sleep.

Although feeding by the mouth can be carried out in a large number of cases, and should always be given a trial, in some instances rectal feeding is absolutely necessary.

Food suitable to the age and condition of the patient should be given; in cases of diphtheria this will as a rule be milk. To young children the milk should be given slowly with a spoon, but with older children the feeding-cup may be used. If swallowing excites more than a little cough, the milk should be thickened with arrowroot. If feeding by the mouth fails, nasal feeding should be tried; and if this fails, resort must be had to rectal feeding. The tube should be removed for cleaning in twenty-four hours, and then replaced; in forty-eight hours after the operation it can be removed, and the child watched for a return of the dyspnoea. This is not likely to be urgent, and there is usually plenty of time to replace the tube. A sudden attack of dyspnoea with the tube in position should be met by removal of the tube, and, if necessary, by tracheotomy.

The tube is easily removed by pulling on the thread; but if this has been removed or is bitten through, expression or removal by the extractor must be performed. Expression is performed by placing the thumb on the trachea just below the level of the lower end of the tube, and then pressing upwards and backwards, forcing the tube out in front of the thumb. The child should be lying on its side near the edge of the bed, and as soon as the tube is in the mouth it should be removed by the thumb and forefinger of the other hand. Great care must be used whenever an attempt is made to remove the tube by the extractor, as this instrument can cause serious damage to the larynx. The method of use is the same as that for removing a foreign body from the larynx, but in the case of children the laryngeal mirror cannot be used.

When intubating for acute conditions, and during the after-treatment, the surgeon must be prepared to perform tracheotomy at once, if relief is not afforded, or if urgent dyspnoea occur.

If intubation has been done for a chronic case, the tube may be left in position for a week without harm resulting. A tube has been worn for fifty-eight days, with interruptions after the first twenty-one days, without any complications following.

INJURIES AND DISEASES OF THE THORAX

Contusions.—Contusions of the thorax result from blows with blunt instruments, kicks, "run-over" accidents, etc. Three varieties may be distinguished:

1. In the simplest variety there is injury of the soft tissues, with extravasation of blood, and bruising of the ribs or sternum, but no injury to the internal organs. The symptoms are pain and swelling, and later the appearance of a bruise. Respiration is painful.

TREATMENT.—Cold may be applied to the bruise, but firm bandaging and massage give the greatest relief.

2. Injury to the soft parts may be combined with serious injury to the viscera, such as laceration or crushing of the lungs, rupture of the large bloodvessels, injury of nerves or the heart, etc.

TREATMENT is that of the lesion caused by the injury, but many cases are rapidly fatal.

3. Injury of the important organs without evidence of contusion of the walls of the thorax—for example, the lungs have been torn across without any external evidence of injury.

Children on the whole suffer less from injury to the thorax than adults, on account of the greater elasticity of the ribs and sternum. On the other hand, it is more common to find serious internal injury without external signs in children than in adults.

Concussion of the Thorax.—This term is applied to a condition of shock which may terminate fatally after a blow on the thorax, par-

ticularly over the heart, without any evidence, either ante- or post-mortem, of a serious lesion of the thoracic wall or viscera. One of the "knock-out" blows in boxing is a blow over the heart. The patient may be rendered unconscious for a short time, and afterwards show no ill-effects from the blow. The treatment, if any is necessary, is artificial respiration.

Fracture of the Sternum.—This is rare, for the sternum is supported by the elastic ribs and costal cartilages, and being attached to the freely moving shoulder girdle, the force of blows on it is lost.

CAUSES.—The sternum may be fractured by direct violence, indirect violence, or muscular action.

Direct violence is usually due to blows, stabs, or gunshot wounds, but it may be caused by the chin being driven down on to the sternum.

Fracture from *indirect violence* may follow blows on the clavicle, or hyperextension of the sternum in the case of fracture of the vertebral column.

Fracture from *muscular violence* is due to violent coughing or sneezing, or the efforts of parturition.

The most common seat of fracture is in the gladiolus between the attachments of the second and fourth costal cartilages; the manubrium itself is seldom broken. The fracture is as a rule transverse, though it may occasionally be longitudinal or oblique. If there is displacement, the rule is for the lower fragment to ride forwards on the upper, but the reverse may occur. The fracture is in a large number of cases complicated by fracture of the ribs, fracture of the spine, injuries to the heart and lungs, etc.

CLINICAL FEATURES.—The patient complains of pain at the site of the fracture, which is increased by deep respiration, coughing, and pressure. Crepitus may be felt or heard with a stethoscope, and if there is displacement of the fragments, a well-marked prominence may be seen and felt. Local bruising is present, and is most marked when the fracture is due to direct violence.

The X rays are of little value in the detection of a fracture of the sternum, for, owing to the shadow cast by the heart and great vessels, it is only possible to get a clear view of the edge of the sternum. If displacement is present, the fracture is usually readily detected without radiography.

PROGNOSIS.—Union takes place in four or six weeks. The prognosis as regards life depends on the accompanying injuries. Non-union is uncommon.

TREATMENT.—The deformity should be reduced by arching the spine backwards over a large sandbag. If this does not reduce the deformity, and the patient has respiratory embarrassment, the fragments may be exposed by an open operation, and plated or wired into position; but union in the deformed position is attended with no disability. If there is no deformity, or reduction is successfully accomplished, the patient should be nursed in the sitting position, with the head thrown backwards and the chest bandaged, in order to limit the movements of respiration; but if the deformity tends to recur, the

patient should be nursed flat on the back with a firm pillow just below the shoulders.

Displacement of the Ensiform Cartilage.—When the ensiform cartilage is broken, it is usually displaced backwards, and it may press on the stomach and cause gastric pain and vomiting.

TREATMENT.—The cartilage should be cut down upon, and fixed in position or removed.

Fracture of the Ribs.—Fractures of the ribs are more common in elderly people than in children, owing to the greater elasticity of the ribs and the costal cartilago in young subjects. They are more usual in men than in women on account of their greater exposure to injury. The ribs most frequently fractured are the fourth to the eighth, and the least frequently the first, second, and third, in consequence of their protected positions.

CAUSES.—Fractures of the ribs occur from direct violence, indirect violence, and such muscular actions as sneezing or coughing. Fractures due to direct violence are the most dangerous, as the fragments of the ribs may be driven inwards and injure the lungs or other thoracic organs. Several ribs are often broken at the same time, and it is not uncommon for a rib to be broken in two places. Greenstick fractures may occur.

Wasting diseases, old age, osteomalacia, fragilitas ossium, and insanity, predispose to fractures of the ribs. Insanity as a predisposing cause is important from a medico-legal standpoint, for charges of cruelty are not infrequently brought against asylum attendants owing to fracture of the ribs being found in lunatics, especially in those suffering from general paralysis of the insane.

CLINICAL FEATURES.—The patient is often aware that something has "snapped" in his chest, and complains of a fixed pain at the site of the fracture. This pain is made worse by deep inspiration, coughing, or sneezing. If one rib only is fractured, there is seldom any displacement of the fragments, and crepitus is difficult to obtain; but if many ribs are crushed, the deformity may be marked, and crepitus felt by merely laying the hand on the chest, the fragments grating together at each inspiration. The site of the fracture is painful on pressure, and when made on the rib away from the suspected site of fracture, a sharp pain is referred to the fracture. The movements of respiration on the side injured are greatly reduced, and if ribs on both sides are fractured, there may be considerable respiratory difficulty. On listening over the site of the fracture with a stethoscope, crepitation may be made out; and a few days after the injury, a rub, due to a dry traumatic pleurisy, may be heard.

Compound fractures are readily diagnosed by careful inspection of the wound.

COMPLICATIONS—1. *Surgical Emphysema.*—If the lung is injured, surgical emphysema may follow, and spread rapidly all over the body. The air is usually absorbed in a few days.

2. *Hemothorax* follows injury to the lungs or the large vessels in the thorax, and may overshadow the symptoms of fractured ribs.

The diagnosis is that of fluid in the chest immediately following an injury. The treatment is given under Injuries of the Lungs, p. 1030.

3. *Pneumothorax* is also due to injury of the lung.

4. Fractured ribs may be complicated by injuries to the heart, pericardium, and great vessels; or the fragments of the broken ribs may penetrate the diaphragm and injure the liver, spleen, or intestines.

5. *Pneumonia* not infrequently follows, especially in the aged.

PROGNOSIS.—The prognosis of simple fracture is good, and the fragments unite in three or four weeks. Non-union is very rare. The prognosis as to life in complicated fractures depends on the nature of the complication.

TREATMENT.—In uncomplicated cases, and when the ribs on one side only are broken, the movements of the injured side should be restricted by strapping the chest. The strapping used should be lead plaster strapping, the strips being 2 inches broad and long enough

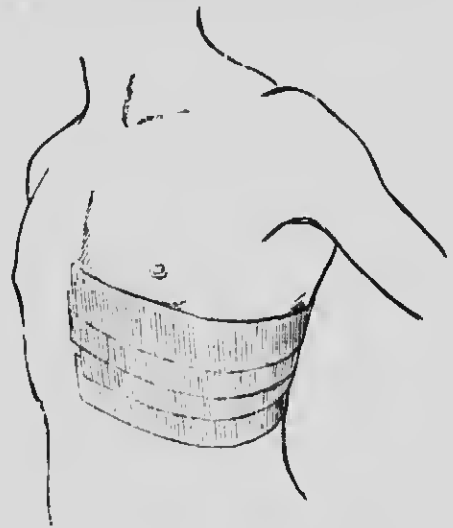


FIG. 462.—METHOD OF STRAPPING FRACTURED RIBS.

to reach from 2 inches beyond the spine at the back to 2 inches beyond the border of the sternum in front. The patient should first be made to expire the air in the chest; then the strip is fastened beyond the spine on the back, carried round the chest, and fixed beyond the sternum in front, with the chest still in the position of expiration. The strips should be applied from below upwards, each strip overlapping the one below by half its own width.

After the strapping is applied, a flannel bandage should be carried round the chest, but not so firmly as to limit seriously the movement of the uninjured side.

If ribs on both sides of the chest are injured, the strapping may be carried right round the chest, but it must not be applied too

tightly. In some cases, when strapping—or even a bandage—applied to the chest will cause great pain and dyspnea, the chest must be left free, but the patient should always be confined to bed. This is not necessary in a healthy adult if the chest is strapped and only one rib fractured. In elderly people with a tendency to bronchitis, or if many ribs are fractured, no strapping or bandage should be applied, but the patient must be propped up in a sitting position in bed, and if broncho-pneumonia supervene, he must be given stimulating expectorants and strychnine, in spite of the pain caused by coughing.

If a fragment of the rib is depressed, strapping and bandaging of the chest are contra-indicated, and the depressed fragment should be elevated by operation.

The treatment of the complications of fractured ribs are symptomatic, and are described elsewhere.

Fracture of the Costal Cartilages.—Fractures of the costal cartilages are less common than, but due to the same causes as, fracture of the ribs. They are most often broken near the junction with the ribs, and least often separated from their junction with the sternum. The line of fracture is usually vertical, and if displacement occurs, the costal portion generally projects in front of the sternal portion. The displacement is very difficult to correct.

CLINICAL FEATURES.—The symptoms and physical signs are very similar to those of a fractured rib.

PROGNOSIS.—Fracture of the costal cartilage unites by bone developed from the perichondrium. The ends of the cartilage are found united by fibrous tissue inside the sheath of bone.

TREATMENT.—Any displacement found should be corrected as far as possible, and the chest strapped in the same manner as in the treatment of fractured ribs.

Dislocation of the Ribs—1. *Dislocation of the Vertebral End.*—Dislocation of the vertebral end of a rib is due to direct violence, and the dislocation is usually in a forward direction. The diagnosis can seldom be made with certainty, except with the X rays. The symptoms resemble those of fracture of the ribs.

TREATMENT.—Reduction of the dislocation is not possible, and the case should be treated as one of fractured rib.

2. *Dislocation of the Rib from the Costal Cartilage.*—This dislocation is always due to direct violence, and the cartilage is displaced forward on the rib. The diagnosis as a rule presents no difficulty on account of the obvious displacement. The symptoms are similar to those of a fractured rib.

Replacement is difficult, and if considered necessary, it may be effected by an open operation; but permanent displacement has little functional disability.

TREATMENT.—The treatment is that of a fractured rib. Simultaneous dislocation of both ends of a rib is rare.

INJURIES OF THE LUNGS

Contusions and Lacerations. These arise from subcutaneous injuries of the thorax, and are most commonly associated with fractures of the ribs, the fragments of the bone being driven into the lung and tearing it.

CLINICAL FEATURES.—A considerable amount of shock, following the accident, is present, and the patient may have fits of coughing, which are extremely distressing. If the pleura is torn with the lung, hæmorrhage into the pleural cavity occurs (hæmothorax). If the bleeding is severe, the patient shows the usual signs of internal hæmorrhage (see p. 183), and there are the physical signs of fluid in the chest—viz., dullness, loss of breath-sounds, loss of vocal resonance, and loss of tactile vocal fremitus. The heart is displaced, and dyspnoea, owing to pressure on the lung, is present.

Hæmoptysis is a common symptom, the blood being frothy and bright in colour; but severe laceration of the lung may occur without any hæmoptysis.

Pneumothorax.—The condition of air in the pleura may also follow wounds of the lung. The symptoms are pain in the chest and dyspnoea. The physical signs are—Bulging of the intercostal spaces, hyper-resonance on percussion, loss of tactile vocal fremitus, vocal resonance, and breath-sounds. The "coin-sound" is well heard. If the pneumothorax is extensive, the heart and liver may be displaced; but even with complete collapse of the lung there may be little distress the pneumothorax is produced gradually.

Surgical Emphysema of the chest wall may occur if both the visceral and parietal pleura are ruptured, and the air spread all over the body in the subcutaneous tissue. It is recognized by the characteristic crackle on palpation. If the visceral pleura remains intact, interstitial emphysema into the lung may arise, spread to the root, and pass up into the mediastinum to the root of the neck. Interstitial surgical emphysema is more serious than subcutaneous.

PROGNOSIS.—In cases of wounds of the lung, death may ensue from shock, respiratory embarrassment, or hæmorrhage. The blood of a hæmothorax may become infected, and an empyema result. The most common result of slight injuries is a mild pleuropneumonia, with slight rise of temperature, followed by recovery.

TREATMENT.—The patient should be put to bed, and the usual treatment of shock carried out. It will be found that he is generally most comfortable in a sitting position. The further treatment will depend on the symptoms.

Hæmothorax as a rule requires no treatment, and the blood should not be removed, for it compresses the lung and tends to check the hæmorrhage; but if the pressure is excessive, the blood should be removed with an aspirator. A large-bore instrument, carefully sterilized, should be used. Aspiration should also be carried out if the fluid is not absorbed in a reasonable time (three weeks). If infection takes place, the case must be treated as an empyema (p. 1036).

Pneumothorax seldom require treatment, but if the presence of the air is seriously embarrassing the heart's action or the respiration, it should be let out by introducing a fine bore aspirating needle. The air in *surgical emphysema* is rapidly absorbed.

Hæmoptysis is treated by giving small doses of morphia. If the bleeding into the lungs is severe, the patient must be encouraged to cough the blood up; in other instances the patient should be kept at rest and percussion of the chest is contra-indicated.

Injuries of the Pleura.—The pleura, without the lung, may be injured by blows on the chest and by the ends of fractured ribs.

SYMPTOMS.—The patient complains of pain on taking a deep breath; and on listening over the painful area, a friction rub is heard, owing to the presence of a traumatic pleurisy.

TREATMENT.—The chest should be strapped as in the case of fractured ribs.

Penetrating Wounds of the Lungs.—Penetrating wounds of the lungs are most commonly due to stabs and bullet wounds, and the prognosis depends on the size and depth of the injuries. If death follows soon after the injury, it is almost invariably due to hæmorrhage; the nearer the wound is to the root of the lung, the greater the danger. With superficial injury the hæmorrhage soon ceases, owing to the elasticity of the lung and the filling of the smaller bronchi with blood-clot. If both lungs are injured, and double pneumothorax results, death may occur from suffocation.

The cases may be divided into two groups: (1) Those in which the external wound is small, and closes immediately after the injury; and (2) those in which the external wound is large, and remains open.

1. *The External Wound is Small, and closes.*—The symptoms in these cases are the same as those of subcutaneous laceration of the lungs—viz., hæmothorax, pneumothorax, hæmoptysis, and surgical emphysema, with dyspnoea, pain in the chest, and signs of internal hæmorrhage.

2. *The External Wound is Large, and remains open.*—If hæmothorax, pneumothorax, hæmoptysis, and surgical emphysema, may also be present in these cases, but, in addition, there may be severe external hæmorrhage. Infection of the wound, followed by empyema, abscess, or gangrene of the lung, is more likely to ensue than in the first cases. In both cases foreign bodies, such as bullets, may be left in the lungs, and may remain quiescent for years; but they are a constant source of danger, for suppuration may occur round them, leading to abscess of the lung and empyema. Foreign bodies left in the lung may be subsequently coughed up. Surprising recoveries from injury of the lungs sometimes take place, such as recovery from a spear or bayonet has been driven through the chest, penetrating the whole thickness of the lung.

Injuries of the lungs may be complicated by injury of the other important organs in the thorax, and this may considerably alter the clinical course and prognosis of the condition.

TREATMENT.—The external wound should be treated at once in accordance with the principles of aseptic surgery, the most modern method being to paint it and the surrounding skin with iodoine (2 per cent. in spirit). Treatment then varies according to which variety of penetrating wound is present.

1. *The External Wound is Small, and closes.*—The wound should not be probed nor sutured, but covered with a large aseptic dressing, and the chest bandaged firmly if it does not cause too much respiratory embarrassment. The case should be treated as a case of laceration of the lung (see p. 1030). The patient is usually most comfortable if propped up in bed. If the hæmothorax is extensive, and causes urgent dyspnoea with displacement of the heart, the blood must be removed by aspiration. It may be necessary to remove the air in a pneumothorax in the same way. Aspiration should, however, be avoided if possible, as the pressure of the blood or air tends to arrest the hæmorrhage from the lung. Should infection occur, the empyema must be treated by resection of a portion of a rib, and drainage.

2. *The External Wound is Large, and remains open.*—The first step is the arrest of hæmorrhage, which may come from an intercostal artery, the internal mammary, or from the lung. The diagnosis between hæmorrhage from the external arteries and hæmorrhage from the lungs is usually easy by careful inspection of the wound, by noting whether the blood is expelled in jets, and to what extent it is mixed with air. Wounds of the internal mammary artery are treated by ligature of the bleeding vessel, either at the site of injury or just above it, a costal cartilage being resected if necessary. The artery runs behind the cartilages about $\frac{1}{2}$ inch from the edge of the sternum, and it is best tied in the second interspace.

Wounds of the intercostal arteries should be treated by ligature, a portion of the rib being resected if necessary. The arteries run in a groove along the lower border of the ribs with the intercostal veins and nerves.

Hæmorrhage from the lung is as a rule either moderate or so severe that nothing can be done. The only efficient method of treatment is opening the thorax and attempting to pass deep sutures through the substance of the lung, in order to arrest the bleeding. After this attention should be turned to rendering the wound aseptic. Foreign bodies should be removed, if easy, but if of metal and buried, the foreign body should first be accurately localized by the X rays. Later, suppuration may occur in the pleural cavity, and necessitate drainage.

Prolapse of the Lung.—Prolapse of the lung may occur through a wound of the chest wall, the protruding lung being recognized by its crepitant feeling and by expanding with inspiration.

TREATMENT.—The protruding portion of the lung should be returned to the thorax, and the wound closed in the usual way. If this is not done, the base of the herniated lung may be constricted in the wound, and gangrene occur. The treatment then consists of removing the gangrenous portion after the base of the hernia has been ligatured.

Hernia of the Lung (Pneumocoele).—Hernia of the lung may be congenital or acquired, the latter variety being by far the more common.

The most common cause is a wound of the thoracic parietes the scar yielding under the pressure in the thorax. The condition is more likely to ensue if the patient has a chronic cough and emphysema. Hernia of the lung may also occur at the root of the neck or in the lower intercostal spaces without any wound in patients with chronic cough, or in those who constantly make such violent respiratory efforts as musicians who play wind instruments. These hernie are termed "idiopathic."

CLINICAL FEATURES.—The patient complains of a swelling in the chest or neck, and on examination, a soft swelling that crepitates on palpation is found. The swelling increases in size on inspiration, and diminishes or may disappear entirely on expiration; it is resonant on percussion, and on auscultation a vesicular murmur is heard over it.

TREATMENT.—The swelling in the thorax should be protected by a pad, but in the neck no treatment is necessary. If it is increasing in size, a plastic operation may be performed, but this is rarely needed.

INJURIES OF THE PERICARDIUM AND HEART

Wounds of the Pericardium without injury to the heart are rare, and are only to be diagnosed by the presence of a hæmopericardium and pneumopericardium. If no serious complication is present, these wounds heal well, a little pericarditis following the injury. The heart as a rule becomes adherent to the pericardium at the site of the wound. Infection is followed by suppurative pericarditis, and is generally fatal.

Wounds of the Heart usually penetrate the whole thickness of the wall, and are most common in the right ventricle.

Ruptures of the heart are due to severe crushes of the thorax, but in cases of grave degeneration of the heart muscle, spontaneous rupture may occur.

CLINICAL FEATURES.—The symptoms of wounds of the heart are those of shock and internal hæmorrhage, and the majority are, of course, rapidly fatal. If the patient does not die at once, the pulse becomes very weak, the heart sounds almost inaudible, and on percussion there is a rapidly increasing precordial dulness from hæmopericardium, or obliteration of the heart's dulness from pneumopericardium.

PROGNOSIS.—It has been estimated that 7 per cent. of wounds of the heart heal spontaneously; even serious wounds have resulted in recovery. Foreign bodies, such as small bullets and pins have been found embedded in the heart muscle years after their introduction. After healing, the heart often remains dilated, and cardiac fibrosis and thickening of the valves are common sequelæ. The wound in the heart heals in the usual way by fibrous tissue, and the scars in the heart and pericardium are as a rule adherent to one another.

TREATMENT.—The patient should be kept lying down, and all interference with the wound avoided until the question of operation is

decided. Of recent years successful cases of heart suture have been recorded, and it is probably more advisable to attempt suture than hope for spontaneous healing, but the condition of the patient must allow of an anæsthetic being given. The wound in the thorax is enlarged, and a flap containing the fourth and fifth ribs is turned up; deep catgut sutures are used to close the wound in the heart, and the sutures should be tightened when the heart is in a phase of diastole. Wounds of the ventricle are more favourable than wounds of the atricle.

INJURIES OF THE DIAPHRAGM

Injuries of the diaphragm may occur from severe crushes of the abdomen or chest, or from stabs or gunshot wounds. In a few cases rupture has followed the violent expulsive efforts of vomiting and parturition.

After a wound of the diaphragm, the abdominal contents pass into the thorax (traumatic diaphragmatic hernia), or the lungs may prolapse into the abdominal cavity. The latter condition is much the rarer. Severe lesion of one of the important abdominal or thoracic viscera may occur, with injury of the diaphragm, and prove fatal.

CLINICAL FEATURES.—If the lesion in the diaphragm is the chief injury, there is pain at the site of injury increased by deep respiration and coughing, shock, and signs of internal hæmorrhage. If the abdominal contents have entered the thoracic cavity, there is dyspnœa, with displacement of the lungs and heart and corresponding physical signs. Later, the symptoms of diaphragmatic hernia are present (see p. 743), but a patient may live for years with the condition unsuspected. The first serious symptoms of the hernia may be those of intestinal obstruction due to strangulation.

TREATMENT.—The rent in the diaphragm should, if possible, be closed by sutures, the musculo being approached from its thoracic aspect by resecting two or more ribs.

INFLAMMATORY DISEASES OF THE THORAX

Pyothorax (Empyema).—An empyema is a collection of pus in the pleural cavity which may fill the whole of the cavity, or be localized to one portion by the development of inflammatory adhesions round the pus. The latter variety is termed *localized empyema*. The organism present may be one of the common pyogenic organisms—*e.g.*, staphylococcus, streptococcus, pneumococcus, *Bacillus coli*, or the tubercle bacillus. Tuberculous empyema will be described separately.

The most common cause of empyema is an attack of acute pleuropneumonia. A pure culture of the pneumococcus is generally present in children; but in adults streptococci and staphylococci are more often found. Empyema may also follow rupture of a liver or subdiaphragmatic abscess into the pleura, or the bursting of an abscess of the lung, or a bronchiecatic cavity. Infection sometimes occurs through the blood-stream—the condition being part of a general

septico-pyæmia—during the course of scarlet fever, typhoid fever, and influenza. Removal of a malarial spleen is not infrequently followed by empyema on the left side.

PATHOLOGICAL ANATOMY.—In acute empyema the surfaces of the pleura are covered with a layer of inflammatory lymph, most abundant in cases of pneumococcal empyema, and the pleural cavity is filled with a turbid sero-purulent exudate. If the fluid is drained away early, the lung quickly expands, and the only after-effect will be a few adhesions between the parietal and visceral pleuræ, clinical examination of the chest showing no physical signs of disease. In other cases the adhesions will be denser, and calcareous salts may be deposited in them; a little dulness on percussion and some contracture of that side of the chest will be found. If the pus is not removed early, the pleura becomes thickened by fibrous tissue, and the lung sclerotic, so that it cannot expand; and after the pus has been drained away the lung remains contracted close to the vertebral column. The cavity thus left will continue to discharge pus, and that side of the chest will be shrunken. The undamaged lung will hypertrophy, and the heart will be displaced towards the diseased side. The diaphragm will be pushed up by the pressure of the abdominal viscera, and as the chest wall sinks in the spine will develop a lateral curve, and scoliosis will follow.

In a chronic localized empyema the pus will be surrounded by a dense wall of adhesions, and sclerotic changes will take place in the adjacent lung.

CLINICAL FEATURES.—The onset of an empyema is usually insidious during the course of some other illness, especially pneumonia, and the condition is often unsuspected until the continuation of the general symptoms leads to a careful examination of the chest. The general symptoms are those of an infectious disease with an irregular temperature; dyspnoea and embarrassment of the heart's action from pressure are also present.

The **PHYSICAL SIGNS** are—*Inspection*: Imperfect expansion of the affected side, and obliteration of the intercostal spaces. *Palpation*: Displacement of the apex-beat of the heart, and displacement downwards of the liver and spleen. *Percussion*: Dulness over the affected lung, and displacement of the precordial dulness. *Auscultation*: Absence of breath-sounds, tactile vocal fremitus, and vocal resonance over the affected lung. In children bronchial breathing may be heard all over the chest, and in adults in the vertebral groove. If the chest is not full of fluid, a high-pitched percussion note may be present below the clavicle (Skodaic resonance). When the pus is on the left side of the chest, the beat of the heart may be communicated to the fluid, and the condition is termed **pulsating empyema**. With a localized empyema, the physical signs are modified.

The above signs are those of fluid in the pleural cavity, and this fluid may be serous or sero-fibrinous, and capable of absorption: the only absolute diagnostic sign of pus in the early stages of the illness is its discovery with the aspirating syringe; therefore this method

should always be used in suspected cases of empyema, for early diagnosis is of the utmost importance. The fluid removed should be examined bacteriologically, as the prognosis, and to some extent the treatment, depends on the organism present. The most favourable variety is a pneumococcal empyema, the least favourable a tubercular. The pus in the case of coli infection is usually foetid.

If an empyema is undiscovered, the pus will point through the chest wall—**empyema necessitas**. The most common situation for pointing is the fifth interspace close to the sternum, and a large subcutaneous abscess may develop. An empyema may also point in other parts of the chest, especially in the second interspace, or it may burst into the lung and be expectorated. In other cases the pus may pass through the diaphragm and point in the lumbar region, or it may spread by means of the lymphatics into the liver, and cause multiple abscesses.

TREATMENT—Aspiration.—In the case of children—and especially with a recent pneumococcal empyema—aspiration, repeated if necessary, may be sufficient to bring about a cure. The best form of instrument to use is a Dieulafoy's siphon aspirator, which can be sterilized by boiling. The skin of the patient and the hands of the operator are rendered aseptic in the usual way. A local anæsthetic may be used, but it is not necessary. In the case of a large pleuritic effusion, the most convenient spot to tap is the sixth intercostal space in the mid-axillary line, or a little farther back. If the effusion be localized, the cavity must be tapped where the signs of fluid are most marked. The skin is pulled up over the selected spot, and the needle plunged in over the upper border of the lower rib bounding the chosen space, and thrust in a slightly upward and backward direction. The thrust should be made smartly, in order to penetrate the tissues, and not push them in front of the needle. The needle is then withdrawn from the canula, the aspirator attached, and the fluid drawn off slowly. Should spasmodic cough occur, the aspiration should be stopped for a time; and if blood is drawn off, the instrument should be at once withdrawn. After the fluid is removed, the needle is withdrawn, and the small puncture covered with a collodion dressing.

Aspiration should also be used if the empyema is a massive one and the respiratory embarrassment is great, or the general condition is very bad. The fluid should be removed by aspiration, and within the next twenty-four hours the operation of thoracotomy with drainage should be performed. In cases of emergency, aspiration and not drainage is the proper method of procedure.

Thoracotomy.—By this operation is understood the resection of a piece of rib and drainage of the pleural cavity; it is the routine treatment of cases of empyema. A general anæsthetic such as chloroform or CE_2 mixture should be administered as a rule; but when it is doubtful if a general anæsthetic can be given with safety, the operation should be performed under local cocaine anæsthesia.

The position of the opening in the thorax depends upon the amount of effusion and the age of the patient. In limited circumscribed

empyema the opening should be made a little below the centre of the area of dulness, and the chest explored with a needle to make sure that the opening is placed over the pus-containing cavity. For a large empyema in infants, the opening may be made through the fourth rib in the mid-axillary line; but in adults, and also in children, a more convenient place for the opening is through the eighth rib just below the angle of the scapula. The pleural cavity can be effectually drained through this opening, the patient either sitting up or lying down in bed.

Position of the Patient during Operation.—One of several positions can be used, all of them being designed to allow the sound lung to expand readily:

1. A high operating-table is used, and the patient, lying on his back, is drawn to the edge, so that the diseased side is well beyond the edge of the table. The operation is then performed from below.
2. The patient is turned nearly on his face, so that the back of the sound lung is free to expand.
3. The patient is turned well on to his diseased side, and the operation performed from behind.
4. Children can be held over on the sound side by the hips and shoulders, so that the diseased side is uppermost, and yet there is no pressure on the sound lung.

In limited empyema there is little danger in laying the patient on the sound side.

An incision $2\frac{1}{2}$ inches long is made over the selected rib and quickly carried down to the periosteum, which is divided in the line of the incision. The periosteum is raised over the outer side of the rib with the rongine, and then stripped off the inner side with the curved raspator, about 2 inches of the rib being laid bare. In children the rib is cut through with forceps, but in adults it is better to saw through the bone, so as to avoid leaving rough edges. About $1\frac{1}{2}$ inches of the bone is removed, in order that the finger can easily enter the thoracic cavity.

The periosteum and the pleura are then incised, and the pus allowed to escape gradually.

The operation should be done rapidly, and if the patient stops breathing, the chest must be opened before artificial respiration is begun.

The finger, or a sponge on a holder, should be introduced into the cavity, and fibrinous masses or blood-clot removed, loculi, if present, broken down, and the cavity wiped as clean as possible. If these manipulations excite cough or much hæmorrhage, they should be discontinued.

In some cases the escape of pus is followed by severe hæmorrhage. If this should happen, the tube is inserted, the wound dressed as quickly as possible, and the patient placed in bed, lying on the side operated upon.

The cavity should not be flushed out unless the contents are putrid, and if it be done, care must be taken that there is a free path of exit for the fluid.

A short, wide drainage-tube is then introduced, in order to drain the cavity. It should not be compressed by the ribs, should have no lateral holes, and should reach the pleural cavity without projecting more than a trifle into it. It must be so fixed by a flange or by tapes passing round the chest that it cannot fall into the pleural cavity. As the ribs fall in, the sinus becomes oblique and longer, and it may be necessary to use a slightly longer tube; but it need never be longer than 2 inches, and the calibre should remain the same.

The dressing should be abundant, and at first frequently changed. Later, the intervals between the dressings may be increased.

Removal of the Tube.—If a tube of proper length has been used, there is no need to shorten it, but it should be removed at once. This is done when the lung has expanded fully, the time varying considerably in different cases, in some being a few days, and in others weeks or months. The expansion of the lung can be ascertained by the amount and character of the discharge (which will be slight and serous if the sinus be limited to the chest wall), by the effect of coughing, and by the freedom with which a bent probe can be rotated beyond the sinus.

If the wound does not close after expansion of the lung and removal of the tube, necrosis of the end of the rib is usually present, and a subsequent operation to remove a sequestrum may be necessary. Expansion of the lung may be aided by making the patient perform breathing exercises, or by making him force water from one bottle to another by blowing.

In **Double Empyema**, which is more common in children than in adults, the pus from both pleuræ should be removed by aspiration, and in the course of the next twenty-four hours thoracotomy performed on one side, and in a few days the operation repeated on the other. The method of operating and the after-treatment are the same as for unilateral empyema.

Non-Obliteration of the Empyema Cavity and Sinus Formation.—In these cases, usually due to late diagnosis, the lung does not expand, and a cavity is left between it and the chest wall. The diaphragm rises and fills the cavity to a certain extent, the opposite lung increases in size, and a lateral curve of the spine, with scoliosis, develops. The discharge from the cavity may continue for many years, the patient often developing indurated disease. He, however, may be able to resume his ordinary occupation and continue to work for years, though many patients become chronic invalids, and ultimately die from toxic absorption.

TREATMENT.—Three operations have been advocated for this condition—Estlander's operation, Schede's operation, and decortication of the lung. It may be advisable to combine all three.

Before any operation is performed, the size and position of the cavity, and the expansile power of the lung, should be estimated, and

attention paid to the patient's general health. The size of the cavity can be estimated by means of a bent probe, or by pouring into the cavity a neutral fluid from a vessel of known capacity. The expansile power of the lung is more difficult to estimate, but a rough idea can be obtained by estimating the capacity of the cavity as above during full inspiration and full expiration.

Estlander's Operation.—In this operation a subperiosteal resection of the ribs over the cavity is made, as in the primary operation for empyema, through a large U-shaped incision, or each rib may be resected through a separate incision. The removal of the ribs allows the chest wall to fall in, and the result of the operation is often satisfactory; but in some cases the parietal pleura and the intercostal muscles are so thickened and rigid that the desired result is not obtained.

Schede's Operation.—A large U-shaped incision is made over the side of the chest, beginning at the costal cartilages, extending downwards to the tenth rib in the posterior axillary line, and upwards to the second rib at a point between the spinous processes of the vertebrae and the scapula. The flap turned up consists of all the tissue between the skin and the periosteum of the ribs and the intercostal muscles. The ribs over the cavity are then resected subperiosteally, and after the cavity has been opened and explored, all the periosteum, intercostal muscles, and pleura over it, are removed. All granulation tissue over the lung should be scraped away, and the skin and subcutaneous flap adjusted to the lung with sutures, the remainder of the cavity being closed by packing it with gauze. The operation is a very severe one, and it may be performed in two stages. The resulting deformity is very apparent, especially if the lung does not expand.

Decortication of the Lung.—In this operation, which may be combined with one of the preceding, the visceral layer of the thickened pleura is dissected away from the lung, so as to allow it to expand. It is useless if sclerosis of the lung is advanced, and is contra-indicated in the case of tubercular lesions. Infection of the lung and death have followed this operation.

The after-treatment of these operations consists of preventing deformity by the wearing of a suitable jacket, and encouraging the expansion of the lung by healthy exercises. This after-treatment must be continued for years, and the ultimate result largely depends on the extent to which the lung expands. If expansion of the lung is good, the deformity may be comparatively slight considering the severity of the operation.

Tuberculous Empyema.—Tuberculous empyema may arise suddenly owing to the bursting of a tubercular cavity into the pleura. The primary condition is the one of pyopneumothorax, but the air becomes absorbed and the pyothorax remains. In the majority of cases the onset is insidious, and the empyema chronic from the first. It is usually localized, and there is great thickening of both the parietal and visceral pleurae, and sclerosis of the lung. The physical signs are

those of empyema due to other causes, combined with the symptoms and physical signs of pulmonary tuberculosis. If the pus is withdrawn by aspiration, it is found to contain an excessive number of lymphocytes, but bacteriological examination is usually negative. Injection of the pus into guinea-pigs generally causes tuberculosis.

TREATMENT.—Small empyemata should be left untouched, but if the pus is present in large amount, and is causing respiratory embarrassment, it should be removed by aspiration. Aspiration may be repeated from time to time; resection of a rib and drainage should be avoided as long as possible, as the sinus is little likely to close. If the pus begins to point through the chest wall, resection of a rib and drainage are necessary, but the patient should be warned of the almost inevitable consequences.

Abscess in the Lung.—Abscess in the lung may be acute or chronic, and the abscesses multiple or solitary.

Multiple Acute Abscesses occur in the course of a septicæmia, and are not amenable to surgical treatment.

Solitary Acute Abscess most frequently follows an acute pneumonia. The usual signs of consolidation of the lung, with the general symptoms of infection, are present. If the abscess opens into a bronchus, there is abundant purulent sputum. A radiogram is of great help in localizing the abscess.

TREATMENT.—If a solitary abscess of the lung is suspected, the diagnosis should be confirmed by aspiration. The thorax is then opened, and if the two layers of the pleura are not adherent, they should be stitched together in order to prevent infection of the pleural cavity by the pus. The lung is incised, or the abscess may be reached with the thermo-cautery, so that hæmorrhage is prevented. Drainage is carried out in the usual way.

Multiple Chronic Abscesses are usually either tubercular or due to the actinomycoses. They are not amenable to surgical treatment.

Solitary Chronic Abscess may be tubercular or actinomycotic, or due to spread into the lung from an empyema, a liver abscess, or a subdiaphragmatic abscess. The signs are those of consolidation of the lung, but the diagnosis is rarely made until the abscess has burst into a bronchus, when there is abundant purulent expectoration. In the case of a tropical liver abscess, the sputum has a characteristic "reddish colour" and the amœba may be found in it.

TREATMENT.—The patient may expectorate the contents of the abscess of the lung, and healing will follow; but if the condition is progressive, and the general symptoms of infection are present, the abscess should be opened in the same way as an acute abscess, and drainage established.

Gangrene of the Lung.—Gangrene of the lung is often associated with abscess of the lung, and generally results from septic bronchopneumonia. It is not uncommon after suppurative conditions of the mouth and naso-pharynx occurring in debilitated patients, and is an occasional sequela to operations on the tongue and jaw.

CLINICAL FEATURES.—These are the usual general symptoms of infection, and a profuse stinking expectoration, which is almost pathognomonic. The sputum contains pus cells, gangrenous lung tissue, and mucus. Severe hæmoptysis may occur.

The area of gangrene is localized by physical examination of the chest and by radiogram.

TREATMENT.—The treatment is similar to that of chronic abscess of the lung.

Operative Treatment of Pulmonary Tuberculosis.—On the whole, this is unsatisfactory, and should never be attempted until general and dietetic treatment has failed. The following operations have been performed:

1. Excision of portions of the lung, especially the apices. This has been most unsatisfactory.
2. Excision of portions of the ribs, so that the chest wall can sink in and aid obliteration of a tuberculous cavity.
3. Production of artificial pneumothorax with nitrogen gas.
4. Incision and drainage of tubercular cavities.

None of these operations is to be advised except, perhaps, the second.

Pyopericardium.—Purulent effusion into the pericardium is due to—Infective wounds of the pericardium, extension of inflammation from the pleura, blood-infection in septico-pyæmia and the specific infections fevers—*e.g.*, typhoid, scarlet fever, and smallpox.

CLINICAL FEATURES.—The usual general symptoms of infection are present. The precordial dullness is increased, especially in the upward direction, and the heart's action is embarrassed, therefore the sounds are indistinct and the pulse is weak. A radiogram will show a greatly increased cardiac shadow.

TREATMENT.—The diagnosis should be confirmed by aspirating the pericardial cavity, the needle being thrust into the chest in the fifth interspace close to the sternum on the left side. This position may be modified according to the extent of the dull area. Should pus be found, the pericardium must be opened and drained. The fourth or fifth costal cartilage should be resected in the manner described for resection of a rib in empyema, and the pericardium exposed. The sac is then opened and a drainage-tube inserted. The general condition of the patient may necessitate the performance of this operation under local anæsthesia.

Mediastinitis

Suppurative inflammation in the anterior and posterior mediastinum is most commonly secondary to suppuration in the neck, or it may follow ulceration of the œsophagus or trachea, or infective processes of the ribs and sternum.

The condition may be acute or chronic.

Acute Mediastinitis.—The general symptoms are as a rule very severe. The patient complains of great pain and a feeling of weight

and oppression in the chest. Urgent dyspnoea and dysphagia are generally present. If relief is not quickly obtained, death ensues.

Chronic Abscess in the Mediastinum.—The patient complains of weight and oppression in the chest, and pain behind the sternum, shooting back between the shoulder-blades. Dyspnoea and dysphagia are present, and as the pus makes its way forwards, the skin over the front of the chest becomes red and œdematous. The heart's action may be embarrassed owing to pressure.

The abscess usually points in an intercostal space near the sternum, but the pus may burst into the trachea, œsophagus, the pericardium, the pleura, or through the diaphragm.

TREATMENT.—Pus in the anterior mediastinum may be reached by an incision through an intercostal space, or by removing as much as necessary of the sternum and costal cartilages to allow of free drainage. The abscess cavity should be swabbed clean, and drainage carried out by means of a tube, or the cavity lightly packed with gauze. The patient should be nursed on the side or in the prone position.

Abscess in the posterior mediastinum should be opened by resecting an inch or more of one or two ribs near their angles *on the left side*. The parietal pleura is pushed out of the way with a blunt instrument, and the abscess opened and drained.

NEW GROWTHS OF THE THORAX

I. NEW GROWTHS OF THE THORACIC WALLS

Innocent

Lipomata are common in the subcutaneous tissue, especially on the back of the thorax. They are less common on the front of the chest, but may occur beneath the pectoral muscles. They have the usual characters of lipomata, and should be removed. Lipomata arising in the subpleural fat, also occur, and spread partly in the thorax and partly outside, coming forward through the intercostal spaces. They should be removed, portions of the ribs being resected if necessary.

Chondroma.—Chondromata usually grow from the costal cartilages, seldom from the sternum. They are most common in young adults, and may follow an injury.

CLINICAL FEATURES.—Chondromata are hard, painless, slowly growing tumours. If myxomatous degeneration of the cartilage occurs however, soft spots appear in the swelling. At any time sarcomatous change may ensue, and the tumour grow rapidly and invade the surrounding structures.

TREATMENT.—These tumours should be removed as soon as diagnosed. It may be possible to remove a chondroma without opening the pleura, but in many cases this cannot be done, and the surgeon must be prepared for collapse of the lung. The operation is best performed under interthoracic positive pressure anaesthesia.

Lymphangelioma, angioma, fibroma, neuro-fibroma, are all found on the chest wall.

Dermoid Cysts are found in the middle line of the thorax, but sometimes are retrosternal in situation, and come forward to one side or above the sternum. The treatment is removal.

Malignant

The malignant tumours of the thoracic wall are sarcomata and carcinomata.

Sarcoma.—The most common sarcoma of the thoracic wall is the chondrosarcoma, which may grow from the sternum, the ribs, or the vertebral column. The tumour may start as an apparently innocent chondroma, but later it begins to grow rapidly and infiltrate surrounding structures. Sarcomata also arise from the periosteum and medulla of the sternum, and may form pulsating tumours, resembling aneurysms of the arch of the aorta.

TREATMENT.—If operation is undertaken, these tumours must be freely removed; it is always necessary to open the pleural cavity or the mediastinum. The operation should, if possible, be done under positive pressure anaesthesia. Invasion of the lung is a contra-indication to operation; therefore before removal is attempted a portion of a rib a little distant from the growth should be resected, and the finger introduced into the pleural cavity. If the growth is not attached to the lung, the operation may be proceeded with. If possible, enough skin should be saved to allow the wound to be accurately sutured, for if this is done, the collapsed lung will soon expand again.

Carcinomata of the thoracic wall are always secondary tumours, usually spreading from the mammae. Operative treatment is mostly impossible.

2. NEW GROWTHS OF THE THORACIC CAVITY

1. **TUMOURS OF THE PLEURA.**—**Fibromata, angiomata, sarcomata,** and **endotheliomata** are the primary growths met with in the pleura. The diagnosis is impossible, the only physical signs being those of pleural effusion. In the case of malignant tumours this is usually blood-stained.

TREATMENT.—Beyond removing the fluid from time to time, treatment is rarely possible.

2. **TUMOURS OF THE LUNGS.**—These may be innocent or malignant; both varieties are rare, however, and not amenable to surgical treatment. Secondary malignant tumours are common, and may be recognized by dyspnoea, hæmoptysis, and a blood-stained pleural effusion. There is no treatment.

3. **TUMOURS OF THE MEDIASTINUM.**—Tumours of the mediastinum are—**Lipomata, fibromata, sarcomata,** and **secondary carcinomata.** In the majority of cases, however, mediastinal tumours are secondary to direct spread from the œsophagus, ribs, vertebrae, lungs, etc.

Tumours may also arise in connection with the thymus gland, and these neoplasms, which are always malignant, have a tendency to grow downwards over the pericardium.

TREATMENT.—A mediastinal tumour is seldom amenable to surgical treatment, but if this is undertaken, the tumour should be approached by resecting the sternum and costal cartilages or portions of the posterior parts of the ribs on the left side, according as it is situated in the anterior or posterior mediastinum.

All interthoracic tumours have to be carefully diagnosed from aneurysms of the aorta. This is most easily done at the present time by the use of the X rays.

CHAPTER XXXII

DISEASES OF THE THYROID GLAND

CONGENITAL ABNORMALITIES

Accessory Thyroids.—Accessory thyroids occur in the line of the thyroglossal tract, and may be found in any situation between the tongue and the arch of the aorta. They are functional, and may be the seat of tumour formation, both simple and malignant.

Absence of the Thyroid.—The condition known as "cretinism" is associated with congenital deficiency of the secretion of the thyroid gland, and the gland may be absent, sclerosed, normal in appearance, or enlarged (congenital goitre).

INFLAMMATION OF THE THYROID

Acute Thyroiditis.—Acute inflammation of the thyroid gland is generally due to a blood-borne infection, and is frequently associated with goitre. It is usually secondary to lesions of the intestinal tract, the organism commonly present being the *Bacillus coli communis*; but it may occur after the infectious fevers, or be due to extension from surrounding structures.

SYMPTOMS.—The gland is acutely swollen and painful, causes embarrassment of respiration, and the usual general symptoms of acute inflammation are present. Suppuration is a common termination, the pus usually bursting into the mediastinum or the trachea with fatal results.

TREATMENT.—The usual local and general treatment of an acute inflammatory condition should be carried out. If pus forms, the abscess must be opened and drained. During the whole course of the inflammation the patient must be carefully watched, for it may be necessary at any moment to perform tracheotomy.

Chronic Inflammation of the thyroid gland may occur as a sequel to an acute attack, or be associated with such causes of chronic inflammation as alcoholism, chronic nephritis, plumbism, syphilis, etc. If the condition is advanced, the patient suffers from myxœdema, and the treatment consists of giving thyroid extract (see textbooks on medicine).

Tuberculosis and Syphilis of the thyroid gland are rare.

Physiological Enlargement.—In women the thyroid gland tends to become enlarged at each of the stages of sexual life—viz., puberty,

at each menstrual period, during pregnancy and lactation, and at the menopause. These enlargements are due to increased vascularity of the gland, and must be considered physiological.

In men also, enlargement of the thyroid gland may occur at puberty.

Goitre

The term "goitre" is a loosely used clinical term implying any enlargement of the thyroid gland; the term should be limited, however, to a simple, non-inflammatory enlargement of the gland.

PATHOLOGY.—A good deal of confusion still exists regarding the pathology of goitre, but the following types may be recognized:

1. **Parenchymatous Goitre.**—The whole gland is enlarged, and both on macroscopical and microscopical examination it resembles the normal thyroid gland. The enlargement is not as a rule symmetrical and the isthmus may be the part chiefly affected. The condition is often present without symptoms, and may be considered an adenomatous hyperplasia of the gland.



FIG. 463.—SIMPLE ENLARGEMENT OF THE THYROID (GOITRE).

2. **Colloid Goitre.**—This form differs from the first in that the vesicles of the gland are enormously distended with secretion, so that on section the gland is moist, glistening, and softer than usual.

3. **Adenoma of the Thyroid.**—In these cases there is the formation of an encapsuled tumour resembling thyroid tissue, while the remainder of the gland is normal in appearance. The tumour

may be single or multiple, and, on microscopical examination, may resemble either *fetal* or *adult* thyroid tissue.

4. **Mixed Enlargement.**—In these cases the whole of the gland is enlarged, and encapsuled adenomatous tumours lie amongst the general enlargement. These tumours may be true neoplasms or portions of the adenomatous enlargement which have been cut off from the rest by the formation of a capsule of fibrous tissue.

Secondary Changes.—Secondary changes may arise in any of these forms of enlargement, giving—

5. Cystic Goitre.—The cysts are formed by a degeneration of the adenomatous tissue, and, when small, are lined by a cubical epithelium, which becomes flattened as the cyst enlarges; it may finally disappear. The contents are a thin serous fluid or a thick colloid material resembling the normal thyroid secretion. Calcification of the cyst wall may occur in old-standing cases, and the hardness of the tumour may cause it to be mistaken for carcinoma. Hemor.

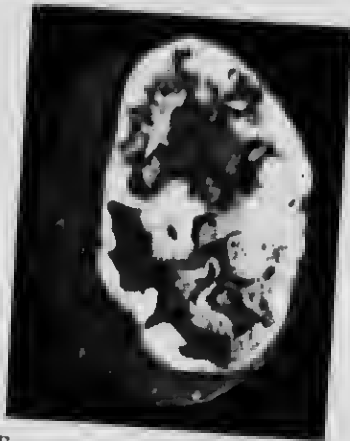


FIG. 464.—ADENOMA OF THE THYROID, DEGENERATING.



FIG. 465.—ADENOMA OF THE THYROID UNDERGOING CYSTIC AND CALCAREOUS DEGENERATION, (London Hospital Medical College Museum.)

change into the cysts with sudden increase of the pressure symptoms is not uncommon.

6. Fibrous Goitre.—In these cases there is an increase in the fibrous-tissue element, which contracts and causes degeneration of the parenchyma, the gland becoming harder and smaller than normal. If the degeneration is excessive, myxoedema results.

CAUSE.—The cause of goitre is unknown. It is probable that the different pathological varieties have entirely different causes. In certain parts of the world—viz., Derbyshire and Gloucestershire in England, various parts of Scotland, Switzerland, and Northern Italy, all of which have the common peculiarity of being hilly, enlargement of the thyroid is endemic, and it has been attributed to the following causes:

1. Presence of lime salts in the drinking-water.
2. Absence of iodine in the drinking-water.
3. Presence of an organism in the drinking-water, the growth of which is prevented by the presence of iodine in water elsewhere.

4. Absence of fresh air and sunshine in the valleys between the mountains, the sufferers living in the valleys.
5. The carrying of heavy weights on the head, and the breathing of the rarefied air of mountains.

None of these theories, however, is entirely satisfactory.

Goitre also occurs sporadically, and is more common in women than in men. In this form it does not seem to be influenced by heredity, intermarriage, or condition of life; it can be attributed to no cause.

PRESSURE EFFECTS OF AN ENLARGED THYROID—Trachea.—In unilateral enlargement the trachea is pushed to one side, and may be longer than normal. Bilateral enlargement leads to lateral pressure on the trachea, causing the lumen to be reduced to a slit (scabbard trachea). Atrophy of the cartilaginous rings is not common, but it sometimes occurs, and the cartilage is replaced by fibrous tissue. In these cases any sudden increase of pressure may result in death from asphyxia owing to closure of the air passage, which is no longer held open by the cartilaginous rings.

Œsophagus.—Pressure on the œsophagus, sufficient to cause dysphagia, is uncommon; but it may occur if the goitre is substernal or interpharyngeal, developing from an aberrant piece of thyroid tissue.

Nerves.—Pressure on the *recurrent laryngeal nerve* may cause hoarseness and alteration in the voice, and, if severe, paralysis of the muscles moving the vocal cords. In the early stages of pressure there is an abductor paralysis, but later the cords assume the cadaveric position. If the paralysis is bilateral, sudden death may ensue from asphyxia.

Pressure on the *vagus* nerves may cause disturbance of the heart's action.

Vessels.—The vessels are pushed outwards from the growing thyroid enlargement, so that the carotid artery may come to lie in the posterior triangle of the neck, and there is little pressure upon it. In cases of great enlargement, pressure on the internal jugular vein may cause congestion of the veins of the head and face, which may become extreme on exertion.

CLINICAL FEATURES.—In many cases the only symptom is the enlargement of the thyroid gland, which may be recognized by its position and shape, and the fact that it moves up and down with the larynx when the patient swallows. The amount of enlargement has no constant relationship to the symptoms of which the patient complains. The majority of the patients are anaemic, and in many cases the pulse rate is increased. Dyspnoea is the most constant symptom, owing to pressure; it is liable to come on in attacks. The attacks may occur during exertion, but very commonly while the patient is asleep. They are attributed to sudden spasm of the infrahyoid group of muscles which lie in front of the thyroid, owing to accumulation of mucus in the larynx exciting coughing.

Sudden urgent dyspnoea may also be due to sudden increase

pressure from hæmorrhage into the substance of the gland or into a cyst, or to paralysis of the vocal cords owing to pressure on the recurrent laryngeal nerve.

Dysphagia from pressure on the œsophagus is uncommon.

Substernal Goitre.—This is a special clinical variety, due to a downgrowth of the normal gland into the mediastinum between the manubrium sterni and the trachea, or to a goitre developing in an accessory mediastinal thyroid. The symptoms are those of an intrathoracic growth, and the pressure effects are usually well marked. In some cases the patient may by violent expiratory efforts project the tumour into the neck; it will disappear again when normal breathing is resumed (plunging goitre).

TREATMENT.—Medical Treatment.—Medical treatment is only of value in cases of general enlargement of the gland. The patient, if living in a district where goitre is endemic, should remove, or, if this is not possible, should only drink distilled or imported water. In sporadic cases the general health should receive attention, and if the patient is anæmic, one of the preparations of iron should be given. The drug most commonly used for the specific treatment of goitre is iodine, which may be given in the form of iodides, by innunction of mercuric iodide ointment, or by giving the active principle of the gland called "thyro-iodine." It is doubtful how far benefit is received from this drug, for many cases of slight enlargement disappear spontaneously. Thyroid extract is also given, and some cases are said to derive benefit from its use.

In many cases of slight general enlargement no treatment is necessary, for the condition in no way interferes with the general health or the enjoyment of life.

Operative Treatment.—Localized Adenomata.—Medicinal treatment is useless in cases of localized adenomata, whether solid or cystic, and these cases should, like adenomata in other parts of the body, be treated by excision. Some difference of opinion exists as to whether the operation should be a partial thyroidectomy, or enucleation of the tumour. The operation chosen should depend on the condition present. If there is a localized enlargement in the gland, and the rest of the thyroid is normal in size, enucleation of the tumour should be performed. It is usually quite a simple operation, and free from danger if the capsule of the tumour is carefully defined and the adenoma shelled out of it. In cases of multiple adenomata, or if general enlargement in addition to localized adenomata is present, the operation of partial thyroidectomy should be performed, and it may be necessary to remove localized tumours from the part of the gland left behind.

General Enlargement.—In slight general enlargement no treatment is necessary; but if the gland is increasing in size, or if there are pressure symptoms, partial thyroidectomy should be advised. The larger lobe of the gland should be removed, and the other will then often decrease in size. If marked pressure effects on the trachea are present, a radiogram should be taken, as this may show which side

of the trachea is subject to the greater pressure, and the thyroid on that side should be removed.

Enlargement of a goitre occurring at the menopause should lead to operation, as it is estimated that 80 to 90 per cent. of the cases of carcinoma of the thyroid arise in a simple enlargement.

Substernal Goitres should always be removed, although the operation may be difficult and dangerous.

CHOICE OF AN ANÆSTHETIC.—Many surgeons recommend that a goitre should be removed under local anaesthesia, and this method is often very satisfactory; but if pressure on the trachea is not marked, a general anaesthesia, given by a skilled anaesthetist, is to be preferred.

Thyroidectomy.—The usual incision for partial thyroidectomy is a curved incision across the neck. The deep cervical fascia is incised in the line of the incision, and the infrahyoid group of muscles pulled aside or divided close to the hyoid bone. The arteries and veins are then secured, and the selected lobe of the thyroid separated from the surrounding tissues. The isthmus is ligatured, or crushed and divided. After removal of the part of the gland, the infrahyoid muscles are sutured and the skin wound closed, drainage being employed.

DANGERS OF THE OPERATION.—1. *Asphyxia* during the operation has been referred to, and is to be feared in cases of substernal goitre, or when respiratory difficulty has been present before the operation. In the latter case a local is preferable to a general anaesthesia.

2. *Cardiac Failure*, both during and soon after the operation.

3. *Acute Thyroidism.*—This is believed to be due to escape of thyroid secretion into the circulation from injury of the gland. The symptoms appear a few hours after the operation, and consist of high temperature (104° F.), rapid pulse (140 to 180), increased respiration-rate, with dyspnoea, twitchings of the muscles, and restlessness. The condition may be prevented by avoiding as far as possible handling and squeezing the gland during the operation, and by draining the wound for forty-eight hours.

4. *Hæmorrhage.*—The amount of bleeding can be minimized by tying the superior and inferior thyroid arteries at an early stage in the operation.

5. *Damage to the Recurrent Laryngeal Nerve.*—This nerve runs upwards between the trachea and œsophagus, and is liable to injury while ligaturing the inferior thyroid artery. To avoid this accident, the artery should be tied as close to the gland as possible.

TREATMENT OF URGENT DYSPNOEA.—Urgent dyspnoea may be due to hæmorrhage into a goitre, or to sudden congestion. If it threatens to cause asphyxia, and the conditions are favourable, the operation of hemi-thyroidectomy should be commenced, and after division of the deep fascia—and sometimes the isthmus of the thyroid—the urgent symptoms are often relieved, and the operation can be proceeded with in comfort. If the conditions are not favourable for such an operation, a long median incision should be made, and the deep fascia divided. If this gives relief, nothing further need be done; but if no relief is obtained, the isthmus must be divided. If dyspnoea persists, trache-

omy must be performed, and a long flexible tube, such as König's cannula, or a large drainage-tube, must be used instead of the usual tracheotomy tube.

NEW GROWTHS

Innocent.—Apart from the adenomatous form of goitre, innocent new growths of the thyroid are of no clinical importance.

Malignant

Carcinoma of the thyroid is most common between the ages of forty and sixty, and it is estimated that between 80 and 90 per cent. occur in cases of simple enlargement. It is more common in women than men, and is very apt to develop at the menopause.

CLINICAL FEATURES.—The patient, who probably for years has had an enlarged thyroid, notices an increase in size of one of the lobes, which is irregular, hard, and nodular. The tumour soon becomes fixed to surrounding structures, and there is enlargement of the deep cervical lymphatic glands.

The large vessels of the neck are not pushed aside, as in simple goitre, but are surrounded and infiltrated by the growth, so that there is congestion of the veins of the head and neck, and the pulse in the superficial temporal artery on the diseased side is smaller than on the other side.

Involvement of the sympathetic nerve chain at first causes exophthalmos on the side of the tumour, with dilatation of the pupil; but as the nerve becomes paralyzed, the eyeball is retracted (enophthalmos), and the pupil contracted. Interference with speech, owing to pressure on the recurrent laryngeal nerve, and paralysis of the vocal cord, is an early symptom. Pressure on the vagus may cause tachycardia.

The trachea is partly compressed and partly invaded by the growth, and dyspnoea results. Later, perforation of the trachea, usually just below the cricoid cartilage, takes place, and the sputum may be blood-stained.

Compression of the œsophagus, causing dysphagia, is often one of



FIG. 466.—MALIGNANT DISEASE OF THE THYROID.

the earliest symptoms that an innocent goitre has become malignant; but actual perforation of the oesophagus is rare.

Towards the latter stages of the illness the thyroid tumour is firmly fixed to the skin after infiltrating the muscles, and the whole neck becomes firm and solid with growth; and when the gland has been largely destroyed, the symptoms of myxoedema are added to the clinical picture. Secondary growths occur in the cervical lymphatic glands, in the bones—especially the skull—and in the lungs.

TREATMENT.—The prophylaxis of carcinoma of the thyroid is removal in all cases of goitres which resist medicinal treatment, especially if the swelling is enlarging about the time of the menopause. Extirpation of the growth is only possible if it is undertaken early, and it should be freely removed, and, if necessary, the internal jugular vein, the external carotid, the sympathetic chain, and the vagus must be resected, for limited operations are useless.

The following are the indications for operation: The outline of the tumour should be easily traced, and the tumour should be movable on the deeper structures. There should be no marked involvement of the lymphatic glands of the neck, and no secondary growths elsewhere. The condition of the heart and lungs should admit of the performance of a long operation. Under these conditions the immediate mortality is from 25 to 30 per cent.

If extirpation—as in the majority of cases—is not possible, little can be done. When the dyspnoea is urgent, an attempt to perform tracheotomy may be made; but this operation is very difficult, and often impossible under the circumstances, and can only prolong existence for a few days at the most. Braun, who performed seventeen tracheotomies for the condition, had nine deaths in the first twenty-four hours, and the remaining eight patients all died within twelve days of the operation. It is doubtful, therefore, whether tracheotomy is justifiable.

If dysphagia is present, the patient can usually be fed by the oesophageal tube. Gastrostomy is rarely advisable.

Latent Carcinoma of the Thyroid.—In this condition the thyroid may be enlarged, but there is no alteration in the contour of the gland, and no infiltration of surrounding structures, the condition resembling an innocent enlargement. Metastases, resembling on microscopical examination normal thyroid tissue, are found in the lungs, bones, skin, etc., and the patient dies from cachexia, with symptoms referable to the organs in which the metastases are growing. Growths in the bones frequently affect the skull, and the tumours are so vascular that they pulsate. Symptoms of hyperthyroidism may be present.

The primary growth in the thyroid may be recognized only on microscopical examination at the autopsy.

Carcinomatous growths may occur in the accessory thyroids, which are found between the tongue and the arch of the aorta.

Sarcoma of the Thyroid.—This form of malignant growth arises at an earlier age than carcinoma, but it cannot be distinguished from it clinically. Endotheliomata of the gland have also been described.

Exophthalmic Goitre (Graves's Disease)

This condition is fully described in the textbooks on medicine, but as surgical intervention is becoming more common, it is necessary to describe briefly the features of this disease.

The pathology is obscure, but the condition is believed to be an affection of the nervous system, causing an overactivity of the thyroid gland, so that an excess of secretion is produced, the patient exhibiting the symptoms of hyperthyroidism.

CLINICAL FEATURES.—The essential features of the disease are tachycardia, enlargement of the thyroid, and exophthalmos.

Tachycardia is the earliest and most constant symptom. The patient complains of palpitation, and the pulse-rate under excitement increases in some cases to 200. Later, arrhythmia, hypertrophy of the heart, and valvular incompetency occur.

The Enlarged Thyroid is at first due to increased vascularity of the gland, which may pulsate visibly, and possess a venous thrill. Subsequently there is general enlargement of the gland, and the vascularity may be less marked. Hypertrophy of the thymus, associated with enlargement of the thyroid, may cause pressure effects in the thorax.

The Exophthalmos appears at the same time as the enlargement of the thyroid, and gives the patient a staring appearance. The white of the sclerotic can often be seen between the cornea and the upper eyelid. When the patient looks down-

wards, the lower lid lags behind the movement of the eyeball (Von Graefe's sign), and paralysis of the muscles of the eye may be present.

Accessory Signs.—The patient is generally excited and nervous, and often complains of headache. A fine tremor of the hands is present. Disturbance of the general functions of the body may cause bulimia, diarrhoea, pyralism, polyuria, and excessive sweating. In men there is frequently impotence, and in women amenorrhœa or dysmenorrhœa. Anæmia is always a constant symptom, and a



FIG. 467. — EXOPHTHALMIC GOITRE (GRAVES'S DISEASE).

blood examination reveals a diminution of the neutrophiles, with an increase in the lymphocytes.

The condition is more common in women than in men, and in many instances seems to be induced by overwork and worry, while some cases develop rapidly (two or three days) after a nervous shock.

PROGNOSIS.—The majority of patients, if treated by complete rest and freedom from worry, recover sufficiently to lead normal lives; but the treatment must be continued for years, and relapses are common, especially if the social conditions under which the disease developed are reproduced.

A minority of the cases end fatally from heart failure.

TREATMENT.—The *Medical* treatment, consisting of complete rest (at first in bed) and freedom from worry, should be continued for months or years. Iron, arsenic, and phosphorus should be given for the anæmia, and the nervous excitability and the tachycardia controlled by bromide of potassium. The functional derangement of the alimentary canal, etc., should receive appropriate treatment, and every possible means must be taken to improve the health generally.

Specific treatment consists of giving thyroid extract, or the dried blood-serum or milk of goats that have been deprived of their thyroid gland; but it is of little value. Extract of thymus has also been given.

SURGICAL TREATMENT.—The surgical treatment consists of removing part of the thyroid gland, and ligaturing the supplying arteries. Half the gland is removed at one operation, and if the improvement is not marked, more of the gland should be removed, or the arteries going to the other lobe should be tied. Three or more operations may be necessary to derive the maximum of benefit, and too much should not be done at one operation.

Operative treatment should not be undertaken until the patient has received thorough medical treatment, but at the same time the operation should not be delayed until it is a last resource.

RESULTS OF OPERATIVE TREATMENT

1. A certain number of cases die during the operation, but the mortality has fallen in the last few years, owing to improvements in methods of inducing anæsthesia, and to the substitution of local, with cocaine or eucaine, for general anæsthesia.
2. Within a few hours of the operation the temperature and pulse-rate may rise considerably. The patient becomes at first delirious, and later comatose, death occurring within forty-eight hours. The cause of death is believed by some surgeons to be a hyperthyroidism, which can be avoided by handling the gland very carefully during the operation, and by draining the wound. If the symptoms occur, the wound must be opened and packed with gauze, which should be frequently changed. Other surgeons attribute the symptoms to nervousness, and take elaborate precautions to prevent the patient dreading the operation.
3. Within a few days of the operation all the symptoms may abate, and even disappear, to return later.

4. After some time (months), there may be complete relief from symptoms, and the patient may be permanently cured.
5. The operation may cause alleviation of symptoms, but not complete relief.
6. The operation may cause no relief of symptoms.

After all forms of operative treatment, medical treatment must be continued for some months. Operation is specially indicated in those patients who are forced to earn their own livings, often under bad hygienic surroundings, and are therefore unable to lead easy and comfortable lives, or to lie up for many months.

The effects of surgical treatment may be summed up in the words of Koehler to the French Congress of Medicine in 1907:

"Messieurs les médecins, envoyez-nous de bonne heure vos basedoiviers et nous vous les rendrons en état de tirer profit du traitement médical"; but he might have added, "if they live."

Other methods of treatment are exposure to X rays and removal of the cervical chain of the sympathetic on both sides of the neck.

Parathyroids.—These small glands are usually four in number—two on each side—and lie close to the posterior surface of the thyroid gland, on the branches of the inferior thyroid arteries. They are flattened bodies, somewhat resembling an orange-pip in shape, about $\frac{1}{4}$ inch in length, and of a light brown colour. They may be inside, or just outside, the capsule of the thyroid gland.

On microscopic section, they show columns of epithelial cells, which are denser than the follicles of the thyroid gland, and exceedingly vascular. Vesicles containing a substance with the same reactions as the colloid material of the thyroid are present.

There is considerable difference of opinion concerning the relative functions of the thyroid and the parathyroids and their relationship to disease, but the majority of physiologists believe that suppression of the secretion of the thyroid gland results in myxœdema and a diminution in the activity of the function of the organs and brain; while suppression of the secretion of the parathyroid glands causes rapid death from tetany, hyperpyrexia, tachycardia, and dyspnoea.

Cachexia (Strumipriva).—Complete removal of the thyroid gland is no longer a surgical procedure, for it is followed by a train of symptoms similar to those of *myxœdema*. The condition supervenes gradually some months after the operation, and mild forms of it are still met with when more than three-fourths of the thyroid gland have been removed. The patient becomes dull and stupid, the temperature is subnormal, and the heart-beat slow and feeble. There is an increase of mucin in the subcutaneous tissue, so that the face is swollen, the features coarsened, and the expression lost. The limbs are thickened and clumsy, and the hair thin and dry. Death from anæsthesia occurs after months or years.

The treatment consists of giving thyroid extract in 5-grain doses three times a day, and in the medical form of the disease the effect

of treatment is most striking, for the patient often becomes completely normal as long as the treatment is continued. In some cases

of complete removal of the gland a condition of *tetany*, which rapidly proved fatal, has developed a few days after the operation. This is believed to be due to removal of the parathyroids with the thyroid gland.



FIG. 468.—MYXEDEMA.

DISEASES OF THE THYMUS GLAND

Normally the thymus gland reaches its maximum growth at the end of the second year. Atrophy of the gland begins about the tenth year, and should be complete before twenty, the gland being replaced by fat and connective tissue. Increase in size and persistence of the thymus are met with in exophthalmic goitre and in the status lymphaticus.

Status Lymphaticus.—This condition is characterized by persistence and increase in size of the thymus, enlargement of the lymphoid tissue generally—viz., lymphatic glands, tonsils, spleen, and lymph follicles in the intestine—increase in the red marrow of the bones, smallness of the arteries, dilatation of the heart, and anæmia. Patients who have the status lymphaticus are liable to sudden death from such apparently slight causes as getting into a cold bath, or the administration of an anæsthetic for a small operation. The condition is often unsuspected until post-mortem examination.

Thymic Asthma.—An enlarged thymus may exert sufficient pressure on the trachea to cause dyspnoea, which is often paroxysmal, resulting in the patient's death from asphyxia. The enlarged thymus may project up into the neck and form a tumour, which is evident in the episternal notch when the patient makes expiratory efforts.

The TREATMENT is removal of the thymus.

Inflammation with suppuration, hæmorrhage, tuberculosis, syphilis (gumma formation), and sarcoma, have all been described in the thymus gland, but they are all so rare that a textbook description is not possible.

CHAPTER XXXIII
DISEASES OF THE BREAST

CONGENITAL ABNORMALITIES

1. Absence of the Breast (Amazia).—Absence of the breast may occur on one or both sides, and is more common in males than females. It may be associated with absence of the sternal portion of the pectoralis major muscle.

Micromazia is an infantile condition of the breast occurring in adult women, and is often associated with non-development of the ovaries, and an infantile condition of the other sexual organs (infantilism).

2. Accessory Breasts (Polymazia).—Accessory breasts, or more frequently accessory nipples, occur more often in males than females. They are usually found in the line of the breast, just below or above the normal nipple. They may also be situated in the axilla or groin, or in other parts of the body, such as the buttock and thigh. As a rule an accessory breast is functionless, but it may enlarge and secrete milk during lactation. Removal is only necessary if the breast or nipple is a source of annoyance to the patient.

3. Gynæcomazia.—This term is applied to an increase in size of the male breast, so that it approaches that of a young female. The condition may be unilateral or bilateral, and the increase usually occurs at puberty. As a rule the breasts are functionless, but they have been known to secrete milk. The condition is sometimes associated with external pseudo-hermaphroditism.

Diffuse Hypertrophy of the Breasts.—The cause of this condition is unknown, but it is frequently associated with menstrual disorders. The enlargement generally begins at puberty, and the breasts may grow steadily; or if the patient becomes pregnant there may be a very rapid enlargement, which will subside again after the pregnancy is terminated. Pain is not a feature of the disease, although the patient suffers great discomfort from the size and weight of the breasts, which may weigh many pounds, and reach the knees when the patient is sitting. The nipples are usually unaffected, and become stretched over the enlarged breasts.

PATHOLOGICAL ANATOMY.—Both the glandular and the fibro-fatty tissue of the breast are increased in amount, but the chief growth is

of the interstitial substance. There is great enlargement of the supplying bloodvessels.

TREATMENT.—If the condition is definitely associated with pregnancy, nothing should be done until after parturition, for the breasts may decrease in size after a continuous and profuse discharge of milk. In virgins no diminution in size is to be expected, and the only treatment is amputation of the breasts. One should be removed at a time, as the operation is severe. After removal of one breast the other sometimes diminishes in size.

AFFECTIONS OF THE NIPPLE

Fissures (Cracked Nipples).—Fissures of the nipple are rarely seen apart from lactation, and are most common during the suckling of the first child, owing to lack of knowledge on the part of the mother. The nipples are left wet after suckling, cleanliness is not attended to, and as a result eczema and small superficial ulceration (fissures) occur. The fissures do not heal readily on account of the continued irritation of suckling and want of cleanliness. The importance of the condition lies in the frequent association of mammary abscess with cracked nipples, the infection spreading along the lymphatics or ducts, and the harm done to the child by constantly swallowing small quantities of pus when suckling.

PROPHYLAXIS.—During the last month of pregnancy, the nipples should be hardened by careful washing and drying, bathing with eau-de-Cologne or methylated spirit. They should then be powdered. After suckling, the nipples should be thoroughly washed, dried, and dusted with boracic powder.

TREATMENT.—The mother should discontinue suckling, or use a protecting shield. The fissures, if callous, should be touched with silver nitrate and dressed with a mild antiseptic lotion, such as lotio boracis.

Retraction of the nipples, apart from that occurring with carcinoma, is sometimes congenital, or is due to inflammatory conditions of the breast. Suckling from the breast is difficult or impossible, and attempts to suckle frequently cause eczema and fissures of the nipple.

TREATMENT.—An attempt to draw out the nipple by means of a breast-pump is often successful, and should always be tried. If this is not successful, the nipple may be made prominent by a plastic operation. Three semilunar pieces of skin radiating from the nipple, and about $\frac{3}{4}$ inch away from it, are excised, and the fascia at the base of the nipple is then drawn together by a purse-string catgut suture.

Abscess of the Areola.—Suppuration in one of the sebaceous glands in the areola is not uncommon during lactation, and has the same signs and demands the usual treatment of superficial suppuration elsewhere.

Syphilis of the Nipple.—This condition is most common in wet-nurses who suckle syphilitic infants. It is rare in women who suckle their own children (Colles's law). The sores are often multiple and

bilateral, and have the customary character of extragenital chancres (see p 123). The axillary glands are enlarged. The usual treatment of syphilis should be carried out.

Eczema of the Nipple.—Mention of this condition has already been made in connection with fissures of the nipple, but the condition, which is similar to eczema in other parts of the body, may be seen apart from lactation, and may spread over the skin of the breast.

TREATMENT.—One of the best applications is the dilute ointment of the subacetate of lead. A dusting-powder of equal parts of oxide of zinc and starch may also be used. The condition may be very intractable to treatment.

Paget's Disease of the Nipple.—Paget's disease of the nipple is a carcinoma developing from the deep layers of the skin, and ultimately invading the breast. It is very slowly growing, and is usually accompanied by an abundant serous discharge. The condition is most common in women between forty and sixty years of age.

CLINICAL FEATURES.—In the early stages the affection, which spreads slowly, resembles an ordinary eczema of the nipple. When the epithelium has been shed, a raw surface is left round the nipple, which is partly destroyed. This surface is raised, and has a definite edge, crusts form on it, and there is a sero-purulent discharge. The axillary glands are enlarged. The disease may be present for years before a hard carcinomatous mass forms in the breast below the nipple.

TREATMENT.—No treatment but excision is of any avail. It is advisable to remove the whole breast and the axillary glands.

INFLAMMATIONS OF THE BREAST

1. Acute Mastitis of Infants.—It is by no means uncommon to find soon after birth that the breasts are swollen and tender. This condition is believed to be due to a physiological engorgement, or to infection through the duct by organisms derived from the maternal genital passages. The inflammation nearly always ends in resolution, but it may cause retraction of the nipple from fibrosis; or suppuration may follow if the nurse squeezes the breast vigorously to "break down the nipple strings."

TREATMENT.—In the majority of cases no treatment is necessary, for the condition often subsides; if suppuration occurs, the abscess must be incised.

2. Acute Mastitis of Puberty.—This occurs in both boys and girls, but is much more common in the latter. One or both breasts may be affected. The cause of the condition is unknown, and it is considered by some to be a physiological congestion, and not an inflammatory condition. Infection by organisms may occur, and suppuration follows.

CLINICAL FEATURES.—One or both breasts become enlarged, hard, and tender. The condition gradually subsides in about a month, but retraction of the nipple or suppuration may occur.

TREATMENT.—No treatment beyond a local application or a placebo

is necessary. Acute mastitis may also be seen during pregnancy or an attack of mumps.

Acute Mastitis of Lactation.—Acute mastitis is most commonly seen during lactation, and usually occurs in the first month of the first lactation. The infection nearly always spreads to the breast from

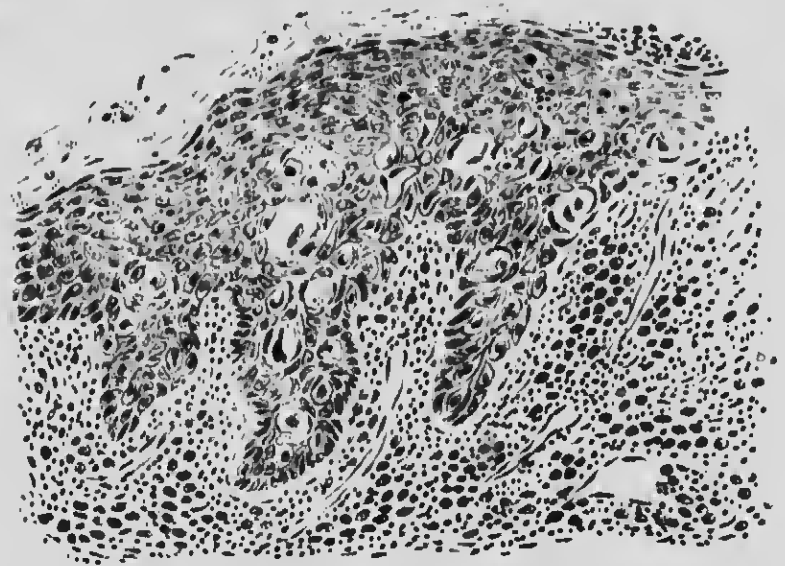


FIG. 469.—SECTION THROUGH PAGET'S DISEASE OF THE NIPPLE.

cracks of the nipple, and gains access by means of the ducts or lymphatics. The *Staphylococcus aureus*, the most common cause of suppuration in the skin, is the organism generally present.

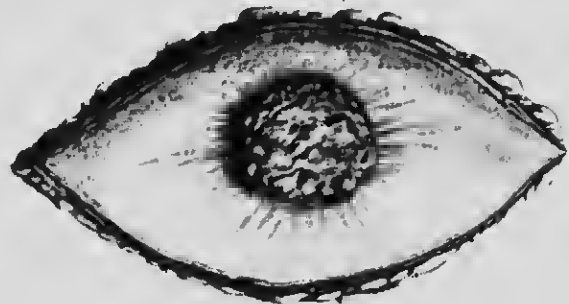


FIG. 470.—PAGET'S DISEASE OF THE NIPPLE.
(London Hospital Medical College Museum.)

CLINICAL FEATURES.—The *General* symptoms of any acute inflammation are present.

Locally, the whole breast is swollen and painful, but the signs of

inflammation are most marked in one quadrant, most commonly the lower, and after a few days a circumscribed painful swelling appears here. The skin over it becomes red and oedematous, and fluctuation is present. The abscess usually points near the nipple. In some cases diffuse suppuration occurs in the breast, and a multilocular abscess forms, the infection often spreading to the pectoral muscles and ribs. In mild cases without suppuration resolution follows; or signs of a chronic abscess—which may take months to reach the skin—will appear after the acute inflammatory symptoms have subsided. In a few cases the inflammation is bilateral.

TREATMENT.—The *General* treatment of any acute inflammation should be carried out.

Local Treatment.—In the early stages of the inflammation the breast should be kept empty of milk by the use of the breast-pump, being supported by a bandage, and the arm kept in a sling. Fomentations may be applied for relief of the pain, or Klapp's suction-bell may be used in order to treat the inflammation by active hyperemia.

If suppuration occurs, the abscess must be freely opened. An incision, radiating from the nipple, is made over the most prominent part of the swelling, the finger introduced, and all septa broken down, so that there is one large cavity. A counter-opening may be advisable, but multiple incisions are rarely necessary. If the hemorrhage is free, it must be checked by firm bandaging or by plugging the incisions with gauze. A drainage-tube is introduced, and an aseptic dressing applied. Healing as a rule takes place readily, and it is surprising how little scar is left even after large abscesses.

In a few cases, usually owing to the incision not being free enough, or to too prolonged use of drainage-tubes, sinuses form, which heal with difficulty. The sinuses should be scraped, and the breast and arm kept in rest by firm bandaging, while careful aseptic treatment should be carried out. If this does not bring about healing of the sinus, a wedge-shaped piece of the breast containing the sinus should be excised, or if the breast is riddled with sinuses, it should be amputated.

Chronic Abscess of the Breast.—Chronic abscess of the breast may be due to suppuration of a hæmatoma, but is most commonly a sequel to the acute mastitis of lactation, although it may first be noticed some months, or even years, later, and the primary mastitis may have not apparently ended in suppuration. The abscess is usually deeply seated in the breast, has thick fibrous walls, and increases in size very slowly.

CLINICAL FEATURES.—An indolent indurated swelling forms in the breast, which is associated with a little pain and tenderness. Fluctuation is absent for a long time, but the swelling is softer in the centre than at the edges. The nipple may be retracted, and the skin becomes adherent to the swelling.

The chief interest of this form of abscess is its liability to be mistaken for carcinoma. Attention should be given to the following points: (1) The history of confinement and lactation (it is very rare

for carcinoma to develop in a lactating breast); (2) the cedematous nature of the swelling; (3) the softness in the centre rather than at the edges. These features, however, are not always sufficient to make a differential diagnosis from carcinoma, and exploration is necessary before removal of the breast (see Swellings in the Breast, p. 1064).

TREATMENT.—The abscess should be opened and drained, but if the abscess cavity is small, and there is a large mass of indurated tissue around it, excision is the better treatment.

Retro-mammary Abscess.—An abscess may form in the cellular tissue beneath the breast from infection by a mammary abscess, but more commonly it arises from tuberculosis of one of the underlying ribs, or from an empyema. The abscess is always chronic.

CLINICAL FEATURES.—The whole breast is pushed forwards, but its outline is not altered. Fluctuation is detected at the periphery of the breast. There may also be the usual symptoms of empyema.

TREATMENT.—A curved incision should be made at the lower junction of the breast and the thorax, and the breast turned upwards. If the condition is due to tuberculosis of a rib, the portion of the rib should be excised. The abscess should be drained at the lower and outer angle of the incision.

Tuberculosis of the Breast.—Tuberculous infection of the breast is most common in young women, and may be associated with tubercle in other parts of the body.

CLINICAL FEATURES.—An indolent swelling appears in the breast, which gradually softens into several chronic abscesses. These burst, leaving sinuses with undermined edges, which do not heal. Tubercular infection of the axillary lymphatic glands may follow.

The diagnosis is made by bacteriological and microscopical examination of the abscess wall.

TREATMENT.—The mass should be excised, or the breast amputated; but if this method of treatment is refused, the abscesses should be opened and scraped. If the axillary glands are infected, they should be excised with the breast.

Syphilis of the Breast, apart from primary chancre of the nipple and condylomata of the skin between the breast and the chest wall in the secondary stage, is exceedingly rare. It is possible that some cases of chronic fibrosis of the breast are syphilitic, and gummata of the breast have been recorded. The usual antisyphilitic treatment should be given.

Chronic Interstitial Mastitis.—The exact pathology of this condition is not fully understood. It may either be looked upon as a primary chronic inflammation, ending in fibrosis, with secondary degeneration of the glandular tissue of the breast, or a primary degeneration of the breast tissue with increase of the intercellular fibrous tissue. The CAUSE is not known, but has been attributed to—(1) Chronic intoxications, associated with syphilis or with chronic constipation (Lane); (2) injury; (3) a premature old age and involution of the breast tissue.

PATHOLOGICAL ANATOMY.—The disease may affect one or both breasts, or only one lobule of a breast. The amount of fibrous tissue is increased, and the epithelial cells of the acini and ducts of the breast undergo fatty degeneration and disappear. In some places the acini become distorted, and the ducts may form small cysts, which lie scattered amongst the fibrous tissue. These cysts are rarely to be appreciated clinically, but occasionally one grows to the size of a



FIG. 471.—CHRONIC INTERSTITIAL MASTITIS, WITH CYST FORMATION.

pigeon's egg. In some cases the whole of the breast consists of many cysts lying amongst fibrous tissue (*multiple cystic disease of the breast*). These cysts contain a thin serous fluid, some of which may escape from the nipple. They may also contain small papillomatous intracystic growths. On microscopic examination, it may not be possible to differentiate a portion of such a breast from a section of the normal breast of an elderly woman.

CLINICAL FEATURES.—This disease is met with at any age after puberty, but is most common in women between thirty and forty who are unmarried, or in married women without children, or in those who have not suckled their children. It is also occasionally met with in women whose breasts have fully fulfilled their normal physiological function. The patient's attention is usually first attracted to the breast by pain, neuralgic in character, which is worse at—or just before—the menstrual period.

On examination, a lump is felt in the breast, generally very indistinct in outline, and difficult to examine precisely, unless a large cyst is present. The lump is not adherent to the skin nor the pectoral muscles, but the nipple is occasionally retracted. Sometimes the whole breast is found to be slightly nodular, and more than one distinct lump may be felt. The other breast frequently presents the same physical signs. The axillary glands are slightly enlarged, but are neither hard nor fixed. A slight serous discharge may occur from the nipple.

RELATIONSHIP TO CARCINOMA.—Whether cases of interstitial mastitis commonly become carcinomatous is a matter of dispute. It is certain that the condition may be present for years without change. On the other hand, a good many cases of lumps in the breast, presenting all the physical signs of interstitial mastitis, ultimately declare them-

selves to be carcinomata. It is possible that the condition was from the first carcinomatous, and the diagnosis of chronic interstitial mastitis a mistaken one. The condition may also be difficult to diagnose from chronic mastitis—*i.e.*, chronic abscess.

TREATMENT.—The difficulty of exact diagnosis of lumps in the breast in their early stages in women after the age of thirty, and the uncertainty of the relationship of chronic interstitial mastitis and carcinoma, has led to the formulation of the following rule: If a swelling is discovered in the breast of a woman over thirty, and an exact diagnosis cannot be made, the condition should be treated as one of chronic inflammation—*i.e.*, pressure should be applied to the breast, mercury inuncted, and the patient given iodide of potassium internally. If this treatment is not successful in three weeks, and the diagnosis is still doubtful, the swelling should be excised and its exact nature determined by microscopical examination.

Chronic interstitial mastitis should be treated by excision of a wedge-shaped portion of the breast containing the diseased part; but if the condition is diffused through the breast, the whole of the gland should be removed. It may sometimes be necessary to amputate both breasts.

If this operation is refused, no local treatment should be carried out, for handling or irritation of the breasts may increase the likelihood of carcinoma supervening on the condition.

Neuralgia of the Breast (Mastodynia).—Neuralgia of the breast is a functional disorder, the only symptom of which is pain. The pain is severe and paroxysmal, being worse at the menstrual period. The skin over the breast may be hyperæsthetic, but there are no physical signs of disease. The patient, who is usually between twenty and forty, generally imagines that she is suffering from cancer.

TREATMENT.—She should at once be assured that she has not cancer, and her general health should receive attention. Local treatment is mostly useless, but the various remedies for neuralgia may be tried. A belladonna plaster will prevent the patient from handling the breast. Removal of the breast if there is no evidence of disease is useless and unjustifiable.

CYSTS OF THE BREAST

Cysts occur in the breast under many different conditions, and may be divided into primary and secondary.

PRIMARY CYSTS of the breast are—Galactoceles, involution cysts, serous cysts (hydroceles), and hydatid cysts. **SECONDARY CYSTS** are found in association with chronic interstitial mastitis (multiple cystic disease of the breast), cysto-adenoma, and malignant tumours. The secondary cysts are described under their appropriate headings.

Galactoceles.—A galactocoele is a retention cyst of the breast, containing milk. It is a rare condition, and is due to blocking of a duct by contraction of cicatricial tissue.

CLINICAL FEATURES.—The cyst appears during pregnancy or lactation, and forms a rounded, painless swelling, which increases rapidly in size. Fluctuation is present, and the condition may be mistaken for an abscess, though there is no evidence of toxæmia, and the breast is not painful. The cyst may not grow larger than a walnut, but Scarpa reported a case from which 10 pints of milk were removed. If the condition is not treated, the milk becomes inspissated, and a thick-walled capsule forms round the cyst.

TREATMENT.—A cyst which has formed during lactation may be left, for it may disappear after lactation is finished. If it is increasing rapidly in size, however, it should be tapped or opened and drained. It is not possible to dissect out these cysts at this stage on account of the thinness of their walls. If the cyst has not been interfered with during lactation, and does not disappear, it should be excised. The operation is easy, owing to the thickening of the cyst wall.

Involution Cysts.—These are retention cysts developing in the atrophying breasts of women after the menopause, owing to obstruc-

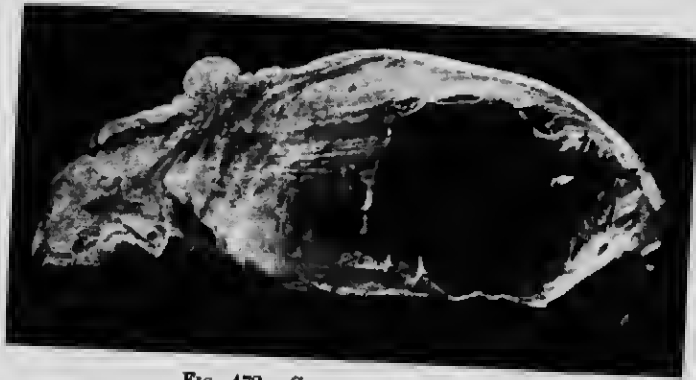


FIG. 472.—CYST OF THE BREAST.

tion of the ducts or acini. They contain a serous fluid, and are usually multiple. One may increase in size and overshadow the others.

A cyst situated deeply in the breast, and tensely distended with fluid, may be mistaken for a solid tumour; but if the patient is examined in the recumbent position, and the swelling pressed against the chest wall, a sense of elasticity is present. The diagnosis may be definitely made on introducing an aspirating needle, or by operation, as all tumours of the breast should be removed as soon as possible.

TREATMENT.—A wedge-shaped piece of the breast containing the cyst should be removed, and the gap close by buried sutures. If the cysts are multiple, the whole breast should be removed.

Serous Cysts of the breast are generally situated in the submammary connective tissue at the periphery of the breast. They are believed

to be due to dilatation of the lymphatic channels of the breast, but the subject requires further investigation. The treatment is removal.

Hydatid Cysts of the breast are rare, and have the usual characteristics of hydatid cysts elsewhere.

NEW GROWTHS

Innocent

Adenomata.—The following varieties of adenomata may be distinguished—Pure adenoma, hard and soft fibro-adenoma, and cysto-adenoma.

Pure Adenomata are so rare as to be unimportant. They resemble hard fibro-adenomata, but are softer in consistency.

Hard Fibro-Adenomata.—These tumours are most commonly met with between the ages of fifteen and thirty, and rarely grow larger

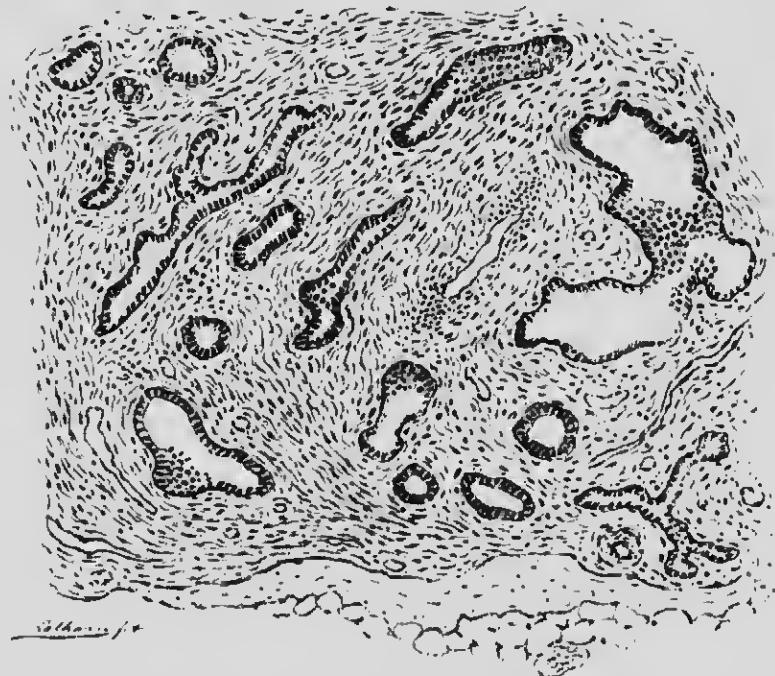


FIG. 473—SECTION OF FIBRO-ADENOMA OF THE BREAST.

than a hazel-nut. They are perfectly encapsuled, and, on section, are found to be composed of mammary acini, with a variable amount of fibrous tissue. They may be multiple in one breast, or may occur in both.

CLINICAL FEATURES.—The patient, who is as a rule unmarried, complains of a small tumour in the breast, which is the seat of neuralgic

pains, worse at the menstrual periods. On examination, a definite, hard, rounded, freely movable tumour is found in the breast. It slips away under the examining finger, and is not attached to skin, deeper structures, or the nipple. There is no glandular enlargement. More than one similar tumour may be discovered in the breast.

Soft Fibro-Adenoma.—Soft fibro-adenomata may develop from hard fibro-adenomata which have been present for years. More commonly, however, they appear first between the ages of twenty-five and forty. They grow rapidly, but remain encapsuled. On section, the surface of a soft fibro-adenoma is lobulated and glistening, and often studded with small cysts. The condition may be mistaken for a sarcoma, and, in fact, it has been described as adeno-sarcoma.

CLINICAL FEATURES.—These resemble those of hard fibro-adenomata, but the tumour is softer, and grows much more rapidly.

Cysto-Adenoma.—This form occurs most commonly in patients between the ages of twenty-five and forty. The distinction from

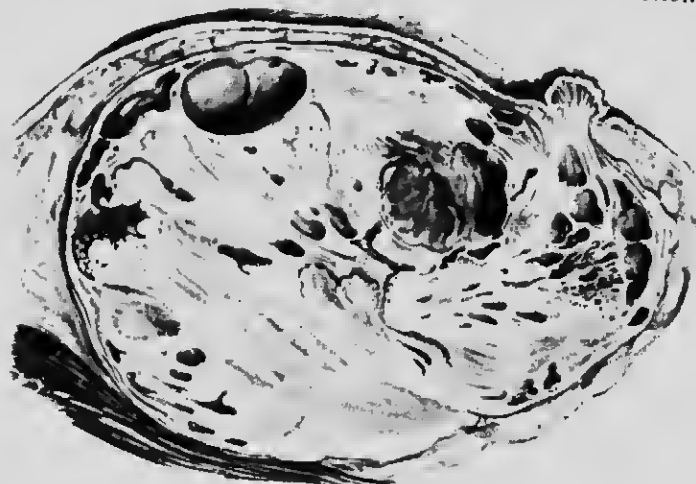


FIG. 474.—CYSTO-ADENOMA OF THE BREAST.

soft fibro-adenomata is artificial. The cysts present mostly vary in size from a small pea to a walnut, though the tumour may grow to the size of a cocoa-nut. The cysts may communicate with the ducts of the breast, and may then be emptied through the nipple by squeezing. Intracystic growths are common, and may fill the whole of the cyst.

CLINICAL FEATURES.—The breast is the site of a large tumour, which may be nodular to the touch, and of uneven consistency. Although the skin may be stretched, thinned out, and blue in colour, it is not adherent to the tumour, and the nipple is not retracted. No matter how large the tumour may grow, it does not become adherent to the pectoral muscles, nor is there any enlargement of the axillary glands. A serous discharge from a nipple is often present,

and if there are intracystic growths in the cyst communicating with the ducts, the discharge may be blood-stained. Later, the skin may ulcerate from pressure, and the tumour fungate; but it still retains its innocent character. On the other hand, it is possible for the intracystic growths to undergo malignant change. These tumours have also been described under the names of "cysto-sarcoma," "proliferating cysto-adenoma," and "sero-cystic sarcoma of Brodie."

TREATMENT OF ADENOMATA.—All the varieties of adenoma should be excised as soon as the diagnosis is made, as no other form of treatment is of any use. At the same time it must be admitted that adenoma may be present for many years without troubling the patient.

Two methods of removal are practised: (1) An incision, radiating from the nipple, is made over the tumour, which is shelled out, and the cavity obliterated with buried catgut sutures. (2) A curved incision is made at the junction of the lower margin of the breast and the chest wall; the breast is turned upwards, and the tumour approached from its posterior surface. It is removed, the cavity obliterated with buried sutures, and the breast replaced. This latter method of removal has the advantage of hiding the scar, but is a slightly more difficult operation than the former. In all cases of partial removal or incision of the breast, hæmorrhage may be troublesome, therefore the cut breast tissue should be carefully sutured.

In the case of a very large cysto-adenoma, especially if it is fungating, the whole breast should be removed.

Papilloma.—Apart from the papillomatous intracystic growths met with in cysto-adenomata and chronic interstitial mastitis, soft papillomata may occur in the main galactophorus ducts in the nipple. These soft papillomata closely resemble those met with in the urinary bladder, and, like them, bleed readily, and are liable to undergo malignant change. As a rule they are small, but they may reach the size of a walnut.

CLINICAL FEATURES.—The first symptom is a serous or blood-stained discharge from the nipple, which may be present for a long time before any swelling can be distinguished. Later, a small swelling appears at the base of the nipple, and when this is squeezed, the discharge flows from the nipple.

TREATMENT.—The part of the breast and nipple containing the papilloma should be freely removed, as malignant growth is apt to supervene.

Malignant

Sarcoma.—Sarcomata form about 5 per cent. of all cases of new growth of the breast, and are spindle-celled or mixed-celled. In the early stages they usually grow slowly, and possess a pseudo-capsule, though in some cases the growth rapidly infiltrates the whole breast. Cyst formation from hæmorrhage into the growth is common, and in a few cases the tumour may contain cartilage or bone. Secondary

growths in the axillary glands are not common, but recurrence, either local or general, after removal is the rule. Sarcoma of the breast is most often met with in women between the ages of thirty and forty.

CLINICAL FEATURES.—The patient complains of a swelling in the breast, which is generally painless. On examination, the swelling in the early stages is rounded and smooth, of uniform, soft consistency, and not attached to the skin or pectoral muscles. The tumour, unlike an adenoma, is not freely movable in the breast. The nipple is not retracted, but is, on the contrary, more prominent than usual. Dilated veins may be seen coursing over the breast. Later, the tumour, which may fungate, becomes adherent to the skin and muscles. The axillary glands are occasionally enlarged. As in cases of sarcoma elsewhere, there may be irregular elevations of the temperature.

The diagnosis from soft or cysto-fibro-adenoma, or from the more rapidly growing forms of carcinoma, is often very difficult.

TREATMENT.—The treatment is complete amputation of the breast and axillary glands, as described under Carcinoma (p. 1073).

Endothelioma and **Perithelioma** have been described in the breast.

Carcinoma of the Breast

Carcinoma is by far the most common neoplasm met with in the breast, and, with the exception of the uterus, the breast is the organ most frequently attacked by malignant disease. The growth may be a columnar-celled carcinoma growing from the ducts, or a spheroidal-celled carcinoma growing from the cells of the acini. The latter is

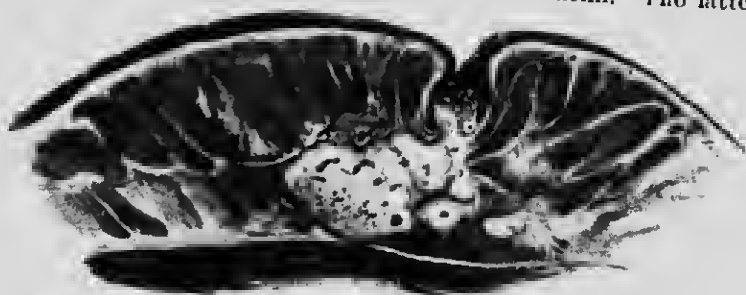


FIG. 475.—CARCINOMA (SCIRRHUS) OF THE BREAST.
(London Hospital Medical College Museum.)

the more common. For the sake of pathological and clinical description, these tumours are classified as "medullary," "scirrhous," "atrophic," and "diffuse infiltrating"; but it must be understood that these are simply variations in the relative amounts of fibrous and cellular elements, and a distinct border-line between the varieties cannot be drawn.

PATHOLOGICAL ANATOMY.—A *medullary* carcinoma in which the cellular elements predominate is most common in young subjects—*i.e.*, below the age of thirty-five. The tumour is soft, often of brain-

like consistency, grows rapidly, and may undergo colloid change. This form is apt to develop if a patient with a carcinoma becomes pregnant.

Scirrhus.—This is by far the most common form of carcinoma of the breast, and occurs in women between the ages of forty and sixty. The fibrous element predominates; therefore the tumour grows slowly, and is hard and nodular. The fibrous tissue is most abundant in the centre, where the glandular element may be absent, so that the tumour is harder in the centre than at the edges. In this and in all the forms of carcinoma of the breast cyst formation may occur. On section, the tumour is found to be hard, creaking as it is cut. The cut section is convex, owing to contraction of the fibrous tissue. There is no capsule. The section has been compared to a section of an unripe pear.

Atrophic Scirrhus.—This form occurs in elderly people (generally over sixty, and is characterized by the excessive production and con-



FIG. 476.—CARCINOMA OF THE BREAST (SCIRRHUS).
(Note the elevation of the nipple.)

traction of fibrous tissue. The tumour and breast both become so contracted that they appear as a nodule of scar tissue.

Infiltrating Carcinoma.—In this variety the whole of the breast is uniformly infiltrated with carcinoma; thus, in the limited sense of the word, no tumour can be discovered, and the condition may easily be mistaken for a diffuse inflammatory condition. It is sometimes termed "mastitis carcinomatosa."

CLINICAL FEATURES.—*Scirrhus*.—The patient complains of the presence of a hump, which she has discovered accidentally when washing her breast. In some few cases pain in the breast first attracts her attention, and leads her to discover the tumour. The absence of

pain is usually the excuse in advanced cases for not seeking advice earlier.

On examination in the early stages, there is a distinct tumour in the breast, harder in the centre than at the periphery, which, although movable under the skin and on the pectoral muscle, is not movable in the breast tissue. The affected breast appears a little more prominent than the normal breast, and the nipple is frequently on a slightly higher level. The disease should be recognized at this stage, although on clinical examination it is sometimes difficult to diagnose it certainly from chronic interstitial mastitis or chronic abscess of the breast. The features which may distinguish it from chronic interstitial mastitis are—(1) The absence of pain; (2) the solitary nodule in one breast; (3) the definiteness of the tumour and the prominence of the breast. In all cases of doubt the tumour should be excised, and a microscopical examination made.

Later physical signs are—The skin over the tumour becomes attached to it, is at first dimpled on moving the tumour, and finally is definitely retracted. On putting the great pectoral muscle into action, it will be found that the tumour does not move freely across its fibres. The nipple is retracted, and the axillary glands are enlarged, hard, and matted together. Later, they are fixed to the skin and deeper structures.

It cannot be too strongly emphasized that these last symptoms appear late, and should *never* be waited for in the diagnosis of carcinoma of the breast. The nature of a tumour of the breast should always be settled by exploratory incision. Unfortunately, many patients do not present themselves for examination until the disease is well advanced, being then compelled to seek advice, owing to the implication of the skin.

The last stage in the physical signs of the disease is fungation through the skin and the appearance of a carcinomatous ulcer with the usual characteristics.

GLANDULAR INVOLVEMENT.—The glands first involved are the pectoral set of the axillary glands lying along the long thoracic vein at the lower border of the pectoralis minor. Later, there is involvement of the other sets in the axilla, the median set, the subscapular set, and the deep axillary glands. Involvement of the supra-clavicular glands occurs either through the lymph stream flowing from the axillary set, or directly through the lymphatics passing over the clavicle. The other glands liable to be infected are the mediastinal glands through the lymphatics of the chest wall, the glands in the abdomen, and the glands in the opposite axilla. Later in the disease, before operation, or if there is recurrence after operation, the arm may become swollen and œdematous, and exceedingly painful. This is due partly to obstruction of the lymph flow through the cancerous glands, partly to pressure on the axillary vein, and partly to blocking of the lymphatic channels from permeation of the cancer cells along them.

Very rarely two distinct carcinomas may appear in one breast, or the disease may be bilateral. In the latter case it is probable that

extension has occurred from one breast to the other by means of lymphatic spread.

It should be specially noticed that a scirrhous carcinoma of the breast may be present for a year or more without causing any wasting or impairment of the general health, but when ulceration of the skin occurs, and secondary deposits appear in other organs, the usual cancerous cachexia is present.

SECONDARY GROWTHS.—Secondary growths are most common—
(1) In the liver; (2) In the lungs; and (3) in the bones. Of the bones,

those most frequently attacked are the femur, vertebrae, and ribs. In all cases of spontaneous fracture of a bone in women above the age of thirty, the breast should be especially examined, as a carcinoma of this organ is frequently ignored until very late.

Secondary growths in the vertebrae cause angular curvature of the spine, pressure on the spinal nerves, and paraplegia.

Atrophic Scirrhus usually occurs after the age of sixty, and runs an extremely slow course. In a typical case the affected breast is diminished in size, the skin puckered, and the nipple markedly retracted. The growth is firmly fixed to the chest wall, and the breast and tumour are represented by what is apparently a



FIG. 477. — DIFFUSE ENCEPHALOID CARCINOMATOSIS OF THE BREAST, WITH MASSIVE OEDEMA OF THE ARM.

dense, hard scar. Ultimately the glands are affected, but the patient may live for years without pain, and have excellent general health.

Cancer en cirasse.—This term only implies that there is extensive infiltration of the skin, and some of the most typical cases are seen in recurrences in the skin after removal of the breast. In the first stage of this condition the skin is hard and brawny from lymphatic obstruction, and dilated lymphatic vessels can be seen on the surface of the breast. Later, this brawny skin becomes infiltrated with carcinomatous nodules, and is tough and leathery (pig's-skin—*peau d'orange*). The infiltration of the skin may be very widely spread, extending from the clavicle to the costal margin.

Medullary Carcinoma—Acute Carcinoma—Mastitis Carcinomatosa—Encephaloid Carcinoma.—All these terms are applied to a rapidly growing type of carcinoma which is generally found in young subjects who are often either pregnant or lactating.

The condition is a diffuse, rapidly growing carcinoma of the breast, which quickly infiltrates the skin (*cancer en cuirasse*) and the lymphatic glands. The whole of the gland is implicated, and becomes firm and fixed. There are not infrequently irregular rises of temperature, which, combined with the very rapid growth, the general involvement of the skin, and the implication of the whole gland, leads to a diagnosis of subacute mastitis, with suppuration. Death, with extensive metastases, may occur in two or three months.

Duct Carcinoma.—There is little to distinguish duct carcinoma from the glandular form, but the growth is generally situated immediately below the nipple, which is involved early, but not as a rule



FIG. 478.—DUCT CARCINOMA OF THE BREAST.
(London Hospital Medical College Museum.)

retracted. There is frequently a blood-stained discharge from the nipple. This form of growth is, on the whole, of a slightly less malignant type than spheroidal-celled carcinoma.

PROGNOSIS.—The prognosis of the length of life in an untreated carcinoma of the breast varies from a few months in cases of acute cancer to fifteen or twenty years in cases of atrophic scirrhus. The average length of life without operation is about three years. With modern methods of operation, the number of cures and delay in recurrence is steadily increasing.

TREATMENT.—The diagnosis of early carcinoma of the breast is so doubtful, and the condition may simulate so exactly other diseases of the breast, that when an operation for removal of a tumour of the breast is advised, consent for complete amputation of the breast should be obtained, in case the condition on exploration should be considered cancerous. The tumour under consideration is com-

pletely excised, and then examined. If possible, arrangements should be made for cutting a microscopical section immediately, in order that the diagnosis can be definitely determined before the operation is proceeded with. In many cases the breast has been needlessly sacrificed for a cyst with thickened walls, or a chronic abscess; and on the other hand, a tumour has been removed which clinically was innocent, but which, on microscopical examination, has been discovered to be malignant, thus entailing a second operation.

The modern operation for carcinoma of the breast is—Removal of (1) the whole breast; (2) a large portion of skin, the centre of which is the tumour, but which should always include the nipple; (3) the subcutaneous fat and fascia, from the clavicle to the upper part of the abdomen, and from the middle line of the thorax to the edge of the latissimus dorsi; (4) the pectoralis major, with the exception of a portion of its clavicular head and its fascial sheath; (5) the pectoralis minor and its fascial sheath; (6) the costo-coracoid membrane; (7) all the fat and fascia in the axilla; (8) the fascia over the subscapularis and serratus magnus, and the fascia under the latissimus dorsi. In some cases the supraclavicular fat and fascia must be removed as well.

The operation is performed as follows: Through a suitable skin incision (see Fig. 470) the pectoralis major is exposed and divided close to its insertion in the bicipital groove of the humerus, and the pectoralis minor is divided close to the coracoid process. The axilla is then cleared of all fat and fascia, the axillary vein being laid quite bare, and the branches of the axillary artery and vein being ligatured close to the main trunk. The subscapular and the long thoracic nerves are dissected out of the fascia in which they lie, as the fascia must be removed. Suitable flaps of



FIG. 470.—INCISIONS FOR AMPUTATION OF THE BREAST.

skin are then dissected up, and the whole of the breast, the pectoral muscles, and the area of subcutaneous tissue mentioned above, are removed with the axillary fascia in one sheet. In the lower part of the incision the external oblique and the rectus abdominis muscles are exposed. In spite of a free removal of the skin, the flaps will come together if the incisions are carefully planned.

The arm should not be bandaged to the chest wall, but left free and movements allowed after the first forty-eight hours. In spite of the large wound and the removal of both pectoral muscles, the movements of the arm are but little interfered with, though the

may be some oedema of the arm and hand, owing to pressure on the axillary vein. There may be pain and numbness in the course of the divided nerves.

Many surgeons, after the wound has soundly healed, advise a course of X-ray treatment as a prophylaxis against recurrence.

RECURRENCES.—Recurrences of the growth, especially in the form of small nodules in the skin or subcutaneous tissue, should be carefully watched for, and promptly removed. If

removal is not possible, the application of X rays and radium treatment will sometimes bring about their disappearance.

Atrophic Scirrhus.—A similar operation to the one above should be carried out for atrophic scirrhus, but the age and general condition of the patient should be carefully considered before operation is advised. In many very elderly patients the growth should be left untouched, as the patient may live for years in good health, although ultimately secondary growths in the viscera will occur.

Acute Cancer.—These growths progress so rapidly that operation is seldom possible when the condition is diagnosed.

Duct Carcinoma.—A similar operation to that advised for glandular carcinoma should be performed. As stated above, the prognosis is slightly better.

TREATMENT OF INOPERABLE CASES.—In cases which are seen too late for radical operation, the mass in the breast may be removed in order to prevent it fungating; or, if it has already invaded the skin, to limit infection and to relieve the patient of a foul, discharging sore. If this is not done, the carcinomatous ulcer should be kept as clean and aseptic as possible. In women below the age of fifty whose ovaries are still functional, double oöphorectomy will sometimes lead to diminution in the rate of growth, or even to disappearance of the tumour. Other cases are not benefited by this operation. Thyroid extract may be given after the operation to bring about the absorption of degenerated cancer cells.



FIG. 480. MOVEMENT OF THE ARM AFTER REMOVAL OF THE BREAST AND BOTH PECTORALS.

For extensive infiltration of the skin, X rays and exposure to radium may be of benefit.

Lymphangioplasty.—In those cases in which oedema of the arm is marked and intense pain is present, owing to lymphatic obstruction, the operation of lymphangioplasty may give relief. Silk threads are



FIG. 481.—EDEMA OF THE ARM FROM RECURRENCE OF A CARCINOMA OF THE BREAST.

introduced into the subcutaneous tissue along the whole length of the back and front of the upper extremity, terminating in the back below the scapula. Their purpose is to provide artificial channels for the return of the lymph.

DISEASES OF THE MALE BREAST

Congenital abnormalities have already been referred to, as well as the subacute mastitis occasionally met with at puberty.

Chronic Interstitial Mastitis is met with in men as well as in women, and if it is a source of annoyance to the patient, the breast should be removed.

Carcinoma of the Breast in men is met with in the proportion of 1 to 100 in women. The average age at which it appears is fifty, and it is more often a spheroidal-celled carcinoma than a duct carcinoma. The same complete removal is necessary in the male as in the female.

CHAPTER XXXIV

INJURIES AND DISEASES OF THE KIDNEY AND URETER

Injuries of the Kidney

Subcutaneous injuries of the kidney follow blows on the loin, "run-over" accidents, and acute flexion of the body. They are more common in men than in women, on account of the greater liability of men to accident, and perhaps also to the absence of protection afforded by corsets.

It is advantageous to divide injuries into slight and severe.

Slight Injuries of the Kidney (Contusions).—(CLINICAL FEATURES.—The patient complains of pain in the loin and hæmaturia following an accident. There is often some frequency and pain on micturition, owing to the presence of blood-clot in the bladder.

On examination, tenderness and rigidity in the lumbar area are discovered, but no swelling can be felt. After a few days a bruise may appear over the crest of the ilium.

The hæmaturia persists for two or three days, and is followed by a little pyuria, due to infection of the damaged kidney by the *Bacillus coli*. The condition then clears up, or diffuse suppuration may occur in the kidney. In a few cases a slight injury in the lumbar region may be followed by severe hæmaturia, and in this case it will be found that the kidney is already the seat of disease—usually tuberculosis or calculus.

TREATMENT.—The patient should be put in bed and given a milk diet, with plenty of bland fluids to drink. Urotropin, or some other urinary antiseptic, should be given to allay infection, and the bowels should be kept acting freely. As soon as the urine is free from blood and pus, the patient can be allowed up. If a slight injury is followed by severe hæmaturia, the condition of the kidneys should be carefully investigated.

Severe Injuries of the Kidney.—Severe injuries are followed by shock, and later by signs of internal hæmorrhage. The hæmorrhage in adults usually occurs into the perinephritic tissue, and causes a large painful swelling to appear in the loin; but in children, who have practically no perinephritic fat, the peritoneum is frequently lacerated, and the hæmorrhage takes place into the peritoneal cavity.

Hæmaturia usually occurs, though it may be absent—(1) In very severe crushes of the kidney; (2) if the ureter is torn across at the

same time as the kidney is damaged; (3) if the renal vessels are torn across; (4) if the ureter is blocked with blood-clot.

Suppuration, due to infection from the alimentary canal, frequently occurs in the perinephritic tissue, and the general symptoms of infection follow—*i.e.*, rise of temperature, rigors, malaise, etc.

TREATMENT.—When a severe laceration of the kidney is diagnosed, the organ must be exposed by the usual lumbar incision, and the further treatment will depend upon the condition present. In many cases it will be found necessary to tie the renal vessels and remove the kidney, but in some instances the laceration in the kidney may be sutured, and the organ saved. The blood-clot should be removed from the loin, and the wound drained. If there is difficulty and pain on micturition, owing to blood-clot in the bladder, this viscus should be washed out.

In those cases in which a primary operation has not been performed, and suppuration has occurred in the kidney or the perinephritic tissue, no time should be lost in giving a free exit to the pus, and if the suppuration is extensive, the kidney should be removed.

Rupture of the Ureter.—Rupture of the ureter as the only serious lesion after an abdominal injury usually occurs in children from “run-over” accidents, and is a rare accident. The ureter may be partly or completely torn across. The peritoneum is not usually implicated, so that the urine is extravasated into the perirenal tissue.

CLINICAL FEATURES.—The early symptoms are those of shock. Later, there is the formation of a fluid swelling in the loin, with diminution in the amount of urine passed. Haematuria does not occur. The urine may remain for days in the loin without infection occurring, but when infection is present, there are the usual signs of suppuration.

TREATMENT.—It is impossible to diagnose rupture of the ureter immediately after the injury, but the condition may be discovered on exploratory operation, and the ureter should be sutured. With the formation of the swelling in the loin, the diagnosis becomes easy, and the ureter should be exposed by a lumbar incision. Four methods of treatment are then open: (1) The urine, and possibly the pus, is drained away, and the urinary fistula that results left to close spontaneously. This method is frequently followed by a permanent urinary fistula requiring nephrectomy later, or by hydronephrosis, from obstruction of the ureter by scar tissue. (2) The upper end of the ureter may be sutured into the side of the lower end (lateral ureteroplasty). This method of treatment is excellent, but owing to the separation of the two portions, it is often impossible. (3) The kidney may be removed. This method of treatment is the one to be generally followed. (4) The upper end of the torn ureter may be ligatured, and the kidney left to atrophy.

Operative Injury.—The ureter is sometimes injured during operations on the uterus or rectum, and if the injury is discovered, it should

be dealt with at once by suture. If the injury passes unnoticed, it will be followed by extravasation of urine if the ureter is cut or torn, or by suppression of urine from the corresponding kidney if the ureter is included in a ligature.

CONGENITAL ABNORMALITIES OF THE KIDNEYS AND URETERS

1. **Lobulation of the Kidney.**—This is the persistence of the fetal condition, and is unimportant; but it is said that these kidneys are more liable to tuberculosis (Barkor).

2. **Abnormal Arteries.**—Abnormal arteries may run into either the upper or lower pole of the kidney. In the latter situation the ureter may become kinked over the abnormal vessel, and hydronephrosis follow. These arteries may arise from the aorta, the iliac arteries, or the suprarenal artery.

3. **Horseshoe Kidney.**—The two kidneys lie nearer the middle line than usual, and their lower poles (occasionally the upper) are joined by kidney tissue or by fibrous tissue. The ureters pass down in front of the connecting band, and if one is occluded, hydronephrosis of that half of the kidney may follow. The horseshoe kidney is usually displaced downwards. Sometimes it may lie in the pelvis, where it may be mistaken for a pelvic tumour.

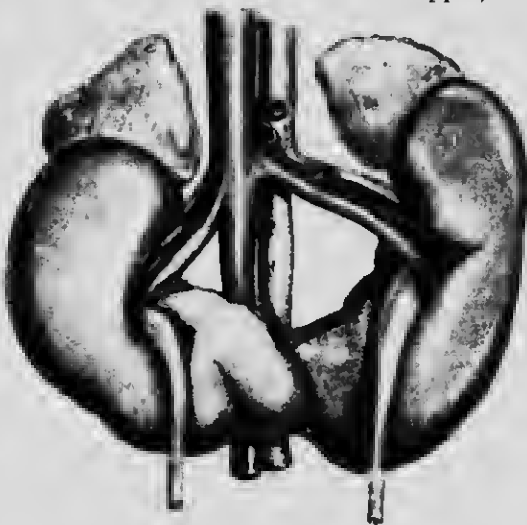


FIG. 482.—HORSESHOE KIDNEY.
(London Hospital Medical College Museum.)

4. **Absence of One Kidney.**—One kidney may be entirely absent, and in this case the other is usually hypertrophied, and the condition only discovered on operation or post-mortem examination. If one kidney is absent, the opening of the ureter into the bladder is also absent, and the condition may be recognized on cystoscopic examination. Occasionally with one kidney two ureteric orifices may be present, both ureters coming from the same kidney.

5. **Atrophic Kidney.**—Without being absent, one kidney may be small and functionless. In this case two ureteric orifices will be present in the bladder.

6. **Extra Ureters.**—A kidney may have two complete ureters, with two pelves and two openings into the bladder, or various anomalies may be present: (1) Two ureters may leave the kidney and unite into one below. (2) One ureter may end blindly in the wall of the bladder, and the pressure of the urine behind it may cause the blind extremity to project into the bladder, forming a "tumour" that can be recognized with the cystoscope. (3) A ureter in the male may open into the vesicula seminalis, the ejaculatory duct, or the prostatic urethra. The condition is usually only recognized on dissection. In the female the abnormal ureter may open into the vagina, and partial incontinence of urine will result.

7. **Malposition.**—One kidney—more commonly the left—may be displaced downwards, and form a palpable tumour in the abdomen or pelvis. In these cases the renal artery arises low down from the aorta or from the iliac vessels.

8. **Floating Kidney.**—The kidney is completely surrounded by peritoneum, and is more freely movable than normal. The condition gives the same symptoms as movable kidney, and can only be distinguished from it by dissection.

9. **Congenital Cystic Kidney.**—This condition will be described later.

Movable Kidney (Rena Mobilis, Nephroptosis)

A movable kidney is one that moves more freely behind the peritoneum than normal. The degree of movement varies from an amount that just allows the lower pole to be palpated on deep inspiration (palpable kidney) to a freedom of movement that allows the kidney to be pushed down into the pelvis, or even beyond the middle line of the abdomen. The latter condition has been termed "floating kidney"—a name also given to the very rare congenital abnormality in which the kidney is completely surrounded by peritoneum. The degree of movement of the kidney and the precise plane in which it moves are of little importance, as the symptoms present have not necessarily any relationship to the amount of movement, nor does the amount of movement indicate the necessity or otherwise for operative treatment. The suprarenal body does not move with the kidney, as it is enclosed in a separate layer of the retroperitoneal fascia.

CAUSE.—Movable kidney is more common in women than in men, and is usually met with between the ages of twenty-five and fifty. It is more common on the right side than on the left, and is more prevalent among the poorer classes than the well-to-do. The following factors are probably important in the production of this condition: (1) Decrease in the intra-abdominal tension and laxity of the abdominal walls after parturition, rapid loss of fat during illness, and removal of large abdominal tumours or ascitic fluid. Insufficient rest in bed after one of these conditions probably increases the liability to movable kidney. (2) The wearing of unscientific corsets, which displace the abdominal viscera, instead of supporting them. (3) Constipation, leading to displacement of the caecum downwards, dragging with it

the kidney, and causing increased straining at stool. (4) Repeated traumatism, such as overlifting and gymnastic exercises, or a severe trauma from falls and blows.

In many cases none of these factors can be discovered, and certainly they do not always result in producing movable kidney, and it has been assumed by some authorities that the predisposing cause is some congenital abnormality in the shape, position, or attachments of the kidney.

CLINICAL FEATURES.—It is convenient to divide cases of movable kidney into the following classes:

1. The patient does not complain of any symptoms referable to the kidney, but the condition is discovered during the course of a routine abdominal examination. This class is a very common one, and it is inadvisable to inform the patient of the condition, as no treatment is necessary.
2. The patient has symptoms directly due to the movable kidney. The symptoms are a dull, dragging pain in the loin, worse when the patient is about, *but relieved by recumbency*. The patient is often aware of "something slipping inside," or may discover an abnormal swelling in the abdomen, which, on examination, proves to be the displaced kidney. In some cases the patient complains of acute attacks of abdominal pain, with vomiting and frequency of micturition, the urine often being blood-stained. These attacks (*Dietl's crises*) are believed to be due to torsion of the pedicle of the kidney. Kinking, with partial obstruction of the ureter, is a common result of movable kidney, and as a consequence hydronephrosis follows. The displaced organ may cause pressure effects, amongst others, pressure on the duodenum, causing pyloric obstruction and, later, dilatation of the stomach. The diagnosis is made by palpating the kidney while the patient takes a deep inspiration. The kidney can often be grasped between the hands, and pressure on it causes a sickening feeling. After the inspiration, the kidney can be squeezed back into the loin with a characteristic jerk, of which the patient is aware. In most cases the kidney is palpable with the patient lying in the bed, but sometime it may be necessary to examine her in the sitting or the knee and elbow position.
3. The patient complains of the same set of symptoms as the above class, but has added the symptoms of neurasthenia, this condition following the constant pain and discomfort of the movable kidney.
4. The patient is a neurasthenic who has been informed that she has a movable kidney, and imagines that all her symptoms arise from this condition.
5. The movable kidney is part of a general enteroptosis and aplanchnoptosis (Glénard's disease), and the other organs in the abdomen are as freely movable or displaced as the kidney.

TREATMENT.—In considering the treatment of movable kidney, the class to which the patient belongs must be carefully taken into account. If there are no symptoms, no treatment is necessary, and the patient should not be informed of her condition. When the symptoms are directly due to the abnormal movement of the kidney, and especially



FIG. 483.—POSTERIOR RELATIONSHIPS OF THE KIDNEY.

if the kidney is being damaged by kinking of the ureter or torsion of the pedicle, the kidney should be fixed in its normal position by operation (nephrorrhaphy). The results of this operation vary, and the prognosis depends largely on the neurasthenic element in the case. If neurasthenic symptoms are absent, the prognosis is good, and it is fairly good if the neurasthenic symptoms are dependent upon the pain and discomfort of the condition, for fixing of the kidney removes the cause of the neurasthenia. On the other hand, when the symptoms are largely neurotic, they will probably continue after the organ has been firmly fixed, although the moral effect of an operation in a functional condition must not be ignored. If the patient is firmly convinced that fixity of the kidney is necessary for cure, operation is indicated.

The operation of **nephrorrhaphy** may be performed in many ways, but no method can be considered to be invariably successful, for sometimes, even if the kidney remains firmly fixed, no relief of the symptoms may follow.

The majority of operations depend for their success on dissecting up a portion of the true capsule of the kidney, so that raw area of kidney substance lies in contact with the fascia on the posterior abdominal wall, to which it becomes attached by adhesions, and then suturing the partially detached capsule to the fascia and muscles. The patient should be kept recumbent for at least three weeks.

In neurasthenic and in other cases in which operation is inadvisable, the patient should wear a well-fitting abdominal belt or corset, with a diamond-shaped pad, which lies just below the kidney, and holds it in position.

Cases of Clénard's disease should be treated with an abdominal belt or corsets (see p. 682), as the fixing of one or both kidneys by operation is unlikely to relieve all the symptoms. The relief given by a properly adjusted belt is often striking.

When a movable kidney follows rapid loss of abdominal fat, the patient should be kept in bed, and dieted carefully until the fat is replaced, when the kidney may become naturally fixed.

Hydronephrosis

Hydronephrosis is a condition of distension of the pelvis and calyces of the kidney followed by atrophy of the glandular tissue of the organ, so that finally a large sacculated cavity with fibrous walls containing a urinous fluid of low specific gravity remains in place of the kidney. The cause of the condition is partial or intermittent obstruction of the outflow of the urine, raising the tension of the urine in the pelvis of the kidney. Complete obstruction to the outflow of urine does not lead to hydronephrosis, but to atrophy of the kidney, which loses its power of secretion.

The cases may be divided into bilateral and unilateral:

Bilateral Hydronephrosis is due to—(1) Obstruction of the outflow of urine from the bladder following urethral stricture, enlarged prostate, etc.; (2) functional disorders of micturition associated with difficulty in passing urine, such as occur with irritable bladder or phimoses; (3) malignant tumours of the base of the bladder obstructing the orifices of both ureters; (4) rarely from malignant tumours of the uterus or rectum, or pelvic cellulitis obstructing both ureters.

CLINICAL FEATURES.—In addition to the symptoms of the condition producing the bilateral hydronephrosis, the patient gradually develops the symptoms of *renal insufficiency*. The most important of these symptoms are headache, thirst, loss of appetite, and vomiting. The tongue and skin are dry, optic neuritis is frequently present, and the amount of urine passed is increased.

On examination, the urine is seen to be pale in colour, of low specific gravity owing to the diminution of urea and salts, and containing a trace of albumin. A well-marked kidney tumour may be present in both loins. It is seldom that bilateral hydronephrosis grows to a large size. Ascending infection of the kidneys with pyelitis and pyelonephrosis, ending in death, is common.

TREATMENT.—Treatment is directed to the cause, which must be removed as soon as possible, for no other treatment is likely to prolong life. If the cause is irremovable, as in the case of advanced carcinoma of the base of the bladder, life may be prolonged for a time by establishing permanent fistulae in the loin (bilateral nephrostomy).

Unilateral Hydronephrosis.—The causes of unilateral hydronephrosis are—(1) Obstruction in the ureter from impacted calculi,

blood-clot, and villous tumours of the ureter or bladder; (2) obstruction in the wall of the ureter from cicatricial contraction during the healing of ulcers or following injury, malignant growths of the ureter or bladder, congenital abnormalities, and kinking of the ureter; (3) obstruction from without, from tumours in the abdomen or pelvis pressing on the ureter.

Apart from calculi in the ureter, the most common cause of unilateral hydronephrosis is kinking of the ureter over normal or abnormal vessels. This condition is frequently associated with movable kidney.



FIG. 484.—HYDRONEPHROSIS DUE TO KINKING OF THE URETER.

(London Hospital Pathological Institute.)

As a consequence of the downward and forward movement of the kidney, the ureter becomes kinked at the place where it expands to form the renal pelvis, and the orifice of the ureter no longer forms the lowest part of the pelvis. Adhesions form between the ureter, and the pelvis fixing the kink, the outflow of the urine is obstructed, and hydronephrosis follows. In the early stages of the formation of the kink the obstruction is often temporarily overcome, giving the phenomenon of *intermittent hydronephrosis*.

CLINICAL FEATURES.—Apart from the symptoms of the cause of the hydronephrosis, such as those of renal calculus, villous tumour, or movable kidney, there are no special symptoms associated with the condition, and the diagnosis has to be made by the discovery of a cystic renal swelling.

The characteristics of a renal tumour are—It is reniform in shape and lies in the loin, or is capable of being pushed into the loin; it moves on respiration and has the colon lying in front of it, while posteriorly it is dull on percussion. In some cases the tumour is more readily examined in the knee and elbow position. The swelling may be so large as to fill the whole of one side of the abdomen, and cause pressure on the stomach and intestines, and bulging of the ribs.

Intermittent Hydronephrosis.—In this condition the patient presents the usual cystic kidney swelling, but after the passage of a large quantity of pale-coloured urine the swelling disappears; it, however, gradually forms again.

COMPLICATIONS.—The great complication of hydronephrosis is infection of the kidney with pyogenic organisms, causing suppuration.

tion, the condition then being termed *pyonephrosis*. The infection may ascend from the bladder or occur directly from the intestine, but hydronephrosis may be present for years without organisms reaching the sac.

TREATMENT.—The first, and sometimes the only necessary, step in the treatment is removal of the cause, as, for example, removal of a calculus obstructing the ureter. When the condition is associated with movable kidney and kinking of the ureter, it is necessary to fix the kidney, and at the same time perform a plastic operation on the pelvis and ureter (ureteroplasty or ureteropyelo-anastomosis) in order to remove the obstruction permanently. The kidney is drained at the same time, so as to allow the muscles of the pelvis and ureter to recover their tone.

In cases in which removal of the cause is not possible, and the second kidney is functioning properly, the diseased kidney should be removed (nephrectomy), or it will always be a source of danger and discomfort to the patient. If for any reason, such as impairment of the power of the other kidney, nephrectomy is contra-indicated, a permanent renal fistula in the loin should be established (nephrostomy).

Tapping of a hydronephrosis is sometimes advised as a temporary measure, but has nothing to recommend it.

INFECTIVE CONDITIONS OF THE KIDNEY

1. Embolic Abscesses—Hæmatogenous Infection.—Abscesses may develop in the kidney from infection with organisms brought by the blood-stream during the infectious fevers, particularly scarlet fever and typhoid, or as a result of infective infarction associated with ulcerative endocarditis.

The cases of most interest to the surgeon, however, are infections with the staphylococcus, secondary to infections of the skin, such as boils, carbuncles, and whitlows. The abscesses may be present in one or both kidneys, and numerous foci of suppuration may be scattered through the kidney substance, or the smaller abscesses may coalesce and form one large abscess situated in one pole of the kidney. The original focus of suppuration in the skin may be healed before the suppuration in the kidney is recognized.

CLINICAL FEATURES.—In *acute* cases the symptoms are those of any infective disease with general malaise and rigors. One or both kidneys are enlarged and tender, and if both are affected, there is partial suppression of urine, and the urine passed contains albumin and pus, and sometimes blood. In the bilateral cases death soon occurs, but if one kidney only is affected, recovery may follow treatment.

In more *chronic* cases the infection is usually unilateral, and symptoms of general mild infection are present. One kidney becomes enlarged and tender, and albumin and pus appear in the urine. The abscess may gradually destroy the whole kidney or may burst through the capsule and cause a perinephritic abscess. In some cases it bursts into the pelvis of the kidney, and is discharged down the ureter.

TREATMENT.—In bilateral cases with multiple foci of infection the only thing to be done is to give urinary antiseptics, for death is inevitable. With unilateral infection, if the abscesses are multiple or there is a large solitary abscess, the kidney should be excised (nephrectomy), but a small localized abscess should be opened and drained (nephrotomy). Suppuration in the perinephric tissue should be treated by incision and drainage, and if the kidney is seriously affected, it should be removed.

2. Pyelitis.—By this term is understood an inflammation of the mucous membrane of the pelvis of the kidney without involvement of the parenchyma, although this frequently follows (pyelonephrosis). The condition may be either bilateral or unilateral.

The cause of the condition is infection with micro-organisms, the most frequent being the *Bacillus coli*, staphylococcus, streptococcus, tubercle, and *Proteus vulgaris*. Infection may occur from the bladder (ascending pyelitis) or from the blood-stream (hæmatogenous pyelitis).

ASCENDING PYELITIS is secondary to cystitis, the organism ascending along the mucous membrane of the ureter or along the lymphatics from the bladder. As a predisposing cause there is nearly always some obstruction to the outflow of urine, with dilatation of the ureters. The condition most often occurs in prostatitis with cystitis, but is also not uncommon in pregnant women, whose ureters may become obstructed, with increase in the size of the uterus.

HÆMATOGENOUS PYELITIS may occur as a primary condition, particularly by infection with the *Bacillus coli*, but it is frequently secondary to new growths or to stone or some other foreign body in the pelvis of the kidney. It may also follow irritation of the kidney by drugs such as turpentine, carbolic acid, and cantharides.

CLINICAL FEATURES—Acute.—Acute pyelitis may be unilateral or bilateral, and the general symptoms are similar to those of any other acute infective disease. Rigors are common. The urine contains pus, albumin, renal cells, and frequently blood. Tenderness and pain are present over one or both kidney areas.

An obvious cause, such as cystitis with an enlarged prostate, or pregnancy, is often present. Acute bilateral cases frequently end in pyelonephritis, suppression of urine, and death. The condition may also become chronic. If the pyelitis is unilateral, pyonephrosis, abscess of the kidney, or perinephritic abscess, may follow.

Chronic.—Chronic pyelitis may also be unilateral or bilateral, and may follow an acute attack, or the condition may develop insidiously.

The *General* symptoms vary considerably. In some cases the condition may persist for years without seriously affecting the general health, while in others there is intermittent temperature, general malaise, and frequently rigors.

The urine contains pus, albumin, epithelial cells, and micro-organisms. As these contents also occur in other infections of the urinary tract, a careful differential diagnosis must be made. The amount of albumin corresponds with the amount of pus, and if the parenchyma of the kidney is also affected, the albumin is much increased in amount.

The characteristics of the epithelial cells are not sufficient to diagnose between cystitis and pyelitis. In pyelitis, although the reaction of the urine is usually acid, it is occasionally alkaline. With cystitis, pus is frequently found in acid urine.

Cystoscopy will demonstrate whether the bladder is inflamed or not, and an examination of the ureteric orifices or the passage of ureteric catheters will show if pus is coming down one or both ureters.

In the chronic cases examination of the kidney area is usually negative, although the kidney may be slightly enlarged and tender.

Chronic pyelitis may result in pyonephrosis, perinephritic abscess, or in pyelonephritis with uraemia and death. The condition may be cured by treatment, but relapses are common.

TREATMENT.—*Acute Pyelitis* should be treated by removal of the cause if possible, and the giving of urinary antiseptics. The diet should be light and the patient encouraged to drink plenty of bland fluids. If the condition is due to an ascending infection from the bladder, it is better to drain this organ by a perineal or suprapubic incision than to depend on treatment of conditions in the urethra such as stricture and enlarged prostate.

The treatment of *chronic pyelitis* also consists of treating any cause, such as stone and new growth in the pelvis of the kidney, or cystitis, and the giving of urinary antiseptics. Vaccine therapy may also be useful.

If these measures fail, the pelves of the kidneys may be washed out with a 1 in 1,000 solution of silver nitrate through a ureteric catheter, or if the condition is unilateral, the kidney may be exposed in the loin and the pelvis drained (nephrotomy). In unilateral cases also, if the condition has spread to the parenchyma of the kidney and the other kidney is working properly, the affected kidney should be excised.

The above remarks do not refer to tubercular pyelitis, which will be considered in a separate section.

Pyelitis of Pregnancy.—The pyelitis of pregnancy usually begins about the fourth month, and more commonly affects the right kidney (93 per cent.). It has been ascribed to pressure of the pregnant uterus on the ureter, but this is not proven.

The symptoms are usually acute, and are similar to those of other forms of pyelitis, pus and bacteria being found in the urine.

PROGNOSIS.—In a number of cases there is premature labour with a dead child, but in the majority the pregnancy goes to full term and the child is healthy. This is especially the case if the pyelitis does not occur until the latter months of pregnancy. After parturition the symptoms subside, but a bacilluria, with return of the symptoms, especially if the patient again becomes pregnant, frequently persists.

TREATMENT.—In severe cases the patient should be kept lying in bed on the left side, with the head of the bed raised. Urinary antiseptics and vaccine therapy should be tried, and no further treatment is required in the majority of cases. If the condition is severe and threatening life, premature labour should be induced, and in a few

cases with infection of the kidney substance (pyelonephritis), drainage of the kidney or nephrectomy will be necessary.

3. Pyelonephritis.—This is inflammation of the pelvis of the kidney together with the parenchyma, and is due to the same causes as pyelitis, from which it is extremely difficult to differentiate. Pyelitis often insensibly passes into the more serious condition.

CLINICAL FEATURES.—Pyelonephritis, apart from tubercle, is most frequently seen as an ascending infection following cystitis associated with infection and obstruction of the lower urinary passages, and is a frequent cause of death in these conditions. It may be either acute or chronic.

Acute pyelonephritis usually starts with rigors and diminution in the amount of urine passed. The urine contains blood, pus, albumin, and epithelial casts, and if cystitis is present, it is usually ammoniacal. The tongue is furred and dry, there is intense thirst, and usually a low muttering delirium followed by coma and death.

In the *chronic* cases abscesses form in the kidney, and perinephritic suppuration may occur.

TREATMENT.—If the condition is secondary to a cystitis, the bladder should be opened and drained, but no further operation on the lower urinary passages should be performed. Urinary antiseptics and plenty of bland fluid should be given, and the diet should be light. Splitting the capsule of the kidney has been followed by recovery, but in unilateral cases drainage of the pelvis or nephrectomy is probably the better treatment.

4. Pyonephrosis.—This term indicates a combination of suppuration in the kidney and obstruction to the outflow of urine, so that the pelvis becomes dilated and full of pus.

The **CAUSES** are—(1) Infection of a hydronephrosis; (2) blocking of the ureter with a calculus, and suppuration behind it; (3) ascending infection from the bladder, with obstruction to the outflow through the urethra; (4) tuberculosis of the kidney with obstruction of the ureter. The condition is often bilateral, and is often more advanced on one side than the other.

The condition is essentially a chronic one, and on post-mortem examination the kidney appears as a number of abscesses communicating with the pelvis, the tissue between the abscesses being thick and fibrous from old-standing chronic nephritis. When the condition is unilateral, the kidney substance may have completely disappeared, and the organ be represented by a bag of pus in which a few fibrous septa may be seen.

CLINICAL FEATURES.—The general symptoms are those of any infective disease, to which are added, if the condition is bilateral, the symptoms of urinary insufficiency—viz., thirst, vomiting, headache, dry tongue, and mental hebetude. The urine is diminished, and often contains blood, albumin, and pus, although these may be absent if the condition is strictly unilateral and the ureter is completely blocked. On cystoscopic examination the ureteric orifice either appears inflamed

with pus issuing from it, or as a round hole with sharp-cut edges (golf-hole ureter), from which there is no flow or a solid stream of pus. Radiography will show a confused blur in the region of the kidney, or shadows due to the deposit of calcium salts in the pus or walls of the pyonephrotic sac.

Examination of the kidney area will show a large tender swelling with the usual characters of a kidney tumour (see p. 1084).

TREATMENT.—If unilateral, the kidney should be removed unless the other organ is not functioning properly. In this case the pelvis should be incised and drained, any cause present, such as calculi, being removed. With bilateral disease the treatment must be directed to the cause, and as a last resource the kidneys must be incised, and permanent urinary fistulae established.

Tuberculosis of the Kidney

Chronic tuberculosis of the kidney may be an ascending infection from the bladder or a primary infection through the blood-stream. The latter is by far the commoner.

Ascending Tuberculosis of the kidney generally occurs in young male adults, and both kidneys are commonly affected, the infection spreading along the mucous membrane of the ureters. The symptoms at first are entirely masked by the bladder symptoms, and the diagnosis can only be made by the discovery of a renal swelling or the formation of a perinephritic abscess. As the disease advances the symptoms of renal insufficiency are added.

TREATMENT.—The treatment consists of treating the primary bladder infection, and, later, opening and draining the kidney if it is considered worth while.

Primary Tuberculosis of the kidney is due to infection through the blood-stream. This is the commoner mode of infection. It is frequently associated with tuberculosis of the epididymes and vesiculae seminales, but it must not be assumed that the infection has spread from one organ to the other, as in many cases it is a simultaneous hæmatogenous infection.

PATHOLOGICAL ANATOMY.—Two types can be distinguished. In the first the tuberculous inflammation attacks primarily the mucous membrane of the renal pelvis and the papillæ of the kidney. These become inflamed, tubercular granulations form on them, and finally ulceration occurs, gradually extending into the substance of the kidney as well as down the ureters. In the second type the tubercular foci form in the substance of the kidney itself, either scattered through the whole organ or more or less grouped at one or other pole. The centre of the tubercular nodule breaks down into pus, so that cavities with irregular, ragged walls form in the kidney.

Surrounding these cavities are areas of tubercular granulation tissue, and in the tissue separating the cavities are nodules of breaking-down tubercle. As the disease extends the kidney becomes enlarged, and soft nodules, which on incision are found to be tubercular abscesses, appear on the outer surface. The tubercular process may continue

until the whole kidney is represented by a bag of pus (tubercular pyonephrosis), or the perinephric tissue may become infected, and a large abscess form in the loin. This abscess may enter the psoas sheath and form a psoas abscess, or pass up through the diaphragm and infect the pleura.

In every case of tuberculosis of the kidney the ureter becomes affected. The mucous membrane is changed to tuberculous granulation tissue in which ulceration occurs, whilst the middle and outer coats are thickened by inflammatory fibrous tissue (sclerosing periureteritis). The ureter may be partially or completely blocked, and it also becomes firmly adherent to surrounding structures. The perinephric tissue, without actually being tubercular, is inflamed, so that there is increase in the perinephric fat, and the organ is firmly attached to the peritoneum, and even to such structures as the vena cava, stomach, and the liver.

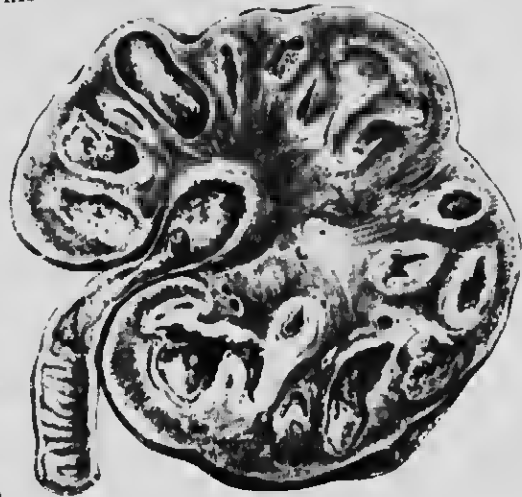


FIG. 485.—TUBERCULOSIS OF THE KIDNEY AND URETER.

(London Hospital Medical College Museum.)

In those cases in which the infection originates primarily in the kidney the bladder is sooner or later infected. The tuberculous inflammation occurs at first round the orifice of the ureter, and ends in the formation of a tubercular ulcer. The rest of the bladder then becomes infected, and the changes described under Tuberculosis of the Bladder (p. 1114) occur.

Primary tuberculosis of the kidney is nearly always *unilateral* at first, but later the other kidney becomes infected as well as other parts of the genito-urinary tract.

Although the disease may be a pure infection with the tubercle bacillus, secondary infection, by the colon bacillus, staphylococcus, or streptococcus, occurs later, especially if instrumentation of the bladder is carried out, while, following the chronic infection, lardaceous changes may occur in the kidney as well as in other organs.

CLINICAL FEATURES.—The condition is most common between the ages of twenty and forty, and opinions differ as to whether it is more frequent in women or in men. Some authorities state it is three times more common in women than in men, others give a slight preponderance to the male sex.

The early symptoms are—Slight general malaise, pain in the kidney

area, frequency of micturition, and pyuria. All or any of these symptoms may be absent, and the disease may remain latent for a long period. As the condition progresses the general symptoms steadily increase, especially if a secondary infection is added. Ultimately the symptoms of tubercular cystitis are added to those of tuberculosis of the kidney.

Examination of the kidney area is at first negative, or at most there may be some rigidity over the affected side; but later, when the kidney is enlarged, it may form a palpable tender tumour, or a large perinephritic abscess may develop. The presence of a palpable kidney on one side does not necessarily imply that that is the kidney which is affected, as it may be that the sound kidney has hypertrophied to compensate for the destruction of the other.

Examination of the urine will reveal the presence of pus, and the reaction in the early stages is always acid; but with secondary infection the urine may become alkaline. Albumin is also present, and in greater quantity than can be accounted for by the presence of the pus. Examination of the pus by modern methods will nearly always reveal the presence of tubercle bacilli. They are particularly difficult to detect, however, when marked secondary infection is present.

Cystoscopic examination in the early stages may show pus coming through one ureteric orifice, although the other is retracted owing to the pull of the thickened ureter, and, later still, tubercular deposits and ulceration will be seen round the orifice of the ureter.

Catheterization of the ureteric orifice is necessary in some cases to demonstrate which kidney is affected, and is also valuable for estimating the functioning powers of the kidneys.

Radiographic examination in the early stages is negative, but eventually there may be a confused blur due to the presence of a pyonephrosis, or definite shadows due to calcification of the tubercular deposit may be present.

A routine examination should also be made of other parts of the genito-urinary tract—*i.e.*, the epididymes, the vesiculae seminales, and the prostate—for the presence of tubercular deposits.

Death occurs from general exhaustion consequent on prolonged



FIG. 486.—ADVANCED TUBERCULOSIS OF THE KIDNEY.

(London Hospital Medical College Museum.)

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suppuration and renal insufficiency, or from general tuberculosis or concomitant tubercle in other organs, as the lungs.

TREATMENT.—The treatment of unilateral tuberculosis of the kidney is **nephrectomy** as soon as the condition is recognized, provided the other kidney is functioning sufficiently to carry on the elimination of the waste products of the body. This operation is not contra-indicated by involvement of the bladder in the tuberculous process, but rather becomes more urgent. Treatment should also be directed to other parts of the genito-urinary tract if they are also affected.

When a perinephritic abscess is present, it should be opened and drained, and the affected kidney removed, provided the opposite organ is reasonably sound.

At the same time as the kidney and the perirenal fat are removed the ureter should be dissected out, or a tubercular fistula may result.

Nephrectomy is contra-indicated if the second kidney is the seat of advanced tubercle, or is absent, or so diseased that its functioning power is lost. It is also contra-indicated with advanced disease in other parts of the genito-urinary tract, or advanced tubercle of the lungs or elsewhere.

The general treatment of tuberculosis, including vaccine therapy, should be carefully carried out, whether nephrectomy is performed or not.

Methods of Estimating the Functionating Power of the Kidneys

1. **BOTH KIDNEYS.**—The best method of estimating the functionating power of both kidneys is a careful examination of a twenty-four hours' specimen of the urine collected under normal conditions. The percentage and actual amounts of urea and salts should be estimated, and the presence of abnormal constituents, such as pus, blood, albumin, sugar, and bile, ascertained. The nitrogenous content of the diet must be taken into consideration.

Other methods of investigation are—

- (1) *Excretion of Colouring Matter.*—Four c.c. of a 4 per cent solution of indigo carmine are injected into the buttock and the length of time that elapses before the colouring matter appears in the urine is ascertained. With normal kidney excretion the colour should appear in the urine in ten minutes, reaching a maximum in thirty minutes. With diseased kidneys the appearance is delayed.
- (2) *Phloridzin Test.*—Thirty minims of a 0.25 per cent. solution of phloridzin are injected subcutaneously. With normal kidneys sugar should appear in the urine in from fifteen to thirty minutes, and reach a maximum in about one hour. With diseased kidneys, the sugar takes longer time to appear, and the amount excreted is diminished.

(3) *Hæmo-Renal Index*.—The electric conductivity of the blood-serum and the urine depends on the amount of salts present at any moment in them. If the excretion of the urine is defective, the electric conductivity of the blood rises, while that of the urine falls. With normal kidneys, the ratio of the electric conductivity of the urine to the blood is $\frac{2}{1}$; but with defective secretion the ratio (hæmo-renal index) falls, and when it falls below 0.6, death from renal insufficiency is likely, and operations are contra-indicated.

(4) *Cryoscopy*.—This method consists of estimating the freezing-point of the blood or urine, which varies with the amount of salts present in them.

The normal freezing-point of the blood is 0.56° C., but if, owing to defective excretion of the kidneys, salts accumulate in it, it falls to 0.60° C., or lower. It is probable that the freezing-point of the blood varies with many other factors besides the excretory power of the kidneys, and therefore the method has little value. The estimation of the freezing-point of the urine is of more value, as it is an index of the amount of salts present in it.

2. ONE KIDNEY.—The presence of two kidneys may be ascertained by cystoscopy, two ureteric orifices discharging fluid being present, and a very rough estimate of the working power of each kidney may be made by noting the force, frequency, and quality of urine ejected from each ureter. With a good radiogram of the lumbar region, the shadow of the lower pole of the kidney may also be seen, and the presence of both kidneys determined.

To estimate still further the functioning power of each kidney, *chromatocystoscopy* may be used. Indigo carmine, as above, is injected into the buttock, and the mouths of the ureters watched with the aid of the cystoscope, or the urine collected by means of ureteric catheters. The rapidity with which the colouring matter appears in the urine will to some extent indicate the functioning power of the kidneys, but inferences must be drawn with caution, and checked by other data.

Phloridzin Method.—Phloridzin is injected as above, and the urine collected from each ureter. The time of the appearance of the sugar in each urine and the amount excreted gives an idea of the working power of the kidney.

A further method is to collect the urine from each ureter by means of a segregator, or, much better, by means of ureteric catheterization. Examination of the urines will demonstrate the presence of pus, albumin, blood, or bacilli, in either or both urines; but an absolute estimation of the salts present is of little value, as the urine is collected for a short time only under most abnormal conditions. On the other hand, if one kidney is known to be the site of advanced disease, a comparison of the percentage composition of the two speci-

mens will give a working idea of the functioning power of the second kidney. For example:

Right Pyocephrosis.	RIGHT.	LEFT.
Quantity of urine collected	33.0 cm.	25.0 cm.
Molecular concentration	0.48 "	1.18 "
Sugar after injecting phloridzin	—	1.0 "
Nitrogen content	0.322 per cent.	0.782 per cent.

CASPER.

An examination of these figures shows that, compared with the right kidney, the left is functioning well, and it is safe to remove the right kidney.

No one of these methods must be implicitly relied upon in estimating the functioning power of a kidney if removal of the other kidney is contemplated, but each is of value, and all the circumstances and results obtained by these methods of examination must be carefully weighed before a decision is made.

Renal Calculus (Nephrolithiasis)

VARIETIES.—The stones met with in the kidney are composed of—(1) Uric acid, usually combined with urates of ammonia and calcium; (2) oxalates of lime; (3) phosphates of lime and magnesium; (4) cystin; and (5) xanthin. The first three are by far the commonest.

Uric Acid and Uric Stones are hard, brownish-red in colour, break with a crystalline fracture, and are frequently multiple and faceted. A pure uric-acid stone does not give an appreciable shadow with the X rays, but such a stone is exceedingly rare in the kidney, as there is nearly always an admixture of calcium salts.

Oxalate Stones are very hard, brownish, or black in colour, owing to the admixture of blood, with a nodular surface (mulberry calculus). They are generally single, and give a good shadow with the X rays. Oxalates are the most frequent constituents of renal stones.

Phosphatic Stones are soft, pinkish-white in colour, and the deposits frequently occur on a nucleus of uric acid or oxalate of lime. They give a well-marked shadow with the X rays.

Cystin Stones are rare. On section, they are greenish in colour, and waxy-looking. They give a good shadow with the X rays on account of the sulphur they contain. The crystals of cystin are small hexagonal plates.

CAUSES.—The causes of stone in the kidney are not fully understood, but the majority of cases are due to errors of metabolism, congenital or acquired, which lead to an excessive formation of the salts concerned or to a diminution of those substances which hold them in solution. The subjects of stone in the kidney therefore tend to suffer from lithiasis, with the passage of sand or gravel, and gout. Phosphatic stones are usually associated with inflammatory conditions of the pelvis of the kidney, and the urine is frequently ammoniacal.

The other contributory causes to stone formation are—Excessive sweating, or the ingestion of too little fluid, causing a highly concentrated urine; residence in hot climates; overeating, and the excessive use of alcohol, causing errors in metabolism. Calculi are also common in the kidneys of children, and are probably due to the highly concentrated urine of childhood, and the presence in newly born infants of crystals of uric acid in the pyramids of the kidneys. These crystals, if not washed away with the urine, form the nucleus of a stone.

EFFECTS OF STONE IN THE KIDNEY.—The effect of stone in the kidney is to cause a progressive destruction of the renal tissue. In some cases a stone will steadily increase in size until it fills the renal pelvis, and sends branches into the calyces (dendritic stone), the kidney substance undergoing fibrosis and atrophy, and being finally represented by a sac of fibrous tissue round the stone. A small stone may also cause so much irritation that the kidney gradually scleroses, and becomes hard and fibrous, or it may be invaded by fat, so that the kidney changes into a mass of fat and fibrous tissue, in the centre of which is a stone. A calculus lying in the kidney substance causes fibrosis of the tissue round it. It is frequently found lying in a thick-walled cyst, the rest of the kidney substance also being fibrotic.



FIG. 487.—CALCULI IN THE KIDNEY
(CALCULUS PYONEPHROSIS).

When a stone partially blocks the opening of the ureter, distension of the renal pelvis and hydronephrosis will result (see p. 1083).

Besides these effects of mechanical irritation of the stone, infection of the surrounding kidney substance is always liable to occur. The chief infecting agent is the *Bacillus coli*, and abscess in the kidney, pyelitis, pyelonephritis, or pyonephrosis, result (see p. 1088). When infection has occurred, the perinephritic tissue is also affected, and inflammation occurs, which tends to fix the kidney to surrounding structures by adhesions, leading to great difficulties in exposing and removing the kidney, should this be necessary.

Perinephric suppuration may also be a result, and a lumbar or psoas abscess follow. Occasionally infection of the pleura and empyema may occur.

When the stone is situated in the pelvis of the kidney, ulceration

of the wall and perforation into the peritoneal cavity may lead to general peritonitis.

A stone in the pelvis of the kidney may pass down the ureter, and either become impacted or pass into the bladder. In the latter case it may form the nucleus of a bladder stone, or be passed *per urethram*.

CLINICAL FEATURES.—Calculous disease is more common in males than in females, and is mostly met with in children or in middle-aged



FIG. 488.—BRANCHED CALCULUS IN THE KIDNEY.

adults. In about one-third of the cases stones are present in both kidneys.

Stones in the Substance of the Kidney.—A stone may remain in the substance of the kidney for years without giving rise to any symptoms, and a patient may be the subject of extensive calculous disease in both kidneys without being aware of it. The first symptoms may be those of infection occurring round the stone, or renal insufficiency from loss of kidney tissue.

The usual symptoms are *pain* in the kidney area, sharp and localized, the patient indicating with his thumb the exact position of the pain. The spot is tender, and the patient generally finds ease in lying on the affected side and pressing the elbow into the loin. Later, when the kidney is inflamed, the patient lies on the opposite side, for pressure aggravates the pain. Examination of the lumbar region may show some rigidity of the muscles, but it is unusual to find the kidney enlarged. It is very rarely possible to feel the stone or stones.

The urine frequently contains a trace of albumin and a little blood, especially after the patient has been jolted; but marked hematuria is not common. Crystals may also be found in the urine, and when infection has occurred, pus cells and bacilli are also present.

Radiography will in the great majority of cases demonstrate the presence of the stone, the exception being pure uric-acid stones, which are exceedingly rare in the kidney, and very small stones in stout people. The shadow will be in the region of the kidney, and in many instances it is possible to see the outline of the lower pole of the kidney. If examined by the screen, the shadow moves on respiration. The shadows most likely to be mistaken for renal stones are those of calcareous glands in the mesentery, phleboliths, foreign bodies in the intestines, appendix concretions, and calcification of the cartilages of the lower ribs.

Stone in the Pelvis of the Kidney.—The symptoms of stone in the pelvis of the kidney are very similar to those of stone in the kidney substance, but are usually better marked. The pain is more severe, and increased by jolting. Hematuria and pyuria occur more frequently. A radiogram shows the shadow to be near the vertebral column and opposite the transverse process of the first or second lumbar vertebra.

The patient may also exhibit the symptoms of renal colic.

Renal Colic is due to the attempts of the stone to pass along the ureter. Its symptoms are severe colicky pain in the abdomen, which causes the patient to sweat and vomit. The pain is often relieved by pressure, and the patient lies doubled up, with the arms pressed into the abdomen. The pain radiates into the loin, down into the groin, and the external genitals. In the male the testis on the affected side is usually strongly retracted against the external abdominal ring. During the attack the patient frequently passes small quantities of urine, which is often blood-stained.

The pain may cease quite suddenly, and the stone pass into the bladder, drop back into the pelvis of the kidney, or become impacted in the ureter.

Renal colic may also be caused by the passage of crystals of uric acid or oxalates, blood-clot, pieces of new growth, and tubercular matter down the ureter. It is very similar to the pain of Dietl's crises in movable kidney. It may also be simulated by intestinal, biliary, or pancreatic colic.

TREATMENT—1. Renal Colic.—Renal colic is treated by giving an injection of morphia to relieve the pain, applying fomentations to the abdomen, or giving a hot bath, and encouraging the patient to drink plenty of hot bland fluids. After the attack, the patient's urine should be carefully examined for the presence of a small calculus, and if this is not passed, a radiogram should be taken of the bladder, ureter, and kidney areas, in order to ascertain the position of the stone, so that appropriate treatment may be carried out.

2. Stone in One Kidney or its Pelvis.—Directly the diagnosis of stone in a kidney or its pelvis is made, the patient should be strongly advised to have it removed, as its presence leads to destruction of the kidney, and there is constant danger of infection occurring.

There is no solvent known for renal stone, and the only effective means of treatment is removal by operation, and this should always be advised, unless there is some very strong contra-indication, such as diabetes, or advanced morbus cordis.

The kidney is exposed by a lumbar incision, running from $\frac{1}{2}$ inch below and outside the junction of the twelfth rib and the edge of the erector spinae, downwards and outwards towards the anterior superior spine. The kidney is brought out on to the loin, and the stone recognized by palpation. If the stone is palpated, and is lying in the kidney substance, it is removed by an incision into it; but if it cannot be felt, or it lies in the pelvis, the kidney is split longitudinally along a line about $\frac{1}{2}$ inch from the convex border on the posterior aspect, and the stone removed. The kidney is then sutured to stop hemorrhage, and if infection is present, it is also drained. A small stone in the pelvis of the kidney may be removed by incising the pelvis. The operation for removal of stone in the kidney is termed "nephrolithotomy."

In those cases in which there is a large stone which has largely destroyed the kidney, or a small stone which has blocked the entrance to the ureter and caused advanced hydronephrosis, the remains of the kidney should be removed with the stone, provided it has been definitely ascertained that the other kidney is functioning properly, and is not the site of calculous disease.

3. Stones in Both Kidneys or their Pelves.—When calculi are present in both kidneys or their pelves, they must be removed. Although both kidneys may be operated upon with safety at the same time, it is safer to remove the stones at two different operations. The first operation should be on the kidney in which the symptoms are the more recent, as this will usually be the kidney least affected. The kidney should be drained. The operation on the second kidney may take place within a week, provided the patient is in a satisfactory condition. If the first kidney has been found on operation to be little affected, and the second kidney is almost totally destroyed, it should be removed with the stone.

4. AFTER-TREATMENT.—As stone in the kidney is due in the majority of cases to a general error in metabolism, and not to a local condition in the kidney, there is a tendency to the formation of fresh

stones after one has been removed, and after-treatment is necessary to prevent this recurrence. In some cases there is a constant tendency to form stones, and within a few months of removing all the stones from a kidney several new ones may have formed.

To prevent recurrence after removal of a uric-acid stone, the patient should take a mixed diet, consisting of a moderate amount of meat, eggs, milk, and plenty of fresh fruit and vegetables. Excess of meat and foods containing a large amount of nucleo-albumin, such as sweetbreads, liver, brains, and kidneys, are especially to be avoided. Alcohol should be taken in strict moderation; beer and heavy wines of all kinds are to be avoided, as well as strong tea and coffee.

The patient should take a sufficiency of exercise. Frequent warm baths, to increase the action of the skin, are to be recommended. He should drink freely of bland alkaline fluids to increase the solvency of the uric acid, and natural or artificial waters containing lithium citrate or acetate, carbonate of lime, and borocitrate of magnesium. The waters of Wildungen, Contrexéville, and Vichy are chiefly recommended, and the simple aerated waters like Apollinaris.

After removal of oxalate stones, the treatment is very similar; but certain vegetables and fruits, as spinach, sorrel, strawberries, apples, and rhubarb, being rich in oxalic acid, must be avoided. Large quantities of simple natural waters should be drunk.

This treatment should also be carried out in people who suffer from lithiasis, with the passage of gravel, as a prophylaxis against the formation of stone.

Calculus Anuria.—This is a term applied to suppression of urine following impaction of a stone in a ureter when the other kidney has been destroyed by calculus disease. It may be the first serious indication that the patient has stones in the kidneys.

CLINICAL FEATURES.—The patient is usually a middle-aged male adult, and the anuria is ushered in by an attack of renal colic, followed by a dull, aching pain in the loin. The suppression of urine is rarely complete, the patient passing a few ounces of urine each day, the urine often being blood-stained. No other symptoms may be present for as long as eight or nine days, and then uræmic symptoms—*i.e.*, vomiting, muscular twitchings, contracted pupils, and coma—supervene, and the patient dies in the next few days.

Radiographic examination shows a stone or stones in one kidney and a stone in the ureter of the other.

TREATMENT.—Operation is urgently required, and the kidney in which the patient last had pain and in which the radiogram shows a stone in the ureter should be exposed, opened, the stone removed, and the kidney drained. If the exposed kidney is found to be almost entirely destroyed by stone, the remaining kidney must be explored and opened at once. The relief of tension by the operation will probably be followed by resumption of the secretion, and any further operation required can be carried out later.

Calculus Pyelitis and Pyonephrosis.—Infection of the pelvis of the kidney or the kidney substance by organisms brought by the blood.

stream to the kidney is a common sequel to stone in the kidney, and stones may lie latent in the kidney until infection occurs. In a case under the care of the author the patient, a hospital porter, had both kidneys almost entirely destroyed by stones, and had never complained of any symptoms until ten days before he died. The symptoms were those of an acute infection of the urinary tract, and the colon bacillus was found in the urine.

More frequently the suppuration is chronic, and the kidney gradually becomes converted into a multilocular sac containing pus, stone, and kidney débris. This may occur without marked enlargement of the organ. The general symptoms are those of infection.

The sequelæ are those of other forms of pyonephrosis—viz., perinephritic abscess and sinus formation—and infection of the other kidney is always liable to occur.

The diagnosis is made by finding a large tender kidney in a patient with general signs of infection, and, on radiographic examination, finding the shadow of the calculus in the kidney area. Pus may not be present in the urine if only one kidney is affected, and the ureter on that side is blocked.

TREATMENT.—The kidney must be exposed, and the further steps of the operation depend on the condition found and the functioning power of the other kidney.

1. If the kidney is almost entirely destroyed and the other kidney is healthy, the diseased kidney should be removed. This operation may be difficult owing to the fixation of the kidney to surrounding structures, such as the peritoneum, vena cava, suprarenal body, or even the stomach and intestine by inflammatory fibrous tissue, and it may be safer to open and drain the kidney, at the same time removing the stones.
If a fistula persists, and removal is still contra-indicated by the fixity of the kidney, the renal vessels may be tied to diminish the secretion.
2. If the kidney is not completely destroyed, but a fair amount of kidney substance is left, the kidney should be drained after removal of the stone.
3. If the second kidney (as shown by careful examination) (see p. 1093) is not functioning properly, nephrectomy is contra-indicated. The kidney should be exposed and opened, the stone removed, and the kidney drained. If there are stones and pus in both kidneys, the stones must be removed and the kidneys drained by two operations following one another in a day or two, or, in cases of urgency, by a double nephrotomy at the same operation.

Stone in the Ureter

A stone passing down the ureter gives rise to the symptoms of renal colic (see p. 1097), and beyond the relief of the pain by giving morphine no treatment is necessary, and the stone may pass into the bladder.

While the stone is passing along the lower third of the ureter the symptoms are similar to those of vesical stone—viz., pain in the hypogastrium referred to the external genitals and frequency of micturition with strangury. The urine is often blood-stained.

On cystoscopic examination the orifice of the ureter is swollen, and small hemorrhages are usually present round it. The stone can fre-



FIG. 489.—STONE IN THE UPPER END OF THE URETER.

quently be felt on vaginal examination in the female and rectal examination in the male.

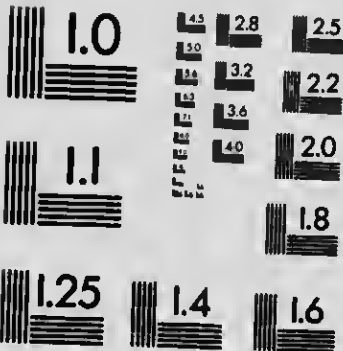
No treatment except giving relief from the pain is necessary as the stone is passing down into the bladder, and it is usually passed in the urine in two or three days.

Stone Impacted in the Ureter.—The three principal places where stones are impacted in the ureter are—At the junction of the pelvis with the ureter, at the junction of the middle and lower thirds, and in the intravesical portion. The effect of the impaction of the stone



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is to cause back-pressure on the kidney, which may be slight or so severe as to cause an excessive degree of hydronephrosis. Ulceration of the ureter at the site of impaction may also occur, and tends subsequently to cicatricial contraction with obstruction of the ureter, or the ulceration may involve the peritoneum, causing leakage and peritonitis.

CLINICAL FEATURES.—A stone may remain impacted in the ureter for years without causing any definite symptoms, and if the obstruction

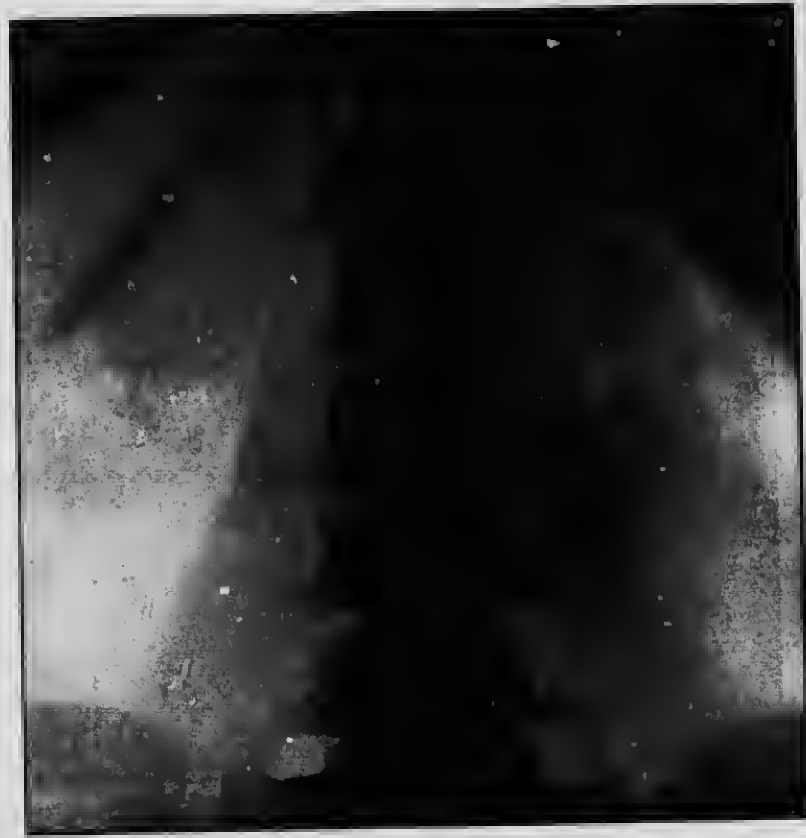


FIG. 490.—CALCAREOUS GLAND IN MESENTERY.

is slight, only a small degree of hydronephrosis occurs. If the obstruction is severe, the symptoms are those of hydronephrosis (see p. 1083). A stone in the ureter may be associated with attacks of renal colic, and in each attack the stone passes a little lower down the ureter. There may also be a continuous pain in the loin due to back-pressure, and pressure over the stone may cause pain. A stone, however, may take years to reach the bladder.

The DIAGNOSIS is made by—

1. *Consideration of the Symptoms*, the presence of blood in the urine, and the evidence of obstruction of the renal pelvis.

2. *X-Ray Examination of the Course of the Ureter*.—A ureteric stone is oval in shape, with its long axis in the axis of the ureter, and it lies in the lino of the ureter. The most frequent cause of errors in diagnosis are calcareous mesenteric glands, phleboliths, and foreign bodies in the intestine. If any doubt arises as to whether a shadow in a radiogram is a ureteric stone, an opaque bougie should be passed into the ureter and a second radiogram taken with this *in situ*.

3. *Examination per Rectum or per Vaginam* may enable the stone to be felt if it is in the lower third of the ureter.

4. *Cystoscopic Examination* may show œdema of the ureteric orifice, or the stone may be seen impacted in the orifice of the ureter.

TREATMENT.—A stone impacted in the ureter should be removed. The methods of approaching the ureter extraperitoneally are—

1. Enlarging the usual lumbar kidney incision downwards.
2. Reaching the ureter by the incision used for tying the common iliac artery extraperitoneally.
3. An incision along the side of the rectum (pararectal), dividing the great sacro-sciatic ligament. This incision is used for stone in the lower third in males.
4. By an incision through the posterior fornix of the vagina. This incision may be used for stones that can be felt *per vaginam*.
5. Transvesical method for intravesical stone. The bladder is opened by the suprapubic route, and the stone removed by incising over the ureteric orifice.

Removal by the intraperitoneal route and by the combined method have been advised, the abdomen being opened in the linea semilunaris or the middle line.

NEW GROWTHS

Innocent new growths of the kidney and pelvis are **adenoma** and **papilloma**, and the adenoma is entirely of post-mortem interest.

Papillomata of the pelvis of the kidney are soft villous growths covered by a transitional epithelium resembling the villous papillomata of the bladder, and may attain a very large size; they are extremely rare.

CLINICAL FEATURES.—These tumours are most frequently met with in middle age, and are unilateral. The symptoms are painless intermittent profuse hæmaturia from one kidney, and sometimes enlargement of the organ. The source of the hæmaturia is ascertained by the cystoscope, and very occasionally the growth can be seen growing out of the orifice of the ureter. Fragments of growth may be found in the urine, and if infection supervenes, pus is present. An exact diagnosis can only be made by cutting down on the kidney.

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TREATMENT.—The treatment of these growths is nephrectomy, as they are unilateral and have a great tendency to become malignant.

Malignant.—The malignant new growths of the kidney are sarcoma and carcinoma.

Sarcoma of the kidney usually occurs between the ages of thirty and fifty, and is generally spindle-celled in type. It may, however, occur in children, and in these growths newly formed epithelium, as well as striped and unstriped muscular tissue, is found.

Carcinoma of the kidney occurs a little later in life than sarcoma, but clinical diagnosis between these two types of malignant neoplasm is impossible. The tumours, formerly known under the name of Grawitz tumour, adrenal tumour, epinephroma, and hypernephroma, are now believed to be carcinoma of the kidney. A rare form of neoplasm of the kidney is a squamous-celled carcinoma of the renal pelvis.

CLINICAL FEATURES—1. *In Children.*

—The patient may be born with a large renal tumour, but as a rule the disease first shews itself at three or four years of age. The early symptom is wasting without obvious cause, with gradual enlargement of the abdomen. The mother or nurse may notice the renal swelling. *Hæmaturia is uncommon.*

On examination, there is a unilateral or bilateral kidney swelling which may appear almost to fill the abdomen, and the diagnosis is usually obvious. Secondary deposits are seldom present.

TREATMENT.—When the disease is unilateral and the tumour is of reasonable dimensions, an attempt may be made to remove it by **abdominal nephrectomy**, but at least 95 per cent. of the cases end fatally.

If the condition is bilateral, there is no treatment.

2. *In Adults.*—The disease may declare itself in one of three ways:

- (1) **Hæmaturia** from one kidney, which is at first intermittent and may follow an accident. Renal colic may occur from the passage of clots down the ureter. Blood in the urine may occur months before any other symptom or physical signs are present, and this symptom in an adult should always lead to exhaustive examination of the urinary passages.



FIG. 491.—CYSTO-CARCINOMA OF THE KIDNEY.
(London Hospital Medical College Museum.)

- (2) Wasting and anemia, with pain and discomfort in the loin, may lead to examination and the discovery of a firm or hard nodular swelling in the kidney area, which does not move freely on respiration.
- (3) The first appearance of a varicocele on the left side in an adult should lead to examination of the left kidney area, as malignant growth of the kidney is apt to penetrate into the renal veins, and if this occurs, the left spermatic vein is obstructed.

The origin of the hemorrhage may be recognized by the cystoscope or by catheterizing the ureters. This examination is also important to estimate the functional activity of the kidneys. A kidney the seat of a new growth has always a diminished functional activity, so that blood in the urine with diminished activity of the kidney should always lead to exploratory nephrotomy. Secondary deposits in other organs are uncommon, and the retroperitoneal glands are seldom affected.

PROGNOSIS.—Although the growth remains limited for a long time to the kidney, the prognosis is not good, as the growth is always advanced when the first symptoms appear. With slowly growing tumours the patient may live as long as five or even ten years.

TREATMENT.—The fatty capsule of the kidney should be completely removed with the kidney by the lumbar route unless the tumour is very large, when the abdominal route must be chosen. As much of the renal vessels as possible should be removed with the kidney.

CYSTS OF THE KIDNEY

Simple Retention Cysts are very common in cases of chronic interstitial nephritis, and may be found in kidneys which are very largely normal. They seldom grow larger than a walnut, and are of no clinical interest.

Simple cysts may, however, grow to very large dimensions, but even then cause no symptoms, and are seldom recognized until post-mortem examination. They are very thin-walled and contain a clear serous fluid, and the condition may occasionally be mistaken for hydronephrosis. The treatment is removal.

Hydatid Cysts may occur in the kidney, and give the usual symptoms of hydatid disease—viz., a painless, symptomless cystic swelling. The cyst may burst into the pelvis of the kidney, and the daughter cysts pass down the ureter, causing the symptoms of renal colic.

The treatment is removal.

Polycystic Disease of the Kidney.—The exact pathology of this disease is unknown, but it is believed to be always of congenital origin and due to the presence of remnants of the Wolffian body (mesonephros). The condition is usually bilateral, but may be much more advanced in one kidney than the other, and the kidney or kidneys may be so large at birth as to obstruct labour. On the other hand, the condition may pass unnoticed during a long life, and only be discovered on post-mortem examination.

PATHOLOGICAL ANATOMY.—The kidney is transformed into a mass of cysts separated by fibrous tissue (fibro-cystic disease). The cysts communicate to some extent with one another, but do not open into the pelvis or calyces of the kidney, showing that the condition is not due to blocking of the ureter. The cysts contain serum, mucus, and blood, but no urine. Suppuration due to infection with the colon bacillus may occur, and these kidneys are sometimes the site of tuberculosis or of malignant disease. Cystic degeneration of the liver, spleen, or pancreas, may be present at the same time.

CLINICAL FEATURES.— If the condition is unilateral or one kidney is only slightly affected, the only means of diagnosis is the discovery of a unilateral kidney swelling, which is painless and freely movable. The cysts may form projections on the surface, which may be recognized. If the disease is bilateral and progressive, the patient has the same symptoms as a patient suffering from chronic interstitial nephritis. The heart becomes hypertrophied and the arteries sclerotic; thirst, dry tongue, harsh skin, headaches, and polyuria are present. The urine is abundant, pale in colour, of low specific gravity, and contains albumin. The termination of the illness will be renal insufficiency and uræmia. The diagnosis from chronic nephritis is made by the discovery of bilateral kidney tumours. Hæmaturia is sometimes present.

TREATMENT.—The treatment is that of chronic interstitial nephritis and patients have been known to live till over eighty.

Removal of one kidney when the disease is advanced has been carried out, but it is unnecessary, and not unattended with danger. It is impossible to say on inspection of the kidney how far it is carrying out its function. Functional examination of the kidneys separately might aid in determining the prognosis and the advisability of nephrectomy. If suppuration, tuberculosis, or malignant disease occur, the kidney should be removed.

Chyluria.—The presence of chyle in the urine is due to blocking of the outflow of the lymphatics of the small intestine, so that the



FIG. 492.—POLYCYSTIC DISEASE OF THE KIDNEY,
(London Hospital Medical College Museum.)

chyle passages become greatly distended. If rupture of one of these dilated lymphatics occurs into the urinary passages, chyluria follows. The commonest situations for the openings are the renal pelvis and the bladder.

The usual cause of this condition is blocking of the main lymphatics by the *Filaria sanguinis hominis* (see p. 345). The urine is milky-white in colour, and contains fat globules, albumin, and not infrequently blood. The embryo of the filaria are found in it.

Bilharzia Hæmatobia.—This parasite rarely attacks the kidney, although a few cases of hæmaturia and renal colic are due to its presence. The ova penetrates the renal pelvis, and causes superficial ulceration and swelling of the mucous membrane, so that hydro-nephrosis may follow. The parasite has sometimes formed the nucleus of a renal stone.

The condition can only be recognized by finding the characteristic ova in the urine. The disease occurs in those who have been resident in Africa, especially in Egypt.

Essential Hæmaturia.—By this term is understood hæmorrhage occurring from a kidney that is apparently healthy. The hæmorrhage is often profuse and intermittent.

With the more accurate means of diagnosis possessed by the modern surgeon, the number of these cases is steadily diminishing; but instances are still seen in which there is no obvious cause for the hæmaturia, and examination of the kidney by operation or after removal is negative.

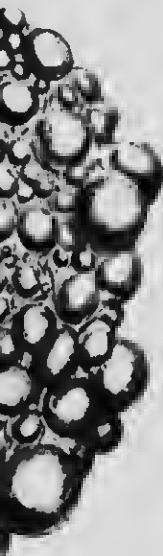
Many cases are associated with chronic nephritis, general or localized, or with perinephritic inflammation fixing the kidney to its fatty capsule. In other cases **angiomas** of the pelvis have been described, and the condition has also been attributed to an angioneurosis.

The **Diagnosis** of essential hæmaturia should never be made until all possible methods of diagnosis, including exploratory nephrotomy, have been exhausted, for new growth of the kidney may give rise to intermittent hæmaturia without any other symptoms or physical signs. Exploratory nephrotomy has been followed by cure of the condition, and decapsulation of the kidney is also recommended. In some cases nephrectomy has been performed.

Neuralgia of the Kidney.—An apparently healthy kidney may be the seat of attacks of pain closely resembling those of calculus colic or acute kinking of the ureter, and yet no cause can be discovered on operation. Hæmaturia may or may not be present with the pain. The condition has been put down to spasm of the ureter, sudden congestion of the kidney, nephritis, angioneurosis, and crises resembling the gastric crises of tabes dorsalis.

After all other methods of diagnosis have been tried, the kidney should be explored, and if no cause is found for the pain, the capsule should be removed. This has been followed by relief of the symptoms, and the same result has been obtained by catheterization of the ureters.

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CHAPTER XXXV

INJURIES AND DISEASES OF THE URINARY BLADDER

Rupture

Rupture of the urinary bladder is usually due to falls, blows, or kicks on the abdomen when the bladder is full, the patient frequently being in a state of intoxication. Fracture of the pelvis may be associated with laceration of the bladder, even when the viscus is empty.

Two varieties of rupture are described—*Intraperitoneal* and *Extraperitoneal*.

Intraperitoneal Rupture of the Bladder.—The rupture is on the superior aspect of the bladder, and the urine is extravasated into the peritoneal cavity.

CLINICAL FEATURES.—More or less shock is present, and the patient has a desire to micturate, but is unable to do so. *On examination*, free fluid is found in the peritoneal cavity, and on passing a catheter, a small quantity only of blood-stained urine is withdrawn, although the patient may not have passed urine for some hours.

On moving the catheter about, it may be passed through the rent in the bladder, and there is a second flow of urine, and the catheter is plainly felt under the anterior abdominal wall. If sterile fluid is passed into the bladder, it may not all be recovered, and the amount of free fluid in the peritoneal cavity increases. This sign is only of value when it is positive, as the fluid may all be returned when the bladder is ruptured.

Peritonitis does not supervene at once if the urine is sterile, but it is sure to occur later, either from infection from a catheter or from organisms descending from the kidneys or passing through the intestinal walls. The usual symptoms of peritonitis will be present.

TREATMENT.—The abdomen should be opened by an incision below the umbilicus, and the rent in the bladder secured with catgut (Lembert's sutures, which do not pass through the lining membrane). The peritoneal cavity should be drained by a tube passing into Douglas's pouch, and the patient nursed in the Fowler position. The urine should be drawn off by catheter at regular intervals.

Extraperitoneal Rupture.—The rupture is as a rule on the anterior wall of the bladder, and the urine, which is extravasated into the cave of Retzius, passes up towards the umbilicus between the muscles of the abdominal wall and the peritoneum.

Rupture of the lower part of the bladder, either anteriorly or posteriorly, is also extraperitoneal, and generally associated with fracture of the pelvis. The urine is extravasated round the base of the bladder, between it and the rectum.

CLINICAL FEATURES.—The patient complains of pain in the hypogastrium, and if allowed to walk, he stoops forward. He has a desire to micturate, but has inability to do so. *On examination*, a swelling is seen above the symphysis pubis, or if the base of the bladder is ruptured, a swelling is felt on bimanual rectal examination. A catheter passed into the bladder cannot be moved freely, owing to the contracted state of the bladder, and a small quantity only of blood-stained urine is removed. If boracic lotion is forced into the bladder, the suprapubic swelling increases in size.

If the urine before the accident is infected, acute inflammation with pus formation follows in the pelvic cellular tissue. This complication also occurs if infection follows the extravasation of healthy urine.

TREATMENT.—If the anterior wall of the bladder is ruptured and the urine is extravasated into the cave of Retzius, an incision should be made through the lower abdominal wall as in the operation of suprapubic cystotomy. The extravasated urine is drained away, and a tube passed through the rent in the bladder. The condition is then similar to a suprapubic cystotomy, and the after-treatment the same as for that operation.

When the rent is at the base of the bladder, the incision should be in the middle line of the perineum, and the cellular tissue between the bladder and the rectum thoroughly drained.

Penetrating Wounds.—The bladder may be wounded—(1) Through the anterior abdominal wall; (2) from the perineum; (3) through the vagina; (4) through the rectum; (5) by instrumentation of the bladder; (6) during operations on the pelvis; (7) with compound fractures of the pelvis.

CLINICAL FEATURES.—The symptoms are similar to those of rupture of the bladder, with the addition of the escape of urine from the wound. The detection of this latter symptom may be rendered easier by giving the patient $\frac{1}{2}$ grain of methylene blue in a pill, as this gives a blue colour to the urine. The accident may be followed by spontaneous recovery, especially if the injury is from the vagina, rectum, or perineum. A urinary fistula may persist, however.

TREATMENT.—The external wound should be rendered aseptic, and an attempt made to suture the rent in the bladder, or the bladder may be drained through the wound.

Foreign Bodies in the Bladder.—Foreign bodies in the bladder, apart from calculi, have usually been introduced through the urethra by the surgeon (parts of catheters, lithotrites) or by the patient (hair-pins, pencils, hat-pins, etc.). Occasionally foreign bodies enter the bladder by ulceration through the walls. Such foreign bodies have included pins from the alimentary canal, teeth and hair from ovarian teratomata, sequestra from necrosis of the pelvic bones, and articles which have been introduced into the vagina or rectum.

CLINICAL FEATURES.—The presence of the foreign body causes a inflammation of the lining membrane of the bladder, and an infective cystitis follows. Decomposition of the urine leads to a deposit of phosphatic salts on the foreign body. The patient has frequency of micturition, hypogastric pain, pyrexia, and, in some cases, hematuria.

The diagnosis is made from—(1) History, which, however, is often wilfully misleading; (2) rectal or vaginal bimanual examination; (3) radiography; (4) cystoscopy; (5) exploratory cystotomy.

TREATMENT.—The foreign body may be recovered through the urethra or by supraumbilical cystotomy. The latter method should be chosen in all instances in which there is severe cystitis, as drainage of the bladder is necessary, and in all cases of large, irregularly shaped foreign bodies. Removal through the urethra is best accomplished by grasping the foreign body with a lithotrite. This should only be attempted after the size, shape, and position of the body have been recognized by the use of the cystoscope. In the female a foreign body of moderate size can be removed by dilating the urethra.

CONGENITAL ABNORMALITIES

Ectopia Vesicæ.—This condition is a congenital absence of the lower part of the anterior abdominal wall and the anterior wall of the bladder, the posterior wall of the bladder being exposed, and continuous with the remainder of the abdominal wall. The defect in the anterior abdominal wall includes the umbilicus. The cause of the condition is unknown, but is believed by some authorities to be due to



FIG. 493.—ECTOPIA VESICÆ WITH EPISPADIAS.

In the male there are usually—(1) Epispadias; (2) defects in the prostate and vesiculae seminales; (3) cleft or absent scrotum; and (4) undescended testes.

rupture of the bladder in early uterine life following occlusion of the urethra. Ectopia is much more common in boys than in girls and is always associated with other congenital defects. In both sexes there are—(1) Non-union of the pubic bones, so that the symphysis is absent; (2) projection forwards of the sacrum, so that the antero-posterior diameter of the pelvis is lessened; (3) defect in the constrictor urethrae.

In the female, separation of the labia majora, the labia minora and the two halves of the clitoris are generally present.

At birth the posterior wall of the bladder is covered by the expanded umbilical cord, but when this separates the bladder is exposed. The mucous membrane is about the size of a walnut, red in colour, and at the lower part the orifices of the ureters can be seen discharging urine by ejaculation. The other deformities are obvious. As the patient gets older the mucous membrane increases in size, and the epithelium tends to become thickened and stratified, so that it resembles the epidermis.

CLINICAL FEATURES.—Ectopia vesicæ is always associated with constant trickling of the urine over the lower part of the genitals and thighs; the skin of these parts is therefore always excruciating and excoriated. The mucous membrane of the bladder is inflamed and bleeds readily, and there is constant danger of ascending pyelitis. In spite of this the condition is not incompatible with long life, and female patients have been known to become pregnant and have a normal parturition.

TREATMENT.—One of the following methods may be tried:

1. The patient may wear an appliance to collect the urine and protect the exposed mucous membrane.
2. Plastic operations of various kinds. The object of these operations is to provide a cavity with a single opening in which the urine can collect. There is always complete continence of urine, and at the best the patient has to wear a urinal. These operations are frequently combined with Trendelenburg's operation, which consists of dividing the posterior sacro-iliac ligaments and forcing the pubic rami together.
3. Grafting the base of the bladder with the ureters into the pelvic colon (intraperitoneal).
4. Grafting the base of the bladder with the ureters extraperitoneally into the rectum. This operation has met with the greatest success, and the patient may be able to hold the urine in the rectum for as long, as six hours.
5. Bringing the ureters out on to the groins or loins and dissecting away the mucous membrane of the bladder. As the valvular action of the bladder wall is lost, these operations are usually followed by ascending pyelitis.
6. In the female, transplanting the base of the bladder in the vagina.
7. Bilateral nephrostomy.

Inflammation of the Bladder (Cystitis).—Inflammation of the bladder is invariably associated with infection by micro-organisms, which may reach the bladder by the following paths:

1. The infection may descend the ureter from the kidney, the primary cause being pyelitis or pyonephrosis.
2. Direct infection by instrumentation of the bladder, especially when non-sterile catheters are used to relieve retention of urine.

3. Infection from the alimentary canal, the organisms passing through the walls of the intestine and bladder, or sometimes by the formation of an intestino-vesical fistula. In the former case there is already some pathological condition present, such as retention of urine, foreign bodies in the bladder, or vesical neoplasm.

4. Ascending infection from the urethra.

5. Extension from the surrounding organs, especially the vesiculae seminales.

6. Infection of wounds of the bladder, including operations on the bladder.

7. Infection through the blood-stream, as in typhoid cystitis and many cases of tubercular cystitis.

PATHOLOGICAL ANATOMY.—In *Acute* cystitis the mucous membrane of the bladder is intensely red and congested, the base as a rule being more affected than the fundus of the organ. Superficial ulceration is common at the trigone, and in very acute cases the mucous membrane may slough in large flakes (gangrenous cystitis). This condition of gangrene is most frequently seen after retention due to retroversion of the gravid uterus. Occasionally the inflammation may spread through the wall of the bladder, and cause infective peritonitis.

In *Chronic* cystitis the mucous membrane becomes slaty in colour and is generally covered with a layer of mucus-pus and phosphates under which superficial ulceration occurs, especially at the trigone. The inflammation also involves the submucous tissue and the muscular coat, which becomes fibrous and contracted. The bladder may become so diminished in size that it will not hold more than an ounce or two of urine. On the other hand, if the cystitis is associated with chronic retention of urine, the bladder may be dilated, the wall fibrous, and the mucous membrane pushed out between the muscular fasciculi, forming pouches in which decomposing urine and sometimes stones may collect.

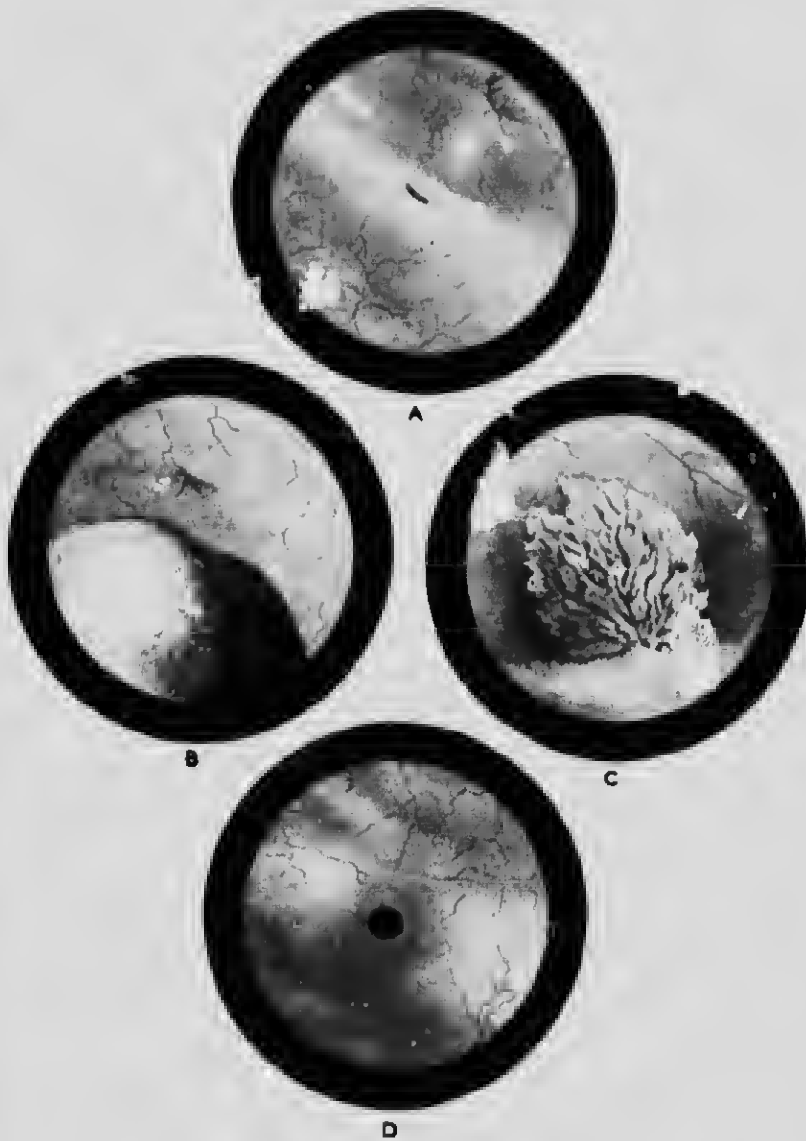
CHANGES IN THE URINE.—The urine invariably contains pus, which may appear as a light flocculent precipitate, a dense greyish-white deposit, or as a semigelatinous mass sinking to the bottom of the urine, which is always alkaline. The reaction of the urine in other cases may be acid or alkaline, according to the organism present.

Some organisms, such as the staphylococcus and the *Micrococcus ureæ*, decompose urea into ammonium carbonate, producing an alkaline reaction, while others, such as the tubercle bacillus, are not capable of producing this reaction, and the urine remains acid.

Other abnormal constituents found in the urine are blood, albumin, bladder cells, shreds of the mucous membrane, urinary salts, and bacteria. In cases of chronic cystitis the urine has usually an ammoniacal or a very offensive odour.

CLINICAL FEATURES.—The three cardinal symptoms of cystitis are—*Pain, frequency, and pyuria.* The *pain* is chiefly felt in the hypogastrum during and just after the act of micturition, and is referred along the urethra. The *frequency* is diurnal and nocturnal and in acute cases micturition is urgent and painful owing to spasmodic

PLATE VIII



A. Normal Ureteric Orifice.
 B. Phosphate stone.
 C. Small Papilloma near the Ureteric Orifice.
 D. "Gold hole" Ureteric Orifice.

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contraction of the bladder muscle. *Pyuria* is always present, and the pus in chronic cases is generally expelled at the end of micturition. The *general* symptoms of infection, even in acute cystitis, are not well marked, for the pus is not under tension. Rigors usually indicate ascending infection of the kidneys or infection of the pelvic cellular tissue.

INVESTIGATION.—In every case of cystitis a bacteriological examination of the urine should be made so as to ascertain definitely the cause of the cystitis. In all but the very acute cases a cystoscopic examination of the bladder should be carried out in order to exclude the possibility of the pus descending the ureters, and to ascertain if there are any other pathological conditions present in the bladder, such as neoplasm or pouches, as well as the cystitis. X-ray examination and cystoscopy are also necessary to exclude the presence of stone and foreign bodies.

TREATMENT.—When cystitis is secondary to another pathological condition, such as pyelitis, calculus, neoplasm of the bladder, or vesico-intestinal fistula, no treatment of the cystitis is of any use until the primary cause has been diagnosed and removed.

A careful investigation of every case of cystitis must therefore be undertaken before treatment is begun.

In acute cystitis the patient should be confined to bed and given plenty of bland fluids. If there is marked spasm of the bladder, belladonna, hyoseyamus, or opium, should be given, and hot fomentations applied to the hypogastrium. Urinary antiseptics, such as urotropin and sandal-wood oil, should also be administered, and if the urine is alkaline, they should be combined with acid sodium phosphate. If the urine is highly acid, bicarbonate and citrate of potash should be given.

In chronic cystitis, after removal of the cause, the above treatment should be carried out, and will usually be successful, but if the cystitis continues, the bladder should be irrigated daily. The fluids most frequently used are boracic acid, permanganate of potash (1 in 5,000), or very dilute solutions of silver salts.

Instillation of the Bladder.—By this means small quantities of strong antiseptics and sedatives are applied directly to the mucous membrane of the bladder. This treatment is most suitable in cases of acute cystitis, where distension of the bladder is contra-indicated. The bladder is first emptied, and then the injection made drop by drop. The best instrument for this purpose is a flexible catheter with a fine bore and a terminal eye, to which a graduated syringe with a screw piston is attached. Twenty to thirty drops of nitrate of silver (1 to 3 per cent.), or perchloride of mercury (1 in 5,000 to 1 in 2,000), may be injected at a time into the base of the bladder. The instillation may be repeated every second day, and pain, if present, can be relieved by a preliminary injection of cocaine or by a morphia suppository.

Neither washing out the bladder nor instillation should be carried out in cases of tubercular cystitis.

If these methods fail to effect a cure of the cystitis, the bladder should be opened and drained by the suprapubic route.

SPECIAL FORMS OF CYSTITIS

Tubercular Cystitis.—Tubercular inflammation of the bladder may follow infection by the blood-stream, the primary focus being found at some distant part of the body, especially the lungs, or it may be due to direct extension from the kidney, prostate, vesiculae seminales, or the testes. The latter mode of infection is the more common. Other forms of cystitis, especially gonococcal, predispose to tubercular cystitis, which is most common in young male adults.

PATHOLOGICAL ANATOMY.—Tuberculosis appears in the bladder, as in other organs, as small miliary tubercles situated chiefly at the base of the bladder, or, in the case of descending tuberculosis, round the orifice of one of the ureters. These grey tubercles undergo the usual degeneration, and tubercular ulcers develop at the trigone of the bladder. At the same time there is a general inflammation of the whole of the mucous membrane. The ulceration generally remains superficial, but the inflammatory condition invades the submucous and muscular coats, the bladder becoming markedly thickened and contracted, and incapable of distension. Tubercular lesions are generally present in other parts of the genito-urinary tract.

CLINICAL FEATURES.—The early symptoms are frequency of micturition and hæmaturia. The frequency is diurnal and nocturnal, and is uninfluenced by rest or activity; the hæmaturia occurs at the end of micturition, and is slight, the microscope often being necessary to recognize the blood. As the disease advances there is strangury, great pain on micturition, and vesical spasm that may render it almost intolerable. The frequency of micturition increases as the bladder becomes contracted, and attempts to hold the urine cause great pain.

On examination, the bladder is tender when felt by the rectum, and nodules of tubercle may be found in the prostate or vesiculae. The urine contains pus, mononuclear leucocytes, and red blood-corpuscles, and on bacteriological examination, the tubercle bacillus can be demonstrated in the majority of cases. If the infection is pure, the urine is acid, but in advanced cases secondary infection is always present, and the urine may become alkaline and offensive.

Cystoscopic examination should only be carried out if the diagnosis is not clear, for the distension of the bladder necessary for cystoscopy may be harmful. If this method of investigation is employed, ulcers are seen on the trigone of the bladder, generally near one of the ureteric orifices.

The other organs of the body, and especially the genito-urinary tract, should be examined for tuberculosis.

In those cases in which the tubercle bacillus cannot be found in the urine, the effects of treatment may lead to a correct diagnosis. Irrigation of the bladder, which will always relieve a cystitis due to other organisms, generally does harm to a tuberculous cystitis.

TREATMENT.—The first step in the treatment is to remove, if possible, any primary focus of infection. For example, tubercular

of the bladder secondary to tuberculosis of one kidney, should be treated by removal of that kidney, and the bladder condition will at once begin to improve.

Every means should be taken to improve and maintain the patient's general health, and injections of tuberculin may be given as long as they seem to have a beneficial effect on the course of the disease.

The pain and strangury should be relieved by giving hot baths, applying hot applications to the hypogastrium, and the use of drugs. Of all drugs used for this purpose morphia is the most valuable, and should be given in sufficient doses to relieve the pain. Belladonna and hyoscyamus may also be used with benefit.

Urinary antiseptics, such as urotropin, salol, and helmitol, are of little value in tuberculosis, though they may be useful if a secondary infection is present. Creosote, guaiacol carbonate, and ichthyol may also be tried.

It may be stated as a general rule that *all instrumentation of the bladder is contra-indicated in tuberculosis*, but if the pain and strangury are excessive, instillation of the bladder with 1 in 5,000 of perchloride of mercury may be beneficial, though at first it often increases the pain and frequency. Instillation of the silver salts usually does harm.

Local operation, either by means of the operating cystoscope or by the suprapubic route, generally aggravates the condition. Towards the last stage, however, with a small, contracted bladder and excessive pain on micturition, suprapubic drainage may be necessary.

Gonorrhoeal Cystitis.—The inflammation of the bladder is always secondary to a gonorrhoeal urethritis, and is due to direct extension of the urethral inflammation to the base of the bladder. It may occur at any stage of the urethritis, and may either be acute or chronic.

In the *Acute* form the inflammation is almost entirely limited to the base of the bladder, and is characterized by strangury, very severe pain, especially at the end of micturition, and the presence of pus and blood in the urine. The blood appears chiefly at the end of micturition, and consists of a few drops squeezed out as the act finishes. It may be absent. Bacteriological examination of the urine shows that the gonococcus is present, but the infection is usually mixed.

The *Chronic* variety gradually invades the whole bladder, and has nothing to distinguish it from other forms of cystitis except the presence of the gonococcus.

The **TREATMENT** does not differ from that of other forms of cystitis, and the prognosis is good. Vaccine therapy is useful.

Coli Cystitis.—Inflammation of the bladder, due to infection with the colon bacillus, occurs at all ages, but is more common in females than in males. The condition frequently starts as an acute cystitis, with the usual symptoms of pain, frequency, and pyuria, but has a great tendency to become chronic with exacerbations. Constipation or some definite inflammatory condition of the alimentary canal, as chronic appendicitis, is often present. In females inflammatory diseases of the uterus and its appendages predispose to the disease.

The **DIAGNOSIS** is made by finding the colon bacillus in the pus and excluding all other predisposing causes of cystitis, such as stone neoplasm, descending or ascending infections.

TREATMENT.—The general health should be improved and maintained in every way, attention being especially given to the alimentary canal. Removal of a chronically inflamed appendix or a pyosalpinx may be a necessary first step in treatment.

Urinary antiseptics, such as urotropin, hehmitol, or benzoic acid, usually cause rapid improvement, but the condition is liable to relapse.

Vaccines prepared from the colon bacillus have been used with success.

In many cases the symptoms of cystitis entirely disappear, but the urine passed remains slightly turbid and has an offensive odour. On examination, no pus is found, but the urine contains the colon or some other bacillus in large quantities. This condition is spoken of as **bacilluria** or **bacteriuria**, and may persist for years. It is liable to be associated with attacks of cystitis and pyelitis.

The **TREATMENT** consists of the use of urinary antiseptics and vaccine treatment.

Typhoid Cystitis.—Inflammation of the bladder may occur during the convalescence of an attack of typhoid fever, and it demands the usual treatment of cystitis.

Bacilluria may be due to the presence of the typhoid bacillus which persists in the urine for years, the patient being a "typhoid carrier."

Stone in the Bladder.—In the majority of cases calculi in the bladder are due to stones passing down the ureter into the bladder and failing to pass out through the urethra. After the stone has reached the bladder it continues to increase in size. This increase is due to deposition of those crystals primarily responsible for the stone in the kidney, such as uric acid, urates, and oxalates, or to an encrustation with ammonio-magnesium phosphate deposits produced by alkaline decomposition of the urine. The presence of the stone in the bladder predisposes to cystitis, which is often followed by alkaline decomposition of the urine and a deposit of phosphatic salts on the calculus. A stone in the bladder may therefore have a nucleus of uric acid or oxalates, and then show successive rings of phosphates and the original crystals, each layer of phosphates representing an attack of cystitis.

Stones may also form primarily in the bladder, and in this case they frequently occur round a foreign body or are associated with some cause of chronic retention of the urine, as an enlarged prostate, combined with cystitis. They also form in pouches of the bladder, which are not emptied by the act of micturition, and in which alkaline decomposition of the urine occurs.

CHARACTERISTICS OF BLADDER STONES.—Bladder stones are usually oval in shape, but if more than one is present, they may be faceted. Branched stones are also met with if the bladder is pouched or if

stone projects into the prostatic urethra or into the orifice of a ureter. In children the stone is mostly single, but in adults several stones are often met with. The stones vary in size, some being the size of an orange and weighing many ounces.

In the majority of cases the stone lies free in the bladder, though it may be encysted. An encysted stone may occur in a preformed pouch of the bladder, or the pouch may form round the stone by the formation of granulation tissue owing to inflammation of the bladder wall, against which the stone rests. In some cases the stone is encysted in the mouth of one of the ureters, and is then dumb-bell in shape.

(CLINICAL FEATURES.—

Although no age is exempt, a stone in the bladder generally occurs at the two extremes of life. In early life the condition is more common in boys, and is due to the difficulty of escape of small stones derived from the kidney along the narrow urethra. In old age enlargement of the prostate with retention of urine is a potent predisposing cause of bladder stone.

A stone may remain in the bladder without causing marked symptoms for months, but sooner or later the three cardinal symptoms appear—*Pain, frequency, and hæmaturia.*

The *Pain* is sharp and cutting, and is felt chiefly at the end of micturition, and referred along the urethra to the tip of the penis. It is rendered worse by exertion or jolting. A feeling of general discomfort in the penis is present, and this causes children to pull at the prepuce, thus inducing habits of masturbation.

Frequency of Micturition is chiefly diurnal, and increased by movement; but if cystitis supervenes, it becomes diurnal and nocturnal.

Hæmaturia is most marked at the end of micturition, is increased



FIG. 494.—BLADDER STONE SHOWING SUCCESSIVE RINGS OF PROSTATES AND URATES. (London Hospital Medical College Museum.)

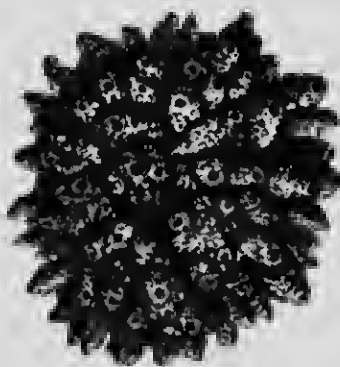


FIG. 495.—STONE OF CALCIUM OXALATE REMOVED FROM THE BLADDER. (MR. HUTCHINSON'S CASE.) (London Hospital Medical College Museum.)

by exercise, and may cease altogether with rest. In some cases there is a sudden stoppage of the stream during micturition owing to the stone falling over the mouth of the urethra, or to spasm of the sphincter muscles. In children there may be incontinence of urine.

The urine may contain crystals of urinary salts, and if cystitis is present, it may become ammoniacal and contain pus.

EXAMINATION.—In boys a stone can often be felt on bimanual rectal examination, and in women by vaginal examination. A stone cannot be felt in an adult man unless it is very large.

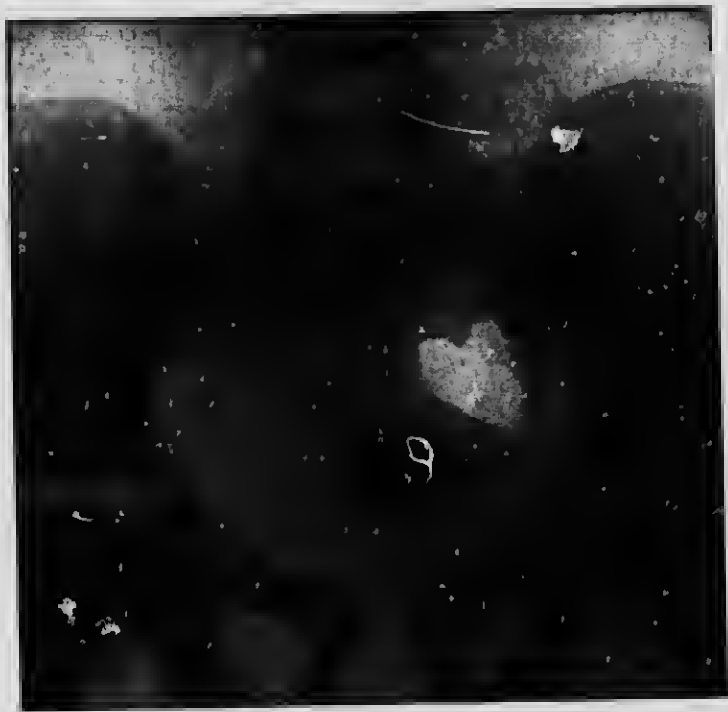


FIG. 496.—RADIOGRAM OF STONE IN THE BLADDER.

Radiographic examination will always reveal the stone unless it is very small or is formed of pure uric acid. At the same time as a radiogram is taken of the bladder area the kidney areas should also be examined, for stone in the bladder is frequently associated with stone in one or both kidneys.

Examination with the cystoscope will indicate the size and position of the stone, and also if more than one stone is present, if the stone is encysted, or if there is any other pathological condition present in the bladder. For these reasons the cystoscope has made the sound almost useless.

Examination with a sound—which is easier to carry out than

cystoscopy—will often, however, reveal the presence of a stone. It may fail under the following conditions: (1) If there is much pus and mucus in the bladder; (2) if the stone is encysted; (3) if it lies in a post-prostatic pouch.

PROGNOSIS.—Stone in the bladder, if recognized and treated early, is not a serious condition; but if neglected, cystitis is an inevitable consequence, being followed probably by ascending ureteritis, pyelonephritis, and death from uræmia. With severe cystitis, peritonitis or pelvic cellulitis may follow.

TREATMENT.—Before removal of the stone the patient should be kept in bed for two or three days and given plenty of bland fluid to drink, and if the urine contains pus, urinary antiseptics, such as urotropin, should also be given.

There are two operations for removal of calculi from the bladder—viz., *litholapaxy*—i.e., crushing the stone with a lithotrite and removal of the fragments by an evacuator; and *lithotomy*, or cutting into the bladder and removing the stone with forceps.

The operation of election is *litholapaxy*, for the following reasons:

- (1) The patient, in favourable cases, can resume his ordinary life in a week or less, while with lithotomy the minimum time of healing of the wound is three weeks; (2) there is no fear of hæmorrhage or sepsis in the wound; (3) fistula formation, which may follow lithotomy, is of course impossible.

On the other hand, litholapaxy demands the use of special skill in the use of special instruments, but lithotomy by the suprapubic route is a simple operation following the ordinary lines of surgical technique. Litholapaxy is contra-indicated in the following cases:

1. *Condition of the Stone.*—(1) Very large, hard stones (with increased skill and special instruments, increasingly large and hard stones may be crushed); (2) very soft stones, which clog the teeth of the instrument.
2. *Conditions of the Bladder.*—(1) If there is severe cystitis which demands drainage; (2) if some other condition, as enlarged prostate or papilloma of the bladder, which requires operation, is present; (3) if the bladder is so contracted that the instrument cannot be manipulated easily; (4) if the stone is encysted in a pouch or impacted in the orifice of one of the ureters.
3. *Conditions of the Urethra.*—(1) If the urethra is too small, as in young boys; (2) if there is a stricture which cannot be dilated sufficiently to allow the lithotrite to pass; (3) if the stone is impacted in the opening of the urethra and cannot be moved.

Litholapaxy.—The patient is placed in the Trendelenburg position and the bladder washed out with boracic lotion, about 8 ounces being left in after the final washing. The lithotrite is introduced, the stone felt, and the jaws of the instrument opened wide enough to admit the stone. When the stone is felt between the jaws, the lithotrite is moved to the middle line of the bladder and the stone crushed. This crushing

is repeated until the surgeon believes that the fragments are small enough to be extracted. The evacuator is then introduced, and the bladder thoroughly washed out until all the fragments are removed. It may be necessary to reintroduce the lithotrite in order to crush a fragment too large to pass down the evacuator. A certain amount of hæmorrhage is inevitable. Finally, the bladder should be washed out and emptied, and the patient put to bed.

AFTER-TREATMENT.—Plenty of bland fluid should be given with urinary antiseptics and sedatives. If there is cystitis, the bladder should be washed out, but this is not necessary as a routine. The patient may be allowed up within the week.

In some cases a median urethrotomy may be performed, and the instrument introduced through the wound. Heavier lithotrites can be used and harder stones crushed by this method, which is termed **perineal lithotripsy**.

Suprapubic Lithotomy.—The patient is placed in the Trendelenburg position, and the bladder distended with fluid after it has been washed out. A median incision is made above the pubis, and the bladder exposed extraperitoneally. The viscus is secured with a hook, opened in the middle line, and the stone removed with forceps. If cystitis is present, the bladder is drained by a tube, which can be removed on the third day; but if the urine is aseptic, the bladder may be sutured, the sutures not passing through the lining membrane. A drain is introduced through the abdominal wound down to the line of suture. If the bladder is drained, it should be washed out daily until the wound is healed.

Perineal Lithotomy.—This operation is rarely performed now, but it may be useful if the stone is impacted in the opening of the urethra, or if it is desired to drain a septic cystitis by the perineal route, more especially if the bladder is contracted.

Stone in Boys.—Litholapaxy is the operation of election in boys if a sufficiently strong instrument can be introduced. Suprapubic lithotomy is a simpler operation than in the adult, as the bladder in childhood is almost an abdominal organ. The results of the operation are excellent.

Stone in the Female.—In the female litholapaxy is the operation of election, and is very easy to perform. Small stones may be removed by dilating the urethra and removing them with forceps. If lithotomy is preferred for any reason, the suprapubic route should be chosen. Vaginal cystostomy is not to be recommended, as a vesico-vaginal fistula may follow.

RESULTS OF OPERATION.—The mortality of operation for stone in the bladder has been estimated at about 4 per cent. Recurrence, which is not common, is due to one of three causes: (1) Imperfect removal of all the fragments; (2) descent of another stone from the kidney; (3) formation of a phosphatic stone from cystitis and alkaline decomposition of the urine, especially if there is some obstruction in the urethra.

Cystitis with ascending pyelitis may follow this operation if aseptic technique is not carefully carried out.

NEW GROWTHS

Innocent

Papilloma.—Papillomata of the bladder are villous growths covered with a delicate transitional epithelium resembling that lining the bladder; they generally grow near the orifice of one of the ureters. They are sessile or pedunculated, and may be quite small or of such luxuriant growth that they almost fill the bladder. There is little relationship between their size and the symptoms they cause. Papillomata are frequently multiple, small growths being found round a larger primary growth, or the whole wall of the bladder may become studded with papillomata. Like all villous tumours, they are liable to become malignant.



FIG. 497.—LARGE PAPILOMA OF THE BLADDER.
(London Hospital Medical College Museum.)

CLINICAL FEATURES.—

They are most common in men: between the ages of thirty and forty, and the characteristic symptom is painless, profuse, intermittent, apparently causeless hæmaturia. The period between the attacks may at first be months or even years, but it becomes shorter and shorter until the hæmaturia is continuous. Occasionally there is pain in one kidney, owing to the tumour obstructing a ureter and causing back-pressure on the kidney.

Fragments of growth may be passed in the urino, and occasionally there is sudden stoppage of the stream from the villi being washed into the urethra. Rectal examination is negative. It may be stated that any tumour of the bladder that can be felt *per rectum* is malignant. Sooner or later the condition is complicated by cystitis.

DIAGNOSIS.—The diagnosis is made by cystoscopy, which should be undertaken in a period when there is no hæmaturia. The growth and the villi moving in the fluid with the movements of the cystoscope can be seen clearly. If the growth is so large as to fill the bladder, cystoscopy fails, for the head of the instrument is buried in the growth.

TREATMENT.—When a villous tumour is suspected in the bladder, consent for operative removal should be obtained at the same time that the cystoscopic examination is made.

The bladder is opened by the suprapubic route, and the growth,

with the piece of mucous membrane from which it arises, removed. This can be done by the use of cutting-forceps or by excising the mucous membrane with forceps and scalpel. The latter method is the better. Hæmorrhage may be arrested by sponge pressure, suturing, or the thermo-cautery.

In the female a small papilloma may be removed by dilating the urethra.

It has recently been advocated that these growths of the bladder should be removed by the transperitoneal route, but this increases the danger of the operation, and is not generally necessary. A large part of the bladder may, however, be removed, and as there is a danger that the growths are malignant, this method may be used in selected cases.

Other innocent neoplasms are **myoma**, **fibroma**, and **angioma**, but these are so rare as to be pathological curiosities.

Malignant

Sarcoma.—Sarcoma of the bladder is rare, and out of fifty cases collected by Wilder twenty-six occurred after the age of forty, and fourteen before the age of ten. The disease may occur, however, at any age.

The symptoms are—Hæmaturia, difficulty and frequency of micturition, and later the presence of a tumour somewhat resembling the enlarged bladder. The disease is rapidly fatal in children, and even in adults it is seldom possible to attempt removal of the growth.

Carcinoma.—Carcinoma of the bladder may be primary or secondary.

Secondary Carcinoma is usually due to direct extension of carcinoma from the prostate, rectum, or uterus; metastases from other organs are rare. There is no treatment for the condition.

Primary Carcinoma generally occurs in patients over forty-five, and is more common in men than in women. It is said to be more prevalent amongst workmen who work in aniline dye factories than in workers in other trades, and this is the only causative factor of any importance. Four types can be recognized:

1. A villous carcinoma resembling in appearance the villous papilloma, and in some cases arising from it. It is distinguished from the innocent growth by its infiltration of the bladder wall and its tendency to become necrotic.
2. A large fleshy growth on the bladder wall, the so-called "bun-shaped" tumour.
3. A growth that rapidly infiltrates the bladder wall, infecting the peritoneum and causing recto-vesical or vagino-vesical fistulae.
4. A scirrhus ulcer of the base of the bladder, causing contraction of the bladder and fixing it to surrounding structures.

Multiple growths, especially of the villous type, may occur.

THE URINARY BLADDER

1123

CLINICAL FEATURES.—The earliest symptom of carcinoma of the bladder is *haematuria*, although this may not occur until the growth is advanced. Like the haemorrhage of papilloma, it is intermittent and apparently causeless; it is generally not so profuse, but is



FIG. 498.—MALIGNANT DISEASE OF THE BLADDER, WITH DILATATION OF THE URETERS AND PELVES OF THE KIDNEY AND ASCENDING SPHINCTER.

more constant, the periods of intermission being short. Pain is not a prominent symptom, and is more often due to the accompanying cystitis than to the neoplasm. Later in the disease it may radiate to the thighs, perineum, and anus, and is due to pressure on the pelvic nerves. Interference with and frequency of micturition occur if

the growth is situated near the orifice of the urethra or when cystitis is present. Fragments of the growth may be passed in the urine and when cystitis supervenes, there is pyuria. If the growth obstructs the orifice of a ureter, pain is present in the corresponding kidney from back-pressure, and the kidney becomes hydronephrotic.

DIAGNOSIS.—The diagnosis can often be made on rectal or vaginal examination, the growth being felt invading the bladder wall. This can be done, *all instrumentation of the bladder is contra-indicated* unless it is thought that the growth is removable. In this case cystoscopic examination may be carried out to determine the intravesical extent of the tumour. If rectal or vaginal examination is negative, cystoscopic examination is essential, and must be carried out in all cases of hæmaturia if vesical new growth is to be diagnosed early. The recognition of the growth by the cystoscope is as a rule easy.

TREATMENT.—It is seldom possible to undertake removal of malignant growth of the bladder owing to late diagnosis; but if diagnosis is made early by means of the cystoscope, **partial or complete cystectomy** should be performed. If the partial operation is performed especially if the growth is on the anterior wall (the most favourable site), no special precautions as to the ureters are necessary; but if the whole of the bladder is removed, the ureters must be transferred (1) into the rectum; (2) into the groins; (3) into the loins; or nephrostomy must be carried out. The most favourable method of transplantation into the groins near the anterior superior spine.

Removal of part of the bladder may be performed extraperitoneally. In the case of malignant growth the peritoneum has to be opened in order to secure free removal, and the operation is carried out intraperitoneally.

If operation is contra-indicated, as is generally the case, the spasm of the bladder and the pain should be controlled by morphia, hyosciamus, or inhalations of chloroform, and later by the establishment of permanent suprapubic drainage.

DIVERTICULA.

Diverticula of the bladder may be congenital or acquired. **Congenital diverticula** are usually single, and have a round or oval, sharply defined opening. Their walls consist of all the coats of the bladder. **Acquired diverticula** are multiple, have irregular, rounded, or angular openings, and their walls mostly consist of mucous and submucous tissue, with perhaps a few muscular fibres. Acquired diverticula are due to some obstruction to the outflow of the urine so that muscular contraction is increased and the muscular trabeculae hypertrophy. The mucous membrane is forced out between the muscular bundles, and the diverticula are formed.

These pouches, congenital or acquired, may contain clear urine, pus, or calculi, and the last may become encysted in the pouch. They cause no symptoms, but their presence may be suspected if, after the bladder is emptied by catheter, pressure from above, or from the rectum or vagina, causes a gush of pus or urine.

The **DIAGNOSIS** is made by cystoscopic examination, or the bladder may be filled with an emulsion of bismuth and a radiogram taken.

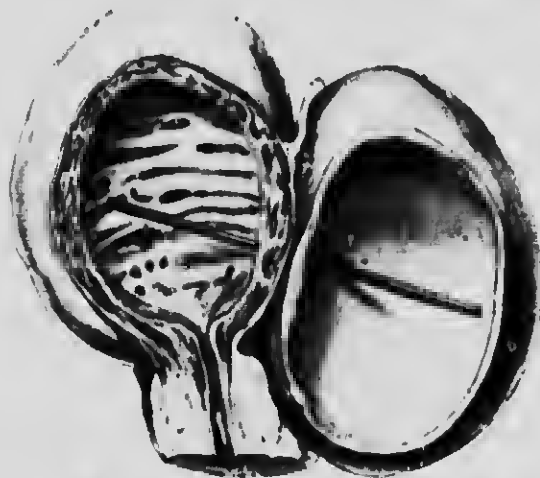


FIG. 499.—LARGE DIVERTICULUM OF THE BLADDER.
(London Hospital Medical College Museum).

TREATMENT.—There is no treatment necessary for these pouches unless cystitis supervenes. The bladder may then be washed out, or, if the pouch is solitary and accessible, it may be removed and the opening into the bladder sutured. The cause of the acquired diverticula requires treatment.

Hernia of the Bladder.—This term has been applied to diverticula of the bladder, but it should be reserved for prolapse of the bladder through one of the hernial orifices. It has already been described in the section on Hernia.

Neurosis of the Bladder.—To understand the neuroses of the bladder it is necessary to indicate briefly the mechanism of micturition. The bladder consists of two muscles—the detrusor vesicæ, which contracts and empties the bladder, and the circular fibres at the base of the bladder, which are tonically contracted and act as a sphincter. These circular fibres are reinforced by the external sphincter or compressor urethric, lying between the two layers of the triangular ligament, which is the voluntary sphincter of the bladder, and the muscle used to cut off the flow of urine if this is desired during the act of micturition.

In normal micturition a sensory impulse started in the mucous membrane of the full bladder passes along the nerves to the spinal cord, and then up to the brain. A voluntary impulse is sent down to a centre in the spinal cord, and motor impulses pass to the bladder. One of these causes the detrusor muscle to contract, and the other

inhibits the two sphincters, and micturition occurs. Micturition is also aided by voluntary contraction of the abdominal muscles.

The neuroses which may occur in this cycle of events are—(1) irritability of the sensory nerves; (2) irritability of the motor nerves; (3) paralysis or paresis of the motor nerves.

1. IRRITABILITY OF THE SENSORY NERVES—*Irritable Bladder*.—This condition only occurs *during the day*, and is characterized by an urgent desire to pass urine, sometimes as often as every half-hour. Pain may be present, and the condition is then termed *neuralgia of the bladder*, but there are no objective signs of disease, either in the bladder or urine, except that there is frequently polyuria.

As in all neuroses, the diagnosis should not be made until every means of diagnosis has been exhausted and no pathological change found. The condition may be a precursor of serious disease of the nervous system.

TREATMENT.—This is unsatisfactory, and follows the usual lines of all neuroses. Any abnormal condition, as phimosis or a small meatus, should receive appropriate treatment. In some cases the condition is quite temporary, and associated with mental overstrain.

2. IRRITABILITY OF THE MOTOR NERVES—*Vesical Spasm*.—By this term is understood a spasmodic contraction of the circular fibres at the base of the bladder so that micturition is difficult. The condition may be due to organic disease, such as tabes dorsalis, spastic paraplegia, and compression paraplegia, or it may be entirely functional. If the latter, the condition is generally most marked when the patient tries to micturate when other people are present, and it may prevent micturition entirely. In some cases the act of micturition is constantly interrupted, a form of spasm spoken of as **stammering bladder**.

The passage of a full-sized bougie excludes organic stricture and other causes of urethral obstruction.

TREATMENT.—The treatment is either that of a neurosis or of the underlying organic nerve disease. Dilatation of the bladder and ureters leading to double hydronephrosis may follow.

3. PARALYSIS OF THE MOTOR NERVES OF THE BLADDER.—If the detrusor nerves or centre in the spinal cord is affected, the condition is one of *retention* of urine, as the sphincters still remain tonically contracted. As the pressure of the urine in the bladder increases, the sphincter is forced, and a condition of *retention, with overflow*, occurs. On the other hand, if the sphincter nerves and centre are affected, incontinence of urine occurs, with an empty or partially empty bladder. If there is merely paresis of the detrusor muscle, the bladder is partially emptied by the act of micturition, and the urine left in the bladder is termed *residual urine*.

Paralysis or paresis of the motor nerves may be due to organic lesions, such as tabes, general paralysis, or compression paraplegia, and may be the earliest symptom of these conditions. In every case, therefore, of incontinence or retention of urine, the nervous system should be carefully examined if there is no obstruction in the urethra.

In other cases the condition is functional, and hysterical retention is frequently met with in young females. Incontinence of urine, on the other hand, is very seldom hysterical.

TREATMENT.—Careful catheterization at regular intervals is necessary if there is retention of urine, and great care should be given to asepsis, as patients with retention of urine owing to nervous diseases are very apt to contract cystitis, followed by ascending pyelitis. In other cases a chronic cystitis may be present for years without seriously damaging the kidneys, the patient constantly passing ammoniacal urine containing muchropy pus. Strychnine and electricity may give temporary relief in cases of nervous incontinence.

Nocturnal Enuresis.—By this term is understood a complete act of micturition occurring during sleep, the bladder being fully emptied. There is usually no abnormality in the act during the day.

The condition is normal in children below the age of two, but if after that age micturition should occur during sleep, the condition is pathological. It is frequently associated with the presence of worms, phimosis, adenoid growths, hyperacid urine, rickets, defective mental development, etc., and of those cases that persist after puberty epilepsy is the most common cause.

TREATMENT.—Any predisposing cause must be treated, and the general health of the patient maintained. The child should not be given supper just before going to bed, the mattress should be firm, the bedclothing light, and the foot of the bed should be slightly raised. The usual time that micturition occurs should be noted, and the patient waked up before this time and made to micturate. The drugs which give the best results are belladonna and thyroid extract. If the condition does not undergo spontaneous cure at puberty, the trouble is probably epileptic.

Atony of the Bladder.—Atony of the bladder is partial or complete loss of the power of contraction of the muscles of the bladder. The onset may be gradual, the condition being due to such diseases as arterio-sclerosis or inflammatory conditions of the bladder, or it may follow a single act of over-distension of the bladder. It is most common among sufferers from enlarged prostate.

TREATMENT.—If atony follows over-distension of the bladder, regular catheterization will often result in recovery of the loss of tone; but when it is due to fibrosis of the musculature, recovery is impossible, and the patient must lead a "catheter life." Strychnine and electricity may also help in recovery of loss of tone.

CHAPTER XXXVI
INJURIES AND DISEASES OF THE URETHRA, PROSTATE, AND
VESICULÆ SEMINALES

THE URETHRA

Anatomy.—The urethra is a canal lined by a mucous membrane extending from the bladder to the glans penis. Its length averages $6\frac{1}{2}$ inches, but as tested by the catheter it is 8 inches, and this second measurement is the one that is of most importance to the surgeon. Its diameter varies in different parts and with the size of the penis, but Otis's ratio of 4 to 9 of the maximum circumference of the canal and that of the penis will serve as a practical guide to its size.

The urethra is divided into three portions: One passing through the prostate—the prostatic portion— $1\frac{1}{4}$ inches; one lying between the two layers of the triangular ligament—the membranous portion— $\frac{3}{4}$ inch; and the third lying in the corpus spongiosum—the penile or spongy portion—6 inches.

The *prostatic portion* is seen on section to be crescentic in shape, with the concavity downwards. This is due to an elevation in the floor of the canal—the verumontanum. About the centre of the verumontanum is a cul-de-sac—the sinus peculiaris or uterus masculinus—and on the lateral margin of the sinus are the two small openings of the common ejaculatory ducts for the discharge of the semen into the canal. The extremities of the crescent form little depressions—the prostatic sinuses—into which the glands of the prostate open. The sinus peculiaris is about $\frac{1}{2}$ inch in length, and represents the cavity of the uterus in the female (Müller's ducts). It contains a few glands, in which small concretions are sometimes found. It rarely causes trouble on catheterization. Stricture is uncommon in the prostatic urethra.

The *membranous portion*, $\frac{3}{4}$ inch in length, lies between the two layers of the triangular ligament, about 1 inch behind the subpubic ligament. It is surrounded by the constrictor urethrae, a strong band of unstriped muscle. The mucous membrane contains glands, but no special ducts open into this part of the urethra. It is the part usually damaged by blows on the perineum, and it is here that traumatic stricture is usually found. In the normal condition the lumen of the tube is stellate on section in this part of the urethra.

The glands of Cowper lie on each side of the membranous portion, and their ducts pierce the triangular ligament.

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1129

The *spongy or penile portion*, 6 inches in length, presents two dilatations. The posterior expansion lies in the bulb of the corpus spongiosum, and is about 1 inch in length; it is the most common seat of stricture. The ducts of Cowper's glands open into this part of the canal. The anterior dilatation lies in the glans penis; it is called the "*fossa navicularis*."

The penile portion of the canal is flattened from above downwards, presenting on section a transverse slit, but its shape changes at the

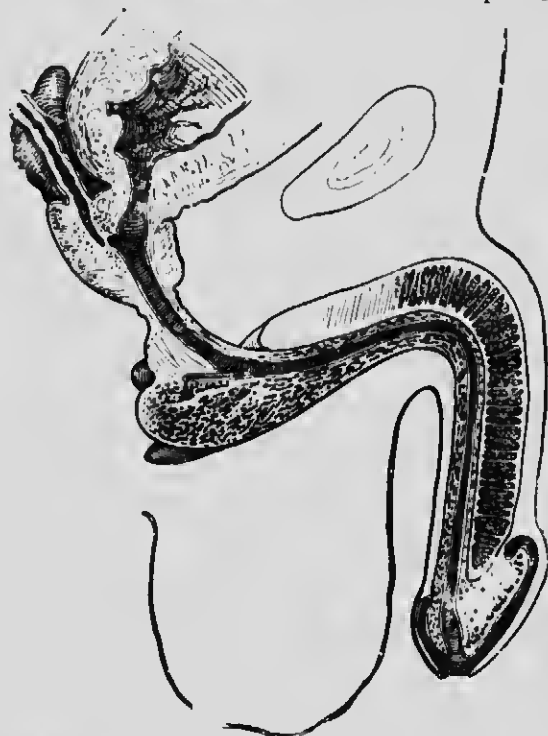


Fig. 500.—DIAGRAM OF THE URETHRA AND ITS ANNEXA.

fossa navicularis, and the external meatus is represented by a vertical slit about $\frac{1}{4}$ inch in length. This is the narrowest and least dilatable portion of the tube, and it is frequently necessary to incise it before instrumentation of the rest of the urethra or of the bladder.

The mucous membrane of the urethra is covered with a columnar-celled epithelium, except near the meatus, where it is squamous-celled, and in the prostatic portion, which is lined with a transitional epithelium like that of the bladder. It contains numerous glands—the glands of Littre; their openings, which are directed forwards, being called the "*lacunæ*." They are most abundant on the floor of the canal. One specially large gland, the *laenna magna*, is found on the dorsal wall, about 1 inch from the meatus, and may arrest the point

of a catheter (see Catheterization). The muscularis mucosæ, which extends the whole length of the tube, appears to be capable of a peculiar vermicular contraction, and will gradually expel a catheter left in the urethra. In some cases this contraction is in the inward direction, and a carelessly tied catheter has passed into the bladder.

In the flaccid state of the penis the urethra has an S-shaped curve, and the lowest part is the meatus. In the position in which a catheter is passed the curve is a single one, and the lowest part is the bulbous urethra.

The *Female Urethra* represents the upper part of the male canal; it is about $1\frac{1}{2}$ inches in length, and directed upwards and slightly backwards to open into the bladder about $\frac{1}{4}$ inch behind the middle of the symphysis. Its posterior wall is in contact with the vagina, and it is surrounded by a plexus of veins (the veins of Santerini). The posterior margin has a slight prominence, by which the meatus can be recognized during catheterization. The narrowest part is the meatus, which is, however, readily dilatable to admit the introduction of a finger when the patient is anesthetized. Over-distention will cause permanent incontinence of urine. The urethra is lined with a mucous membrane, with a few glands in it. Skene's tubules, representing the prostate in the male, also open into it.

Injury of the Urethra.—The urethra may be injured from *within* during the passage of catheters, sounds, or the cystoscope—*false passages*—by foreign bodies pushed into the meatus, or during the passing of a calculus.

False passages are usually made in the penile urethra in front of a stricture or in the prostatic urethra, the instrument being pushed into the substance of the prostate. This occurs particularly when the organ is enlarged, and in some cases the instrument is pushed through the prostate into the bladder.

CLINICAL FEATURES.—The moment of making the false passage is usually unmistakable. The instrument which has been encountering resistance suddenly slips forward, generally to one or other side of the middle line, and the patient complains of a sharp cutting pain. A little blood follows withdrawal of the instrument. Once a false passage is made, the instrument always tends to enter it rather than pass along the urethra.

TREATMENT.—No further attempts at instrumentation should be tried until the wound has time to heal. If there is no retention of urine, nothing need be done; but if the false passage is made during an attempt to overcome retention, the bladder should be emptied by suprapubic aspiration, and this should be repeated as often as necessary, or, if cystitis is present, the bladder may be drained. The lesion in the urethra will have healed in three or four days. Urinary antiseptics and quinine should be given in these as well as other lesions of the urethra.

Rupture of the Urethra.—Rupture of the urethra is due to blows, falls, and kicks on the perineum, or it may be caused by fracture

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1131

the pelvis. The part of the urethra most frequently damaged is the junction of the penile and membranous portions. The anterior layer of the triangular ligament is usually torn so that extravasation of urine takes place in front of the triangular ligament, and infiltrates the perineum, scrotum, penis, and anterior abdominal wall. With fracture of the pelvis the membranous or the prostatic urethra may be ruptured, and extravasation occur into the cellular tissue between the bladder and rectum, and into the cave of Retzius.

CLINICAL FEATURES.—There is a history of a blow or fall on the perineum, and generally marked extravasation of blood in the perineum and scrotum. The patient complains of pain in the perineum, and has a desire to pass urine, but with inability to do so; the bladder therefore becomes distended. In some cases the urine may be passed into the cellular tissue of the perineum and scrotum, causing a sharp cutting pain and swelling of the part. The principal physical signs are *bleeding from the urethra* and the swelling in the perineum. The hæmorrhage may be very severe.

TREATMENT.—The patient should be warned not to attempt to pass urine, or extravasation will occur.

A distinction must be made between contusion of the urethra and rupture. By a contusion is meant laceration of the mucous membrane with a little hæmorrhage, and by rupture a solution in the continuity of the whole wall of the urethra, which may be completely divided into two parts.

If the first condition is believed to be present, an attempt may be made to pass a soft catheter into the bladder. If this is successful, it may be tied in, and the bladder drained for three or four days. When **rupture** is diagnosed, or when extravasation of urine has occurred, the patient should be at once prepared for perineal section, and no attempt made to pass a catheter. After the patient is anesthetized, an attempt should be made to pass a blunt metal catheter, great care being taken to proceed as gently as possible. If this instrument cannot be passed, other varieties should be tried, but no force of any kind must be used. If an instrument can be passed, it should be cut down upon through the perineum, and the site of the rupture exposed.

If no instrument can be passed into the bladder, Wheelhouse's staff should be passed down to the site of the rupture, cut down upon, and the two ends of the urethra carefully sought for in the blood-clot. In some cases it is impossible to find the posterior end of the urethra, and if this be so, the perineal wound must be covered up, and a suprapubic cystotomy done. Retrograde catheterization is performed, and the proximal end of the urethra thus discovered. Having found the two ends of the urethra, they should be sutured together with catgut round a metal catheter.

Two methods of drainage can be used. In cases operated upon soon after the rupture without pulping of the urethra and without extravasation of the urine, all that is necessary is to have a fair-sized catheter tied into the bladder, and to drain the perineal wound with a

small drain. The catheter should be left in for a week, and afterwards the case treated like one of external urethrotomy (see p. 1145).

In cases in which delay has occurred, or the urethra is pulsed, or extravasation is present, a tube should be passed from the perineum into the bladder, and secured. A soft rubber tube should then be passed down the penis till it reaches the perineal tube, and tied in. The perineal wound is then sutured. The urethral tube should be removed in one week, and the perineal tube in ten days. On the tenth day a metal sound of moderate calibre should be passed, and afterwards the case treated as an external urethrotomy.

Foreign Bodies in the Male Urethra.—Foreign bodies impacted in the male urethra consists of calculi or of various foreign bodies, such as

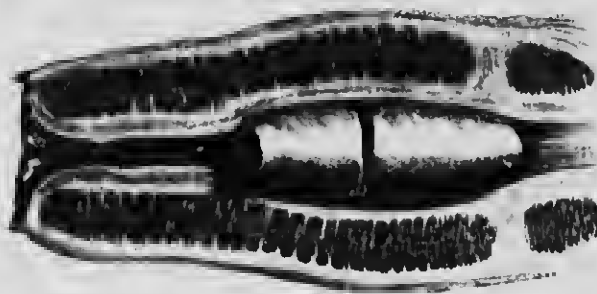


FIG. 501.—CALCULUS IMPACTED IN THE URETHRA.
(London Hospital Medical College Pathological Institute.)

slate pencils, hairpins, pieces of catheters, etc., which have been introduced by the patient or surgeon.

In the case of a foreign body the history is usually sufficient to make the diagnosis clear; but with calculi, especially in children, the first symptom may be sudden stoppage of the stream of urine, followed by retention. The lips of the external meatus are œdematous. The diagnosis is made by passing a bougie and feeling it strike the obstructing calculus, which may also frequently be felt through the penis or perineum.

TREATMENT.—If the foreign body is smooth and retention of urine is not complete, an attempt may be made to get it expelled by the urinary stream by gripping the end of the penis during micturition, and then suddenly letting go, so that the rush of the urine will carry the foreign body with it.

When the foreign body is retained in the penile urethra an attempt should be made to remove it with urethral forceps, or with a small blunt hook; but if not quickly successful the foreign body should be cut down upon and removed, the urethra being at once closed with buried catgut sutures. A catheter is retained in the urethra for five days.

If the obstruction be due to a stone in the deep urethra, it can be pushed back into the bladder, crushed, and removed.

CONGENITAL ABNORMALITIES OF THE URETHRA

Atresia.—Narrowing of the urethra is a rare congenital abnormality, and most commonly occurs at the external urinary meatus, which may be so small as to admit a fine probe only, or it may be completely closed. In the latter case the patient usually passes urine at the umbilicus through a patent urachus, or there is a connection between the urethra and the rectum. Ectopia vesicæ is believed by some authors to be due to rupture of the bladder early in fetal life following constriction of the urethra.

Hypospadias.—By this term is meant a congenital malformation of the urethra and penis, in which the urethra does not open at the end of the glans but on the under surface of the penis. The cause of the condition is unknown, but it is an arrest of development of the external genitals occurring early in fetal life. Three degrees of hypospadias are recognized:

1. *Hypospadias of the Glans Penis.*—The urethra opens on the under surface of the penis at the junction of the glans and the body of the penis. It is due to failure of development of the invagination of the epiblast, which forms the urethra in the glans. The penis is normal in size and shape, with the exception of the prepuce, which forms a loose hood over the glans. There is as a rule no functional disability, and no treatment is necessary unless the opening is too small, when it should be enlarged.

2. *Penile and Peno-Scrotal Hypospadias.*—In this variety the opening of the urethra is in the body of the penis or at the junction of the penis and scrotum. The penis is ill-developed, and the corpus spongiosum is represented by two narrow fibrous bands one on each side of the furrow representing the urethra. These bands cause the penis to be curved downwards and to be incapable of erection. There is difficulty both in micturition and coitus, and the latter may be impossible.

3. *Perineo-Scrotal Hypospadias.*—It is usually difficult in this variety of hypospadias to determine the sex of the patient, as the penis is ill-developed, resembling the clitoris, and there is cleft scrotum and undescended testes. The urethra opens into the perineum, and the patient has to micturate in the squatting position. Coitus is impossible, but fortunately in the majority of these patients the sexual feeling is absent or slight. In some cases the patient has married as a woman (see Hermaphroditism, p. 1178).

TREATMENT.—The treatment—if any be advisable—of the last two degrees of hypospadias is the performance of a series of plastic operations to form a urethra in its normal position. These operations should not be done until the patient is old enough to assist in the treatment, and too much should not be attempted at each sitting.

Attempts have also been made to graft the internal saphena vein into the penis and use this as the urethra. The average result of these operations is not satisfactory to the patient, and severe degrees of malformation of the external genitals are better left alone.

Epispadias.—In this condition the urethra opens on the dorsum of the penis, which is usually short, ill-developed, and turned upwards. It is believed to be developmentally a hypospadias with torsion of the penis. The urethra may open just behind the glans or anywhere on the dorsum of the penis, but the most common variety is a complete epispadias with extroversion of the bladder. In these cases the glans is almost the only part of the penis remaining, and the urethra is represented by a furrow of mucous membrane on its dorsum. There is complete incontinence of urine, owing to the cleft in the sphincter muscle.

TREATMENT.—The treatment, as in hypospadias, consists of performing plastic operations, which are usually unsatisfactory. With complete epispadias the treatment is that of ectopia vesicæ. Coitus is impossible, and the condition is frequently associated with ill-development and imperfect descent of the testes, cleft scrotum, and congenital herniæ.

INFLAMMATION OF THE URETHRA

Urethritis.—Urethritis is due to infection of the mucous membrane of the urethra with various forms of organisms. The healthy urethra is resistant to the majority of pathogenic bacteria, but if the mucous membrane is irritated by the passage of catheters, or if an instrument is tied into the urethra, urethritis readily occurs, but equally readily disappears if the cause of the condition is removed. Infection by the tubercle bacillus or the *Bacilli coli* is rare, although these organisms may pass down the urethra for years in cases of cystitis and pyelitis.

Infection with pyogenic bacteria other than the gonococcus may also occur during the sexual act, but as a rule the inflammation is not severe, and rapidly subsides. It is only to be distinguished from gonococcal inflammation by bacteriological investigation of the pus.

Gonococcal Urethritis—Gonorrhœa.—The common cause of urethritis is infection of the mucous membrane by the gonococcus of

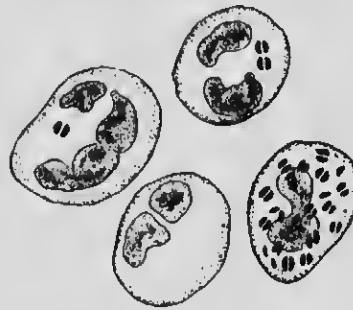


FIG. 502.—GONOCOCCI IN PUS.

Neisser. This organism is a diplococcus, each organism being bean-shaped, and the two lie in a capsule with their concave surfaces facing each other. The gonococcus stains readily with the aniline dyes, but is Gram-negative; while the majority of the organisms for which it can be mistaken retain their colour in the presence of Gram's solution. It is cultivated with some difficulty, and is best grown on agar and sterilized blood. Inoculation experiments are useful as the lower animals are immune

from the infection. The organism is found in the pus cells, epithelial cells of the urethra, and to a large extent in the serum of the discharge.

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1135

The intracellular distribution is of great value in diagnosis, but it is not pathognomonic, and the gonococcus is chiefly extracellular.

During the early stages of a gonorrhœal discharge the gonococcus may be found in pure culture, but later other pyogenic organisms are usually found, and the number of gonococci diminishes. The secondary inflammations also are frequently due to a mixed infection.

PATHOLOGV.—As a result of infection by this organism an acute inflammation of the mucous membrane of the urethra occurs, with rapid desquamation of the epithelial cells and the formation of pus. The inflammation also extends to the submucous tissue, which becomes infiltrated with inflammatory exudates, and exudation may also occur into the surrounding structures, such as the corpus spongiosum and the corpus cavernosum.

The inflammation usually ends in resolution, but may become chronic, and the gonococcus remaining latent in the urethra for years, an acute inflammation may occur at any time, especially after instrumentation of the urethra, sexual excitement, or even alcoholic excess. This latent condition of the gonococcus accounts for many cases of acute gonorrhœa following the sexual act in which neither party is conscious of any discharge. The condition must always be considered in questions involving the chastity of either participant.

If part of the mucous membrane has been destroyed, healing by fibrous tissue results, and fibrosis may also occur in the submucous tissue without suppuration. Both these results lead to fibrous stricture of the urethra. Suppuration may, however, occur in the submucous tissue, and a peri-urethral abscess form. Infection may also be carried by the blood-stream to the serous and synovial membranes, or directly to the conjunctival sac, causing an acute conjunctivitis.

Suppuration in the inguinal lymphatic glands is generally due to infection from other organisms than the gonococcus, and is secondary to infection of the prepuce and glans penis.

CLINICAL FEATURES.—Infection in the great majority of cases occurs during the sexual act, but it may also follow the use of underlinen, towels, syringes, the seats of water-closets, etc., which have been contaminated with a gonorrhœal discharge. The incubation period is usually two days, and is seldom longer than ten.

The **SYMPTOMS** are—An itching at the urinary meatus, which becomes œdematous, scalding pain on passing urine, and a discharge from the urethra which is first mucoid and sticky, then thick, abundant, and yellow in colour, and later thin and serous, before it finally disappears. There is also a certain amount of constitutional disturbance with rise of temperature and aching, dragging pain in the loins.

These symptoms indicate an *anterior urethritis*, and in favourable cases the discharge lessens in about a fortnight, ceasing altogether in about a month.

Posterior Urethritis.—The infection may spread backwards past the compressor urethræ and affect the posterior urethra. The following symptoms are then added—Pain and frequency of micturition, the urine not infrequently being blood-stained, a feeling of weight and pain in

the perineum, frequent and painful erections of the penis, and pain on defecation. The general symptoms are usually increased in severity.

Gonorrhœa in the Female.—The site of election of the gonococcus in the female, as in the male, is the urethra, although infection of the vagina (vaginitis) and vulva (vulvitis) are practically always present. Mixed infections are common.

SYMPTOMS.—The patient complains of a burning, itching pain in the vulva, which is swollen and œdematous. There is frequency of micturition, scalding on passing urine, and a profuse purulent discharge. That this discharge comes from the urethra may be demonstrated by running the finger from behind forwards along the anterior wall of the vagina, and so squeezing the pus from the urethra.

DIAGNOSIS.—It cannot be too clearly laid down that the only certain diagnosis of gonorrhœa is the finding of the gonococcus in the discharge, as purulent discharges from the penis, vulva, and vagina, apart from gonorrhœa, are common. This rule must be especially remembered in the diagnosis of vulvo-vaginitis in children, as accusations of rape are frequently founded on the discovery in a child of a vaginal discharge, which in a large number of cases is *not* due to the gonococcus.

In the male the presence of a profuse urethral discharge without obvious cause is almost diagnostic of gonorrhœa, but care should be taken to see that the discharge does come from the urethra. In cases of phimosis a purulent discharge may come from a concealed sore or from a balanitis, and it may be necessary to slit up the prepuce before a positive diagnosis can be made.

TREATMENT—1. *General.*—If possible, the patient should rest in bed for the first one or two weeks; but if this is impossible or refused, the scrotum and penis should be kept in a suspensory bandage, and the patient warned to get about as little as possible, all exercise being forbidden. The diet should be light and non-stimulating; alcoholic beverages, as well as strong tea and coffee, are contra-indicated. The patient should be encouraged to drink plenty of bland fluids, such as barley water, lemonade, soda water, Vichy water, etc., so as to flush out the urinary passages. The bowels should be kept acting regularly. Balsamics should be administered by the mouth as the discharge lessens, the best being copaiba, sandal-wood oil, buchu, and cubeb. As these are apt, however, to upset the digestion and cause rashes, they should be given with care. Sedatives, such as hyoscyamine and belladonna, should be given if there is frequency and pain on micturition, and large doses of bromides or heroin should be tried for painful erections. Great care should be taken to prevent infection of the conjunctival sac, and all dressings, etc., should be burnt immediately after use. Coitus is, of course, forbidden.

Serum-Therapy.—Gonococcus vaccines should not be given before the end of the first week. The vaccine should, if possible, be prepared from the particular cases, as stock vaccines tend to lose their potency. Vaccine treatment is especially useful in chronic cases and in the treatment of complications, as epididymo-orchitis and gonorrhœal arthritis.

2. *Local.*—The penis should be kept very clean, being bathed three or four times a day in hot water, and wrapped in antiseptic gauze to prevent the soiling of the linen and constant reinfection. If micturition is painful, the urine may be passed with the penis held in hot water. Bathing with cold water is useful in the case of painful erections. The further local treatment of gonococcal urethritis is the subject of controversy, and the following methods must be considered:

1. *Abortive Treatment with Anterior Urethritis.*—This consists of instillation of 2 per cent. solution of silver nitrate; injection of $\frac{1}{4}$ to $\frac{1}{2}$ per cent. solutions of protargol, or irrigation of the urethra with potassium permanganate, or dilute silver solutions during the early stages of the disease. This treatment is usually unsuccessful, which is to be expected when it is realized that the gonococci are lying deep in the cells of the mucous membrane, and that the effect of these strong solutions is to increase the amount of inflammation. It is also maintained by some authors that this early method of treatment increases the liability to posterior urethritis, prostatitis, epididymitis, etc., and they state that *all local treatment is contra-indicated during the acute inflammatory stage of gonorrhœa.*

2. *Injection Treatment with Weak Solutions.*—The solutions recommended are protargol ($\frac{1}{2}$ per cent.), thallii sulphate (1 per cent.), potassium permanganate (1 in 10,000), resorcin (1 per cent.). The injections are made with a syringe into the anterior urethra *immediately after the patient has passed urine.* The pressure used should not be sufficient to force the compressor urethræ and allow the injection to enter the posterior urethra.

This method of treatment is considered to be of benefit when the acute symptoms are subsiding, and if used with care can do no harm.

3. *Irrigation Method.*—In this method large dilute solutions, especially of potassium permanganate, are used to irrigate the urethra, sufficient force being used to distend the urethra and to make the solution enter the bladder. In cases of anterior urethritis this method brings with it increased risk of infecting the posterior urethra.

4. *Injection and Irrigation of the urethra with stronger solutions,* and especially the solutions of the silver salts—*e.g.*, silver nitrate (1 in 5,000), protargol (1 per cent.), zinc chloride (2 grains to the ounce), are useful after the acute stage is over. The injection should be made four or five times a day, and the patient should always pass urine immediately before the injection is given so as to wash out the urethra. The injections should be continued for some time after the discharge has ceased, as it is likely to return if they are discontinued at once.

ACUTE POSTERIOR URETHRITIS.—With acute posterior urethritis, all local treatment to the urethra should be stopped, and the patient should be given hot baths and hot fomentations to the perineum. The treatment of chronic posterior urethritis is considered below.

TREATMENT IN THE FEMALE.—The *General* treatment is the same as in the male.

Local Treatment.—During the acute stage the patient should take three or four hot baths a day, or the parts should be frequently bathed with hot water, and a gauze pad should be worn to absorb the discharge. As the acute inflammation subsides, the vagina and vulva should be kept clean, with mild antiseptic douches such as iodine or lysol, and later astringent douches should be used. If the condition changes into a chronic urethritis, local application of strong silver salts should be made to the urethra, but it is not often necessary, as the urethritis is seldom persistent.

Chronic Gonorrhœa (Chronic Urethritis, Gleet).—A distinction must be made between these conditions. *Chronic gonorrhœa* is a chronic inflammation of the mucous membrane of the urethra associated with the presence of the gonococcus, while *chronic urethritis*, although it may follow an acute attack of gonorrhœa, may be due to the presence of other organisms. The distinction is necessary if vaccine therapy is used, and can only be made on bacteriological examination.

By **gleet** is understood a chronic discharge of pus from the urethra. It may depend on chronic gonorrhœa or urethritis, or be due to such conditions as Cowperitis, prostatitis, lacunar abscess, etc.

SYMPTOMS.—In all these conditions the patient complains of a discharge from the urethra, which is most abundant in the morning and liable to be increased by exercise, the use of alcohol, coitus, nocturnal emissions, or sexual excitement. There is a feeling of fulness and weight in the perineum, and the patient is liable to become hypochondriacal. Treatment is often sought when the patient contemplates marriage.

DIAGNOSIS.—The pus should always be examined to determine the nature of the organisms present. The urethra should be examined with the endoscope; and the prostate, vesiculæ seminales, and the whole length of the urethra should be examined with the finger, as an exact diagnosis is necessary before treatment is commenced.

TREATMENT.—If the condition is a chronic urethritis in the anterior or posterior urethra (usually it is the posterior), the condition should be treated by the application of strong solutions of the silver salts (1 to 2 per cent.). This solution is instilled into the inflamed part of the urethra by a Guyon's instillating syringe after the patient has passed urine, and repeated until the discharge ceases.

Another method is to distend the urethra forcibly with dilute solutions of permanganate of potash by means of an irrigator. The anterior urethra is first washed out (1 pint), and then the irrigator is raised so that the compressor urethræ is forced and the solution flows into the posterior urethra and bladder ($\frac{1}{2}$ to 1 pint).

These two methods of treatment can be combined, but they should not be left in the hands of the patient.

If examination with the endoscope shows a *granular patch*—i.e., granulation tissue—or an *ulcer* in the mucous membrane of the urethra, it should be treated by topical applications of silver nitrate, but care must be taken not to cauterize excessively, or the formation of a stricture will be favoured.

If these methods of treatment do not clear up a gleet, one of two conditions is present. Either the patient has chronic infiltration of the submucous tissue, or there is chronic prostatitis. In the first case the treatment has little effect, and in the second the discharge returns as soon as treatment is stopped. Chronic prostatitis is associated with gleet in about 85 per cent. of the cases.

The treatment of *chronic infiltrative urethritis* consists of keeping the urethra dilated by passing full-sized metal bougies, care being taken that the urethra is not lacerated, and the application of ointments containing iodine, salicylic acid, or boric acid; but the prognosis is not good, and in a large number of cases a slight urethral discharge persists in spite of all treatment. If such a discharge does not contain the gonococcus, and is slight in amount, local treatment should not be persisted in, as there is a great tendency to neurasthenia (gonorrhophobia) in these patients, and they are likely to concentrate most of their attention on a slight gleet which is of little importance.

A gleet due to chronic prostatitis is considered on p. 1153.

THE COMPLICATIONS OF GONORRHOEA

These may be classified as follows:

1. Direct extension in the male genital tract: Balanitis, lacunar abscess, cavernitis, Cowperitis, prostatitis, vesiculitis, epididymo-orchitis.
2. Direct extension in the female genital tract: Vulvitis, inflammation of Bartholin glands, vaginitis, cervicitis, endometritis, salpingitis, and peritonitis.
3. Extension in the urinary passages: Stricture, cystitis, ureteritis, pyelitis.
4. Accidental infection: Conjunctivitis, rhinitis, proctitis.
5. Infection through the blood-stream: Gonorrhœal pyæmia, arthritis, teno-synovitis and bursitis, iritis and scleritis.

The majority of these conditions are described under their respective sections, but it is convenient to describe the following here:

Lacunar Abscess, or peri-urethral abscess, is the result of inflammation occurring in one of the glands of Littre which open into the urethra. The small abscess which can be readily felt along the course of the urethra hursts into the urethra, and is one of the causes of gleet, or it discharges externally, and leads to the formation of a fistula which is often very difficult to heal.

TREATMENT.—The abscess should be excised from the outside as soon as it is diagnosed, for there is less likelihood of a fistula forming

if this is done early. If a fistula forms and does not close spontaneously, the edges should be cauterized. Fistulæ near the glans penis usually heal, but those in the body of the penis often necessitate a plastic operation.

Chordeitis (Chordee).—This condition is an inflammatory effusion into the corpus spongiosum or into one of the corpora cavernosa. As a consequence the penis when erect is bent downwards or to one side as the infiltrated tissue does not become distended. The erection is very painful (chordee). Suppuration very rarely occurs, but occasionally the exudate becomes organized, and a permanent disability of erection follows.

TREATMENT.—The penis should be bathed frequently in hot water, and large doses of bromide given before the patient goes to bed. If erection occurs, the penis should be bathed with cold water, or iced evaporating lead lotion can be applied.

Cowperitis.—Inflammation of Cowper's gland may be acute or chronic.

Acute Cowperitis may end in suppuration, the abscess bursting into the urethra or pointing in the perineum. *Chronic Cowperitis* is one of the causes of gleet, and has similar symptoms to chronic prostatitis (see p. 1153).

TREATMENT.—An abscess of Cowper's gland should be freely opened in the perineum. Chronic Cowperitis is best treated by removal of the gland.

Inflammation of Bartholin's Gland.—Bartholin's gland is situated in the posterior part of the labium majus, and inflammation of it is a common sequel to gonorrhœa in the female.

{ **SYMPTOMS.**—A tender swelling appears at the posterior part of the labium majus, with the usual local and general symptoms of inflammation. The condition may be bilateral. Suppuration is common.

TREATMENT.—This consists of the application of fomentations to the vulva. If suppuration occurs, the abscess should be incised, or the gland may be dissected out.

Stricture of the Urethra.

{ A stricture is a persisting diminution in the calibre of the urethra at one place, due to the formation of cicatricial tissue or to a congenital abnormality. Two or more strictures may be present in the same urethra.

This definition of stricture excludes the so-called congestive and spasmodic strictures which are not strictures in the ordinary meaning of the word. The term "congestive stricture" was applied to the inflammatory swelling of the mucous membrane of the urethra in urethritis, or to swelling of the prostate and prostatitis which causes difficulty in passing urine and sometimes acute retention. The treatment consists of treating the urethritis or prostatitis, and drawing off the urine by catheter as often as is necessary. The term "spasmodic stricture" was used to denote conditions of spasm of the

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1141

compressor urethræ or the constrictor fibres at the base of the bladder, associated with retention of urino. It occurs in inflammatory condition of the base of the bladder and prostatic urethra, or in neuroses, and has already been considered (p. 1126).

CAUSE.—Strictures of the urethra may be classified into congenital, traumatic, and inflammatory:

1. *Congenital Strictures*, which are rare, are due to abnormalities of development of the urethra. They are most common near the external meatus.
2. *Traumatic Strictures* are due to contraction of the fibrous tissue resulting from the healing of wounds, or rupture of the urethra. They are most commonly situated in the membranous and bulbous urethra, and usually involve the floor. They develop rapidly after an injury, and are very dense, resilient, and difficult to treat.
3. *Inflammatory Strictures* follow inflammatory conditions—generally gonorrhœa—of the urethra. These include about 90 per cent. of all cases. The cicatricial tissue may follow loss of the mucous membrane of the urethra from ulceration or the formation of a granular patch, or it may be due to infiltration of the submucous tissue with inflammatory exudates without loss of the covering epithelium.

The stricture is most commonly situated in the bulbous urethra, and may involve the sides, floor, or roof of the urethra (most frequently the floor) or completely encircle the tube (annular stricture).

Inflammatory strictures may first be evident years after the original urethritis. Their formation is favoured by the severity of the attack, the persistence of the inflammation, and recurrent attacks. The use of *strong caustics* which destroy the epithelium of the urethra also favour the formation of a stricture.



FIG. 503.—STRICTURE OF THE URETHRA.

PATHOLOGICAL ANATOMY.—*At the site of the stricture* there is the presence of fibrous tissue, which may be dense and invade the sub-mucous and muscular tissue, or be so delicate that, on laying open the urethra, its presence is only determined with difficulty. This fibrous tissue may be covered with epithelium or with granulation tissue, and in the latter case there is a constant urethral discharge (gleet). Small polypoid growths are not uncommon at the site of the stricture.

In Front of the Stricture.—The urethra is normal except that the openings of false passages may be seen if attempts have been made to pass catheters.

Behind the Stricture.—The urethra is dilated, and the glands opening into it are also distended. This part of the urethra is often chronically inflamed, and peri-urethral suppuration is common.

The Bladder is at first hypertrophied and contracted from the increased force necessary to micturate, but it gradually becomes dilated as the difficulty increases. The final condition is a dilated bladder, the muscular walls of which have undergone fibrosis, so that it forms a big, dilated fibrous sac, frequently with diverticula, instead of an actively contracting muscular organ. Cystitis usually occurs at some time from infection during catheterization.

The Ureters remain normal for a long time owing to the protection afforded by their valves in the bladder wall, but as the back-pressure increases they become dilated and their muscular walls fibrous. Ureteritis also follows if cystitis is present.

The Pelves of the Kidneys are dilated, and the parenchyma fibrous, so that a condition of double hydronephrosis with renal insufficiency develops. With the advent of cystitis there is frequently an ascending infection, and the patient has pyelitis and pyelonephritis.

CLINICAL FEATURES.—The early symptom is difficulty of passing urine, which is relieved by straining. The stream is small and the time occupied in micturition increased. There is frequently dribbling away of a little urine after the act is apparently over, due to retention of the urine in the dilated pouch above the stricture. Forking of the stream has no diagnostic value. As the stricture becomes further contracted, or the muscular power of the bladder diminishes, the bladder is not emptied by the act of micturition, and *frequency* occurs. This may be increased until there is constant dribbling of urine with a distended bladder (incontinence of overflow).

When hydronephrosis develops, the usual symptoms of renal insufficiency—thirst, polyuria, dry skin, headache, and vomiting—occur.

At any time while the stricture is present acute retention of urine, or infection of the urinary tract, may occur. A stricture is frequently associated with herniæ, prolapse of the rectum, and piles produced by the straining efforts to pass the urine.

If the urethra is very much narrowed, the ejaculation of semen is difficult, and it either flows slowly out of the urethra or is regurgitated back into the bladder.

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1143

DIAGNOSIS.—The patient should be watched while he passes urine, and the amount of straining and the size of the stream noted. The course of the urethra should be examined, as it may be possible to feel the fibrous thickening.

With a patient lying down, a No. 10 olivary black catheter should be passed to determine the site of the stricture, and then smaller and smaller catheters or bougies passed until one just passes through the stricture and enters the bladder. On attempting to remove the catheter it is "gripped" by the stricture, a feature which is pathognomonic. A tube of the urethroscope may then be passed down to the stricture, and its face examined, so that its shape and position may be determined, and lastly its calibre may be measured by means of a urethrometer.

TREATMENT.—The following methods are employed: Gradual dilatation, continuous dilatation, internal urethrotomy, external urethrotomy, excision.

1. *Gradual Dilatation.*—By this is understood the passage of catheters of gradually increasing size at intervals of three or four days, no anaesthesia or interruption of the patient's usual life being necessary. Gradual dilatation may be used for any form of stricture through which an instrument can be passed. It is best suited for recent strictures which are not too firm and resilient, and in patients who do not wish to lie up or who are unsuitable for an anaesthetic. The urethra must tolerate the frequent passage of instruments, and there should be no marked degree of cystitis or renal insufficiency present.

The instruments used should be French olivary black catheters or bougies, or in the case of large strictures, metal instruments such as Lister's steel bougies are satisfactory. The bougie of a size that will just pass through the stricture with a slight amount of force should be found, and then left in for five minutes. It should then be removed and the next size passed, and so on, three or four bougies being passed at each sitting, but practically no pain, and certainly no hæmorrhage, should be caused.

The sittings should be at intervals of three or four days, and the size of the bougies gradually increased until the largest that the urethra will admit is reached.

The **AFTER-TREATMENT** is important. A bougie must be passed at certain intervals, so that the calibre which has been reached may be maintained. The length of the interval must be ascertained for each stricture. At first two weeks is sufficient length of time, and it is usually unwise to go beyond a month, although in some cases the passage of a catheter once a year is sufficient.

2. *Continuous Dilatation* is useful in the early stages of treatment of very tortuous and narrow strictures, in which great trouble has been experienced in passing a catheter. A small catheter is passed and tied into the urethra, the patient of course remaining in bed. After twelve or twenty-four hours it will be found to be quite loose and should be removed, and a previously prepared larger one at once introduced and secured.

This treatment should be continued until a fair-sized catheter (No. 6, English) can be easily passed, and then the treatment may be continued by gradual dilatation. This form of treatment should not be used if the urine is sterile, for a certain amount of urethritis and cystitis is always set up by the catheter. If a fine bougie only can be passed in the first instance, it should be tied in in the same way as a catheter, for the urine will find its way along the sides of it even when it seems at first to be tightly gripped.

3. *Internal Urethrotomy*.—This method of treatment is quick and precise, but leaves a wound in the urethra. It requires an anæsthetic and rest in bed for about a week. It is most valuable in tough and resilient strictures when dilatation fails, and in patients with irritable urethræ who cannot bear the pain of dilatation. It is to be advised in penile strictures in young subjects with clear aseptic urine.

The operation is dangerous if there is marked cystitis, and is absolutely contra-indicated in cases of peri-urethral suppuration and renal insufficiency.

It cannot be performed unless the stricture will admit the pilot of the urethrotome. Cases which will not do this, but are otherwise suitable for the operation, should be treated by rest in bed and the use of urinary antiseptics and sedatives for a week, and then a second attempt may be made to pass the instrument.

The best-known instruments are those of Civiale, Maisonneuve, Berkeley Hill, Teevan, and Otis. The stricture may be divided from behind forwards or from before backwards.

With Maisonneuve's instrument the pilot is passed through the stricture, and the guide is then screwed into the pilot and pushed onward, the pilot curling up in the bladder. The knife is then passed along the guide and the stricture divided. The knife and then the guide and pilot are withdrawn, and a full-sized Lister's bougie passed through the divided stricture into the bladder.

Stress is sometimes laid upon the question as to whether the floor or the roof of the urethra should be divided. This is really of no importance, although it is advisable to divide the densest part of the stricture. Besides the risk of hæmorrhage and sepsis, there is often a condition of chordee for some time after the operation, although this passes off in a few weeks as a rule, but a permanently bent condition of the penis during erection may remain.

AFTER-TREATMENT OF INTERNAL URETHROTOMY.—A catheter may or may not be tied in the bladder after the operation. If one is left in, it is usual to remove it after twenty-four hours, and a large stout bougie (Lister's) should be passed every other day at first. At the end of a week the patient should be taught to pass the bougie himself.

Some patients readily learn to pass a steel instrument, which can be easily boiled and so rendered sterile, but may cause damage to the urethra. It is perhaps safer to give a patient a Cox's bougie of large size (No. 22, French). He should be told to pass it at first once a week, and later at increasing intervals. It is, however, impossible to give fixed times in all cases for passing an instrument. Some strictures

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1145

are much more resilient than others, requiring the instrument to be passed after shorter intervals.

A patient should be warned that if at any time he cannot pass his instrument he should consult the surgeon at once. (For method of sterilizing catheters, see p. 1162.)

If no instrument is left in the urethra, no interference should take place for seven or ten days, and then a Lister's steel bougie (Nos. 13 to 15, English) should be passed. After this the patient should be taught to use his own instrument.

Apart from sepsis, which is common to all urethral and bladder operations, the chief danger is excessive hæmorrhage.

Should this occur, a large steel bougie should be passed, and tied into the urethra; a pad is then placed on the perineum and firmly bandaged, so that the vessels in the urethra are compressed between it and the bougie. An icebag may be substituted for the urethral pad. If the bleeding still persists, it may be necessary to perform an external urethrotomy.

Epididymitis from the passage of septic matter along the vas to the epididymis may occur as a complication. Suppuration is much more probable in these cases than in the more common gonorrhœal epididymitis.

The usual treatment of epididymitis should be carried out (see p. 1186), and if pus forms, a free incision should be made and the scrotum drained.

4. *External Urethrotomy*.—This operation is performed by two distinct methods, varying if an instrument can be passed or not.

In the first case a grooved staff is passed through the stricture, and the section is made upon this. In the second the surgeon cuts through the stricture without a guide.

The operation is suitable for cases (1) in which no instrument can be passed; (2) with very septic urine; (3) when drainage of the bladder is desirable; (4) when perineal abscess or extravasation is present; (5) when numerous false passages exist.

(1) *Syme's Operation*.—External urethrotomy in which an instrument can be passed is very simple. A Syme's staff is passed through the stricture, and a small incision is made through the perineum into the groove, dividing the stricture. The perineal incision need not be more than $\frac{3}{4}$ inch long in a simple case.

AFTER-TREATMENT.—A tube is placed through the wound just inside the bladder and a dressing adjusted, with a little gauze packed round the tube. The gauze packing is removed in forty-eight hours, and the tube at the end of four to six days, unless some vesical complication calls for more prolonged drainage. A large-sized Lister's bougie is passed on the eighth day, and then again at the end of the second week, and then once a week or so till the urethra is thought to be thoroughly healed. If everything goes well, the patient can leave his bed about the twelfth day, and his room on the sixteenth.

Cases complicated with fistula, abscess, etc., require longer rest in bed, for healing will not be so rapid.

(2) **Wheelhouse's Operation.**—When no staff can be passed through the stricture, Wheelhouse's external urethrotomy should be performed. The patient is placed in the lithotomy position, and Wheelhouse's staff passed down to the stricture. The staff is held with the groove forwards, and the surgeon cuts upon it in the middle line of the urethra, making an incision $1\frac{1}{2}$ inches long. The staff is now pushed out of the wound and turned round, and then drawn upwards, so that the hook catches the upper angle of the wound. The edges of the urethra are then caught with artery forceps, and the interior exposed. It can be recognized by its smooth, shining surface. The orifice of the stricture should now be sought with a probe, and if difficult to find, the urethra should be slit *forwards* for a short distance, as the staff may have been pushed into a pouch or false passage beyond the stricture. No pains should be spared to find the proper opening. After a probe has found the orifice, a probe-pointed director is passed, and the stricture slit up from before backwards. Teele's gorget is then passed, and a catheter can easily be guided along this into the bladder. The catheter should be tied in for three or four days, and after this the treatment is the same as after Syme's operation.

In some cases in which failure has attended every other means of passing an instrument through the stricture, suprapubic cystotomy has been performed, and a catheter passed from above.

5. **Excision.**—Excision of the stricture with or without urethral grafting is sometimes very successful in instances of dense resilient strictures, especially those following trauma, but the cases must be very carefully selected. The operation is seldom attempted, as the results of urethrotomy are so good.

COMPLICATIONS OF STRICTURE

1. **Acute Retention of Urine.**—Acute retention of urine with a stricture is due to—(1) Congestion of the base of the bladder from prolonged holding of the urine, especially after alcoholic excess; (2) congestion of the urethra from instrumentation; (3) a fresh attack of gonorrhœa; (4) lighting up of an old gleet from sexual excess or alcoholism.

SYMPTOMS.—Acute pain and discomfort in the lower abdomen, the patient is unable to pass his urine, and presents the physical signs of a distended bladder—a rounded tumour, cystic in feel and dull on percussion, lying in the middle of the hypogastrium and arising out of the pelvis. It may reach as high as the umbilicus, but the flank remain resonant.

TREATMENT.—If retention has not continued very long, an attempt should be made to pass a small catheter. This will often be facilitated by distending the urethra with a drachm of sterile oil or by the injection of a 10 per cent. solution of cocaine. If this should fail, the patient should be given a full dose of opium, and placed in a hot bath in which he will often pass urine, or a catheter can again be tried. If only a very small one can be passed, it should be tied in for forty-eight hours, the patient being kept in bed, and then dilatation

proceeded with in the usual way. If no catheter can be passed, preparation should be made for Wheelhouse's external urethrotomy; but before this operation is done an attempt should be made to pass a catheter under anæsthesia. This will usually succeed, and the stricture can be treated by dilatation, continuous or gradual, or internal urethrotomy. If it fail, the operation of external urethrotomy should be proceeded with (see p. 1146).

With cases in whom it is not convenient to attempt at once the somewhat difficult operation of Wheelhouse, the retention can be relieved in two ways—(1) By aspiration of the bladder suprapubically; (2) by opening the urethra behind the stricture.

Aspiration is the simplest and safest method of giving relief. The skin above the pubes is shaved and prepared as for an operation. The trocar of a Dieulafoy aspirator is passed directly above the pubes in the middle line in a backward and slightly downward direction. The urine is then drawn off.

After this relief the patient should be confined to bed, a morphia suppository given, and a brisk saline purge. It will usually be possible in a few hours to pass a catheter, or aspiration may be repeated two or three times.

When constant surgical attention is not available, the bladder may be punctured with a trocar and canula above the pubes, and the canula left in the bladder until the stricture can be efficiently treated.

Opening the Urethra behind the Stricture.—This operation (Cock's perineal section) is rarely required, but it should be performed as an emergency operation in those cases of stricture complicated by retention and commencing extravasation of urine or perineal abscess.

In these cases incision into the dilated urethra behind the stricture will not only relieve the patient from the distress and danger of retention, but will afford a free exit for pus or extravasated urine.

Cock's Operation.—The patient is placed in the lithotomy position, and the surgeon introduces the left forefinger into the rectum, resting it against the apex of the prostate. The point of a scalpel (Cock advised a double-edged one) should be plunged into the centre of the perineum towards the finger in the rectum, keeping accurately in the middle line. As soon as the point of the knife is felt under the mucous membrane of the bowel, the direction is changed to upwards and forwards, and a gush of urine along the knife shows that the bladder has been entered. A director is passed along the blade of the knife into the bladder, and along this a tube is guided and sutured in the wound.

In cases with perineal abscess and extravasation of urine the operation is simpler than that described, as a free opening of the abscess will expose the sloughing urethra.

The stricture must always be subsequently treated, or a permanent fistula will remain.

2. Peri-Urethral Abscess.—Peri-urethral abscess behind a stricture usually arises in connection with suppuration in one of the glands of Littré or in Cowper's glands. The condition may be acute or chronic.

CLINICAL FEATURES.—The patient, who is known to have a stricture, or who has difficulty in passing urine, complains of pain and swelling in the perineum and increase in the difficulty of micturition.

On examination, a tender swelling is felt in the perineum round the urethra, the skin over it being red and œdematous. Fluctuation is very hard to detect in the early stages. The usual general signs of infection are present.

These abscesses tend to burst both into the urethra and externally, so that a fistula results. The frequency with which the abscess is the starting-place of an extravasation of urine is of more importance.

TREATMENT.—An incision should be made in the middle line of the perineum and the abscess laid freely open, the stricture being divided if possible at the same time. All loculi should be broken down, and if the abscess is chronic, the walls should be scraped. The cavity should be allowed to granulate up from the bottom, firm packing being used to avoid healing taking place too rapidly and so causing fistulæ. Careful attention must be given to the stricture.

3. Extravasation of Urine.—This is usually one of the sequela of stricture, and is invariably due to suppuration occurring in the urethra behind the stricture.

CLINICAL FEATURES.—Extravasation of urine may be acute or chronic. In the former case the dilated and inflamed portion of the urethra behind a stricture suddenly gives way during a violent effort at micturition. The patient complains of a sudden cutting pain, and the urine is extravasated, with rapid swelling of the perineum, scrotum, and penis.

In chronic extravasation the process is gradual, and preceded by the formation of a perineal abscess. The swelling will not be marked for several days.

The part of the urethra that gives way is almost invariably the membranous portion of the canal between the two layers of the triangular ligament, and the urine bursts through the anterior layer and lies beneath Colles's fascia (the deep layer of the superficial fascia of the perineum). This is firmly attached behind to the posterior border of the triangular ligament, and at each side to the rami of the ischium and pubis. Directly forwards it is continuous with the dartos in the scrotum and penis, and then passes on to the abdomen between the pubic spine and the symphysis, becoming continuous with Scarpa's fascia (the deep layer of the superficial fascia of the abdomen).

Scarpa's fascia is attached to the pubic spine, and then to the thigh just below Poupart's ligament. The extravasated urine therefore passes into the perineum, distends the scrotum and penis, and passes up to the abdomen along the spermatic cords. The attachments of the fascia prevent the urine from entering the thighs.

Occasionally it will pass through the posterior layers of the triangular ligament and infiltrate the cellular tissue round the base of the bladder and the cave of Retzius.

As the urine is nearly always septic and very irritating, the vitality

of the tissue with which it comes into contact is rapidly destroyed, and the parts present the appearance of a rapidly spreading, gangrenous cellulitis. Sometimes the anatomical boundaries are broken through, and sloughing may take place in the ischio-rectal fossæ, leaving the rectum bare.

At the same time the patient suffers from the general symptoms of acute septic poisoning.

TREATMENT.—The patient should be put in the lithotomy position, and a deep median incision made into the perineum, opening the urethra behind the stricture. A tube should be introduced into the bladder, so that further extravasation is prevented. Free incisions are then made into the swollen œdematous tissue of the perineum, scrotum, penis, and



FIG. 504.—INCISIONS FOR EXTRAVASATION OF URINE.

lower abdomen, so as to let out the extravasated urine. These incisions should be along the course of the vessels and free enough to need no drainage-tubes (see Treatment of Suppuration, p. 81); they should reach the deep fascia.

Instead of perineal drainage some surgeons now prefer suprapubic cystotomy and drainage combined with free incisions into the inflamed tissue. This relieves the retention, secures a path of exit for deep-seated extravasation, if this be present, and allows of the operation of retrograde catheterization and division of the stricture, at the time of the operation in early cases, or subsequently in more advanced cases. It is claimed to be safer than perineal section, and, from the careful treatment of the stricture, less likely to be followed by perineal fistulæ.

After the incisions the usual treatment of extensive suppuration is carried out, with fomentations, baths, etc.

Sloughing of the skin and subcutaneous tissue is common, and the testicles are frequently exposed, but skin-grafting is rarely needed in these cases.

The stricture must receive constant attention during the convalescence, and the usual after-treatment of an external urethrotomy must be carried out.

Stricture in the Female.—Stricture is much rarer in the female than the male, and most often results from injury received during childbirth or during operations on the vagina, vulva, or bladder.

The symptoms are difficulty in passing urine and burning pain in the urethra. The diagnosis is made by passing catheters.

TREATMENT.—The urethra should be gradually dilated with one of the many forms of urethral dilators. Internal urethrotomy is sometimes necessary for very dense strictures.

Urinary Fistulae.—Acquired fistulae in the male are—(1) Urethro-rectal; (2) perineo-scrotal; (3) penile.

1. **URETHRO-RECTAL FISTULÆ** result from—(1) Suppuration in the prostate; (2) injury and fracture of the pelvis; (3) ulceration or new growth either in the prostate, rectum, or urethra. The usual result of the fistula is for the urine to find its way into the rectum, but occasionally faeces and flatus pass into the urethra.

TREATMENT.—This consists of dilating the urethra fully and cauterizing the opening in the rectum. With the exception of fistula following prostatic abscess, the prognosis is bad.

2. **PERINEO-SCROTAL FISTULÆ.**—In the great majority of cases these are due to suppuration occurring behind a stricture with or without extravasation of urine. They frequently follow the operation of external urethrotomy when suppuration has been previously present.

The diagnosis is obvious.

TREATMENT.—The stricture should be fully dilated and the external opening of the fistula cauterized. This will suffice if the fistula is recent and there is no dense induration of the tissues. In old-standing cases, after the urethra has been fully dilated, the fistulous tracts must be thoroughly opened up, and, if necessary, a plastic operation performed to restore the calibre of the urethra. A catheter should be tied into the bladder until healing is advanced.

3. **PENILE FISTULÆ.**—These fistulae are also generally found behind a stricture, though they may follow lacunar abscesses, phagedenic ulceration, or carcinoma of the penis.

TREATMENT.—If the fistula is a simple one, dilatation of the stricture and cauterization of the external opening will usually effect a cure; but if there is loss of substance, a plastic operation will be necessary. For fistula in connection with carcinoma there is no treatment but removal of the penis.

Urinary or Catheter Fever.—By this term is understood a condition of pyrexia generally associated with rigors following instrumentation of the lower urinary passages.

CAUSE.—Although it is possible that in some cases this may be a nervous phenomenon, there is no doubt that in the great majority of cases urinary fever is due to absorption of bacteria or bacterial toxins from the urethra. It is particularly prone to occur if cutting operations on the urethra are carried out, or if the kidneys are diseased, a condition which renders the patient more liable to infection.

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1151

The following types may be recognized;

1. A single rigor usually occurring some hours after the instrumentation, and frequently after the first passage of urine after the operation. The patient is well in forty-eight hours.
2. A single rigor followed by a continuous rise of temperature lasting four or five days, the temperature falling by lysis.
3. A succession of rigors at irregular intervals with severe general symptoms usually ending in death. On post-mortem examination extensive suppuration is usually found in the perirectal tissues.
4. A rigor followed by acute suppression of urine, the patient dying in one or two days. This generally follows internal urethrotomy performed on a patient with peri-urethral suppuration or severe cystitis.
5. Rigors occurring at irregular intervals after the passage of a catheter in a patient with enlarged prostate, and over-distended bladder, and back-pressure kidneys. The patient passes into a condition of low, wandering delirium, with a dry tongue, almost complete suppression of urine, and vomiting. Death occurs in about a week in a large majority of these cases.

TREATMENT—Prophylaxis.—A patient before instrumentation of the urethra should be given urinary antiseptics, especially if the urine is already infected. Many surgeons also give a prophylactic dose of quinine. All the instruments used should be carefully sterilized and the urethra washed out. Dilute silver nitrate solutions may be applied to the urethra after cutting operations.

If urinary fever occurs, urinary antiseptics, diuretics, and blaud drinks should be given freely, and the usual general treatment of an infective condition carried out. The bladder should be drained by a catheter tied into the urethra or suprapubically.

Tuberculosis of the Urethra.—Tuberculous inflammation of the urethra is always secondary to tuberculosis of the bladder, vesiculae, or prostate.

It may cause a discharge from the urethra in which tubercle bacilli have been found.

NEW GROWTHS

Papillomata are most commonly found in the penile urethra, and are often associated with stricture and chronic urethritis. They cause a constant slight discharge from the urethra, and a little urethral hæmorrhage or some obstruction in passing urine. They are diagnosed by the urethroscope and removed through the tube of the instrument by scissors, snare, or galvano-cautery.

Carcinomata of the urethra usually occur in the bulbous urethra, and are frequently associated with stricture or fistula, but the condition is very rare. As a rule the growth is a squamous-celled carcinoma.

SYMPTOMS.—Difficulty of micturition, slight hæmorrhage, and the presence of a palpable tumour along the course of the urethra. Later, fistula formation and involvement of the inguinal glands occur. Early diagnosis is made with the urethroscope.

TREATMENT.—Complete removal of the penis is usually the only treatment possible, but with early diagnosis growths in the posterior part of the urethra have been successfully treated by resection of the urethra.

PROSTATE

Injuries.—The only common injuries of the prostate are those inflicted during catheterization and other instrumentation of the urethra. When the prostate, and especially the middle lobe, is enlarged, a metal catheter may be pushed through it, causing considerable hæmorrhage, and the urine removed in this way. No treatment is necessary.

Congenital Abnormalities.—Congenital abnormalities of the prostate are so rare as to be pathological curiosities.

INFLAMMATION OF THE PROSTATE

Acute Prostatitis.—The common cause of acute prostatitis is extension along the ducts of the gland of an acute urethritis, usually gonorrhœal, but it may occur during the course of one of the acute specific fevers.

CLINICAL FEATURES.—A patient who has a urethral discharge suddenly has frequent and painful micturition, the pain being most marked at the end of the act, associated with the usual general signs of infection. On examination, the urine is found to contain "comma"-shaped threads of pus and epithelium, the prostate is enlarged and very tender, and the mucous membrane of the rectum is red and inflamed. If the prostatitis is severe, there is strangury or acute retention of urine, and pain on defæcation.

The terminations are resolution or suppuration. If suppuration occurs, the symptoms become more acute, and there is retention of urine requiring regular catheterization; fluctuation may be detected *per rectum*. In the majority of cases, however, the abscess points in the urethra, and is frequently opened by the passage of the catheter, a sudden pain and gush of pus indicating what has happened. The abscess may also burst into the rectum, or point in the perineum or in the ischio-rectal fossa.

After a **prostatic abscess** has burst into the urethra it may heal, but more commonly the opening is insufficient, and the suppuration continues, the patient suffering from a constant gleet. Gonocœcc may be found in such a discharge years after the original attack.

TREATMENT.—During an attack of acute prostatitis all local treatment of the urethra should be stopped, and the patient treated by rest in bed, the application of heat to the perineum and rectum, and the administration of urinary antiseptics. The bowels should be kept

freely acting by accidents, and if there is retention of urine, the bladder should be emptied by the regular passage of a soft rubber catheter. Morphia is usually necessary to relieve the pain. If suppuration occurs, the abscess should be opened by a perineal incision, care being taken not to open the urethra in front of the prostatic portion. The gland should be divided in the middle line until the urethra is reached, and the abscess cavity freely explored by the finger, all loculi being broken down, so that there is one cavity that can be freely drained.

This treatment should also be carried out if the abscess has burst into the urethra and there is not thorough and efficient drainage. After the operation the patient passes his urine by the perineal wound, but this rapidly closes, and the final result is satisfactory. Sterility does not as a rule follow suppuration and incision of the prostate, but it may do so from obstruction of the common ejaculatory ducts by fibrous tissue during healing.

Chronic Suppurative Prostatitis.—Chronic suppuration in the prostate is either secondary to a chronic urethritis or follows an acute prostatitis. The organism most frequently present is the gonococcus, but there is usually a mixed infection. Two varieties may be distinguished—(1) A chronic suppuration occurring in the ducts of the prostate with interstitial fibrosis of the gland, the pus being squeezed through the ducts and appearing in the urine as comma-shaped threads; and (2) a chronic abscess of the prostate, either secondary to an acute abscess that has burst into the urethra or suppuration round a prostatic calculus.

CLINICAL FEATURES.—The patient, who usually gives a past history of gonorrhœa, complains of a chronic urethral discharge (gleet), which is usually most abundant in the morning. There may also be a feeling of weight and fulness in the perineum, irritability of the sexual function with nocturnal emissions, and difficulty of micturition due to spasm of the constrictor urethræ muscle.

The diagnosis is made by a careful examination of the urethral discharge and the conditions which increase it. The patient should be made to pass half his urine into a glass, and the prostate, which is often slightly enlarged and tender, is then massaged. The remainder of the urine is then passed, and it will be found to contain a much more abundant discharge and more prostatic threads than the first-passed urine. Cystoscopic examination may show the trigone of the bladder to be inflamed.

TREATMENT.—Chronic suppurative prostatitis owes its importance to two factors—(1) The discharge generally contains the gonococcus, and is capable of causing an acute infection, so that as long as the discharge continues and contains this organism, marriage should be forbidden; and (2) the tendency of these patients to develop a sexual hypochondriasis. The patient often mistakes the urethral discharge for semen, and this and the frequency of nocturnal emissions makes him fear loss of virile power, and concentrates his thoughts on his sexual functions, and as a consequence he becomes neurasthenic.

The treatment in the first place consists of the treatment of chronic

urethritis and urethral stricture if either of these conditions is present, and the administration of urinary antiseptics and sedatives. When there are abundant threads in the urine, massage of the prostate is the only efficient and rational treatment of the condition, as by this means the prostate is emptied of its pathological secretion. The massage must be continued regularly, often for months, but will generally result in cure.

On the other hand, if the condition is one of chronic abscess of the prostate with inefficient drainage or suppuration around a prostatic calculus, the abscess cavity must be freely opened and drained from the perineum. If a calculus is present, it must of course be removed.

Local treatment of chronic prostatitis by massage should not be too prolonged, as it tends to establish the condition of sexual neurasthenia. If this complication appears to be supervening, all local treatment should be stopped, and the patient assured that the condition is really a trifling one which has little effect on the general health, and that loss of virility is not to be feared. Sexual neurasthenia should be treated by work, exercise, social intercourse, and common sense.

Prostatic Calculi.—Two different conditions have been described under this term: (1) Calculi in the prostatic urethra, and (2) calculi in the prostate. In the first condition the stones which come from the bladder, kidney, or prostate become impacted in the prostatic urethra, and cause more or less frequency and difficulty of micturition. They should be removed either by pushing them back into the bladder and crushing them with a lithotrite, or by perineal prostatectomy. The second variety is the true prostatic calculus formed in the prostate itself.

These calculi are formed by the infiltration by lime salts of small bodies that are found in every adult prostate, the corpora amy-lacea, which consist of inspissated secretion, epithelial cells, and lecithin. The calculi are usually small and multiple, over a hundred being met with in some cases; a calculus has been known to weigh as much as 100 grammes. They chiefly consist of phosphates, oxalates, and carbonates of lime, and give a well-marked shadow with the X rays.

CLINICAL FEATURES.—Prostatic stones may be passed *per urethram* without any other symptoms, or may be discovered at autopsy. If symptoms are present, they are those of prostatic urethritis and cystitis of the base of the bladder, the stone having ulcerated through into the urethra, or those of abscess of the prostate, suppuration having occurred round the stone. Hæmaturia is sometimes present.

On examination *per rectum*, especially if this is done bimanually under an anæsthetic, the stone may be felt, and if there are several, they may be felt to grate together. If the stone is projecting into the urethra, a sound passed along the urethra will strike the stone as it enters the bladder, and the stone does not move its position. A radiogram may show the presence of prostatic stones, positive evidence only being of value.

URETHRA, PROSTATE, AND VESICULÆ SEMINALES 1155

TREATMENT.—Stones in the prostate should be removed either through an incision in the perineum or by incising the prostate through the suprapubic route. The former is the operation most commonly performed, and after all the stones have been removed the wound is drained. Unfortunately there is a great tendency to recurrence. If an abscess is present round the stone, it should be opened by the perineal route, the stone removed, and the abscess cavity drained.

Tuberculosis.—Tuberculosis of the prostate is usually associated with tuberculosis of the kidneys, bladder, vesiculæ, and testes, and is most commonly met with in young adults. Amongst the important local predisposing causes is believed to be chronic prostatitis due to the gonococcus, but probably of mere importance is the inherited predisposition to tuberculosis.

Invasion of the gland by the tubercle bacillus usually starts at the periphery near the prostatic plexus of veins, and gradually spreads towards the centre. The tuberculous nodules degenerate and coalesce to form chronic tuberculous abscesses, which may point in the rectum, perineum, or urethra.

CLINICAL FEATURES.—The patient complains of pain, frequency, and difficulty of micturition, and sometimes of the presence of pus and blood in the urine and semen, the hæmaturia being slight and most marked at the end of micturition. In other cases the disease is latent, and the condition is only discovered during the routine examination of the prostate in a case of tuberculosis of the kidneys or testes. In a third clinical variety of the disease the patient comes for treatment for a soft fluctuating swelling in the perineum. A urethral discharge may be present if the tuberculous abscess has opened into the urethra.

On examination of the prostate *per rectum*, it is felt to be enlarged and nodular, the nodules being small and scattered all over the gland, or one or more soft fluctuating swellings may be present. The other parts of the genito-urinary tract should be examined for tubercle, and a bacteriological examination made of any discharge from the urethra, or of any secretion that can be squeezed out of the prostate by massage. Examination of the urethra by the urethroscope, or of the prostate by the cystoscope, is of little value, and may cause hæmorrhage.

The **PROGNOSIS** is unfavourable.

TREATMENT.—In the majority of cases the treatment is palliative, but it may occasionally be advisable to attempt removal of the prostate and vesiculæ when the disease is chiefly localized in these organs. Abscesses should be opened from the perineum, and the walls thoroughly scraped, but fistula formation frequently follows the operation. These fistulæ have to be scraped from time to time.

General treatment includes the giving of urinary antiseptics and the injection of tuberculin. Catheterization with a soft catheter may be necessary to relieve retention of urine, but as a rule it cannot be borne, and if retention occur, the bladder must be drained suprapubically. Local applications to the prostatic urethra are useless, and in the majority of cases are harmful.

Syphilis of the Prostate.—Gumma of the prostate may occur in tertiary syphilis, but is rare. The symptoms closely simulate those of carcinoma of the prostate, but the disease usually occurs at a younger age, and there is frequently a urethral discharge, a symptom seldom seen with malignant disease. The possibility of gumma of the prostate should be considered if a man below the age of fifty has the symptoms and physical signs of carcinoma, and gives a history of syphilis, or has a positive Wassermann's reaction.

Antisyphilitic treatment should be tried before operation is advised.

Chronic Enlargement

Chronic enlargement of the prostate is a condition occurring in men who are over fifty years of age in which the prostate is enlarged, but the exact pathology of the enlargement is obscure.

PATHOLOGY.—Examination of the prostate most commonly shows a diffuse overgrowth of the glandular element (adenomatosis), but there may be a diffuse overgrowth of the fibromuscular tissue (fibromyomatosis), or localized adenomata, or fibromyomata; lastly, these conditions may be combined in the same prostate. The whole of the prostate may be enlarged, the gland weighing as much as 250 grammes (the normal weight being 20 grammes), or the enlargement may be more localized, affecting chiefly the lateral or the median lobes, the latter being the more important on account of the interference with micturition. An enlarged median lobe projects into the bladder as a spherical mass on the posterior lip of the orifice of the urethra, or as a collar surrounding the urethral orifice, except at the anterior margin, the anterior commissure of the gland being rarely affected.

If the enlargement is chiefly adenomatous, the gland is soft and fleshy; but when the enlargement is fibromyomatous, the gland is firm, and enucleation is difficult. The following theories have been held as to the cause of the enlargement:

1. The condition is neoplastic, the new growths being either adenomata or fibromyomata; in the latter case the tumours have been believed to arise in the walls of the uterus masculinus.
2. It is a result of chronic inflammation of the gland, due in the majority of cases to gonorrhœa.
3. It is a hyperplasia of the gland tissue, associated with sexual excesses and irregularities.
4. French pathologists have considered it as part of a generalized arterio-sclerosis, or a localized arterio-sclerosis chiefly affecting the genito-urinary organs.

Much discussion has occurred as to whether the enlargement affects the gland itself or whether it is a tumour formation separate from the prostate, which is squeezed into a thin layer over the encapsuled new growth. From a practical operative point of view the discussion is unnecessary, as whichever view is correct the modern operation is always equivalent to a complete prostatectomy. Enlargement of the

prostate in itself is a matter of no importance, its seriousness entirely depending on the interference with the act of micturition.

Effects on the Urethra.—The urethra is lengthened by the upward growth of the gland into the bladder, downward growth being prevented by the strong unyielding triangular ligament, and the curve of the prostatic urethra is made more pronounced by the forward projection of the median lobe. The calibre of the urethra may either be increased by being stretched by the mass, or narrowed by the inward pressure of the lateral lobes, and if one of these lobes is more enlarged than the other, the urethra is made to deviate from the middle line.

Effects on the Bladder.—The muscular wall of the bladder at first hypertrophies, owing to the increased resistance met with in expelling the urine. As the patient is elderly this hypertrophy soon gives way to fibrosis of the muscular tissue, with dilatation of the bladder, and a tendency to form pouches of mucous membrane between the muscular strands. The orifice of the urethra being no longer the lowest part of the bladder owing to the projection upwards of the median lobe, there is a tendency to the formation of a post-prostatic pouch in which the urine may stagnate, and this predisposes to the production of a bladder-stone. The circulation at the base of the bladder is interfered with, and the veins become varicose. Rupture of one of these veins may cause profuse hæmaturia.

Effects on the Ureters and Kidneys.—When the sphincter action of the wall of the bladder gives way before the increasing pressure, the ureters and the pelves of the kidneys become dilated, and their muscular tissue atrophies. At the same time the increased pressure on the kidney tubules causes an interstitial fibrosis, so that a condition of double hydronephrosis gradually develops, which will result in renal insufficiency. Ascending infection will change the hydronephrosis into pyonephrosis, and this infection will always occur sooner or later. It usually follows instrumentation of the bladder to overcome retention of urine. The organism most frequently associated with the cystitis and ascending pyelitis is the colon bacillus.

Effects on the Sexual Organs.—The first effect is usually to cause irritation of the sexual organs, with increased sexual desire, but later sexual desire and power are diminished. The enlarged gland may press on the common ejaculatory ducts, and cause obstruction and



FIG. 505.—CHRONIC ENLARGEMENT OF THE PROSTATE.

aspermia, and sterility will result, with dilatation of the vesiculae seminales. In some cases prostatectomy may restore the lost sexual power.

CLINICAL FEATURES.—The patient, who is a man of fifty or over, complains of increasing *difficulty* and *frequency* of passing urine. The *difficulty* is usually most marked at the commencement of the act of micturition, and the patient discovers that straining increases the difficulty, so that he waits for the act to commence, and during the act does not contract the abdominal muscles. As a consequence of this and the increasing fibrosis of the bladder muscle, the stream has only a small projection. The difficulty is increased if the patient has to micturate in the recumbent position, and catheterization is frequently necessary if the patient has to remain in bed from any cause. The difficulty is also increased by any cause of congestion of the base of the bladder, such as sexual indulgence, cold, alcoholic excess, and overfilling of the bladder.

The *frequency* is most marked during the night, the patient having to rise several times to pass his urine, and there is usually nocturnal polyuria. As the enlargement increases, the bladder ceases to be emptied at each act of micturition, and the urine gradually accumulates in the bladder (residual urine). This accumulation may continue without the patient's knowledge until the bladder is constantly over-distended, and the patient has the incontinence of overflow. He will then complain of inability to hold his water, and the distension of the bladder is discovered on physical examination.

The increased irritability of the sexual organs, with erections of the penis, may lead to acts of impropriety, which possibly may end in prosecutions for indecent behaviour.

These symptoms may remain very slight for years, and the patient's health may not suffer in any way, but the increasing frequency leads to disturbance of sleep, and gradually the general health becomes impaired. As the kidneys become destroyed by back-pressure, there are signs of renal insufficiency—namely, headache, thirst, polyuria, and anorexia, with loss of flesh and strength. At first the blood-pressure is raised, but later it becomes lowered, and this lowering of the blood-pressure must be regarded as a serious symptom. At any time during the course of the disease infection of the urinary tract may occur, and the general symptoms of infection are then added to the symptoms due to the mechanical effects of the enlarged prostate.

EXAMINATION.—*On rectal examination*, two varieties of enlarged prostate may be distinguished—(1) a large, soft prostate, and (2) a firm, slightly enlarged prostate—but this method of examination gives little information of the amount of obstruction there is to micturition. Rectal examination only reveals the size and consistency of the lateral lobes, and it is on enlargement of the median lobe that the seriousness of the condition chiefly depends.

Urethral Examination.—The obstruction to the passage of an instrument due to an enlarged prostate is found about 7 inches from

the meatus just as the instrument is about to enter the bladder. The instrument is not gripped, but meets with a solid obstruction. By altering the curve of the instrument, or by using a coudé catheter, the obstruction may be easily passed, and it is often more easy to pass a large-sized instrument than a small one. If a metal catheter is used, it should be one with a large curve, and about 4 inches longer than the ordinary catheter. The increase in length of the urethra is estimated by noting the distance the catheter must be passed before urine flows, and the amount of projection of the median lobe is suggested by noting the extent to which the handle of a metal catheter must be depressed between the patient's thighs before the point enters the bladder. The calibre of the prostatic urethra may be measured by one of the various forms of urethrometers, such as Otis's or Moullin's, but the information given is of little value.

The amount of residual urine is estimated by passing a catheter, and measuring the amount of urine drawn off after the patient has apparently emptied the bladder naturally. One examination is not sufficient for this estimation, but the amount must be estimated several times under varying conditions, and the mean taken. If the amount of residual urine is over 8 ounces, it is better not to empty the bladder completely at one sitting.

The tone of the bladder muscle is estimated by the force with which the urine is propelled through a good-sized catheter, and how far it is influenced by the respiratory rhythm.

An estimation of the working capacity of the kidneys is made by a careful analysis of a twenty-four hours' specimen of the urine, by examining the blood-pressure, and by finding the hæmo-renal index (see p. 1192). Microscopical and bacteriological examination of the urine should also be made.

Examination of the urethra with the *urethroscope* has little value, but examination of the bladder with a *cystoscope* may show enlargement of the middle lobe, and will reveal the condition of the walls of the bladder and the orifices of the ureters.

COMPLICATIONS.—The most important complications of enlargement of the prostate are—(1) Sudden complete retention of urine; (2) cystitis, ureteritis, and ascending pyelitis; (3) hæmorrhage from a ruptured varicose vein at the base of the bladder; (4) stone in the bladder. Any of these complications, and especially acute retention of urine, may be the first symptom that brings the patient under observation, and their onset may alter the entire clinical features of chronic enlargement of the prostate.

TREATMENT.—In advising treatment for an enlarged prostate a careful consideration must be given to all the features of the case. The local condition should be fully investigated, the functioning power of the kidneys estimated, and the social position of the patient taken into account from the point of view of his ability to obtain careful aseptic catheterization.

The question of treatment may be considered under the following headings:

1. *Cases with Slight Symptoms.*—The patient should so regulate his life as to avoid all causes of pelvic congestion, such as alcoholic excess, constipation, bicycling, horseback-riding, and excessive sexual indulgence, and, above everything, he should avoid retention of urine in any degree. If it is necessary for him to take long railway journeys, or to attend long public meetings, he should make such arrangements that he can empty the bladder at the first call to micturate. Late meals, highly spiced food, liqueurs, and coffee, should be avoided, and the patient should drink freely of bland fluids. If an early prostatic will follow the rules of a simple and regular life, he may remain vigorous in mind and body for many years, and avoid both the necessity for catheterization and operation. It may be necessary in some cases to occasionally pass a catheter to get rid of residual urine or to overcome retention, but if this is done aseptically it is of little consequence.

2. *Cases with Obstruction necessitating the Frequent Use of Catheters.*
—If the prostate is large and soft, the urine is aseptic or only slightly

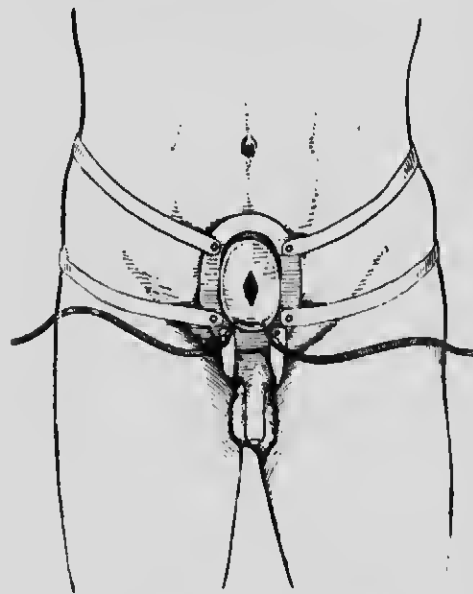


FIG. 506.—SUPRAPUBIC DRESSING.

infected, the kidneys are sound, and the general health good, operation should be advised, especially if the surroundings of the patient are such that aseptic catheterization is an impossibility. In many cases, also, it is not possible for the patient to live a catheter life, owing to the difficulty of passing a catheter, which may be followed by hæmorrhage and urinary fever (see p. 1150). The operation to be advised is complete prostatectomy either by the suprapubic or the perineal route.

Suprapubic Prostatectomy.—This is the operation of election, and has almost entirely superseded the perineal operation. The

bladder, after being distended so that it rises well above the symphysis pubis, is opened by a small median incision, and the condition of the prostate examined. The mucous membrane over the prostate is then incised, and the gland enucleated with the middle and fore fingers, aided by the fingers of the other hand placed in the rectum, and pushing the prostate upwards. The prostatic urethra and the common ejaculatory ducts are torn across. The hæmorrhage, which is rarely excessive, is stopped by sponge pressure, and the bladder drained. In the

after-treatment the bladder is washed out daily through the suprapubic wound, and after ten days through a catheter passed along the urethra. The tube is removed on the third day, the patient should pass urine naturally about the end of the second week, and the wound should be closed in about a month.

Perineal Prostatectomy.—The prostate may be exposed either by a median longitudinal or a transverse incision, and the gland enucleated with the finger, as in the suprapubic method. The bladder is drained by a tube, and the cavity left by removal of the prostate packed with gauze, which is taken out in forty-eight hours. The drain is removed in three days, and later the patency of the urethra must be maintained by the regular passage of bougies.

RESULTS OF OPERATION.—In carefully selected cases the mortality is about 7 per cent., but hospital statistics usually give a much higher mortality, as operation has to be advised in many cases which are not very suitable, on account of the impossibility of the patient obtaining proper catheterization. The causes of death are—(1) Hæmorrhage and exhaustion, (2) ascending pyelitis, (3) pelvic cellulitis and peritonitis, (4) suppression of urine. On the other hand, the result in the majority of cases is excellent, the patient regaining the power of voluntary micturition and avoiding the dangers of back-pressure on the kidneys and ascending infection, and it is not too much to say that this operation is the means of giving most prostaties a new lease of life.

The sexual power may be lost, and this is said to be more common after the perineal than the suprapubic operation, or the patient may retain the power of erection, but suffers from aspermia. In some cases lost sexual power is regained.

The following sequelæ sometimes occur: (1) Acute infective epididymo-orchitis ending in suppuration, (2) formation of a suprapubic fistula, (3) stricture of the urethra, (4) incontinence of urine, (5) the formation of calculi in the pouch left after the removal of the prostate.

3. Cases in which Operation is refused or contra-indicated by the General Condition of the Patient.—Under these circumstances the patient has to lead a catheter life.

CATHETER LIFE.—The catheter should not be passed more often than is necessary, and the frequency with which it must be passed varies very much in different cases. It may only be necessary to empty the bladder of residual urine at intervals of a month or more, while in other cases all the urine has to be voided by catheter. In these last cases catheterization twice a day is usually all that is necessary if care is exercised in drinking, but if the bladder is small, or there is much spasm, more frequent catheterization is necessary.

For routine emptying of the bladder, either by the surgeon or by the patient, the softest catheter that can be passed is the best. The catheter must be smooth, easily sterilized, and the end beyond the eye should be solid, so that no dirt can collect in it. Jaque's catheters are to be preferred, if they can be passed, as they are readily sterilized

by boiling, and their passage can hardly cause harm; but their use in enlarged prostate is limited by the difficulty of passing them.

Black gum-elastic eoudé or hi-coudé catheters are useful, and they are made so that they can be sterilized by boiling. They must not be boiled for more than three minutes, and care must be taken that they are quite straight when in the sterilizer.

English gum-elastic catheters with a stylet can frequently be passed when others fail. The stylet is curved, and the instrument passed down to the obstruction, and then the stylet is withdrawn a little way. This increases the curve of the catheter, and it passes gently over the obstruction.

Metal catheters are sometimes absolutely necessary. They should be made of silver, and have a large prostatic curve. It is better to restrict their use to the surgeon, but some patients, however, learn to pass them with ease. The size of the catheter used should be the largest that will readily pass the external meatus.

CARE OF CATHETERS.—The patient should have a number of catheters equal to the number of times he has to pass one in twenty-four hours. They should be kept in a glass catheter case, the best being one on a stand, and having a perforated plate to suspend the catheters from. Two such jars should be provided. One should be filled with boracic lotion, which should be changed daily, and the other should have at the bottom a piece of cotton-wool soaked in formalin.

After use, the catheter is thoroughly washed by passing a little soap solution into it, and then washing it well under a tap of hot water. It is then placed in the jar with boracic lotion. Once a day all the catheters are boiled for three minutes, and then placed in the jar with the formalin vapour until required. Oval metal boxes are sold for packing catheters when travelling. A piece of cotton-wool, soaked in formalin, should be placed in the centre of the box, and the catheters carefully sterilized before placing them in it.

Before passing, the catheter should be lubricated with boroglyceride or sterilized glycerine, and the penis, especially the meatus, should be well washed. The patient should also be instructed to wash his hands before passing the catheter.

4. *Cases with Severe Cystitis.*—The patient should be put to bed, and careful treatment of the cystitis carried out. If a catheter can be readily passed, the bladder should be washed out through the urethra, but if this is difficult, the bladder should be drained through a suprapubic opening. When the severe cystitis has improved, suprapubic prostatectomy should be performed if the case is otherwise suitable.

5. *Cases with Renal Insufficiency or Severe Infection.*—These cases are not suitable for prostatectomy, and palliative treatment by catheterization is all that can be done.

In those cases which are unsuitable for operation, and in which there is cystitis, and catheterization is painful and difficult, *permanent catheterization* may be carried out. A soft self-retaining catheter (Fig. 507) is passed into the bladder, and retained *in situ* for a month.

or more, the bladder being washed out regularly twice a day. At first the patient must be kept in bed, but later he may be allowed up, wearing a suitable apparatus, the bladder being emptied every three or four hours. The catheter at first causes a urethritis, but this is of little importance.

TREATMENT OF ACUTE RETENTION WITH ENLARGED PROSTATE.—The patient should be put to bed, and a full dose of urotropin given, and in a short time an attempt to pass a catheter should be made. If the catheter passes, the urine should be drawn off slowly, and if the bladder has been very distended, it should not be completely emptied, but the patient should be regularly catheterized every six hours. In these cases where regular aseptic catheterization is impossible, a self-retaining catheter should be passed, or an ordinary catheter should be tied in for a few days.

When catheterization fails, and the attempt to pass a catheter should not be prolonged, the bladder should be aspirated above the pubes, the best instrument being a Dieulafoy's aspirator. After three or four hours another attempt should be made to pass a catheter, and as the congestion will have largely disappeared, this second attempt may be successful. Suprapubic aspiration may be repeated if necessary, but it is better, if the relief is only temporary, to open the bladder by a suprapubic route and put in a drainage-tube. The prostate may then be removed in a few days. In selected cases acute retention of urine due to the enlarged prostate may be treated by immediate prostatectomy.



FIG. 507.—
SELF-RETAINING
CATHETER.

NEW GROWTHS

Innocent.—Apart from chronic enlargement of the prostate, this is considered to be neoplastic, innocent new growths are unknown.

Malignant—Sarcoma.—Sarcoma of the prostate is rare, and is most commonly seen in young adults.

CLINICAL FEATURES.—The patient complains of increasing difficulty in passing urine, which goes on to complete retention. Hæmaturia and pyuria occur later. Rectal examination shows that the prostate is enormously enlarged, and is becoming adherent to the rectal wall. Metastases occur early, and the disease is invariably fatal.

TREATMENT.—An attempt may be made to enucleate the prostate in early cases, but rapid local recurrence generally occurs. The palliative treatment is the same as that of carcinoma, chiefly consisting of suprapubic drainage when the difficulty of micturition becomes serious and catheterization causes hæmorrhages.

Carcinoma.—Carcinoma of the prostate is a rare disease, but is much more common than sarcoma. It has been stated that about 10 per cent. of all cases of enlargement of the prostate that need treat-

ment are carcinomatous, and that carcinoma not infrequently supervenes on simple chronic enlargement, but the latter statement still requires proof.

Pathologically the growth is a spheroidal-celled carcinoma, and may either be of the scirrhous or medullary type, but clinically three varieties are distinguished:

1. The enlargement appears to be one of simple enlargement, its malignant nature only being recognized on microscopical examination after removal.
2. A rapidly spreading carcinoma early involving the pelvic glands, and seldom permitting of any operative interference.
3. The growth in the prostate is small, and often apparently innocent, and attention is first called to the condition by the appearance of secondary growths in the bones leading to spontaneous fractures. On microscopical examination, these growths resemble the prostate in structure (*latent carcinoma of the prostate*).

A prostatic carcinoma usually invades the bladder, but invasion of the prostate by malignant growth of the bladder is uncommon.

CLINICAL FEATURES.—The patient is usually over forty-five years of age, and complains of difficulty and frequency of micturition, which is rapidly progressive, and which may end in retention with overflow. The symptoms closely resemble those of chronic enlargement, but are more rapid in their onset, and there are no periods of remission. Later in the disease pain is present, due to involvement of the pelvic plexus of nerves. At first it is felt in the hypogastrium, and is referred along the penis, but later may be referred along the course of the great sciatic. Like all pain due to involvement of nerves in malignant growth, it is resistant to treatment. Hæmaturia is not an early symptom, and has nothing to distinguish it from other forms of hæmaturia of bladder origin.

Pyuria is present when the growth has ulcerated or when cystitis supervenes. As the growth enlarges, it may cause difficulty of defæcation, and later ulceration into the rectum will be associated with a discharge of blood-stained pus from the bowel.

On examination, the prostate is found to be enlarged, hard, and nodular, the hardness extending along the vesiculæ seminales and into the cellular tissue round the rectum. The rectal mucous membrane does not move freely on the swelling, and enlargement of the pelvic gland may be found. Examination by the cystoscope gives little information, and if carcinoma of the prostate is diagnosed by digital rectal examination, all instrumentation of the urethra and bladder is contra-indicated, as it is likely to cause hæmorrhage or start a cystitis. Later in the disease there is complete obstruction of the urethra, dilatation of the ureters and pelvis of the kidneys, cachexia, and renal insufficiency. Secondary growths, exhaustion, and hypostatic pneumonia are the common immediate causes of death.

TREATMENT.—In a few cases carcinoma of the prostate is treated by excision of the gland. These cases may be divided into two groups: (1) Cases in which suprapubic prostatectomy is carried out for a supposed innocent enlargement, and carcinoma is found on microscopical examination; and (2) cases in which the diagnosis is made early, and radical cure is attempted.

The operation most frequently performed is Young's, which consists of removal of all the tissue lying between the symphysis pubis in front, the rectum behind, the entrance of the ureters into the bladder above, and the triangular ligament below. Recurrence after this operation is common.

The usual treatment of carcinoma of the prostate is palliative, and consists of—(1) The relief of pain with morphia, and (2) the overcoming of retention of urine by the use of *soft* catheters if they do not cause severe pain and hæmaturia. Later it usually becomes necessary to establish permanent suprapubic drainage.

Neurosis of the Prostate.—Neuroses of the prostate and prostatic urethra usually occurs in young adults who have either had gonorrhœa and prostatitis or who have indulged in masturbation or sexual excess.

CLINICAL FEATURES.—The patient complains of difficulty in passing urine, usually in starting the act, which varies from time to time, being most marked when the patient attempts to pass urine in the presence of others. There may be a feeling of weight and pain in the perineum.

On examination, the prostate feels normal in size, but may be hyperæsthetic, and when a catheter is passed the prostatic urethra may be very sensitive, and there may be some resistance as the catheter enters the bladder, but this is readily overcome. The urine is normal, and contains no prostatic threads.

In some cases the condition is associated with a necessity for urgent micturition without pain or difficulty.

TREATMENT.—This should be that of neurosis in general, and it may be advisable to pass a full-sized bougie once a day to demonstrate to the patient the freedom of the passage.

Fibrosis of the Prostate.—This is believed to be the cause of symptoms of enlarged prostate without any enlargement being present. The patient, an elderly man, complains of the usual symptoms of chronic enlargement, but on examination, the prostate is not enlarged, although it is a little harder than usual, and on passage of a catheter the urethra is found to be normal in length.

If a suprapubic opening into the bladder is made, the urethral orifice will not yield to digital pressure so readily as it does normally. The opening should be dilated, the suprapubic wound closed, and the bladder emptied daily by the passage of a large-sized catheter.

Prostatorrhœa.—By this term is understood a flow of prostatic secretion from the urethra apart from a purulent discharge. The condition usually occurs during defæcation or micturition, but may occur independently of both. It is most usually met with in young

adults who are masturbators, and follows erection or semi-erection of the penis, and in itself is a matter of no importance. It is frequently thought to be spermatorrhœa, and is regarded by the patient, who is generally afraid of loss of sexual power, as a most important condition.

The TREATMENT is directed to the cause.

VESICULÆ SEMINALES

INFLAMMATION

Acute Vesiculitis.—Acute inflammation of the seminal vesicles is secondary to acute urethritis due to the gonococcus, or following instrumentation of the urethra, acute cystitis, acute prostatitis, or infection after removal of the prostate. The commonest cause is posterior urethritis due to the gonococcus, and both vesicles are usually affected.

CLINICAL FEATURES.—As in other complications of gonorrhœal urethritis, the urethral discharge may lessen or disappear at the onset of the vesiculitis, only to return as the acuteness of the inflammation subsides. The patient complains of pain in the lower abdomen and perineum, difficulty and pain on micturition and defœcation, and frequent painful erections. The general symptoms of infection are also present.

On rectal examination, the vesiculæ are hot, very painful, and swollen. Resolution generally occurs, but suppuration with discharge of pus into the urethra is not uncommon. An abscess may form between the bladder and rectum, or the infection may spread to the peritoneum. The inflammation may become chronic.

TREATMENT.—The early treatment consists of rest in bed, fomentations to the perineum, and morphia suppositories. If an abscess forms, it may either be opened from the perineum or through the rectal wall after the rectum has been washed out.

Chronic Gonorrhœal Vesiculitis.—This usually follows an acute attack, or it may be associated with chronic urethritis or prostatitis.

CLINICAL FEATURES.—The patient complains of a feeling of weight and fulness in the perineum, pain on defœcation, frequency of micturition, and sexual irritability, with nocturnal emissions, the semen containing pus.

On examination, the vesiculæ are felt to be enlarged and tender, and if a urethroscope is passed at the same time as the vesiculæ are squeezed, pus can be seen issuing from the ejaculatory ducts. The condition may be present for years without seriously interfering with the patient's health, and pus in the semen does not necessarily cause sterility. In course of time sexual desire is lost.

TREATMENT.—Treatment of this condition is not very satisfactory and should not be prolonged, as a condition of sexual neurasthenia is apt to develop. Any urethritis or stricture should be treated, and

urinary antiseptics administered. The vesiculæ should be massaged daily, so that they are emptied of pus.

If this treatment fails, and the patient is becoming neurasthenic, the vesiculæ may be removed through a perineal incision.

Tuberculous Vesiculitis.—Tubercle generally affects the vesiculæ during the period of active sexual life, and the condition is associated with tuberculous prostatitis and epididymo-orchitis.

CLINICAL FEATURES.—The onset of the disease is painless and the condition is usually discovered during a routine examination of the pelvic organs in a case of genito-urinary tuberculosis, but in some cases blood-stained seminal emissions first attract the patient's notice.

On examination, the vesiculæ are hard and nodular in the early stages, but later a soft fluctuating swelling is present. This tubercular abscess may point in the perineum or rectum, or occasionally tubercular peritonitis may follow.

TREATMENT.—The treatment depends on the amount of tubercular disease present in other parts of the genito-urinary tract. If the patient has tuberculo-epididymo-orchitis, with tuberculosis of the corresponding vesiculæ, the testis and vesicle should both be removed. Vesiculectomy should also be carried out in cases of primary disease.

Tuberculous abscesses should be opened from the perineum, and the contents carefully scraped out. Fistulæ are apt to follow.

Calculi are sometimes found in the vesiculæ, but are very rare.

Cysts and New Growths may be considered to be pathological curiosities.

CHAPTER XXXVII

INJURIES AND DISEASES OF THE PENIS, SCROTUM, AND TESTES

PENIS

Injuries of the Penis

INJURY of the penis is an uncommon accident. It occurs most frequently when the organ is in a state of erection, and in this condition the penis has been completely **avulsed**. If the injury is so severe as to rupture the sheaths of the corpora cavernosa, the penis is said to be **fractured**. The urethra may be injured at the same time, and extravasation of urine occur at the next attempt to mic-turate.

Fractured Penis—**CLINICAL FEATURES**.—The penis is the seat of severe pain, and the organ is enormously swollen owing to extravasation of blood. If the urethra is ruptured, bleeding from the external meatus occurs. After the extravasated blood has been absorbed, fibrosis of part of the corpora cavernosa may ensue. The sexual function of the penis is then interfered with, and the posterior part only of the penis becomes rigid during erection, the anterior part remaining flaccid, or the anterior part becomes rigid after the erection has passed off in the posterior part.

TREATMENT.—If the injury is slight, the patient is kept in bed with the penis supported, and evaporating lead lotion is applied to limit the hæmorrhage. When the swelling is excessive, the hæmatorrhagia should be incised, the blood-clot removed, and the sheath of the corpus cavernosum, if ruptured, should be carefully sutured in order to prevent interference with erection later.

Dislocation of the Penis.—The penis may, as a result of violence be dislocated out of its skin sheath into the subcutaneous tissue of the groin or abdomen, and the attachment of the prepuce to the corona torn away. The skin of the penis hangs down in its usual position.

TREATMENT.—The penis should be brought back into position and sutured after all bleeding has been arrested.

Incised Wounds are usually the result of self-mutilation, and require the usual treatment of wounds. If a part of the penis has been cut completely off, a plastic operation is necessary to prevent constriction of the opening of the urethra.

Constriction of the Penis.—Constriction of the penis by thread, india-rubber bands, rings, and other foreign bodies, is usually due either to an attempt in children to prevent nocturnal enuresis or to perverted sexual impulses.

CLINICAL FEATURES.—The constricting band is buried in the oedematous swollen tissues of the penis, and in some cases gangrene of the penis beyond the constriction occurs.

TREATMENT.—The band should be removed, an anæsthetic usually being necessary, and the penis kept wrapped in aseptic gauze. Plastic operations will rarely be necessary to remedy defects in the organ.

CONGENITAL ABNORMALITIES

The commonest congenital abnormalities of the penis are those associated with epispadias and hypospadias. They have already been described (p. 1133).

Absence of the Penis is very rare, but the organ may be very small and buried in the fat of the symphysis pubis, the orifice being merely represented by a dimple. **Double penis** may occur, and both organs may be functional, discharging urine and semen. **Webbed penis** is a condition in which the penis is united by a web of skin to the middle line of the scrotum.

Congenital Shortness of the Frænum may cause the glans penis to be curved downwards during erection, and so make coitus painful. A short frænum is also liable to rupture during coitus, and the hæmorrhage may be severe. The raw surface left is very liable to syphilitic infection.

TREATMENT.—If the frænum is so short that it interferes with coitus, it should be divided. Hæmorrhage should be arrested in the usual way.

Phimosis

Phimosis is a condition in which the prepuce cannot be retracted over the glans penis owing to the smallness of the opening or to adhesions between the prepuce and the glans. It is frequently associated with a long prepuce. Phimosis may be **congenital** or **acquired**, and is the normal condition in the newly born infant. At birth the prepuce and the glans are slightly adherent to one another, so that complete retraction of the prepuce is not possible. If these adhesions do not disappear as the child grows older, or if the preputial orifice remains small, congenital phimosis is present.

Congenital Phimosis.—A child with congenital phimosis is generally brought to the surgeon for the following reasons: (1) The parents think circumcision is necessary, (2) pain and difficulty of micturition, (3) an attack of balanitis, (4) habit of pulling at the prepuce. In many cases the condition is discovered in children suffering from hernia, prolapsus ani, nocturnal enuresis, and masturbation. Later, phimosis may interfere with coitus, or be complicated by concealed sores, gonorrhœal discharge, or paraphimosis. The diagnosis is obvious.

TREATMENT.—The treatment of phimosis is circumcision, and this operation is necessary (1) if, in a child above infancy, the prepuce cannot be completely retracted; (2) if the prepuce is of abnormal length; (3) if the prepuce is adherent to the glans penis; (4) if there is a tendency to paraphimosis; (5) if any complication is present, or if phimosis complicates hernia, etc.

Circumcision.—As a rule a general anæsthetic should be given, but in exceptional circumstances local anæsthesia by cocaine may be employed, and may allow of a painless operation.

The prepuce is drawn forwards until the portion which lies over the corona is brought just in front of the glans. In this position it is seized with forceps, which are inclined slightly forwards below. Care is necessary that the glans is not included in the forceps. The prepuce in front of the forceps is next removed with a single sweep of the knife or with a sharp pair of scissors, the cut following the direction of the forceps, and so having a sharp point below. The skin should retract as far back as the corona.

The reflected layer of the prepuce is then slit up along the middle line of the dorsum, and turned backwards from the glans, adhesion being broken down and the smegma removed.

The excess of mucous membrane is cut away with scissors, leaving a narrow strip round the base of the glans. The cut underneath should be quite close to the frænum.

Hæmorrhage is arrested by forcipressure or ligature, if necessary.

The skin is stitched to the strip of mucous membrane, a fine needle and catgut being used. The suturing may be either continuous or interrupted, and the first stitch should attach the pointed extremity of the skin flap to the frænum, the frænal artery being secured in the stitch.

DRESSING.—In adults, if erections are likely to take place, the penis may be wrapped round with two pieces of aseptic gauze. The first covers the wound only, and should not be removed. The second covering the whole penis, is soaked in an iced boracic lotion, and may be removed and wetted by the patient, or it may be kept wet by dropping some iced lotion on it from time to time.

For children, a piece of sterilized cotton-wool soaked in Whithead's varnish or friar's balsam makes a good dressing, which need not be removed for three days. At the end of that time it is soaked off by placing the patient in a bath. The after-dressing is a strip of lint covered with boracic ointment, which can be changed as often as necessary. If catgut sutures have been used, there is no need to remove them.

After this operation the patient should rest as much as possible, and it is well for an adult to stay in bed for forty-eight hours, and afterwards lie on a couch till the end of a week. If erections occur, the patient should be given potassium bromide (grs. xv. t.d.s., or grs. xx. nocte).

Meatotomy.—After circumcision in children it is sometimes found that the external urinary meatus is very small (pinhole meatus), and

the same condition may be found in adults, either from the result of healing of a sore near the meatus or as a congenital condition.

If this be the case, the opening should be enlarged by introducing a blunt-pointed knife into the meatus, and cutting downwards.

In all cases when circumcision has been performed in children for some definite symptom, such as incontinence of urine or pain on micturition, it is a good plan to introduce a sound into the bladder while the patient is under the anæsthetic, in order to exclude vesical calculus.

Acquired Phimosis is the result of such inflammatory lesions of the prepuce and glans penis as hard and soft sores, ulcers, and balanitis. The preputial orifice becomes smaller, owing to the formation and contraction of the scar tissue, the prepuce usually being fixed to the glans by adhesions. The *treatment* is circumcision.

Paraphimosis.—This condition is said to occur when the prepuce, having been retracted behind the corona, cannot be brought forward. As a result, the prepuce and the glans penis are swollen and congested, and if the condition is not relieved, the constricting band ulcerates through or the glans penis becomes gangrenous. The former is by far the commoner result, and it is doubtful if sloughing of the penis ever occurs in a case of uncomplicated paraphimosis. The condition may be acute or chronic. The diagnosis is obvious.

TREATMENT.—The penis should be firmly handaged with a cold-water bandage in order to contract the bloodvessels and reduce the swelling. The bandage is removed after two minutes. The penis is then grasped between the index and middle fingers of each hand, and the skin pulled forwards; at the same time the two thumbs press the glans steadily backwards. The pulling of the skin over the glans is more effectual than the pushing of the glans through the constriction.

If this procedure fail, an anæsthetic should be given, and after puncturing the œdematous parts with a tenotomy knife, reduction should be again attempted.

If this is unsuccessful, the constricting band must be divided. It will be noticed that the glans is separated from the body of the penis by a narrow, deep sulcus, which is overlapped in front by the œdematous mucous membrane of the prepuce, and posteriorly by the skin of the penis. This sulcus corresponds to the margin of the preputial orifice, and it is by division of this that relief is given. The glans and swollen prepuce are drawn forwards, and a cut about $\frac{1}{2}$ inch long is made through the integuments at the bottom of the groove. Reduction of the paraphimosis can be at once effected.

A patient who has suffered from paraphimosis should be circumcised.

Balanitis.—Balanitis is a superficial inflammation of the skin covering the under surface of the prepuce and the glans penis. It is usually associated with phimosis, and is due to (1) retained smegma, (2) dirt, (3) gonorrhœal infection, (4) concealed sores, or (5) the irritation of gouty or diabetic urine.

CLINICAL FEATURES.—The patient complains of burning and itching of the prepuce, and scalding on micturition. On examination, the prepuce is swollen and œdematous, and there is a purulent discharge. In many cases phimosis is present, but if the prepuce can be retracted, the inner aspect of the prepuce and the glans penis will be red and swollen, and small ulcers are frequently present.

TREATMENT.—The part must be kept thoroughly clean, and in order to do this it may be necessary to slit up the prepuce, circumcision being performed later. The prepuce and glans should be syringed with boracic and hydrogen peroxide lotion, and the penis kept wrapped in gauze, a piece of cotton-wool being introduced under the prepuce to keep the inflamed surfaces apart.

Phagædenic Ulceration.—This condition is most commonly seen at the present time attacking the penis in patients who have a sore concealed under a tight prepuce, thus preventing it being kept clean. It is more generally seen in connection with soft sores than with Hunterian chancres, and the patients are often broken down in health. It is not necessarily venereal in origin.

The penis is red, swollen, and painful, and a stinking discharge escapes from under the prepuce. If left, the prepuce and the glans penis slough, or the larger part of the penis may be destroyed.

TREATMENT.—The prepuce should be slit up under anæsthesia, and the ulcer thoroughly exposed. After cleaning the surface of the ulcer it should be painted with pure carbolic acid, acid nitrate of mercury, nitric acid, or chloride of zinc paste, or the actual cautery may be applied. The wound is dressed with a fomentation, and the after-treatment consists of the frequent application of hot fomentations and the giving of hot baths until a healthy granulating surface is present.

While this surface is healing, care should be taken that the lumen of the urethra is maintained patent by the frequent passage of a bougie. Hæmorrhage may occur from the opening up of an artery, and should be treated by the application of a ligature. If this will not hold, the bleeding can often be arrested by applying the actual cautery at a dull red heat.

HERPES

Herpes Zoster, or shingles, following the course of the ilio-inguinal nerve, may attack the penis, but it is rare.

Catarrhal Herpes is much more common, usually occurring on the prepuce or glans penis (herpes progeneralis), and may be associated with coitus or nocturnal emissions.

CLINICAL FEATURES.—There is first an itching or burning sensation of the prepuce and glans penis, associated with a patchy erythema. This is succeeded by a crop of vesicles similar to those seen in herpes labialis. The vesicles burst, and leave small superficial ulcers, which heal rapidly. The course of the disease is about a week. The condition is chiefly of importance on account of its liability to be mis-

taken for venereal disease, and the possibility of infection with the spirochæte of syphilis if exposure occurs. The condition is apt to be recurrent.

TREATMENT.—The part should be kept scrupulously clean, and dusted with a little boracic powder. Arsenic may be given in order to prevent recurrence, but it is not always successful.

Preputial Calculi.—Calculi under the prepuce are always associated with phimosis, and are of three kinds: (1) Deposits of salts from the urine; (2) calcification of retained smegma; (3) kidney and bladder stones which have passed along the urethra, but cannot escape through the preputial orifice.

CLINICAL FEATURES.—A patient with phimosis has a purulent discharge from under the foreskin, and on examination, a hard mass is felt. These stones have reached the size of a fist.

TREATMENT.—The stone should be removed, and the patient circumcised.

NEW GROWTHS OF THE PENIS

Innocent—Papilloma.—Papillomata of the penis may be hard or soft.

Hard Papillomata, or warts, resemble warts in other parts of the body, and if present in elderly men, and left untreated, or if irritated, are liable to develop into carcinomata. They are most common on the prepuce and glans penis.

Soft Papillomata, or villous growths, occur at all ages, and are frequently associated with phimosis or gonorrhœa, though they may be seen quite independently of the latter disease. They are generally multiple, are situated on the under surface of the prepuce, bleed readily, and have a foul secretion. Enlargement of the inguinal glands may be present.

TREATMENT.—The treatment of both varieties of papilloma is excision and cleanliness. In elderly patients microscopic examination of the base of the neoplasm should always be made in order to exclude carcinoma.

Horns associated with suppurating sebaceous cysts, papillomata, and carcinomata, sometimes occur on the penis. The diagnosis is obvious, and the treatment removal, the primary condition receiving attention.

Malignant—Carcinoma.—Carcinoma of the penis may be a squamous-celled carcinoma arising from the superficial epithelium, or a glandular carcinoma arising from the sebaceous glands, which are situated at the corona. The former is by far the more common, but the latter variety is said to be the more malignant.

PREDISPOSING CAUSES.—Carcinoma of the penis is a disease of elderly people, being rarely seen before the age of fifty. In a large number of cases the patient has phimosis either congenital or acquired, and a history of venereal ulcers, gonorrhœa, balanitis, or papillomata is common. A precancerous condition of the under surface of the

prepuce and the glans penis is sometimes seen. It consists of a chronic superficial inflammation resembling in appearance chronic superficial glossitis. This condition is recognized by finding white epithelial patches on the glans, or in some cases raw, red patches where the epithelium has been shed. There is increasing difficulty in retracting the prepuce, and if it is forced back, the skin usually cracks and bleeds. This condition is sometimes spoken of as eczema, or Paget's disease of the penis.

CLINICAL FEATURES.—The patient complains of a sore or a growth on the penis, or if phimosis is present, of a discharge, which may be blood-stained, from under the prepuce. On examination, a warty growth or an ulcer with an indurated base and a foul secretion is found. The growth is most frequently situated on the corona, but it may arise on the body of the penis or the prepuce. It is at first limited by the tunica



FIG. 508.—SQUAMOUS-CELLED CARCINOMA OF THE PENIS.

(London Hospital Medical College Museum.)

albuginea of the corpora cavernosa, but when this sheath is perforated, the growth spreads rapidly through the body of the penis, secondary nodules separated from the primary growth being sometimes present. The urethra is seldom affected, and there is usually no obstruction to micturition, but fistula may develop. The glands affected are the superficial and deep inguinal glands, the pelvic glands, and later, when the body of the penis is involved, the iliac glands. Glandular

infiltration occurs early, but general dissemination of the growth is rare.

DIAGNOSIS.—The diagnosis is as a rule easy, for the patient does not often seek relief until the condition is advanced. Care must be taken, however, to exclude gummatous ulceration of the penis, which may closely resemble carcinomatous ulceration. When the condition is concealed under a very long prepuce, it is necessary, particularly in the case of elderly people with a preputial discharge, to slit the prepuce before a diagnosis can be made.

TREATMENT.—The treatment of carcinoma of the penis is free removal of the growth, with a large part of apparently healthy penis, and excision of the inguinal lymphatic glands on both sides. When the diagnosis has been made early, partial amputation, with removal of the glands, is all that is necessary. In the case of later diagnosis complete amputation of the penis must be performed. If the latter operation is indicated, some authorities consider it advisable to remove the testes at the same time. This, however, adds to the gravity of the operation, and patients may be quite comfortable even if the testes are left.

Partial Amputation of the Penis.—A tourniquet is placed round the base of the penis, and a small ventral flap containing the urethra is dissected up well behind the growth. The corpus spongiosum is freed from the rest of the penis and skin from about $\frac{3}{4}$ inch. A long dorsal flap of skin and subcutaneous tissue is then cut, and the corpora cavernosa divided. The dorsal flaps fall over the divided ends of the corpora cavernosa, in which a hole is made for the corpus spongiosum and urethra to pass through. The urethra is slit up laterally for a short distance, and its edges sutured to the hole in the dorsal flap. The dorsal and ventral flaps are then united by sutures.

Complete Amputation of the Penis.—The corpus spongiosum and urethra are separated in the perineum from the rest of the penis, and the penis is then amputated by a circular incision, the crura being removed from the rami of the pubes by blunt dissection. The urethra is sutured into the perineum, and the wound closed. Removal of the inguinal glands is the most difficult part of the operation, and to make it complete it may be necessary to remove portions of the saphena and femoral veins. Sloughing of the skin of the groin often follows the operation, owing to the destruction of the blood-supply.

Sarcoma.—Sarcoma of the penis is rare. The growth, which is generally of the spindle-celled variety, springs from the sheaths of the corpora cavernosa.

CLINICAL FEATURES.—The onset of the disease is insidious. The penis becomes hard, swollen, and very painful. Difficulty of micturition and a blood-stained discharge from the urethra follow later.

TREATMENT.—Complete amputation of the penis and removal of the inguinal glands.

NEUROSIS OF THE PENIS

Priapism.—Priapism as a pathological condition implies continued erection of the penis, accompanied by pain and unaccompanied by sexual desire. It may arise as a symptom of such varied conditions as inflammation of the prostate, stone in the prostatic urethra, or leucæmia; but as a neurosis it is met with in young men, and is associated with excessive coitus and alcoholism.

CLINICAL FEATURES.—The penis is firm, erect, and very painful, and indulgence in coitus does not relieve the condition, which may last for weeks. Micturition may be difficult.

The pathology is doubtful, some authorities considering it as a true neurosis; others ascribe the condition to injury of the corpora cavernosa, and hæmorrhage into the erectile tissue.

TREATMENT.—The drug that gives most relief is bromide of potassium in large doses. The patient should have frequent hot baths. Morphine may be necessary to control the pain. If drug treatment is not quickly successful, small incisions should be made into the penis.

STERILITY

Sterility is a condition in which there is inability to cause conception of children. It is estimated that the male is responsible for one in six of the sterile marriages.

The **Causes** of sterility are—

1. **Impotence.** This is inability to perform the sexual act, and is due to a variety of causes to be discussed in the next paragraph.
2. **Azoöspemia,** or absence of the spermatozoa from the semen. This is due to disease of the bodies of the testes or imperfect development, usually associated with imperfect descent. A cryptorchid is as a rule potent, but sterile, owing to absence of spermatozoa. Double orchidectomy may leave a patient his sexual power, although procreation is impossible. Prolonged exposure to X rays which have not been properly shielded also results in sterility.
3. **Aspermia.** In this condition the semen does not reach the vagina. This may be due to the following causes: (1) Obstruction of both epididymis from fibrous tissue following gonorrhœa, epididymitis, orchitis; (2) a tight urethral stricture, the semen passing back into the bladder instead of being ejaculated from the penis; (3) a stricture with fistulæ, the semen escaping along the fistulous tracts; (4) obstruction of both vasa, usually due to inflammatory conditions of the prostate.

The examination of a male on account of alleged sterility involves the question of the ability to fully perform the sexual act. A careful physical examination should be made of the testes, cord, prostate, and urethra. The semen should be examined microscopically in order to determine the presence of live spermatozoa.

The **Prognosis** of the condition obviously varies with the cause, and the possibility or otherwise of its removal. In some cases in which no cause for sterility can be found in either the male or female remarriage of both parties may be followed by two families.

IMPOTENCE

This is a condition in which ability to perform the sexual act is absent or very much lessened. It may be permanent or temporary. It must be distinguished from sterility, of which it is one of the causes. A patient who is impotent is not necessarily sterile, for the semen, which possibly contains live spermatozoa, may be artificially conveyed to the female.

CAUSES.—Impotence in the male is due to the following causes:

1. *Physical Defects of the Genital Organs.*—These may be *congenital*, as complete epispadias, hypospadias, and rudimentary penis;

or acquired, as in amputation of the penis, elephantiasis, fibrrosis of the corpora cavernosa, the presence of large herniæ or hydroceles, and fracture of the penis.

The impotence in these cases may be complete or partial. It is a point of legal controversy how far such conditions existing before marriage are a cause for dissolution of the marriage on account of sexual disability.

TREATMENT AND PROGNOSIS.—The treatment and prognosis depend on the condition present, and its capability of being removed by operation. Excision of a fibrous nodule in the corpora cavernosa or corpus spongiosum is sometimes successful in relieving impotence due to this cause.

2. *Loss of Power of Erection from Organic Disease.*—The most common diseases causing loss of power of erection are nerve diseases, particularly tabes dorsalis, general paralysis of the insane, head injury followed by atrophy of the testes, and injury or diseases of various cerebral centres. The condition also occurs in such general diseases as diabetes, anæmia, phthisis, and the chronic blood diseases; and it may follow the excessive use of such drugs as morphia, alcohol, salicylic acid, and potassium bromide.

TREATMENT.—In many instances it is obvious that all treatment is useless. In cases of impotence associated with the excessive use of drugs treatment consists of discontinuing their use, sexual power and appetite being then usually regained.

3. *Psychical Conditions.*—Although impotence from psychical causes may be congenital, sexual desire being absent, it is more usually acquired. It is then due to excessive indulgence in coitus, persistent perverted sexual practices, mental overwork, or over-imagination of the pleasures of the sexual act. These causes are very often combined. The impotence may be absolute, coitus under all conditions being impossible, or it may be relative, coitus being free and vigorous under certain conditions. For example, owing to congenital sexual anomaly or to persistent perverted sexual practices, the stimulus for erection of the penis may come from a person of the male sex, the female being incapable of supplying the necessary stimulus. The subject of such a condition is incapable of coitus—*i.e.*, he is impotent—although he may frequently perform the act of sodomy. Relative impotence may also be present without sexual perversion, and psychical impotence is a most frequent cause of sudden postponement of marriage or inability to perform the sexual act after marriage. The patient becomes obsessed with the idea that he will not be able to effect coitus, and this obsession may be sufficient to prevent erection of the penis, although there is no cause for impotence, and the patient has perhaps often indulged in coitus with prostitutes.

TREATMENT.—The treatment of psychical impotence consists of aiding the patient to regain his moral control if it is due to excessive coitus or to perverted sexual impulses. If due to a congenital anomaly, treatment is useless. When the condition is associated with recent marriage, abstinence from attempts at coitus is advisable, and the

power of erection is usually regained. In some cases apparent psychical impotence is the first serious symptom of organic brain disease.

4. *Neurasthenia*.—Impotence associated with neurasthenia is generally brought about by excessive coitus or masturbation, but occasionally it may occur in patients who have not indulged in sexual excitement. The impotence may be complete. More commonly there is a condition of undue excitability of the sexual nervous centre, and the ejaculation of semen occurs prematurely, often with the penis only partially erected. This form of impotence is often associated with psychical impotence, the patients who contemplate matrimony often fearing they will not be able to consummate the marriage.

TREATMENT.—The general health should be improved in every way, and the patient should take plenty of exercise and keep his mind fully occupied. The reading of sensational and medical books or patent medicine literature on the sexual functions should be carefully avoided. The patient should abstain from any attempt at sexual intercourse. Drugs are useless in this form of impotence—in fact, they have very little value in the treatment of any form of impotence, although certain of the aphrodisiacs may increase the sexual power and appetite for a short time.

HERMAPHRODISM

A true hermaphrodite is an individual who has the primary sex organs—i.e., ovaries and testes—of both sexes, but it is extremely doubtful if such a being has ever existed, and certainly none have survived birth. Rudimentary sex organs belonging to the opposite sex, however, are constantly found in both sexes—for example, the uterus masculinus in the male and the clitoris, representing the penis, in the female. It is not surprising, therefore, that individuals are frequently met with in whom these rudimentary organs become more fully developed, and a condition of pseudo-hermaphroditism exists. These pseudo-hermaphrodites are divided into two classes, according as the internal or external genital organs of the opposite sex become developed. They are termed "internal" and "external pseudo-hermaphrodites."

Internal Pseudo-Hermaphrodites are usually males in whom the ducts of Müller, which form the uterus and Fallopian tubes in the female, have undergone development. The patient, who is in every other respect a male, is found to be possessed of a large uterus and Fallopian tubes.

The condition is generally only discovered on post-mortem examination, though occasionally during an operation. The most frequent cause for the operation is the presence of the uterus or one of the Fallopian tubes in an inguinal hernia, where it has been dragged by the descent of the testis. The condition is extremely rare, and quite undiagnosable before operation.

TREATMENT.—If such a condition is found at operation, the uterus should be removed, and the usual radical cure of hernia carried out.

External Pseudo-Hermaphroditism.—In this condition it is difficult from an examination of the external genitalia to determine the sex of the patient, but at least 95 per cent. of the cases are males—i.e., possess testes. It is more common than internal pseudo-hermaphroditism. During the course of development of the external genitalia, the male organs pass through a stage of development in which they resemble the female. Arrest at this stage will produce external pseudo-hermaphroditism, the most common form being a condition of perineal hypospadias. These cases are frequently associated with non-descent of the testes, and the differentiation of sex may be impossible. In many instances the individuals have been brought up



FIG. 509.—EXTERNAL PSEUDO-HERMAPHRODITE.

as females, and have even married and lived sexually as women, the mistake only being discovered on microscopical examination of genital glands. This condition is sometimes complicated by ectopia vesicæ.

TREATMENT.—These individuals should invariably be educated as boys. At puberty, the sexual instincts will as a rule—though by no means invariably—definitely indicate the sex. When the sex is evident on careful examination, plastic operation may be beneficial; but the cases are rarely very satisfactory. These patients are usually sterile, and frequently impotent, for obvious reasons.

DISEASES OF THE SCROTUM

Inflammatory Conditions of the scrotum only differ from inflammatory conditions of the skin and subcutaneous tissue elsewhere, in that the swelling of the tissue is very marked, and that acute pyogenic inflammations often end in gangrene. The condition has been sufficiently described under Extravasation of Urine, which is

the most frequent cause of acute infective inflammation of the scrotum.

Sebaceous Cysts may occur on the scrotum in large numbers, but they seldom grow to a size sufficient to warrant advising removal.

MALIGNANT GROWTHS

Carcinoma.—A squamous-celled carcinoma generally occurs on the skin of the scrotum of chimney-sweeps, tar-workers, and men engaged in trades in which it is impossible to keep the skin very clean. The condition is often termed "chimney-sweep's cancer," and may appear years after the patient has given up the trade. An examination of the skin of a patient who has been a chimney-sweep will often demonstrate the presence of soot in the cells of the deeper layers.



CLINICAL FEATURES.—The neoplasm as a rule grows very slowly, but does not otherwise differ from carcinoma in other parts of the body. The glands affected are the inguinal glands on both sides. Metastases in distant organs are very uncommon.

TREATMENT.—The growth should be removed with a large area of surrounding skin, and the lymphatic glands in both groins dissected away.

Melanoma.—Although the skin of the scrotum is usually more deeply pigmented than the rest of the body, melanoma is uncommon. It has the same characteristics as melanoma elsewhere, and should be freely removed with the inguinal glands on both sides.

FIG. 510.—SQUAMOUS-CELLED CARCINOMA OF THE SCROTUM (CHIMNEY-SWEEP'S CANCER).

Lymph Scrotum and Elephantiasis of the Scrotum have been described under Diseases of the Lymphatics (p. 345).

INJURIES AND DISEASES OF THE TESTIS

Contusions of the Testis.—A blow or squeeze of the testis may lead to extravasation of blood into the tunica vaginalis, the body of the testis, or the epididymis. Severe contusions are rare, however, owing to the mobility of the organ.

CLINICAL FEATURES.—A severe blow on the testis is followed by shock, vomiting, pain and swelling of the testis, and ecchymosis of the scrotum. The pain is very severe, and the injury is followed

by a sharp attack of epididymo-orchitis, which may end in resolution or in atrophy of the testis. Tuberculosis and neoplasm of the testis are often ascribed by the patient to injury, but the connection is doubtful. In many cases of gonorrhoeal epididymo-orchitis, the patient will attempt to conceal the urethral discharge, and state that the condition of the testis followed a blow or strain.

TREATMENT.—The patient should be put to bed, with the scrotum elevated, and fomentations or evaporating lead lotion applied. If pain and swelling are very marked, an incision should be made into the scrotum, and the blood-clot removed, for this will ease the pain and may prevent subsequent atrophy of the testis.

Incised Wounds of the testis do not differ from incised wounds in other parts of the body. They require similar treatment.

Dislocation of the Testis. The testis, as the result of a blow or squeeze, or a violent muscular exertion, may be dislocated from the scrotum into the inguinal canal or the subcutaneous tissue over the symphysis pubis.

TREATMENT.—The testis should be manipulated back into the scrotum, otherwise it may be fixed to the abnormal position by adhesions, and probably atrophy.

CONGENITAL ABNORMALITIES

Polyorchism.—The possession of three or more testes is rare. Cases supported by microscopical examination should alone be considered, as other conditions, especially hydroceles of the cord, have been mistakenly thought to be extra testes.

Anorchism and Monorchism are more common than polyorchism, but the condition is rare, being most often met with in monsters.

Anterior Inversion.—In this condition the testis is twisted, the epididymis being in front, and the body of the testis and the tunica vaginalis behind. It is said to be present in one in every twenty males, and may lead to mistakes in the diagnosis of tuberculosis of the epididymis and hydroceles of the tunica vaginalis.

Imperfect Descent and Ectopic Testis.—The testis is originally developed in the abdomen immediately below the kidney, the body developing from the genital eminence and the epididymis from the Wolffian body. During the early months of fetal life it descends to the internal abdominal ring, passes through the inguinal canal during the seventh and eighth month, and about the middle of the ninth month should reach the bottom of the scrotum. This descent of the testis is intimately associated with the presence of the gubernaculum testis, which is a fibromuscular band, the lower part being attached to the bottom of the scrotum, the skin of the perineum, the skin over the symphysis pubis, and the anterior superior spine. The upper part of the gubernaculum is attached to the lower pole of the testis, the epididymis, and the cæcum.

If the testis is arrested at any point along its normal course, it is spoken of as an imperfectly descended testis, and if it passes along the lower attachments of the gubernaculum to an abnormal position, as an ectopic testis. The former is the more common condition.

The **imperfectly descended testis** may be situated in the abdomen, the inguinal canal, or just outside the external abdominal ring. The **ectopic testis** may be found—(1) in the perineum; (2) in the subcutaneous tissue over the symphysis; or (3) near the anterior superior spine; or (4) in Scarpa's triangle.

The condition may be present on one or both sides. The patient is termed either a "monorchid" or a "cryptorchid." The unilateral condition is more common on the right side than on the left.

PATHOLOGICAL ANATOMY.—The abnormally situated testis is always an imperfectly developed testis, and there is either no development of spermatozoa, or the power of spermatogenesis is lost soon after puberty. The condition, however, does not seem to affect the internal secretion, for cryptorchids usually develop the secondary male characteristics, and are quite potent, although sterile. The attachments of the testis and epididymis to each other and to the mesorchism are generally abnormal, therefore torsion is much more liable to occur in the imperfectly than in the normally descended testis. The processus vaginalis is always present in the scrotum, so that a potential or an actual inguinal hernia is present in every case. Interstitial herniæ are nearly always associated with imperfect descent of the testis.

CLINICAL FEATURES.—The patient is generally brought by the parents on account of the emptiness of the scrotum, and sometimes there is complaint of pain and tenderness in the misplaced organ. The diagnosis is as a rule obvious; but mistakes are not infrequent, owing to the extreme mobility of the testis in children. The stimulus of the slight coldness due to removal of the clothes may cause the testis to be retracted into the inguinal canal by the cremaster muscle, and an error of diagnosis be made. The mistake may be avoided by attempting to press the testis into the scrotum. In the case of an imperfectly descended testis, this cannot be done, but a mobile one can be easily replaced in the scrotum. An imperfectly descended testis will occasionally descend into the scrotum at puberty.

COMPLICATIONS.—The common complications are hernia, torsion, and congenital hydrocele. Malignant disease is slightly more common in abnormally placed testes. Tuberculosis is very rare.

TREATMENT.—The following methods of treatment are practised. The testis is (1) left alone; (2) removed; (3) fixed in the scrotum—*orchidopexy*; (4) replaced in the abdomen. The treatment advised depends on the clinical features and the condition found on operation.

1. UNILATERAL CASES

- (1) Abdominal testis. The condition should be left alone, as the increased liability to torsion and malignant disease is not sufficient to warrant operation.

- (2) Inguinal testis. An attempt may be made to fix the organ in the scrotum (orchidopexy), although this will usually fail on account of the shortness of the cord. The testis and the processus vaginalis should therefore be removed, the latter in order to prevent the formation of a hernia. Extensive division of the structures of the cord, in order to allow the testis to be placed in the scrotum, is useless, for this causes the organ to atrophy.
- (3) Testis at the external abdominal ring. The testis may be left, for it will frequently complete its descent. If it does not do so, or if a hernia is present, an attempt should be made to place it in the scrotum, and if this fails, the testis should be removed.
- (4) Ectopic testis. The testis should be exposed and examined. If it appears fairly normal, and can easily be made to lie at the bottom of the scrotum, it should be placed there; otherwise it should be removed.

2. BILATERAL CASES

- (1) Abdominal testes (cryptorchids). In these cases no treatment is advisable.
- (2) Testes in the canal. No treatment is advisable unless pain is complained of, or a hernia has developed. If one of these conditions is present, the testes should be explored. If they can easily be placed at the bottom of the scrotum, orchidopexy should be performed; if not, the testes should be placed in the abdomen, and radical cure of the herniæ carried out.
- (3) Ectopic testis, with imperfect descent on the other side. The ectopic testis should be exposed, and an attempt made to place it in the scrotum. If this fails, the testis should be removed. The imperfectly descended testis should either be left alone or replaced in the abdomen. Under no circumstances should both testes be removed until growth is complete.

Axial Rotation of the Testis (Torsion of the Spermatoc Cord).—Axial rotation, or torsion of the testis, is much more common in the imperfectly descended than in the normally placed organ, and is always associated with abnormalities of attachment of the testis and epididymis to the mesorchium. The actual exciting cause may be a blow, squeeze, or violent exercise—sometimes no cause may be ascertained. Torsion may occur while the patient is asleep.

PATHOLOGICAL ANATOMY.—The twist, usually situated at the attachment of the globus minor, is of such a nature that the testis is inverted, and the globus major and hydatid of Morgagni are found below. As a rule there is only half a turn, although as many as four turns have been described. The testis is generally purple or black,

owing to extreme congestion and extravasation of blood. The tunica vaginalis contains blood-stained fluid.

CLINICAL FEATURES—Acute Torsion.—The patient, who is possibly known to have an imperfectly descended testis, is suddenly seized with violent pain in the lower abdomen, and vomiting. *On examination*, the scrotum is empty on one side, and the skin red and œdematous. In the groin on the same side is a hard, oval, tender lump resembling a strangulated bubonocœle; but the general symptoms of intestinal obstruction are not marked.



FIG. 511.—TORSION OF THE SPERMATIC CORD.

RESULTS.—The testis generally undergoes atrophy, which occurs even if the twist is rapidly undone. In some cases, however, the testis may be saved. Suppuration from infection with the colon bacillus is an unusual sequel.

TREATMENT.—If the case is seen early, and the testis is in the scrotum, an attempt should be made to untwist the cord without operation. If this is unsuccessful, or if the testis is an imperfectly descended one, operation should be advised. The testis is exposed, and if imperfectly descended, it should be removed; but if it is in the scrotum, the cord should be untwisted and the testis fixed in position, although atrophy will probably result.

Recurring Torsion may occur in the fully or in the imperfectly descended testis, and the symptoms are similar to, though less severe and of shorter duration than, those of acute torsion. The patient may learn how to untwist the cord and relieve the symptoms.

Atrophy of the testis occurs as the result of the repeated attacks.

TREATMENT.—If the patient is seen during an attack, the cord should be untwisted. Later, the testis should be fixed by an open operation in order that torsion cannot recur.

INFLAMMATION OF THE TESTES

Non-Infective Epididymo-Orchitis.—Although an occasional attack of epididymo-orchitis may be due to injury, strain, or gout, such a diagnosis must always be considered with grave suspicion, for in the great majority of cases careful investigation will reveal the presence of an infecting organism. It is by no means uncommon for patients to allege an injury or strain as the cause of an epididymo-orchitis, wilfully or unconsciously suppressing the knowledge of a urethral discharge. As this may cease on the occurrence of the acute inflammation, an error in diagnosis is easily made. In some instances the discharge may be very chronic, and depends on a chronic prostatitis or vesiculitis, to which the patient is so accustomed that he considers it of no importance. In other cases of alleged traumatic epididymo-orchitis the condition is really one of acute tuberculosis.

Gout is more likely to affect the body of the testis (orchitis) than the epididymis. It is seen in patients over fifty, who give a well-marked history of articular gout. The condition is often recurrent and may take the place of the more usual inflammation of the metatarso-phalangeal joint.

Infective Epididymo-Orchitis.—The most common cause of infective epididymo-orchitis is extension of inflammation along the vas from the posterior urethra, and the condition may therefore complicate any form of urethritis. It may also follow such infection through the blood-stream as is associated with smallpox, septico-pyæmia, or tuberculosis.

Gonorrhœal Epididymo-Orchitis.—About 20 per cent. of all cases of gonorrhœa in the male are accompanied by acute epididymo-orchitis. The attack may occur at any stage in the disease, but it is rarely seen before the second week. After this period there is no limitation to the onset of the inflammation, although no gonococci may be demonstrable in the urethral discharge. The inflammation is frequently bilateral, arising in the second testis as it is subsiding in the first.

CLINICAL FEATURES.—The patient complains at first of pain in the groin and lower abdomen, and later of acute pain and swelling in the testis. The general symptoms of infection are marked, the temperature often rising to 102° F. A slight rigor is not uncommon. On examination, the scrotum is found to be red and œdematous, and somewhat adherent to the epididymis below and behind. There is a slight hydrocele in the tunica vaginalis, which may be large enough to cause translucency. The only affection in the body of the testis is tenderness. The epididymis, especially the globus minor, is so swollen as to become wedge-shaped; it is exquisitely tender. The cord is swollen and congested, the vas thickened and tender, and on rectal examination, it may be found that the vesiculæ and prostate are also enlarged and tender. The urethral discharge grows less, or may cease entirely, as long as the acute inflammation continues.

COURSE OF THE DISEASE.—The inflammation reaches its height in about seven days. After this period a gradual retrogression takes place. In about two weeks the testis is normal, with the exception of some little thickening in the epididymis, particularly in the globus minor. This thickening, often termed "chronic epididymo-orchitis," may end in fibrosis, which leads to obstruction of the tubules of the epididymis, rendering the passage of the spermatozoa impossible. If the condition is bilateral, sterility will result. This chronic epididymo-orchitis is the most common cause of childless marriages, when the husband is at fault.

In other cases tuberculosis supervenes on a chronic gonorrhœal epididymo-orchitis.

Suppuration only takes place if a mixed infection is present, the pus usually forming in the tunica vaginalis.

The fluid in the tunica vaginalis may be absorbed, or remain as a persistent hydrocele.

TREATMENT.—The patient should be kept in bed with the scrotum elevated on a pillow, and lint soaked in iced evaporating lead lotion should be applied. Fomentations, or Bier's method of passive congestion, may take the place of the iced lotion. The bowels should be kept open, and aspirin or antipyrin given for the relief of the pain. A marked hydrocele, if present, should be tapped. After the acute pain and swelling have subsided, the patient may be allowed to get about with the testis supported in a suspensory bandage. While the testis is inflamed, all local treatment for the urethritis should be discontinued, but balsamics and urinary antiseptics should be given. When the condition becomes chronic, no pains should be spared to secure resolution of the nodules of inflammatory exudate. Counter-irritation with iodine or mercurial ointment, or strapping of the testis, may be useful. Potassium iodide should be given by the mouth.

Epididymo-Orchitis Secondary to Urethritis other than Gonorrhoeal.—The most common causes are infection following instrumentation of the urethra, operations on the urethra, the passage of urethral calculi, removal of the prostate, etc., the infection spreading along the vas.

CLINICAL FEATURES.—These are similar to those of gonorrhoeal epididymo-orchitis, from which it can only be distinguished by bacteriological examination of the organism found in the urethral discharge.

RESULTS.—The majority of cases end in resolution or fibrosis, but suppuration is more common than in epididymo-orchitis due to the gonococcus. If suppuration does ensue, the pus forms in one of three places:

1. *In the Tunica Vaginalis.*—The redness, swelling, and fluctuation occur in the front of the scrotum, and atrophy of the testis does not necessarily follow if the pus is evacuated early.
2. *In the Body of the Testis.*—This is generally followed by gangrene of the testis, and complete atrophy is almost inevitable.
3. *In the Epididymis.*—The abscess forms in the lower and back part of the scrotum, and after incision and healing, the tubules of the epididymis are completely blocked; therefore no spermatozoa from that testis reaches the semen.

TREATMENT.—The treatment is similar to that advised for gonorrhoeal epididymo-orchitis, but if suppuration occurs, early and free incision is necessary. Great care should be taken in letting pus out of the tunica vaginalis, or the tunica albuginea may be incised, and the body of the testis infected. If gangrene supervenes in the testis, this organ should be excised.

Tuberculous Epididymo-Orchitis.—As a rule tuberculosis of the testis first attacks the epididymis—either the globus major or globus minor—gradually spreading into the body. In some few instances the

body is primarily involved. The disease may apparently be localized in the testis, but more commonly it is associated with tuberculosis of the lungs or tubercle in other parts of the genito-urinary tract. The usual method of invasion is a matter of dispute, some authorities stating that it is nearly always a blood-infection, while others believe that the common mode of infection is through the *vas*, following tuberculosis of the vesiculae and prostate. In a large number of cases these organs are affected at the same time as the testis. The disease is at first unilateral, but ultimately becomes bilateral unless the condition is cured.

CLINICAL FEATURES.—Tuberculous epididymo-orchitis occurs most commonly between the ages of twenty and thirty. Injury and gonorrhoea are important etiological factors. Two types may be distinguished—the acute and chronic.

The *acute* variety in its clinical features resembles a subacute attack of gonorrhoeal epididymo-orchitis. There is no urethral discharge, however, and instead of clearing up in about fourteen days, the epididymis remains hard and nodular, abscess formation ultimately ensuing. The body is usually affected early and severely.

The *chronic* variety, which is by far the more common, is insidious in its onset, and the patient's attention is directed to it by an accidental examination of the testis, when a nodule is felt in it, or by the formation of a fluctuating swelling in the lower and back part of the scrotum. Pain is rarely present. The general health is not affected.

On examination of a well-marked case, the following physical signs are present: The *skin* at first free, becomes adherent below and behind to the epididymis, and in this situation an abscess, leading to a sinus, may form. The *epididymis* is hard and nodular, the nodules being most marked in the *globus major* and *globus minor*. Later, these nodules—especially in the *globus minor*—soften, and abscess formation occurs. Small nodules may often be felt in the *vas*, giving it a beaded feel. The rest of the spermatic cord appears to be normal. The *body* is usually not enlarged, but if a section is made of it, nodules of tuberculosis, spreading in lines from the *mediastinum testis*, are generally found. A small *hydrocele*, which is often loculated, is present in about 30 per cent. of the cases. Rectal examination often reveals nodules of tubercle in the prostate, and corresponding vesiculae and tubercle bacilli may be found in the urine.

RESULTS.—As a rule acute tuberculosis of the testis leads rapidly to abscess and sinus formation, with complete destruction of the organ. Chronic tuberculosis may remain for a long time a purely local

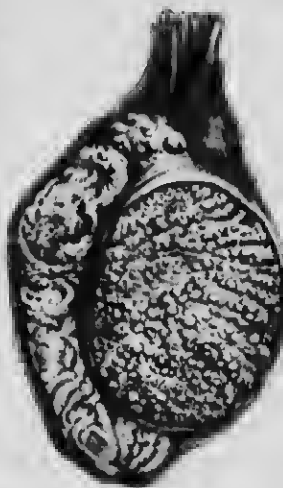


FIG. 512.—TUBERCULOSIS OF THE EPIDIDYMIS AND TESTIS

disease, the inflammation ending in fibrosis; but in the majority of cases it is steadily, if slowly, progressive, and even after apparent arrest slight injury or depression of the general health may be followed by a recrudescence of this disease. Other parts of the genito-urinary tract are always liable to become involved.

TREATMENT.—In cases of *acute* tuberculosis, if no other extensive focus of disease is present in the body, excision of the affected testis should be advised, for suppuration and destruction of the organ are inevitable. If this treatment is refused, the case should be treated by rest in bed and elevation of the scrotum until the acute symptoms have subsided. Abscesses should be opened and their contents thoroughly scraped out.

In *chronic* cases the local treatment depends on the stage in which the case is seen and the extent of involvement of other organs. Speaking generally, for unilateral disease **orchidectomy** should be advised. The operation is not contra-indicated if disease of the vesicula and prostate is also present, for the vesicula can be removed at the same time as the testis, and after removal of the testis the disease may be arrested in the prostate. If orchidectomy is refused, the testis should be supported in a suspensory bandage, and general treatment, including injections of tuberculin, carried out. Bier's method of passive congestion has also been tried with some success.

An abscess should be opened and the walls thoroughly scraped with a sharp spoon, in order to remove all tuberculous material. Healing may ensue and the testis be saved, but its external secretion becomes useless, as it cannot escape along the vas.

Epididymectomy.—In this operation the body of the testis is saved, and the internal secretion of the testis preserved. It is, however, rarely to be advised, for it is impossible to say to what extent the body of the testis is affected. Consent for this operation can sometimes be obtained when orchidectomy is refused. It is also useful if one testis has already been removed and the other is attacked by tuberculosis.

If both testes are affected when the patient comes under observation, general treatment is usually indicated, although orchidectomy on one side and epididymectomy on the other may be advised. **Double orchidectomy** may be advised if the patient is an adult, for this operation is not followed by any alteration in the physical condition of the patient, and psychical disturbances are uncommon.

When orchidectomy is performed for tuberculous disease, as much of the vas as possible should be removed. The vesicle, if affected should be excised at the same time.

Tuberculosis of the Testis in Children.—Tuberculosis of the testis is rare before the age of twelve. If it does occur, it is often associated with tuberculosis of the peritoneum or vertebrae. The disease is insidious in its onset, and presents the same physical signs as the chronic form in adults; but as it is a blood-borne infection, associated

disease of the vesicula and prostate is not present. The prognosis as regards the testis is bad, suppuration always taking place.

TREATMENT.—Orchidectomy should be advised if the disease is unilateral, and if there is no advanced tuberculosis elsewhere. In the case of bilateral disease, an attempt should be made to treat the condition by general means, for double orchidectomy, by removing the internal secretion of the testes, will result in infantilism. Abscesses should be thoroughly opened and scraped.

ORCHITIS

Acute orchitis, apart from secondary involvement from the epididymis, is a comparatively rare condition. It may follow injury, or be associated with gout (see p. 1185); but in the majority of cases it is secondary to one of the infectious fevers, especially mumps, enteric fever, smallpox, scarlet fever, and influenza.

Orchitis of Mumps.—Although the inflammation of the body of the testis generally occurs about the seventh day of the disease, it may precede the swelling of the parotid, or in some cases, during an epidemic, the testis alone may be affected. Boys and young adults are mostly affected, young children being almost entirely exempt. Orchitis is more common in some epidemics than others.

CLINICAL FEATURES.—The patient complains of acute pain in the testis, and on examination, the skin of the scrotum is found to be red and oedematous, the body of the testis hard, swollen, and painful, and a small secondary hydrocele is present. The epididymis may occasionally be slightly enlarged. The inflammation disappears in four or five days, but atrophy of the testis may follow. The disease may be unilateral or bilateral.

TREATMENT.—The patient should remain in bed with the testes supported until all the swelling and tenderness have disappeared. Fomentations or iodo-lead lotion may be applied to relieve the pain.

SYPHILIS OF THE TESTIS

Syphilitic Epididymitis.—Syphilitic inflammation of the epididymis may occur in the secondary stage of the disease about six months after the primary infection. The lesion is a symmetrical, subacute inflammation of the epididymis, chiefly affecting the globus major, which is swollen and tender. There is usually a small secondary hydrocele.

The **TREATMENT** is the general antisyphilitic treatment, and complete resolution is the usual result.

Syphilitic Orchitis.—Syphilitic inflammation of the body of the testis occurs in the tertiary period of the disease, and may develop years after the primary infection. It is, however, more common in the intermediary period—i.e., three or four years after the primary sore, and is frequently bilateral. The inflammation is essentially chronic, and ends in fibrosis and atrophy of the testis, or in gumma

formation. The former, the more common, is often discovered post mortem in patients who have had no symptoms of the condition during life.

Physical Signs of Gumma of the Testis.—The skin of the scrotum is unaffected in the early stages, but as the gumma enlarges, the skin becomes adherent to the front of the body of the testis. As the condition is painless, treatment is often neglected, and later the skin sloughs, and a gummatous ulcer, with a wash-leather slough in the floor, is formed. The body of the testis is at first uniformly enlarged, but if multiple gummata are present, it is nodular, and as the gummata break down, softening takes place in the centres of the nodules. The organ feels heavy for its size, and testicular sensation is lost early.



FIG. 513.—TERTIARY SYPHILITIC DISEASE (GUMMA) OF THE TESTIS.
(London Hospital Medical College Museum.)

The epididymis is unaffected, but soon becomes so stretched out over the enlarged body that it cannot be felt. A secondary hydrocele is common in the early stage, but subsequently the fluid is absorbed, and the two layers of the tunica vaginalis are adherent. The vas and cord are unaffected. On rectal examination, no lesion is discovered in the prostate or vesicula. There is no enlargement of the lumbar glands. The diagnosis on physical signs is often very difficult to differentiate from new growth, but the presence of a positive Wassermann's reaction and the effects of treatment usually serve to indicate the true condition.

Physical Signs of Fibrosis of the Testis.—The body of the testis is hard, and smaller than normal. Testicular sensation is lost. The epididymis, which can generally be plainly felt, is distorted, and a

large secondary hydrocele is often present. In many cases it is necessary to tap the hydrocele before the condition of the testis can be made out. As the condition is mostly bilateral, sexual desire is diminished and impotence follows.

TREATMENT—General antisyphilitic remedies should be given and pushed energetically, no matter how far the disease has advanced. Castration is only necessary when sloughing and hernia testis have occurred. These conditions are rarely seen at the present time.

Inherited Syphilis of the Testis.—This variety of the disease consists as a rule of an interstitial fibrosis of the organ. Gumma formation is rare. It is generally seen between the ages of four and ten years, both testes being simultaneously affected. The testes are

hard and somewhat enlarged, but neither painful nor tender. The condition is frequently associated with such other manifestations of inherited syphilis as interstitial keratitis and otitis interna.

If treatment is not carried out early, atrophy of the testes and infantilism result. The treatment is general antisyphilitic.

NEW GROWTHS OF THE TESTIS

Innocent.—Innocent new growths of the testis are so extremely rare as to have no clinical importance. Nearly all the cases described by the older writers are now included among the malignant neoplasms.

Malignant.—Malignant new growths may arise in the testis at any age. They are sometimes congenital, but are most common between the ages of thirty and forty-five. In a large proportion of the cases the patient gives a history of a blow on the testis or an attack of acute inflammation. The causal relationship between these conditions and new growth is doubtful, however. In many instances the blow only leads to the examination of the testis and discovery of new growth which, in its early stages, is quite painless. The disease is slightly more common in the imperfectly descended than in the fully descended testis.

CLINICAL FEATURES.—The patient usually comes under observation for enlargement of the testis. Later, he complains of a dragging pain in the testis and an aching pain in the loins. If the lumbar glands are involved, severe attacks of pain in the abdomen and the usual symptoms of cachexia are present.

On examination, dilated veins are seen across the *skin* of the scrotum, which is quite free, or slightly attached all over the surface of the swelling. The *body* of the testis is uniformly enlarged, and may retain its customary form until it is as large as a coconut. In some cases it is nodular, and cysts may be felt on its surface. Testicular sensation is lost early. The consistency, which varies with the nature of the growth, is in some instances of cartilaginous hardness, and in others so soft and fluctuant that it may be mistaken for a hydrocele. The *epididymis* is unaffected, but is soon lost as it is stretched over the surface of the enlarged body. A *hydrocele* may be present in the early stages, but the fluid is absorbed later, for the two layers of the tunica vaginalis become adherent. The fluid in the hydrocele is occasionally blood-stained. The *vas* is unaffected. The *cord*, in the early stages of the disease, is somewhat thickened by its increased vascularity and hypertrophy of the cremaster muscle. Later,



FIG. 514.—CARCINOMA OF THE TESTIS.

nodules of growth as large as, or larger than, a normal testis appear in it.

On rectal examination, the prostate and vesiculae are found to be normal. The lumbar glands are always ultimately affected unless the patient is cured by orchidectomy. These glands lie on each side of the aorta between the renal vessels and the bifurcation; when they are involved, they form a hard, nodular tumour in the *upper* part of the abdomen just above and to one side of the navel. They are often affected when the patient first comes under observation. Later, ascites and œdema of the lower extremities are present, owing to pressure on the vena cava. Secondary growths may appear in any part of the body, and in a few instances the glands along the iliac arteries may be involved apparently before the lumbar glands. With involvement of the skin of the scrotum the glands in the groin may be enlarged.

Malignant growth of the testis in children has the same physical signs as in adults, but the disease is sometimes bilateral, and the prognosis is even worse than in older patients.

DIAGNOSIS has to be made from hæmatocele, hydrocele, syphilitic orchitis, and some cases of tuberculosis. The diagnosis from syphilitic orchitis is made by the history, evidence of syphilis in other parts of the body, Wassermann's serum reaction, and the effects of treatment. The diagnosis is very difficult to differentiate from old hæmatocele; and it is often necessary to make an exploratory incision before arriving at a conclusion.

PROGNOSIS.—The prognosis in all varieties of malignant disease of the testis is very grave, owing to two factors—(1) The late period at which the disease usually comes under observation; and (2) the difficulty of effectively removing the lumbar glands. The most favourable cases are teratoid growths (see below), which contain a large amount of cartilage and fibrocystic tissue.

PATHOLOGICAL VARIETIES.—In the above description no attempt has been made to differentiate the various pathological varieties of new growth, as it is impossible to do so clinically. By microscopic examination after removal of the testis, the following varieties may be differentiated:

1. **Sarcoma.**—This may be round-celled or spindle-celled, the former being the more common and the more malignant. These tumours contain no other elements than the sarcomatous tissue.

2. **Carcinoma.**—This tumour is columnar-celled or spheroidal-celled, and arises in the ducts, or from the secreting elements of the gland. The carcinomata, like the sarcomata, exhibit a uniform structure.

3. **Endothelioma.**—Endotheliomata are rare. They exhibit the same histological features as in other organs.

4. **Teratoid Growths.**—These are exceedingly complex tumours, which occur chiefly in patients between the ages of thirty and forty.

They may appear to be innocent encapsuled tumours, containing a large amount of cartilage, fibrous tissue, and cysts, and grow slowly for years; or they may be among the most rapidly growing and malignant of the testicular neoplasms, and contain sarcomatous, carcinomatous, or even chorion-epitheliomatous tissue. The tumours have been called "adenoma of the testis," "fibrocystic disease," "chondrosarcoma," "chondrocarcinoma," "chorion-epithelioma," "mixed testicular tumours," etc.; but all these forms are now definitely recognized as malignant tumours of the same nature. The confusion in nomenclature arose from the practice of examining and describing solitary specimens in which one or other of these elements predominated. They are now considered to be teratoid growths arising from all three layers of the embryo. At the present time it is not possible to diagnose these tumours clinically from other varieties of malignant growth of the testis.

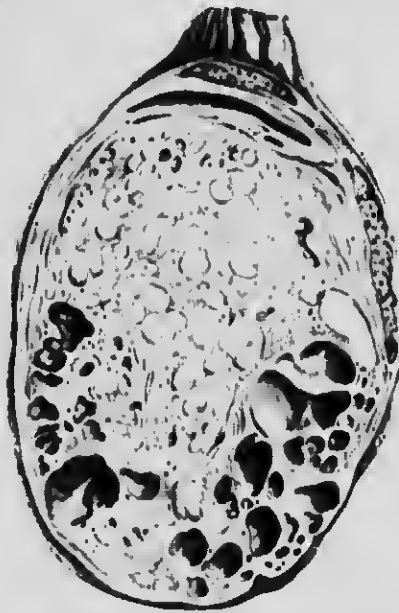


FIG. 515. TERATOMA OF THE TESTIS
(FIBRO-CYSTIC DISEASE).
(London Hospital Medical College
Museum.)

TREATMENT.—The modern treatment of malignant disease of the testis is removal of half the scrotum containing the diseased testis, the spermatic cord, the spermatic vessels as high up as possible, and the cellular tissue containing the lymphatic glands lying along the external and common iliac arteries, and the aorta as high as the renal vessels. This complete extensive operation is at present only possible in a limited number of cases, and is contra-indicated if the lumbar glands are clinically enlarged. If the operation is considered inadvisable, the testis and the spermatic cord should be removed, even if the lumbar glands are involved, as the patient will be rid of a source of annoyance, and avoid the danger of the growth fungating. Local recurrence is rare. Operative treatment is useless if there is marked cachexia, or if the spermatic cord is infiltrated with growth. In the latter case it is dangerous on account of the hæmorrhage that occurs.

Dermoid Tumours.—Three different pathological conditions have been included under this heading:

1. *Encapsuled Tumours of the Testis containing Hair, Teeth, Bones, etc.*—The term "dermoid of the testis" should be reserved for this variety, and it is exceedingly rare. The



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- tumours are congenital in origin, grow slowly, and are apt to become inflamed and to suppurate, the contents being discharged through a sinus. The treatment is removal.
2. *Pilo-Schaeccous Dermoids*, which arise in the skin of the scrotum, and have only a secondary attachment to the testis.
 3. *The Cases of Malignant Teratomata* described above, which contain cartilage, bone, and tissue resembling gut, nervous tissue, and even special sense organs.

Malignant Disease of the Epididymis.—Malignant disease arising in the epididymis is very rare, the most common variety being sarcoma. The treatment is early removal.

Cysts of the Epididymis.—Cysts of the epididymis, which are not uncommon, are generally seen in patients over forty. They are frequently bilateral, but one side is generally much larger than the other, thus attracting the patient's attention, the cyst on the other side being discovered at the examination. They are usually small, though they may grow to the size of an orange or a small cocoa-nut. They are then very difficult to diagnose from vaginal hydroceles.

The *fluid* present is a slightly straw-coloured fluid containing a trace of albumin, or a milky, opalescent fluid containing spermatozoa, living or dead. This last variety of cyst is termed a **spermatocele**. Diagnosis is impossible before tapping.



FIG. 516.—CYSTS OF THE EPIDIDYMIS.

but can as a rule be made by finding the testis below and separated from the cystic swelling, and lying more horizontal than usual. A blow may cause hæmorrhage into the cyst.

PATHOLOGY.—The following views of the origin of these cysts are held: (1) They arise from the fetal remnants of the testis—viz., the Wolffian body or paradidymis, the vas aberrans of Haller, the pronephros or hydrid of Morgagni, or the remains of Müller's ducts; (2) they are retention cysts of the vasa efferentia or the tubules of the epididymis; (3) they are irritation cysts, due to the rupture of one of the vasa efferentia into the surrounding connective tissue. It is probable that all these views are correct.

CLINICAL FEATURES.—The patient generally seeks advice on account of the swelling in the scrotum, for pain and other symptoms are absent. A medium-sized cystic swelling is found lying above the testis (these cysts nearly always arise in connection with the globus major), which is translucent and attached to the testis. Examination of the globus major on the opposite side will often reveal a second cystic swelling. If the cyst is large it envelops the testis, and the differentiation from vaginal hydrocele is difficult.

TREATMENT.—The cysts may be tapped, but the fluid generally re-accumulates. Radical treatment, which consists of dissecting out the cyst wall, should only be advised if the cyst is enlarging and the size of the scrotum is becoming a nuisance to the patient. In a few cases, when the patient complains of severe neuralgic pains in the testis, the cyst should be removed, although the patient must be warned that removal does not necessarily relieve the pain.

Neuralgia of the Testis.—This term is applied to paroxysms of acute pain in the testis occurring without obvious cause.

CLINICAL FEATURES.—The testis is usually hypersensitive, the attacks of pain occurring at irregular intervals, and lasting a few minutes or several hours. The pain starts in the testis, which is often retracted by spasm of the cremaster muscle, and radiates along the spermatic cord to the lumbar region. It may be induced by exercise, slight injury, or even change in temperature. Coitus may either relieve or excite the pain.

On examination, the testis may appear to be perfectly normal, or there may be slight fibrous nodules in the epididymis, generally the result of past gonorrhoeal epididymo-orchitis. The pain seems to radiate from these nodules, which are exquisitely tender. Sometimes there is some obvious lesion of the testis or its annexa, such as hydrocele, cyst of the epididymis, varicocele, etc. A few cases depend on pressure on the nerves of the testis from abdominal tumours or new growths of the spine.

TREATMENT.—Any obvious pathological condition, as a varicocele, hydrocele, or cyst of the epididymis, should receive treatment, which may possibly relieve the pain. If relief does not follow, or if there is no obvious pathological condition, the prognosis is not good. Even if temporary relief is obtained, recurrences of the attacks are common.

The general health and sexual life of the patient must be considered, and the usual treatment for neurosis carried out. When the pain is severe, morphia may be necessary. The other drugs generally used are quinine, aconite, and aspirin.

Pressure of the spermatic cord against the symphysis pubis will sometimes relieve the pain. *Orchidectomy* is generally useless to relieve the attacks, unless there is some obvious pathological lesion in the testis which cannot be removed in any other way. It should therefore not be advised if the testis appears normal on examination.

Orchidectomy.—An incision from 2 to 3 inches long is made over and just below the external abdominal ring, and the spermatic cord exposed and isolated by blunt dissection.

It is then crushed with a clamp, and a ligature applied round the part crushed. The vas may be ligatured separately or included in the same ligature as the vessels. The cord is again clamped below the ligature and divided between the clamp and the ligature. The proximal end is then examined, and if the ligature is secure and there is no bleeding, it is allowed to retract inside the inguinal canal. The testis is pulled into the wound and separated from the surrounding

tissue by blunt dissection, all hemorrhage being carefully arrested. The wound should be drained for forty-eight hours.

The chief danger of the operation is slipping of the ligature on the cord, and if this structure is thickened, it should be tied in two or more portions.

DISEASES OF THE TUNICA VAGINALIS AND SPERMATIC CORD

Hydrocele

A hydrocele is an effusion of serous fluid into some part of the processus vaginalis. The following varieties are distinguished:

I. Primary or Idiopathic Hydrocele of the Tunica Vaginalis.—The cause of this condition is unknown, two views being held:

- (1) It is a passive effusion into the cavity of the tunica vaginalis from unknown causes.
- (2) It is secondary to some chronic inflammatory condition of the testis or epididymis.

The former view is most generally held by English surgeons.

The condition may arise at any age, but is most common in elderly subjects, especially in Europeans resident in tropical countries. It may be bilateral.

CLINICAL FEATURES.—The patient complains of a swelling in the scrotum, which by its size is causing inconvenience.

On examination, there is found a pear-shaped swelling, with the base downwards in one-half of the scrotum. It does not extend up to the external abdominal ring, and the cord can clearly be felt above it. The swelling is cystic; there is no impulse on coughing, and the skin over it is freely movable. If a light is placed behind it, the swelling is found to be translucent, unless the walls are very thick or calcified, as is the case in old hydroceles. It must be remembered that in a child a hernia containing gut may be translucent. If the testis can be distinguished, it is found below and behind the testis, except in cases of anteversion (see p. 1181), when it is found in front and above. In the case of large hydroceles the skin of the penis and scrotum may be so dragged forward by the swelling that the penis is lost in it. This will cause inconvenience in micturition and coitus.



FIG. 517.—VAGINAL HYDROCELE.

Hydroceles have to be diagnosed from hamatoceles, cysts of the epididymis, scrotal herniæ, and new growths of the testis.

PATHOLOGICAL ANATOMY.—The sac of a hydrocele may remain thin, even in old-standing cases; but more often, especially if the hydrocele has been frequently tapped, it becomes thickened and calcified.

Small nodules of fibrous tissue and cartilage may be found on the inner aspect of the sac, which is more or less divided into loculi by bands of fibrous tissue. Injection of the sac with wax shows finger-like processes running out into the connective tissue of the scrotum. The fluid in a hydrocele is generally straw-coloured, with a specific gravity of 1022. It contains 6 per cent. of albumin, and therefore it becomes solid on boiling, and may coagulate spontaneously. In some instances it contains cholesterol, and occasionally spermatozoa.

The tunica albuginea of the testis may be thickened. Even old-standing hydroceles with calcified walls have little effect on the secretory tubules of the testis; therefore atrophy of the testis is not to be feared.

COMPLICATIONS—1. *Rupture*.—A hydrocele may rupture as the result of trauma, or the sac may give way spontaneously. A sudden, sharp, cutting pain is felt, and the localized swelling disappears, to be succeeded by a diffuse swelling of the scrotum, penis, and lower part of the abdomen, resembling that due to extravasation of urine. Rest is the only necessary treatment of this condition, as the fluid becomes absorbed. The hydrocele usually recurs. Suppuration in the cellular tissue is an occasional termination.

2. *Inflammation and Suppuration* may take place if an infected trocar is used to tap a hydrocele. Spontaneous inflammation rarely arises.

3. *Hæmorrhage into the Sac* (hæmatocele) may follow tapping or blows on the sac; it may also occur spontaneously.

TREATMENT.—A hydrocele may be treated by tapping, or by operative radical cure.

Tapping.—This can be done without inconvenience to the patient, but is usually followed by recurrence. The skin of the scrotum is rendered aseptic, the position of the testis ascertained, and a sterilized trocar is plunged into the sac, care being taken to avoid any large vein in the scrotum. After the sac is emptied, the small puncture is closed with collodion. This tapping can be repeated at intervals, and the patient may desire no other method of treatment.

Radical Cure.—This may be advised in all cases, unless the general condition of the patient contra-indicates any—not absolutely necessary—surgical operation. The cure is as a rule complete.

Two methods are used at present—(1) The sac is opened by an incision at the root of the scrotum, and the parietal layer of the tunica vaginalis separated from the dartos. The sac is next removed, all hæmorrhage carefully stopped, and a small drain placed in the wound, which is then closed. The patient is kept in bed for about a week. (2) The sac is opened in the same way as before and inverted, no part of it being removed. Both operations are equally successful.

In old-standing cases with very thick sacs in elderly men, orchidectomy is the simplest form of treatment if a radical cure is desired.

2. **Congenital Hydrocele**.—A congenital hydrocele is an effusion of serum into an entirely unobliterated processus vaginalis. It may be present at birth, or appear later, and is frequently bilateral. In children it is sometimes associated with tuberculous peritonitis.

CLINICAL FEATURES.—The scrotum contains a cystic, translucent, pyriform swelling, extending up into the abdomen. There may be a slight impulse on coughing. When the patient is lying down, steady

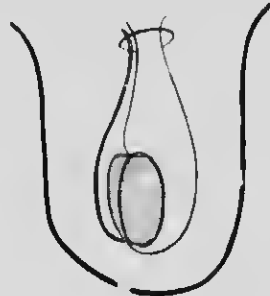


FIG. 518.—CONGENITAL HYDROCELE.



FIG. 519.—HYDROCELE INTO A FUNICULAR PROCESS.

pressure causes the swelling to disappear *slowly* (a hernia disappears suddenly); but the swelling fills up from the bottom when the patient stands up.

TREATMENT.—The processus vaginalis being patent, the patient has a potential hernia, and treatment for hernia is necessary. A truss must be worn (see Hernia in Infants, p. 731), and the hydrocele should be tapped occasionally. As this treatment is not certain to result in cure, it is simpler to perform radical cure for an inguinal hernia, excising the whole of the sac down to the testis. If it is decided to tap the hydrocele, special precaution is necessary, as the sac is in direct communication with the peritoneal cavity.

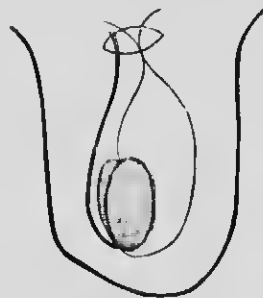


FIG. 520.—INFANTILE HYDROCELE.

3. Infantile Hydrocele.—In these cases the processus vaginalis is closed above at the internal abdominal ring, but the remainder is patent, and fluid collects in it. The condition is most common at, or soon after, birth.

CLINICAL FEATURES.—Infantile hydroceles are often bilateral. The swelling in the scrotum, which is cystic and translucent, extends up to the internal abdominal ring. There is no impulse on coughing.

TREATMENT.—The condition may be left as it commonly undergoes spontaneous cure. If cure does not take place, the hydrocele may be tapped two or three times, and if it persists after this, radical cure should be performed.

4. Encysted Hydrocele of the Cord.—This term is used to describe a collection of fluid in the portion of the processus vaginalis lying in the spermatic cord—i.e., the portion below the external abdominal ring, and above the tunica vaginalis. The condition is most common

in children, but may be found at any age, and has not infrequently been mistaken for an extra testis.

CLINICAL FEATURES.—There is a small painless cystic, translucent, rounded swelling lying in the spermatic cord above the testis. It moves with the testis, and cannot be reduced into the abdomen, although it may be pushed up through the external abdominal ring. Occasionally the sac has a communication with the abdomen. Hemorrhage may occur into these cysts, causing an encysted hematocele of the cord.

TREATMENT.—In children the cyst may disappear spontaneously, or after tapping; but if the parents wish, it can be removed by dissection.

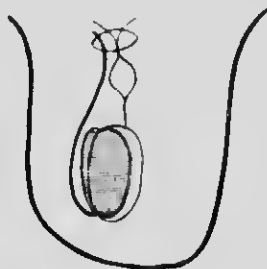


FIG. 521.—ENCYSTED HYDROCELE OF CORD.

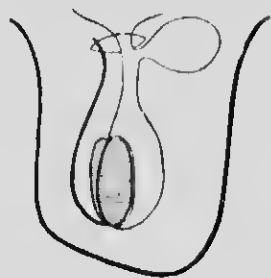


FIG. 522.—BILOCULAR HYDROCELE.

5. Bilocular Hydrocele.—This form of hydrocele is nearly always associated with imperfect descent of the testis. It has two pouches—one passing down into the scrotum, as in a congenital hydrocele, and the other extending up into the abdomen, behind or in front of the peritoneal cavity. The abdominal sac generally lies in front of the peritoneal cavity, and is much the larger of the two sacs. It may extend above the umbilicus and into the pelvis, and contain pints of fluid. Fluctuation may be obtained between the two sacs. The constriction between them usually occurs at the internal abdominal ring.

TREATMENT.—The hydrocele should be removed by dissection.

6. Diffuse Hydrocele of the Cord.—This term denotes a condition the cause of which is unknown, in which there is a collection of serum in the connective tissue of the spermatic cord. There is no definite sac.

CLINICAL FEATURES.—The patient, an adult as a rule, has a pyriform swelling in the region of the spermatic cord, the apex of which disappears through the external abdominal ring. The swelling is painless, becomes smaller when the patient lies down, and reappears on standing.

TREATMENT.—The spermatic cord should be exposed, and the space containing the fluid opened and drained. This condition is very rare.

7. Secondary Hydrocele.—A secondary hydrocele is a collection of serous fluid in the tunica vaginalis, secondary to a patho-

logical condition of the testis, epididymis, scrotum, or spermatic cord. Secondary hydroceles may be divided into acute and chronic.

(1) **ACUTE SECONDARY HYDROCELE.**—The most common cause of this condition is acute gonorrhœal epididymo-orchitis, although it may occur with acute orchitis from other causes, torsion of the spermatic cord, or cellulitis of the scrotum.

The amount of fluid is as a rule slight, and the condition often passes unnoticed, for it is masked by the acute symptoms in the testis.

After the inflammation in the surrounding structures subsides, the fluid may either be absorbed or it may persist as a hydrocele, which will require similar treatment to that of a primary hydrocele. In a few cases suppuration occurs, and must be treated by incision and drainage.

(2) **CHRONIC SECONDARY HYDROCELES** are usually associated with such a chronic inflammation of the testis as syphilis and tuberculosis, but they may also occur with new growths of the testis. It may be necessary to tap a secondary chronic hydrocele before an opinion as to the condition of the testis can be given.

TREATMENT.—The treatment is that of the primary condition causing the hydrocele.

Hæmatocele

A hæmatocele is an extravasation of blood into the cavity of the tunica vaginalis.

CAUSE.—A hæmatocele is generally preceded by a hydrocele. The most common cause of its production is injury of a bloodvessel during tapping, or rupture of a vein after tapping, owing to the sudden relief from pressure. In some cases the formation of a hæmatocele is spontaneous, and as the most careful questioning fails to elicit any cause for the condition, it is assumed that it is due to a degenerative disease of the bloodvessels. Blows and squeezes of the scrotum may cause a hæmatocele when no hydrocele has been present, but the condition is more likely to result if the tunica vaginalis is already distended with fluid. In a few cases a hæmatocele is secondary to malignant new growths of the testis, epididymis, or tunica vaginalis, or it may follow acute torsion of the spermatic cord.

CLINICAL FEATURES.—Clinically, the cases may be divided into acute and chronic hæmatoceles.

1. **Acute Hæmatocele.**—The onset is sudden, following a blow on the scrotum, or, more commonly, the tapping of a hydrocele, the scrotum swelling rapidly after the accident. The swelling is painful, tender, doughy to the feel, and non-transparent. The skin over it is commonly blood-stained. The testis cannot as a rule be identified, and if the swelling is tapped, there is some escape of blood without marked diminution in the size of the swelling. If radical treatment is not carried out, the swelling gradually diminishes in size, and the

ecchymosis of the scrotum disappears. Complete resolution is uncommon, however. Suppuration occasionally occurs.

2. **Chronic Hæmatocele.**—The swelling in the scrotum appears slowly, and there are usually irregular increases in size, suggesting repeated small hæmorrhages. The patient can often give no history of any cause, and is generally very vague as to the exact time of onset of the condition. The swelling is firm and non-translucent, and the position of the testis and the relationship of body and epididymis cannot be determined. The skin of the scrotum is often slightly adherent all over the swelling, and the resemblance to malignant neoplasm of the testis may be so exact that a differential diagnosis may not be possible without exploratory incision. If the swelling is tapped, a little brown fluid, with blood-corpuscles and cholesterol, is removed, without diminution in the size of the swelling. Suppuration may occur.

The walls of a hæmatocele are generally much thicker than those of a hydrocele, and the interior is lined with laminated blood-clot. The tunica albuginea is generally thickened, but even old-standing, thick-walled hæmatocèles have little effect on the secretory tubules of the testis, and atrophy is not to be feared.

DIAGNOSIS.—The common error is to mistake a hæmatocele for malignant disease of the testis, and remove the organ. A hæmatocele may also be mistaken for syphilitic orchitis or a non-translucent hydrocele.

TREATMENT.—A small recent hæmatocele may be treated with rest in bed and the application of evaporating lead lotion, or an icebag, with or without tapping with a large-sized trocar; but in the majority of cases operative treatment is to be preferred. Three methods of treatment are employed:

1. The tunica vaginalis may be incised, the blood-clot removed, and the cavity drained for forty-eight hours. This method is advised in recent hæmatocèles not preceded by hydrocele.
2. Opening the tunica vaginalis, removing the clot, and excising the parietal layer of the tunica vaginalis. All bleeding vessels are carefully secured, and the wound is drained for forty-eight hours. This method is advised in cases of recent thin-walled hæmatocèles preceded by hydrocele.



FIG. 523.—OLD HÆMATOCELE OF THE TUNICA VAGINALIS REMOVED FOR MALIGNANT DISEASE. (London Hospital Medical College Museum.)

3. Orchiectomy. In old-standing hæmatoceles with very thick and calcareous walls, removal of the parietal layer of the tunica vaginalis without injury to the testis or cord is a very tedious operation, and there may be considerable difficulty in arresting the hæmorrhage. As these hæmatoceles are generally met with in elderly patients, orchiectomy can be advised, and before attempting a radical cure of an old hæmatocele in an elderly person, consent to remove the testis should be obtained.

Suppuration in a hæmatocele is treated by incision, removal of the blood-clot, and drainage.

SPERMATIC CORD

Hæmatocele of the Spermatic Cord.—This is a rare condition, and may either be *localized*, being then due to hæmorrhage into an encysted hydrocele of the cord; or *diffuse*, caused by rupture of one of the veins of the pampiniform plexus. The latter variety may be due to a blow, but is more often the result of straining at stool, or of a severe lifting effort.

TREATMENT.—A localized hæmatocele of the cord should be removed by dissection. A small diffuse hæmatocele should be left to be absorbed. If there is a large hæmorrhage, the swelling should be incised, the clot turned out, and the bleeding vessel tied.

Varicocele

A varicocele is a varicose condition of the veins of the pampiniform plexus of the spermatic cord. These veins, which start in the tunica vasculosa of the testis, unite at the internal abdominal ring to form a single spermatic vein, which enters the renal vein at a right angle on the left side, and the vena cava on the right. The veins in the spermatic cord lie in front of the vas, with its accompanying artery and veins, separated from them by a slight cellular interval. The spermatic artery lies in the midst of the veins. The veins of the scrotum and lower part of the abdomen are often affected at the same time.

The condition is much more common on the left side than on the right. When right-sided, the patient is often left-handed. The condition tends to disappear as age advances.

CAUSE.—The cause of the condition is unknown, but it is probably due to a congenital abnormality of the veins. The varicosity is increased by several causes—for example, by the long, tortuous course of the spermatic artery, causing the pressure on the spermatic veins to be very low, the absence of valves in the veins, the passage through the abdominal rings where the veins are likely to be constricted, and the entrance of the spermatic vein into the renal at a right angle.

Oblivious pressure on the spermatic vein will cause a varicocele, and this is sometimes due to a malignant neoplasm of the kidney; therefore the appearance of a varicocele after adult life is reached should always lead to examination of the renal area.

PATHOLOGICAL ANATOMY.—The veins are lengthened, increased in number, and tortuous; their walls are diseased (see *Varicose Vein*, p. 328). Phleboliths may be found in them, but thrombosis or rupture of the veins is rare. The skin of the scrotum is lax, and the testis usually hangs much lower than is normal. The testis on the side affected may feel softer than usual, but no marked atrophy of the testis occurs.

CLINICAL FEATURES.—Varicocele is a disease of adolescence, and the onset is insidious, the patient frequently being unaware of the condition until he is medically examined before entering one of the public services. In some cases there is a feeling of weight in the scrotum, and aching is complained of, especially after long standing; or the condition may be associated with neuralgia of the testis (p. 1195). The condition can usually be recognized at a glance by the long lax scrotum with big veins coursing over it. On palpation, the scrotum feels like a "bag of worms." There is an impulse on coughing, and the swelling disappears more or less on recumbency, to reappear slowly when the patient stands up. As stated above, the condition tends to disappear as the patient gets older.

TREATMENT.—Palliative.—In the majority of cases this is all that is necessary. The patient is directed to bathe the scrotum in cold water night and morning, and to wear a suspensory bandage during the day.

Constipation, if present, should be treated. The patient should be assured that atrophy of the testis and loss of virile power are not to be feared.

Operative.—Operative treatment is necessary if the patient wishes to enter one of the public services, and is advisable also if the varicocele is very large and painful. An incision is made over the external abdominal ring, and about 2 inches of the veins of the spermatic cord are removed, care being taken to preserve the artery and veins of the vas. The spermatic artery is included in the ligature. The cord is shortened by uniting the cut ends of the veins, and an elliptical piece of skin should be removed, if necessary, from the scrotum.

After the operation, the patient should be kept in bed for a fortnight, and should wear a suspensory bandage for the next three months.

The operation is as a rule most successful, but patients with neuralgia of the testis may continue to have pain as before, and neurasthenic patients may complain of pain in the testis and loss of virile power.

Inclusion of the ilio-inguinal nerve in the ligation may cause true nerve-pressure pain (see p. 372).

Funiculitis. Inflammation of the spermatic cord is usually secondary to inflammation of the testis, but a special variety of primary acute funiculitis occurs in tropical and subtropical countries. An acute inflammation of the cord is present, the clinical signs somewhat resembling those of strangulated hernia. Suppuration is common, and a diplococcus has been isolated from the pus.

The **TREATMENT** in the severe cases consists of excision of the cord and testis, but in the milder cases the inflammatory swelling should be incised and drained.

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INDEX

- ABSCESSES**, gunshot wounds
 of, 61
 effects of, 59
- Abdominal aneurysm**, 322
 incision, capture of, 613
 operation, 774
 pressure, causes of in-
 creased, 715
 viscera, contusions of
 abdomen associated
 with injuries to, 611
- Abdominal wall, diseases of**,
 612
 injuries of, 610
 new growths of,
 614
 phantom tumours
 of, 613
 wounds of, 612
- Abdomino-perineal opera-
 tion**, 774
- Abscess, 91**
 acute, 71
 alveolar, 954
 amebic or tropical, 791
 atheromatous, 308
 cerebral, 843
 chronic, 72
 embolic, 1085
 formation and appen-
 dicitis, 705
 in spine, 881, 884
 ischio-rectal, 754
 lacunar, 1139
 lumbar, 803
 of areola, 1058
 of bone, chronic, 490
 of breast, chronic, 1061
 of liver, 789, 791
 of lung, 1040
 of rectum, submucous,
 757
 of spleen, 786
 pancreatic, 790
 pelvic, 622
 pelvi-rectal, 757
 perianal, 754
 periarticular, 504
 periurethral, 1147
 psoas, 893
- Abscess, retropharyngeal**,
 1062
 retropharyngeal, 987
 subdiaphragmatic, 623
 in appendicitis, 719
 with Pott's disease, 890
- Accidental wounds**, 55-58
- Acromioclavicular fractures of**
 the, 453
- Achilles bursa**, 362
- Achondroplasia**, 515
- Achroon schonioidii**, 15
- Acromegaly**, 529
- Acromion, fracture of**, 43
- Actinomyces**, 104
- Actinomyces**, 104, 702, 2
 in appendicitis, 71
 in jaw, 956
- Aenpressure in hamorr-
 age**, 192
- Acupuncture for aneurysm**,
 317
- Acute glanders**, 101
 infective gangrene, 176
 general peritoni-
 tis, 616
 localized peritoni-
 tis, 621
 inflammation, 18, 30
 lymphadenitis, 337
 lymphangitis, 336
 necrosis of bone, 180
 neuritis, 375
 tetanus, 94
 traumatic gangrene,
 177
 ulceration, 151, 152
- Adonitis, chronic**, 337
 of mesenteric glands,
 tuberculous, 634
- Adenoids**, 917
- Adenomata**, 234, 641
 malignant, 236
 multiple, of the intes-
 tine, 683
 of breast, 1066
 of liver, 793
 of rectum, 768
 of scalp, 809
 of soft palate, 943
- Adenomata, of thyroid-
 gland**, 1016
 sebaceous, 395
 treatment of, 215
- Adhesions after inflamma-
 tion of gall-bladder**, 803
- Adiposis dolorosa**, 216
- Adolescent scolliosis**, 253
- Adventitious bursa**, 363
- Aglossia**, 966
- Air, entrance into veins**, 305
 passages, foreign bodies
 in, 1011
 operations on,
 1019
 swellings in neck, 904
- Albimuria, myelopathic**,
 233
- Alimentary canal, rupture
 of part of**, 611
- Alveolar abscesses**, 954
- Alveolar tumours of**, 958
- Amazia**, 1057
- Amoeba**, 15
- Amputation for aneurysm**,
 316
 for tuberculous disease
 of joints, 567
 in gangrene, 160
 neuromata, 218, 377
 of penis, 1175
- Amorphous degeneration of
 arteries**, 308
 disease, 75
- Anaemic ulceration**, 159
- Anaesthesia in reduction of
 contraction**, 418
 of deformity, 416
- Anal canal, stenosis of the**,
 748
- Anastomosis of nerves**, 381
- Anatomical neck of hu-
 merus, fracture of**,
 438
 tubercle, 400
- Anatomy of urethra**, 1128
- Anel's operation for aneu-
 rysm**, 315
- Aneurysm**, 309, 362
 by anastomosis, 333

- Aneurysm, diffuse traumatic, 302
 dissecting, 312
 fusiform, 311
 of buttock, 323
 of special arteries, 318-326
 rupture of, 313-314
 sacculated, 311
 suppuration of, 314
 treatment of, 314-318
 varicose, 324, 325
- Aneurysmal varix, 320, 324
- Angeioma, 222
 of bloodvessels, 332
 of lips, 939
 of liver, 703
 of pleura, 1043
 of scalp, 809
 of tongue, 972
- Anklo, dislocation of, 546
- Ankle-joint, diseases of, 607
 fractures of the, 475
- Ankylosis of the jaw, 580
- Annular carcinomatous stricture, 242
- Annulus migrans, 972
- Anorchism, 1181
- Anterior metatarsalgia, 299
- Anthrax, 08
 treatment by sero-therapy, 100
- Antisepsis, 38
- Antiseptics, 38-40
- Antitoxins, 13, 22
- Antyllus's operation for aneurysm, 315
- Anuria, calculus, 1099
- Anus, congenital malformations of, 746
 fissure of, 752
 imperforate, 746
 injuries and diseases of (Chapter XXII.), 746-775
 new growths of, 768;
 inoperable cases of, 775
 ulcers of, 751
- Apthons stomatitis, 942
- Apoplexy, traumatic late, 823
- Appendectomy, 705
- Appendicitis, 702-712
 acute, 704
 with general peritonitis, 703
 catarrhal, 707
 chronic, 708
 complications of, 709
 recurrent, 708
 subacute, 707
 terminating in abscess formation, 705
- Appendicostomy, 675
- Appendicular colic, 708
- Appendicular concretions, 709
- Appendix, acquired abnormalities of the, 702
 congenital malformations of, 702
 diseases of the, 702-712
 hernia of the, 744
 new growths of, 711
 removal of, 707
 tuberculosis of the, 711
- Arcola, abscess of, 1058
- Arteries, abnormal, 1079
 aneurysms of special, 318
 degeneration of, 308
 inflammation of, 306
 injuries of, 301-303
 syphilitic affections of, 137
 wounds of, 303
- Arterio-venous aneurysm, 324
- Arteritis, chronic, 307
 infective, 184, 306
 septic, 306
 syphilitic, 306
 tubercular, 306
- Arterio-sclerosis, 307
- Arthritis, 92, 550-576
 deformans, 569
 gonorrhœal, 559, 579, 894
 lipomatosa, 215
 of hip, pyæmic, 601
 pneumococcal, 558
 pyogenic, 579
 scarlet fever, 559
 staphylococcal and streptococcal, 558
 syphilitic, 567
 typhoid, 558
- Arthritis, tuberculous, 561
 amputation for, 567
 deformity resulting from, 599
 of ankle, 609
 of elbow, 583
 of hip, 587
 of knee, 603
 of sacro-iliac joint, 585
 of shoulder, 581
 of sterno-clavicular articulation, 580
 of temporo-maxillary joint, 570
 of wrist, 584
- Arthrodesis, 288
- Arthropathy following lesions of peripheral nerves, 578
 in syringomyelia, 577
 of tabes dorsalis, 576
- Articular rheumatism, acute, 560
- Articulation, sterno-clavicular, 580
- Ascending colon, volvulus of the, 693
- Asepsis, 40
- Aseptic moist gangrene, 159
 traumatic fever, 20
 wounds, 38; drainage of, 40
- Aspergillus, 15
- Asphyxia, 980
 in Raynaud's disease, 165
- Asthma, thymic, 1056
- Astragalectomy, 283
- Astragalus, dislocation of, 547
 fractures of, 479
- Atheroma, 307
- Atony of bladder, 1127
- Atresia, 1133
- Atrophic carcinoma, 241
 kidney, 1079
- Atrophy of bone, 481
- Auditory nerve, injury of, 382
- Auricle, cysts of, 1002
 accessory, 1002
- Axial rotation of testis, 1183
- Axilla, cellulitis of the, 83
- Axillary aneurysm, 322
 artery, wound of, 196
- Bacilli, 1
- Bacilluria, 1116
- Bacillus anthracis, 98
coli communis, 702
 Ducey's, 148
aërogenes capsulatus, 176
filiformis, 662
malleyi, 101, 336, 337
 of syphilis, 120, 124
tetanus, 03
 tubercle, 108
- Bacteria, 1-15
 attenuation and death of, 4
 condition of growth, 3
 decolorization by acid, 5
 Gram's method of treating, 5
 higher, 2
 immunity from, 7-12
 inoculation of, 6
 lower, 1
 methods of studying, 5
 microscopical examination of, 5
 mode of action of the pathogenic, 6
 multiplication of, 2, 3
 products of the metabolism of, 4
 structure of, 2

- Baker's cysts, 551
 Balanitis, 1171
 Bandage, elastic, 153
 Unna's, 151
 Bandaging, tight, gangrene from, 166
 Barbadoes leg, 346
 Bartholin's gland, inflammation of, 1140
 Bassini's operation in hernia, 732
 Bavarian splint, 474
 Bazin's disease, 400
 Bedsores, 167
 Bell's paralysis, 384
 Bennett's fracture, 451
 Biceps, rupture of, 350
 Bior's method in treatment of inflammation, 25, 79, 88, 117, 179, 304, 565
 Bile-ducts, carcinoma of, 805
 Bilharzia haematobia, 1107
 Biocular hydrocele, 1199
 Binioidide of mercury, 39
 Birth palsy, 383
 Bites of animals, 64
 Black eye, 999
 Bladder, atony of, 1127
 congenital abnormalities of, 1110
 diseases of urinary, 1111-1127
 foreign bodies in, 1109
 hernia of, 745
 inflammation of, 1111
 neurosis of, 1125
 new growths of, 1121
 rupture of, 1108
 stone in, 1116-1120
 wounds of, 1109
 Blanket suture, 49
 Blastomycetes (yeasts), 15
 Blastomycotic dermatitis, 15
 Blood-clot, healing of wound by, 55
 Blood-cyst, 635
 -cysts of neck, 904
 Blood-supply, interference of, 150
 Bloodvessels, effects of gunshot wounds on, 59
 injuries and diseases of the (Chapter X.), 301-334
 injury to large, in fractures, 412
 new growths of, 332
 rupture of large, 611
 Boils, 180, 392
 Bone, atrophy of, 481
 caries of, 483
 chronic abscess of, 490
 cysts of, 406, 509
 diseases of (Chapter XV.), 480-521
 hypertrophy of, 481
 inflammation of, 482-493
 marrow, 480
 tumours connected with, 231
 necrosis of, 180, 483
 new growths of, 501-509
 operations in talipes, 289
 regeneration of, 482
 sclerosis of, 483
 syphilis of, 495-501
 syphilitic condition of, 133, 144
 tuberculous disease of, 493-495
 Bones, effects of gunshot wounds on, 59
 injuries of (Chapter XIV.), 405-470
 mucopurulent otitis of nasal, 498
 Boracic acid, 39
 Bow-legs, 276
 Box splint, 465, 595
 Braces and jackets, 889
 Brachial aneurysm, 322
 neuritis, 384
 plexus, injury of, 383
 Brain, 835-862
 and meninges, inflammatory conditions of, 839
 congenital malformations of, 835
 diseases of, 835
 effects of gunshot wounds on, 59
 gunmatous tumours of, 855
 injuries and diseases of, 820-824
 tapping lateral ventricle of, 860
 wounds of, 820
 Branchial cysts, 902
 fistula, 902
 Branchiogenic carcinoma, 905
 Brasdor's operation for aneurysm, 316
 Breast, absence of, 1057
 accessory, 1057
 chronic abscess of, 1061
 cysts of, 1064
 diffuse hypertrophy of, 1057
 diseases of (Chapter XXXIII.), 1057-1076
 of male, 1076
 neuralgia of, 1064
 new growths of, 1066
 syphilis of, 1062
 Breast, tuberculosis of, 1062
 Bridge callus, 429
 Brophy's operation, 934
 Bryant's triangle, 455
 Bubonicle, 715, 726
 Bullets, explosive, 61
 high-velocity, 58
 low-velocity, 61
 removal of, 60
 Bunion, 364
 Burns, 169-175
 of the stomach, 647
 treatment of, 172-174
 Bursae, diseases of special, 362
 injuries of, 360-364
 inflammation of, 360
 Bursal cysts, of neck, 904
 Bursitis, 360-362
 Buttock, aneurysm of, 323
 Cachexia, 211, 212, 1056
 Cæcostomy, 675
 Cæcum, hernia of, 744
 volvulus of, 693
 Calculi, pancreatic, 782
 preputial, 1171
 salivary, 947
 Calculus anuria, 1099
 in vesiculae, 1167
 prostatic, 1154
 pyelitis and pyonephrosis, 1099
 renal, 1094
 Callosity, 390
 Callus, 414
 tumours of, 430
 Calmette's reaction, 115
 Cammidge's reaction, 777
 Cancer (see also Tumour)
 en cuirasse, 1072
 increase of, 211
 juice, 241
 Cancerum oris, 177, 178
 Carbolic acid, 38
 gangrene, 176
 poisoning, 38
 Carbon dioxide "snow" in treatment of naevi, 333
 Carbuncles, 178, 179
 Carcinoma, 236, 614, 641
 atrophic, 241
 branchiogenic, 905
 columnar-celled, 241, 242, 659
 encephaloid, 241, 684
 fungating, 239
 medullary, 241
 of accessory thyroids, 905
 Carcinomata of alveolus, 958
 of anus, 770
 of appendix, 712
 of bile-ducts, 805
 of bladder, 1122

- Carcinomata of bone, 508, 509
 of breast, 1083
 male, 1076
 of cardia, 663
 of duodenum, 671
 of floor of month, 944
 of gall bladder, 805
 of intestine, 863
 of jaw, 959
 of kidney, 1104
 of larynx, 1016
 of lip, 939
 of liver, 793
 of mediastinum, 1043
 of nose, 923
 of œsophagus, 995
 of omentum, 833
 of palate, 943
 of pancreas, 782
 of penis, 1173
 of pinna, 1002
 of prostate, 1163
 of pylorus, 663
 of rectum, 770
 of salivary glands, 940
 of scalp, 809
 of scrotum, 1180
 of skull-bones, 835
 of spine, 896
 of stomach, 850, 060
 of testis, 1192
 of thoracic wall, 1043
 of thyroid, 1081, 1052
 of tongue, 973; palliative treatment, 979
 of tonsil, 986
 of urethra, 1151
 retroperitoneal, 832
 sarcomatodes, 241
 soirrhous, 684
 secondary, 508, 898
 simplex, 240
 spheroidal-celled, 240
 squamous-celled, 239, 809, 942
 supervening on gastric ulcer, 659
 treatment of, 242
 varieties of, 239
 Carden's amputation, 103
 Cardia, carcinoma of, 863
 Cardiac orifice, stenosis of the, 654
 Cardiospasm, 903
 Caries of bone, 483
 Carotid gland, tumours of, 905
 Carpal bones, fractures of, 450
 Cartilages, fracture of costal, 1029
 Catarrhal stomatitis, 942
 Catgut, to sterilize, 45
 Catheter fever, 1150
 Causalgia, 372
 Cavernitis, 1140
 Cavernous angiomas, 333
 lymphangioma, 341
 navus, 333
 Collulitis, 80
 of neck, 82
 of orbit, 83
 of scalp, 84
 of subcutaneous tissue of the extremities, 81
 Cementome, 963
 Cephalæmatocœle, 834
 Cephalocœle, 835
 Cerebellar tumours, 852
 Cerebral abscess, 843
 compression, 812
 condensation, 810
 irritation, 812
 operations, 862
 tumour, 849
 Cerebro-spinal meningitis, 841
 Cernmen in ears, 1003
 Cervical ribs, 908
 Chancres, extragenital, 123
 Hunterian, 122, 124
 multiple, 124
 primary, destruction of, 125
 soft, 148
 Charcot's disease, neuro-arthropathy, 578, 582, 583, 602
 Chabuffeur's fracture, 449
 Chest, gunshot wounds of, 61
 Chiene's method, 858
 Chilblains, 393
 Chloroma, 230
 Cholangitis, suppurative, 790
 Cholecystectomy, 799
 Cholecystitis, acute phlegmonous, 804
 chronic, 804
 suppurative, 801
 Cholelithiasis, 796
 Cholesteatoma, 1010
 Chondro-dystrophia foetalis, 515
 Chondroma, 220
 of jaw, 959
 of joints, 579
 of nose, 922
 of thorax, 1042
 Chordee, 1140
 Chorion-epithelioma, 244
 Choroiditis, 145
 Chronic adenitis, 337
 arteritis, 307
 glanders, 192
 inflammation, 30-35
 of thyroid gland, 1045
 lymphangitis, 336
 neuritis, 378
 Chronic septico-pyæmia, 93
 suppuration in accessory sinuses of nose, 928; treatment of, 927
 tetanus, 96
 tuberculosis, 928
 ulceration, 163-158
 Chylous ascites, 338, 345
 cyst, 635
 Chylorrhœa, 335
 Chylorthorax, 335, 345
 Chyluria, 345, 1106
 Circumcision, 1170
 Circumflex nerve, injury of, 384
 Cirroid aneurysm, 333
 Cladotrix, 107
 Claviceps purpurea, 165
 Clavico, dislocation of acromial end of, 530
 of sternal end of, 530
 fractures of, 430-435
 Claw foot, 290
 hand, in ulnar palsy, 387
 Cleft, mandibular, 937
 oblique facial, 937
 palate, 931
 Cline's splint, 474
 Clots, 185
 Cluh hand, 281
 Cocci, 1
 Coccydinia, 453, 895
 Coccyx, fracture of the, 452
 Cock's operation, for stricture of urethra, 11
 tumour, 394, 395
 Cohnheim's theory of mout formation, 209
 Coley's fluid, 227, 244
 Coli cystitis, 1115
 Colic, appendicular, 708
 intussusception, 691
 of gall-bladder, 795
 renal, 1097
 Colitis, 675
 Colles's fracture, 447
 law, 142
 Colon, congenital idiopathic dilatation of the
 iliac, hernia of the
 Common carotid, aneurysm of, 319
 duct, stricture of
 Compensatory talipes, 291
 Complement serum
 tion, 116
 Compression, cerebral
 Concussion, cerebral, of thorax, 1025
 spinal, 864
 Condylomata, 132, 13

- Congenital abnormalities of
 bladder, 1110
 of breast, 1057
 of kidneys and ureters, 1079
 of liver, 788
 of pancreas, 776
 of penis, 1169
 of prostata, 1152
 of testis, 1181
 of thyroid gland, 1045
 of tongue, 968
 of urethra, 1133
 contraction of the fingers, 281
 deformities of ear, 1002
 of nose, 912
 dilatation of œsophagus, 988
 dislocation of elbow, 260
 of hip, 264-289
 of shoulder, 260
 of wrist, 260
 displacement of the patella, 272, 273
 diverticula of bladder, 1124
 elevation of scapula, 260
 flat-foot, 292
 hydrocele, 1197
 malformations of anus, 748
 of brain, 835
 of neck, 902
 of œsophagus, 988
 of rectum, 746
 of spine, 875
 phimosis, 1189
 post-anal fistula, 878
 sacroœsophageal tumours, 878
 shortness of frœnum, 1169
 sterno-mastoid tumour, 908
 weakness of abdominal walls, 714
 Constipation, chronic, 680
 in appendicitis, 702
 Constriction of penis, 1189
 Contraction, Dupuytren's, 263
 in fractures, 417
 Contractures after burns, 171, 173
 Contusions, 36, 405
 and laceration of brain, 820
 "black eye," 999
 of abdomen, 811
 of abdominal wall, 810
 of arteries, 301
 of bones, 360
 Contusions of intestines, 672
 of lungs, 1030
 of spine, 863
 of testis, 1180
 of thorax, 1025
 resolution of, 37
 treatment of, 37
 Coracoid process, fracture of, 435
 Cord and meninges, diseases of, 896-898
 effects of gunshot wounds on, 59
 Corns, 390
 Coronoid process, fractures of, 446, 537
 Costo-transversectomy, 891
 Cowperitis, 1140
 Coxa valga, 271
 vara, 269; treatment of, 271
 Cranial nerves, injury of, 379
 sinus, wounds of, 196
 Cranio-cerebral topography, 858
 Craniotabes, 499
 Cranium, injuries and diseases of, 810-819
 Crateriform ulcer, 402
 Crepitus in fractures, 411
 Croft's splint, 422, 474
 Crutch palsy, 385
 Cubitus valgus, 443
 varus, 443
 Cuneiform osteotomy, 276, 283
 in hallux valgus, 298
 Curative serum therapy, 12
 Curvature of spine. *See* Scoliosis
 Cutaneous lesions, syphilitic, 131
 Cystic duct, stone impacted in, 800
 stricture of, 803
 goitre, 1047
 bygromata, 341, 904
 Cystitis, special forms of, 1114
 Cysto-adenoma, 235, 246
 Cysto-carcinoma, 246
 Cyst, chylous, 635
 dental, 951
 dentigerous, 983
 dermoid, 635, 903, 1043
 detention, 245
 hydatid, 248, 635, 1105
 implantation, 248
 in connection with new growths, 246
 lutein, 838
 mesenteric, 635
 mucous, 941, 945
 multilocular adeno-matous, 838
 Cyst of auricle, 1002
 of bone, 406, 509
 of breast, 1064
 of epididymis, 1194
 of kidney, 1105
 of liver, 793
 of neck, 902, 903
 of omentum, 633
 of pancreas, 783
 of scalp, 808
 of scrotum, 1180
 of spleen, 787
 of thorax, 1043
 of thyro-glossal duct, 903
 of tongue, 980
 parasitic, 246
 retention, 245, 1105
 sebaceous, 394, 1180
 treatment of, 248
 tubo-ovarian, 838
 Cysts, 245-249, 614, 832
 arising in embryonic remnants, 637
 in ovary, 636
 Baker's, 551
 blood, 635
 branchial, 902
 broad ligament, 638
 Czerny-Lembert's suture, 873
 Dactylitis, syphilitic, 500
 tubercular, 495
 Davies-Colley's operation, 934
 Deciduoma-malignum, 244
 Decortication of lung, 1039
 Deep palmar arch, wound of, 198
 Deformities (Chapter IX.), 250-300
 cause of, 250
 prevention of, 251, 513
 Degeneration in arteries, 308
 in carcinoma, 237
 Delirium, 204-206
 after head injuries, 206
 toxic, 204
 traumatic, 204
 tremens, 205, 208
 in fractures, 413
 Dental ulcer, 971
 Dercum's disease, 216
 Dermatitis, X-ray, 174
 Dermoid cysts, 835
 of neck, 903
 of scalp, 808
 of thorax, 1043
 tumours, of testis, 1193
 Dermoids, 248, 249
 Diabetic gangrene, 164
 Diaphragm, injuries of, 1034
 Diaphragmatic hernia, 743
 Didot's operation for syndactyly, 262

- Digits, hypertrophy of, 202
 Dilatation of colon, con-
 genital idiopathic,
 674
 of stomach, 668
 of ventricle of larynx,
 904
 Diplogia, 289
 Dislocations, 523-549
 complications, 525
 compound, 527
 dorsal, 540
 objective signs of, 525
 of ankle, 546
 of acromial end of
 clavicle, 530
 of astragalus, 547
 of bones of pelvis, 539
 of carpal bones, 539
 of elbow-joint, 536
 of hip, 542, 543
 of hip-joint, 540
 of knee, 544-546
 of lower jaw, 529
 of metacarpo-phalan-
 geal articulation, 539
 of patella, 543
 of penis, 1168
 of phalangeal joints, 548
 of radius alone, 537
 of ribs, 1029
 of semilunar cartilage,
 544
 of shoulder-joint, 531
 complicated by
 fracture of hu-
 merus, 535
 unreduced, 534
 of spine, 874
 of sternal end of clav-
 icle, 530
 of tendons, 352
 of testis, 1181
 of ulna alone, 537
 of wrist, 538
 pubic, 541
 recurrent, 535
 subastragaloid, 547
 subjective signs of, 525
 subspinous, 534
 thyroid, 541
 treatment of, 526
 traumatic, 524
 unreduced, 527
 Displacement of cnsiform
 cartilage, 1027
 of hip, 265
 treatment of, 267-
 269
 Dissecting aneurysm, 312
 Divarication of the recti,
 740
 Diverticula, of bladder,
 1124
 acute, 712
 chronic, 713
 Diverticula of intestine, ac-
 quired, 678
 of oesophagus, 991
 Diverticulum, Meckel's, 712
 Dorsal, dislocation, 510
 Double fracture, 407
 Dressing of wounds, 51
 Dressings for operations, 50
 to sterilize, 47
 Drugs in treatment of he-
 morrhage, 187
 of inflammation,
 acute, 22;
 chronic, 31
 of shock, 202
 of tuberculosis, 117
 Dry gangrene, 158
 Ducroy's bacillus, 317
 infection, 148
 Duct cancer, 242
 Duodenal ulcer, 669
 Duodenum, affections of
 the, 660-671
 carcinoma of the, 671
 Dupuytren's contraction,
 263
 fracture dislocation, 476
 splint, 477
 Dura mater, incision of,
 362
 thrombosis of
 sinus: cf, 846
 Dyspeptic ulcer, 972
 Ears, affections of, 1002-1013
 injuries of, 1002
 prominent, 1002
 Echondroses, 220
 Echinococcus cysts, of neck,
 704
 Ecthyma, 132, 137
 Ectogenous cyst formation,
 247
 Ectopic vesicæ, 1110
 Ectopic gestation, 644
 testis, 1181
 Eczema, inflammation, and
 ulceration of umbili-
 cus, 616
 of nipple, 1059
 varicoso, 330
 Eczematous ulcer, 157
 Elbow, congenital disloca-
 tion of, 260
 diseases of, 582
 Elbow-joint, dislocations of,
 536
 Electrical burns, 175
 Electricity in treatment of
 inflammation, 33
 Electrolysis in nævi, 333
 Elopantiasis, 345-348
 hilarial, 346
 scroti, 346
 treatment of, 347
 Embolic abscesses, 1085
 Embolism, 161, 162, 309
 and thrombosis of mes-
 enteric vessels, 631
 fat, 412
 Embryonic rests, 209
 Emphysema, surgical, 1030
 Empyema, 1034
 cavity and sinus for-
 mation, 1038
 double, 1038
 necessitas, 1036
 pulsating, 1035
 tuberculous, 1039
 Encephalocele, 836
 Encephaloid carcinoma, 241,
 684
 Encysted hernia, 728
 hydrocele of cord, 1198
 Eudarteritis obliterans, gan-
 grone from, 166
 syphilitic, 137
 Entocyst, 247
 Endogenous cyst formation,
 247
 Embolthelioma, 228, 641
 of peritoneum, 630
 of pleura, 1043
 of testis, 1192
 Ensiiform, cartilage, dis-
 placement of, 1027
 Enteric intussusception, 695
 Enteritis, 675
 Enterocoele, 717
 Enteroliths, 709
 Enteroptosis, 681
 Entero-spasm, 699
 Enuclation of tonsil, 985
 Enuresis, nocturnal, 1127
 Eosinophilia, 248
 Epicritic sensibility, 366
 Epicondyles, fractures of,
 442
 Epididymectomy, 1188
 Epididymis, cysts of, 1194
 malignant disease of,
 1194
 Epigastric hernia, 741
 Epilepsy, Jacksonian, 818
 Epileptiform neuralgia, 379
 partial separation, of
 the, 408
 Epiphyses, separation of,
 407-409, 431, 439, 441,
 445, 446, 449, 458, 461,
 469, 479
 Epiphysitis, syphilitic, 144
 Epiplocele, 717
 Epispadias, 1134
 Epistaxis, 197, 911
 Epithelial odontome, 963
 Epithelium, growth of, 52
 Erb-Duchenne paralysis,
 383
 Erethritic shock, 200
 Ergot, gangrene from, 165
 in hemorrhage, 187

- , 162, 300
 bosis of mes-
 vessels, 633
 ts, 209
 urgical, 1030
 4
 d sinus for-
 1038
 818
 , 1036
 , 1035
 s, 1030
 , 836
 rcinoma, 241.
 ia, 728
 of cord, 1198
 oliterans, gau-
 ne from, 166
 litic, 137
 yst formation,
 , 228, 641
 neum, 630
 , 1043
 1192
 artilage, dis-
 of, 1027
 usception, 695
 17
 09
 681
 , 699
 of tonsil, 985
 urnal, 1127
 248
 ibility, 366
 fractures of.
 omy, 1188
 cysts of, 1194
 it disease of.
 rnia, 741
 cksonian, 818
 neuralgia, 370
 separation. of
 98
 separation of,
 431, 439, 441,
 449, 453, 461.
 syphilitic, 144
 17
 1134
 7, 911
 ontome, 963
 growth of, 52
 ne paralysis.
 ock, 200
 rene from, 165
 orrhage, 187
 Erichsen's splint, 437
 Ernst's varus splint, 281
 Erosions, gastric, 640
 Erysipelas, 77
 cellulo-cutaneous, 81
 migrans, 78
 Erythema, due to burns, 172
 induratum, 400
 solare, 175
 Esmarch's elastic tourni-
 quet, 191
 Estlander's operation, 1030
 Exercises in scoliosis, 256.
 257
 Exomphalos, 738
 Exophthalmic goitre, 1053
 Exopthalmos, pulsating,
 321, 1000
 Exostosis, 221
 subungual, 404
 Extension treatment of
 fractures, 417,
 437, 440, 468
 in fractures of fe-
 mur, 462
 External auditory meatus,
 affections
 of, 1003
 foreign bodies
 in, 1003
 carotid, aneurysm of,
 320
 hæmorrhage, 181
 popliteal nerve, injury,
 of, 389
 Extraparietal hernia, 734
 Extravasation of urine, 1148
 Eyeball, injuries of, 1009
 Eyes, syphilitic lesions of
 the, 134, 145
 Face, new growths of, 942
 wounds of, 941
 Facial nerve, injury of, 381
 paralysis, 1919
 Fæcal impaction, 680, 749
 False joints, 428
 neuromata, 218, 366
 Fasciæ, ossification in, 354
 Fat embelism, 412
 Fatty degeneration of ar-
 teries, 308
 Favus, 15
 Femoral aneurysm, 323
 hernia, 723, 735
 Femur, fractions of the,
 454-466
 Fever, aseptic traumatic, 20
 catheter, 1150
 Fibro-adenoma, 235
 Fibro-angioma, in nose, 922
 Fibro-cellular tumours, 217
 Fibroids, 222, 223
 Fibroma, 614
 Fibromata, 217, 640
 hard, 217
 Fibromata in nose, 922
 of alveolna, 958
 of jaw, 959
 of mediastinum, 1043
 of pleura, 1013
 soft, 217
 Fibromatosis, 218
 Fibro-myomata, 222, 223
 Fibro-sarcoma, 217
 Fibrosis from inflammation,
 27
 in healing of wounds, 51
 of prostate, 1165
 result of tubercular in-
 flammation, 112
 Fibrous goitre, 1047
 odontome, 963
 union of fractures, 427
 Fibula, fracture of the, 470
 rickety curve of, 276
Filaria sanguinis hominis,
 345, 346
 Fingers, congenital con-
 traction of, 261
 rupture of common
 extensor of, 351
 webbed, 261
 Finney's operation, 666
 Finsen light in the treat-
 ment of lupus, 398
 First aid treatment in frac-
 tures, 415, 425
 in hæmorrhage,
 190, 193
 of accidental
 wounds, 56
 of bullet wounds,
 69
 Fissure of anus, 752
 of nipple, 1058
 of Rolando, 858
 of Sylvius, 858
 Fistula, 73
 acquired, 616
 between rectum and
 other organs, 758
 blind, 615
 branchial, 902
 congenital post-anal,
 878
 fæcal, 710
 in infants, acquired, 616
 ischio-rectal, 755
 of gall-bladder, 800
 of lower lip, 937
 of rectum submucous,
 757
 perianal, 754
 salivary, 946
 tubercular, 119
 urachal, 615
 urinary, 1150
 Fixed scoliosis, anatomical
 changes in, 253-255
 Flail joint, 288
 Flat-foot, 291
 Flat-foot, acquired, 292
 congenital, 292
 deformities associated
 with, 298
 rigid, 295
 spasmodic, 295
 treatment of, 296-298
 Flexor tendons, suppurati-
 on in the sheaths of the, 86
 Floating kidney, 1080
 Follicular odontome, 963
 Foreign bodies in al-pas-
 sages, 1014
 in appendix, 702
 in bladder, 1109
 in external audi-
 tory meatus,
 1003
 in intestine, 691
 in male urethra,
 1132
 in nose, 911
 in œsophagus, 989
 in rectum, 749
 in stomach, 647
 in wounds, 62
 Formalin, 39
 Fractured penis, 1168
 Fractures (Chapter XIV.),
 405-479
 See also Special Frac-
 tures
 cause of, 409
 causes of deformity in,
 417
 clinical features of, 410
 complete, 406
 complicated, 406
 complications in, 412
 compound, 406, 437,
 444, 445, 475; treat-
 ment of, 425
 disunion of, 428
 fibrous union of, 427
 incomplete, 406
 non-union of, 428
 of coronoid process, 537
 of costal cartilages,
 1029
 of hyoid bone, 901
 of jaw, 952
 of laryngeal cartilages,
 901
 of nasal bones, 910
 of ribs, 1027
 of skull, 824
 repair of, 831
 of spine, 867-874
 of sternum, 1026
 of trachea, 902
 repair of, 413
 simple, 406
 spontaneous, 405
 treatment of, 415-426
 union of, 426-429
 united, 427

- Frænum, congenital shortness of, 1169
 Fragilitas ossium, 406, 510
 Functional disease of joints, 578
 Funiculitis, 1204
 Furuncle, 302
 Fusiform aneurysm, 311
- Galactoceles, 1064
 Gall bladder and bile-ducts, abnormalities of, 795
 affections of, 795-805
 deformities of, 795
 colic, 795
 fistula of, 800
 rupture of, 612
 Gallows splint, 465
 Gall-stone colic, 799
 obstruction, 691
 Gall-stones, 700
 effects of, on gall-bladder, 797
 in common bile-duct, 801
 Ganglion, 358
 compound, 359
 palmar, 357
 Gangrene, 158
 acute traumatic, 177
 after acute inflammation, 30
 amputation in, 160
 diabetic, 164
 dry, 158
 due to carbolic acid, 176
 to direct injury, 168
 to embolism, 101
 to endarteritis obliterans, 166
 to ergot, 165
 to gradual interference of blood-supply, 162
 to infective inflammation, 176
 to injury to an artery, 101
 to ligature of arteries, 161
 to pressure, 166
 to Raynaud's disease, 164
 to sudden interference of blood-supply, 161
 to thrombosis, 161
 to tight bandaging, 166
 from contusion, 37
 in acute inflammation, 30
- Gangrene, in mucous membranes, 34
 moist, 150
 of intestine, infective, 687
 of lung, 1040
 resulting from tubercular inflammation, 114
 asymmetrical, 165
 thermal, 109
 traumatic, 161, 162, 168
 treatment of, 160
 varieties of, 161
 Gastrectomy, 663
 Gastric erosions, 660
 ulcer, 649
 acute, 650
 perforation of, 650
 chronic, 650
 perforation of, 656
 treatment of, 652
 Gastritis, acute phlegmonous, 648
 Gastro-jejunosotomy, 652
 Gastropexy, 668
 Gastroplication, 608
 Gastroptosis, 667
 Gastrorrhagia, 658
 Gastrostomy, 997
 General paralysis of the insane, 142
 Genu recurvatum, 273
 valgum, 273-274
 treatment of, 275
 varum, 276
 Geographical tongue, 972
 Gigantism, local, 262
 Gingivitis, 050
 Glanders, acute, 101
 chronic, 102
 treatment by serotherapy, 103
 Glands, suppurating malignant lymphatic, 980
 Gleet, 1138
 Glénard's disease, 667, 681
 Glioma of brain, 231
 of spinal cord, 231
 Gliomata, 231
 cerebral, 855
 Glossitis, acute parenchymatous, 907
 superficial, 966
 chronic superficial, 967
 Glossopharyngeal nerve, injury of, 382
 Glottis, acute œdema of, 1016
 Glover's suture, continuous, 49
 Gloves, care of, 43
 dry sterilization of, 43
 use of, 42
- Glycosuria following head injury, 817
 Goitre, 1046
 colloidal, 1046
 cystic, 1047
 fibrous, 1047
 parenchymatous, 1046
 substernal, 1049
 Gonococcal peritonitis, 627
 Gonorrhœa, 1134
 chronic, 1138
 complications of, 1130
 in female, 1136
 Gonorrhœal arthritis, 559, 570, 894
 cystitis, 1115
 Gooch's kettle-holdersplint
 ing, 465
 Gout, 548
 rheumatic, 509
 Gram's method, 5
 Granulating surface, 154
 Granulation, healing of wound by, 55
 tissue, 27, 51
 Granulomata, of alveolus, 958
 Graves's disease, 1053
 Greenstick fracture, 406
 Gumma, 138
 Gummata on mucous membranes, 140
 Gumboil, 954
 Gums, inflammation of, 950
 Gunshot accidents to spine, 866
 wounds, 58-62
 of abdominal wall, 612
 of gall-bladder, 796
 of intestine, 673
 Gynæcomazia, 1057
- Hæmatemesis, profuse, 658
 Hæmatocele, acute, 1200
 chronic, 1201
 of spermatic cord, 1202
 Hæmatoma auris, 1002
 formation of a, 37
 of scalp, 806
 treatment of, 37
 Hæmaturia, essential, 1107
 Hæmo-endothelioma, 228
 Hæmoglobinuria, paroxysmal, 165
 Hæmophilia, 107, 198
 conditions simulating, 198, 199
 joint affections in, 574
 treatment of, 198
 Hæmoptysis, 1036
 Hæmorrhage (Chapter VII.), 181-199
 after effects of, 186
 concealed, 181, 183

- hemorrhage, external, 181
 from internal carotid and vertebral arteries and their branches, 823
 from nose, 107
 from tooth socket, 196
 from venous sinuses of skull, 822
 in duodenal ulcer, 671
 in newly-born, subdural, 824
 intermediary, 181, 183
 internal, 181
 in varicose veins, 330
 middle meningeal, 821
 natural arrest of, 185
 primary, 181
 reactionary, 181, 183
 secondary, 181, 184
 treatment of, 186-107
- Hæmorrhoids, 763
 external, 764
 inflammation of, 765
 internal, 764
 intero-external, 767
 operations for removal of, 766
 stragulations of, 765
 treatment of, 764, 765, 767
- Hæmostasis after operation, 48
 Hæmostatics, 194
 Hæmothorax, 1030
 Hair-balls, 647
 in syphilitic patients, 132
- Hallux flexus, 299
 rigidus, 298
 valgus, 298
- Halstead's operation in hernia, 732
 subcuticular stitch, 40
- Hammer-toe, 299, 300
- Hands, sterilization of the, 41
- Hard fibroma, 217
 papillomata, 233
- Hare-lip, 930
 operations for, 934
 treatment of, 933
- Headache following injury, 817
- Head injuries, 810
 after-effects of, 816
 delirium after, 206
 treatment of after-effects, 819
 tetanus, 96
- Healing under a scab, 55
 of wounds, 50
 by blood-clot, 55
 by first intention, 53
- Healing of wounds by second intention, 55
 clinical aspects of, 53
- Heart, injuries of, 1033
- Hectic fever, 74
- Hemiplegia, 289
- Hepatopexy, 789
- Hermaphroditism, 1178
- Hernia (Chapter XXf.), 714, 745
 anatomical varieties of, 726
 causes of, 714
 cerebral, 837
 complete, 726
 complications of, 718
 diaphragmatic, 743
 direct inguinal, 733
 encysted, 728
 epigastric, 741
 extraparietal, 734
 femoral, 723, 735
 incarcerated, 719
 indirect acquired, 728
 infantile, 728, 730, 731
 inflamed, 725
 inguinal, 723, 726
 interparietal, 734
 interstitial, 734
 intraparietal, 734
 ischiatic, 742
 Littre's, 744
 lumbar, 742
 obstructed, 719
 obturator, 742
 of bladder, 745, 1125
 of cæcum and appendix, 744
 of iliac colon, 744
 of linea alba, 741
 of lung, 905, 1033
 of muscle, 351
 of ovary, 745
 of trachea, 905
 of uterus, 745
 operative treatment in, 732, 733, 734
 perineal, 742
 peritoneal, 734
 radical cure in femoral, 737
 Richter's, 738
 scrotal, 726
 special varieties of, 744
 strangulated, 691, 720
 femoral, 737
 treatment of, 717, 728
 umbilical, 723, 738
 ventral, 710, 740
- Herniotomy, 724
- Herpes, 972, 1172
 catarrhal, 1172
 zoster, 1172
- Hilton's method of opening an abscess, 72
- Hip, congenital dislocation of, 264-269
 deformity of, resulting from tubercular arthritis, 599
 displacement of, 265
 irregular dislocation of, 542
 splint, Thomas's, 596
 treatment of displacement of, 267-269
 uncommon regular dislocations of, 542
 unreduced dislocations of, 543
- Hip-joint, diseases of, 586
 dislocations of, 540
- Hirschsprung's disease, 674
- Hodgkin's splint, 402
- Hodgkin's disease, 343
- Hoffa's method of treating dislocation of hip, 269
- Hollow foot, 290
- Horns on penis, 1173
 sebaceous, 394
- Horsehair, to sterilize, 46
- Horseshoe kidney, 1079
 truss, 731
- Hour-glass stomach, 651
- Housemaid's knee, 361, 362
- Humerus, fractures of, 436, 445
- Hunger pain, 669
- Hunterian chancre, 122, 124
- Hunter's operation for aneurysm, 316
- Hutchinson's teeth, 146
 wart, 133, 233
- Hydatid cysts, 246, 635
 laboratory diagnosis of, 248
 of breast, 1066
 of kidney, 1105
 of liver, 794
- Hydatids of liver, 794
- Hydrocele, hilocular, 1109
 congenital, 1107
 infantile, 1198
 of cord, diffuse, 1199
 encysted, 1108
 of hernial sac, 716
 of neck, 341
 primary, 1196
 secondary, 1199
- Hydronephrosis, 1083
- Hydrophobia, 103
 Pasteur's preventive treatment, 104
- Hydrops, tubercular, 357
- Hygromata, cystic, 341
- Hyoid bone, fracture of, 901
- Hydramnios, 837
- Hydronephalocoele, 836
- Hydrocephalus, acquired, 838

- Hydrocephalus, congenital, 837
- Hypæremia, Bier's method of, 117
in treatment of inflammation, 25, 33
- Hypertrophic tuberculosis of the intestines, 676
- Hypertrophy of bone, 481
of breasts, diffuse, 1057
of digits, 262
- Hypoglossal nerve, injury of, 382
- Hypomyces, 15
- Hypospadias, 1133
- Hypostatic pulmonary congestion, 413
- Hysterical spine, 895
- Ileo-cæcal intussusception, 694
- Ileo-colic intussusception, 695
- Iliac paralyticus, 688, 698
- Iliac colon, hernia of the, 744
- Iliopsoas bursa, 363
- Ilium, fracture of the, 452
- Immunity, 7-11
acquired, 6, 11
from bacteria, 7-12
from syphilis, 122
natural, 7, 8, 11
passive, 10, 12
therapeutic uses of, 11
- Impacted fracture, 407
- Imperforate anus, 746
- Implantation cysts, 246
- Impotence, 1176
- Incised wounds of arteries, 303
- Incision of dura mater, 862
- Infantile hernia, 728, 730, 731
hydrocels, 1108
scurvy, 514
- Infected wounds (Chapter IV.), 68-107
- Infection of non-specific pyogenic organisms, general, 89
- Infections by organisms of nature of streptothrix and cladothrix, 107
- Infective arteritis, 184, 306
phlebitis, 327
sinusitis, 347
- Infiltration in malignant tumours, 212
small round cell, 50
- Inflamed aneurysm, treatment of, 318
- Inflammation (Chapter II.), 16-35
acute, 18-30
fibrosis in, 27
gangrene in, 30
- Inflammation, acute, general treatment of, 22
focal treatment of, 23
pathological histology of, 18
resolution in, 26
results of, 26
suppuration following, 27
symptoms of, 19
causes of, 16
chronic, 30-35
clinical features of, 31
general treatment of, 31
local treatment of, 32
of accessory sinuses of nose, 924
of Bartholin's gland, 1140
of bladder, 1111
of bone, 482-493
of breast, 1000
of eye, syphilitic, 137
of gums, 950
of intestines, 675
of larynx, 1016
of lips, 937
of mucous membranes, 33
of œsophagus, 993
of ovaries, 146
of prostate, 1152
of salivary glands, 947
of serous membranes, 34, 90, 93
of synovial membranes, 34, 90
of testes, 146, 1164
of thyroid, 1045
of urethra, 1134
of vesicula seminales, 1166
- Inflammatory conditions of bones, classification of, 484
of cord and meninges, 896
of gall bladder, 796
of nasal mucous membranes, 913
of peritoneum, 616
of scrotum, 1179
of spine, 878
of tonsils, 982
diseases of scalp, 808
of thorax, 1034
oxidates, examination of, 115
lymph, 18
reflex torticollis, 909
- Infusion, for hemorrhage, 187-189
of blood, 203
saline, 203
- Inguinal aneurysm, 323
hernia, 723, 726
congenital, 727
indirect, 726
- Inherited syphilis of testes, 1190
- Injuries of abdominal wall, 610
of anus, 749
of arteries, 161, 301-303
of bones, 105
of brain, 820
of cranium, 810
of eyeball, 1000
of intestines, 672-713
of joints, 523
of kidneys, 1077
of larynx, See Cut throat
of liver, 788
of lymphatic vessels, 335
of muscles, 348
of neck, 899
of nerves, 365
of nose, 910
of œsophagus, 988
of pancreas, 776
of penis, 1168
of prostate, 1152
of rectum, 749
of spine, 863
of stomach, 646-669
of tendons, 348
of testis, 1180
of thorax, 1025
of tongue, 965
of trachea, See Cut throat.
of urethra, 1130
of urinary bladder, 1108
of veins, 304-306
- Innocent and malignant tumours, relationship, 213
tumours, 211
associated with connective tissue, 213-223
of thalial origin, 213
- Innominate artery, aneurysm of, 319
- Inoculation tuberculosis, 399
- Instruments and drainage-tubes, 44
- Intercostal artery, wound of, 196
- Interligamentous fracture of the clavicle, 431
- Intermediary hemorrhage, 181, 183

INDEX

1215

- Intermediary hemorrhage, treatment of, 694
 Internal carotid, aneurysm of, 320
 artery, wound of, 195
 hemorrhage, 181, 183
 malleolus, fracture of the, 470
 mammary artery, wound of, 196
 maxillary artery, wound of, 195
 popliteal nerve, injury of, 389
 Interparietal hernia, 734
 Interrupted sutures, 49
 Interstitial leucia, 734
 keratitis, 145
 Intestinal obstruction, 687
 acute, 687
 causes of, 690
 chronic, 699-701
 in appendicitis, 410
 treatment of, 689
 Intestines, acquired diverticula of the, 678
 sarcoma of the, 683-687
 electrical stricture of the, 678
 congenital stenosis of the, 673
 contusions of, 672
 guns, of wounds of the, 673
 inflammation of the, 675
 injuries and diseases of the (Chapter XX.), 672-713
 in lardaceous disease, 76
 new growths of the, 683
 rupture of, 672
 sarcoma of the, 683
 tuberculosis of the, 673
 Intracerebral hemorrhage, 823
 Intracranial aneurysms, 320
 new growth, 849
 Intracystic growths, 234
 Intramuscular lipoma, 215
 Intraparietal hernia, 734
 Intubation of larynx, 1024
 Intussusception, 693-697
 chronic, 696
 treatment of, 696
 Inversion of testis, anterior, 1181
 Involution cysts, 1065
 Iodine, 39
 Iodolium, 39
 emulsion, injection of, 118
 Iritis, 145
 syphilitic, 134, 135
 Irritable ulcer, 156, 157
 Irritation, cerebral, 812
 Ischamic contracture, Volckmann's, 355
 Ischial bursa, 368
 Ischiatic hernia, 742
 Ischio-rectal abscess, 754
 fistula, 755
 Ischium, fracture of the, 452
 Jacksonian epilepsy, 818
 Jaw, actinomycosis in, 956
 ankylosis of, 580
 fractures of, 952
 inflammatory conditions of, 954
 innocent tumours of upper, 959
 new growths of, 957
 phosphorous necrosis in, 956
 sequestra in, 955
 syphilis of, 957
 tuberculosis of, 957
 Jejunostomy, 604
 Joint affections in hæmophilia, 574
 Joints, chondroma of, 579
 diseases of (Chapter XVII.), 550-609
 false, 428
 functional disease of, 578
 injuries of (Chapter XVI.), 522-549
 loose bodies in, 574
 sarcoma of, 579
 syphilitic affections in, 133, 144
 wounds of, 522
 Judson's nodol, 250
 splint in talipes equinovarus, 281
 Juxta epiphysial strain, 408
 Kangaroo tendon, to sterilize, 46
 Keloid, 67
 Keratomycosis, 15
 Kidney, absence of one, 1079
 atrophic, 1079
 cysts of, 1105
 diseases of (Chapter XXXIV.), 1077-1107
 effects of stone in, 1095
 floating, 1080
 horseshoe, 1079
 infective conditions of, 1085
 injuries of (Chapter XXXIV.), 1077-1079
 malposition of, 1080
 movable, 1080
 neuralgia of, 1107
 new growths of, 1103
 Kidney, polycystic disease of, 1105
 stones in, 1094-1100
 tuberculosis of, 1089
 Kidneys, congenital abnormalities of, 1070
 in lardaceous disease, 76
 method of estimating functioning power of, 1092
 Klumpko's paralysis, 383
 Knives, to sterilize, 45
 Knee, diseases of, 692
 dislocation of, 544-546
 splint, Thomas's, 605
 Kocher's method, 333
 Kyphosis, 258
 Laboratory methods of diagnosis of tubercle, 115
 Lacerated wounds of arteries, 304
 Laceration of muscles, 348
 of lungs, 1030
 Lacunar abscess, 1139
 Lagonback's operation, 931
 Laminectomy, 891
 Lancet splint, 473
 Lardaceous disease, 75, 304
 Laryngeal cartilages, fractures of, 901
 Laryngotomy, 1020
 Larynx, and trachea, affections of (Chapter XXXI.), 1014-1044
 dilataions of ventricle of, 904
 inflammation of, 1016
 injuries of, 1015
 intubation of, 1024
 Lateral sinus, 860
 Leontiasis ossea, 959
 Leptomeningitis, acute diffuse, 841
 Lesions in connection with vitelline duct, 615
 Leucocythæmia, lymphatic, 345
 Leucocytosis, 206, 207
 Leucopenia, 207
 Ligation in continuity of vessels, 193
 Ligature for aneurysm, 316
 Ligature of arteries, 161
 Ligatures, 45
 Lightning burns, 175
 Linea alba, fatty horns of the, 741
 Lingual artery, wound of, 195
 dermoids, 980
 Lip, fistula of lower, 937
 Lipoma, intramuscular, 215
 of intestine, 683
 of mediastinum, 1043
 of scalp, 809

- Lipoma, of thorax, 1042
 of tongue, 973
 parosteal, 215
 retroperitoneal, 631
 subcutaneous, 214
 subserous, 215
 subsynovial, 215
 treatment of, 216
 Lipomata, 213-216, 614
 arborescens, 215
 Lipomatosis, 216
 Lips, affections of (Chapter XXVIII.), 930-934
 congenital deformities of, 937
 inflammatory conditions of, 937
 mucous cysts on, 941
 new growths of, 939
 tuberculosis of, 939
 wounds of, 941
 Litholapaxy, 1119
 Lithotomy, perineal, 1120
 suprapubic, 1120
 Littre's hernia, 744
 Liver, abnormalities of, 738
 injuries and diseases of, 788-795
 lardaceous disease, 75
 Lobulation of kidney, 1079
 Locking of bone fragments in fractures, 418
 Long Liston splint, 464
 Loose bodies in joints, 574
 Lordosis, 259
 of the lumbar spine, 589
 Lorenz's method of treating dislocation of hip, 267, 268
 Lower extremity, deformities of, 264-278
 jaw, dislocation of, 529
 Ludwig's angina, 82
 Lumbar abscess, 893
 hernia, 742
 puncture, 860
 Lung, decortication of, 1939
 hernia of, 905
 injuries of, 1930
 penetrating wounds of, 1931
 Lupus hypertrophicus, 397
 syphilitic, 139
 ulcerans, 397
 verrucosus, 397
 vulgaris, 396
 treatment of, 398
 Lutein cysts, 636
 Luxatio erecta, 535
 Lymphadenitis, 337
 acute, 337
 Lymphadenoma, 343-345
 Lymphangioma, 222, 341, 342
 Lymphangioplasty, 348, 1976
 Lymphangitis, 336
 Lymphatic glands, in lardaceous disease, 70
 new growths in, 342
 secondary growths in, 343
 syphilitic affections of, 133
 injection, 124
 in malignant tumours, 212
 leucocythæmia, 345
 nervus, 222
 Lymphatics, new growths in, 341
 injuries and diseases of the (Chapter XI.), 335-364
 Lymphatic vessels, injuries of, 335
 Lymph endothelioma, 228
 fistula, 345
 Lymphorrhœa, 345
 Lymphosarcoma, 226, 342
 Lysol, 39
 MacEwen's operation, 275
 in hernia, 732
 MacIntyre's splint, 464
 Mackintoshes, to sterilize, 47
 Macrocheilia, 342, 939
 MacroGLOSSIA, 342, 972
 Macrostoma, 937
 Magnesium sulphate in treatment of tetanus, 97
 Male breast, diseases of, 1076
 Malformations of intestine, 673
 Malignant adenoma, 237
 cysts of neck, 944
 disease of epididymis, 1194
 from a scar, 68
 growths, treatment of inoperable, 243, 244
 œdema, 177
 pustule, 99
 tumours, 211
 arising in the connective tissue, 223-229
 environment of, 212
 of epithelial origin, 236
 ulcers, 157, 239
 Mallet finger, 263
 Malposition of kidney, 1080
 Mandibular cleft, 937
 Manipulation in the treatment of fractures, 417, 419
 Marriage and syphilis, 139
 Massage in bow legs, 277
 in hurns, 174
 in anteroptosis, 682
 in flat-foot, 290, 297
 in fractures, 423
 in scoliosis, 258
 in talipes, 280, 284
 in treatment of chronic inflammation, 32
 of fractures, 448, 450, 457, 459
 of noma division, 369, 372
 of tuberculosis, 118
 of ulcers, 153
 Mastitis, chronic interstitial, 1062, 1976
 of infants, acute, 1960
 of lactation, acute, 1000
 of puberty, acute, 1000
 Mastodynia, 1064
 Mastoidectomy, complete, 1007
 partial, 1008
 Mastoiditis, 1008
 Matas's operation, 315
 Meatotomy, 1170
 Meatus, affections of external auditory, 1003
 foreign bodies in external auditory, 1003
 Meckel's diverticulum, 690, 712
 Median nerve, injury of, 386
 Mediastinitis, 1041
 Mediastinum, tumours of, 1043
 Medullary carcinoma, 241
 Melanoma of anus, 770
 of scrotum, 1180
 Melanomata, 229, 230
 treatment of, 230
 Membrana tympani, traumatic rupture of, 1004
 Meningeal artery, middle, 859
 hæmorrhage, middle, 821
 Meningitis, acute spinal, 800
 cerebro-spinal, 841
 chronic, 897
 syphilitic, 842
 tubercular, 842
 Meningocele, 836, 870
 Meningo-encephalitis, 841
 Meningomyelocele, 876
 Mercurial stomatitis, 943
 Mercury in treatment of syphilis, 126
 Mesenteric cysts, 635
 glands, affections of, 634
 vessels, embolism and thrombosis of, 633

- bilis, 136
 oga, 277
 sis, 682
 290, 297
 423,
 258
 80, 284
 e of chronic
 amation, 32
 tures, 448,
 457, 459
 ve division,
 372
 roulosis, 118
 rs, 153
 ic intersti-
 l, 1070
 cute, 1060
 ion, acute,
 acute, 1060
 064
 , complete,
 008
 08
 ion, 315
 170
 tions of ex-
 uditory, 1003
 odies in ex-
 uditory, 1003
 rtenium, 600,
 injury of, 386
 1041
 tumours of,
 reinoms, 241
 anus, 770
 m, 1180
 220, 230
 t of, 230
 ympani, trau-
 ure of, 1004
 rtery, middle,
 hage, middle,
 cute spinal, 896
 spinal, 847
 , 897
 le, 842
 lar, 842
 e, 836, 870
 cephalitis, 841
 elocele, 876
 otomatitis, 943
 a treatment of
 126
 cysts, 635
 , affections of,
 a, embolism and
 rabosis of, 633
 Mesentery, affections of, 633
 new growths of, 635
 Mesodlast, 213
 Metacarpal bones, fractures
 of, 451
 Metastases in malignant
 tumours, 212
 Metatarsalgia, anterior, 290
 Metatarsals, fractures of
 the, 470
 Microcephaly, 839
Micrococcus neoformans, 244
prodigiosus, 227
 Micromazia, 1057
 Micro-organisms, transmis-
 sion of, from mother to
 fetus, 14
Microsporou furfur, 15
 Microstoma, 937
 Middeldorff's triangle, 438
 Middle ear, affections of,
 1004
 Mikulicz's disease, 948
 method of removal of
 malignant disease of
 tonsil and pharynx,
 987
 Miliary tuberculosis, acute,
 628
 Miner's elbow, 363, 363
 Moist gangrene, 159
 Mules, 395
 Molluscum contagiosum,
 395
 fibroam, 218
 Monoplegia, 289
 Morbus zehis, 1181
 Morbus coxae senilis, 801
 Morton's disease, 290
 Moulds (hyptomycetes), 15
 Mouth, inflammatory affec-
 tions of, 942
 mucous cysts in, 945
 new growths of, 943
 Mucoperiostitis of nasal
 bones, 498
 Mucous membranes, syphi-
 litic affections of, 132,
 137, 140, 144
 Multilocular adenomatous
 cysts, 636
 Multiple neuritis, 376
 plexiform neuromata,
 218
 Mumps, 947
 Muscle and tendons, injuries
 of, 348-352
 diseases of, 352-356
 hernia of, 351
 inflammation of, 352
 new growths in, 355
 ossification in, 354
 rupture of, 349
 transplantation, 288
 Muscular spasm in tetanus,
 effects of, 95
 Musculo-spiral nerve, in-
 jury of, 385
 Myalgia, 358
 Mycetozoa, 15
 Myelitis, spinal, 897
 Myelocele, 870
 Myeloma, 231, 232, 591
 Myelomata of splanchnic, 678
 Myelomatosis, 232, 592
 Myomata, 222
 of uterus, 642
 atriped, 222
 unstriped, 222, 223
 Myositis, 352
 ossificans, 354
 traumatic, 440
 rheumatic, 351
 septic, 353
 syphilitic, 351
 traumatic, 352
 tubercular, 353
 Myxomata, 223
 Naevus, 213
 Navus, 222
 capillary, 332
 cavernous, 313
 lymphatic, 223
 Nails, affection of the, 403
 404
 Nasal bones, fracture of, 910
 polypi, 920
 septum, deviation of,
 910
 Natural functions, atten-
 tion to, in treatment of
 inflammation, 22
 Neck, air-swelling in, 804
 cellulitis of the, 82
 congenital malforma-
 tions of, 902
 cysts of, 902
 injuries of, 899, 901
 Necrosis of bone, 180, 481
 of jaw, 956
 quiet, 491
 Needles, to sterilize, 45
 Nélaton's line, 454
 operation, 923
 Neoplasm, 208
 Neo-salvarsan in treat-
 ment of syphilis, 130
 Nephritis, suppurative, 91
 Nephrolithiasis, 1094
 Nephroptosis, 1080
 Nerve anastomosis, 288,
 371, 381
 extraction, 377
 stretching, 377
 trunks, injury to, in
 fractures, 412
 Nerves, complete division
 of, 365
 diseases of, 375
 effects of gunshot
 wounds on, 69
 Nerves, functions of, 366,
 369
 incomplete division of,
 371
 inflammation of, 375
 injuries and diseases of
 (Chapter XII.), 365,
 389
 involvement in scar
 tissue, 378
 See also the special
 nerves
 surgery of the various,
 379
 Nervous system, syphilitic
 affections of, 137
 Neuralgia, 376
 major, 379
 of breast, 1064
 of kidney, 1107
 of testis, 1195
 Neurasthenia, traumatic,
 864
 Neuroctomy, 377
 Neuritis, 375
 brachial, 384
 chronic, 376
 Neuro-arthropathy, 374
 of elbow, 583
 of hip, 602
 of shoulder, 582
 Neurofibromatosis, 218
 Neuromata, 218-219
 false, 218
 multiple plexiform, 218
 plexiform, 218
 of scalp, 809
 treatment of, 219
 Neuromimesis, 578
 Neurosis of bladder, 1125
 of penis, 1175
 of prostate, 1165
 traumatic, 373-375
 Neurotomy, 377
 Neville's splint, 472
 New growths, cysts in con-
 nection with,
 246
 innocent, of neck,
 905
 imperable cases
 of, 775
 intracranial, 849
 of abdominal wall,
 614
 of appendix, 711
 of arms, 708
 of bladder, 1121
 of bone, 501-509
 of breast, 1096
 of duodenum, 671
 of face, 942
 of gall-bladder,
 805
 of intestines, 683
 of jaws, 957
 77

- New growths of kidney and pelvis, 1163
of larynx, 1018
of lips, 939
of liver, 791
of mesentery, 815
of mouth, 943
of nose, 922
of oesophagus, 905
of omentum, 632
of orbit, 1001
of pancreas, 782
of penis, 1173
of peritoneum, 630
of pharynx, 986
of prostate, 1163
of rectum, 768
of salivary glands, 949
of scalp, 869
of skull bones, 834-842
of spinal cord and membranes, 807
of spine, 816
of spleen, 786
of stomach, 660
of testis, 1191
of thoracic cavity, 1043
of thorax, 1042
of thyroid, 1051
of tongue, 972
of tonsils, 986
of urethra, 1151
retroperitoneal, 611
- Nipple, affections of, 1058
Paget's disease of, 1060
retraction of, 1058
syphilis of, 1058
- Nodule, painful subcutaneous, 210
- Noma, 177, 178
- Non-infective peritonitis, 630
- Non-specific chronic ulcers, 156
ulcers, 150
- Non-union of fractures, 428
- Nose, accessory sinuses of, 924
chronic suppuration of, 926; treatment of, 927
deformities of, 912
foreign bodies in the, 911
hemorrhage from, 197
injuries and diseases of (Chapter XXVII.), 910-929
loss of part of, 912
malignant resection of septum of, 920
- Oblique facial cleft, 937
- Obstruction, intestinal, 987
oesophageal, 904
- Obturator hernia, 742
- Obturator, 936
- Oczipito-axoid disease, 801
- Oculi motor nerve, injury of, 379
- Odontomata, 223, 963
malignant, of jaw, 950, 962
- Odontome, composite, 964
malignant, 964
- Oedema, malignant, 177
of glottis, acute, 1016
- Oesophageal spasm, 962
- Oesophagitis, acute, 903
- Oesophagoscopy, 901
- Oesophagus, horns of, 980
congenital dilatation of, 968
inflammation of, 903
injuries and diseases of, 908-908
wounds of, 988
- Ogston's operation, 283
- Odium albicans, 15
- Olecranon bursa, 361
fracture of the, 445
- Olfactory nerve, injury of, 379
- Omega, vulvulus of, 862
- Omentocele, 717
- Omentopexy, 794
- Omentum, diseases of, 632
new growths of, 632
torsion of great, 631
- Onychia, 403
maligna, 403
- Onycho-gryphosis, 403
- Operating-room, the air of the, 40
- Operation, in neuralgia, 377
in talipes equino-varus, 282
on tendons, 350
- Operations during shock after accidents, 203
on air-passages, 1019
- Operative injury of ureter, 1078
treatment in flat-foot, 297, 298
in varicose veins, 331
of fractures, 418, 420
of pulmonary tuberculosis, 1041
- Operator's mouth, nose, and hair, care of the, 43
- Oppler-Hoas bacillus, 662
- Opsonic index, 116
- Optic nerve, injury of, 379
- Orbit and ear, affections of (Chap. XXX.), 990-1013
- Orbit, cellulitis of the, 83
injuries and diseases of, 909
wounds of, 999
- Orehidectomy, 1195
- Orethritis, 1189
gonorrhoeal epididymo-, 1185
infective epididymo-, 1185
non-infective epididymo-, 1184
of mumps, 1189
secondary to urethritis, epididymo-, 1189
tuberculous epididymo-, 1186
- Os calcis, fractures of the, 478
- Osteitis deformans, 519
- Osteo-aneurysm, 508
- Osteo-arthritis, 509
of elbow, 583
of hip, 601
of shoulder, 582
of spine, 804
of sterno-clavicular joint, 589
of temporo-maxillary joint, 579
syphilitic, 508
- Osteo-arthropathy, hypertrophic pulmonary, 521
- Osteochondritis, syphilitic, 144, 499
- Osteochondroma of brain, 855
- Osteoclasia, 276, 277
- Osteogenesis imperfecta, 516
- Osteomalacia, 517
- Osteomata, 221-222
cancellous, 221
compact, 221
of brain, 855
of jaw, 959
of nose, 922
- Osteomyelitis fibrosa, 500
of skull, acute infective, 631
of vertebrae, acute, 878
tubercular, 494
tuberculous, of skull, 822
syphilitic, 497
- Osteoplastic resection, 489
- Osteoporosis, 483
- Osteosarcoma, 406
congenital, 516
- Osteosarcoma of brain, 855
- Osteosclerosis, 483
- Osteotomy, 278
- Otitis interna, 146
acute, 1011
subacute and chronic, 1011

- Otitis media, acute, 1004
 chronic suppura-
 tive, 1005
 complications of,
 1008
- Otomycosis, 15
- Ovarian dermoids, 241
 tumours, 635
 solid, 640
- Ovariectomy, 244
- Ovary, cysts arising in,
 636
 hernia of the, 745
 Ovaries, to sterilize, 47
- Overlapping toes, 299
- Oxycephaly, 830
- Oxygen, 4
- Ozæna, 915
- Pachydermatocle, 218
- Pachymeningitis externi,
 840
 interna, acute, 840
- Pacquin's cantery in the
 treatment of warts, 396
- Paget's disease of nipple,
 1000
- Palate, adenoma of, 943
 carcinoma of, 913
- Pancreas, congenital abnor-
 malities of, 776
 cysts of, 783
 diseases and injuries of
 (Chapter XXXIII.),
 776-785
 inflammation of, 778
 new growths of, 782
 wounds of, 770
- Pancreatitis, acute, 778
 chronic, 780
- Papillomata, 233, 234, 641
 hard, 233
 of anus, 768
 of bladder, 1121
 of breast, 1008
 of kidney, 1103
 of larynx, 1018
 of lips, 939
 of nose, 922
 of penis, 1173
 of rectum, 769
 of scalp, 809
 of tongue, 972
 of urethra, 1151
 peritoneal, 631
 soft, 233
 villous, of the intes-
 tine, 683
- Paralysis, facial, 1010
 spastic, with deformity,
 289
- Paraphimosis, 1171
- Paraplegia, 289, 884
 treatment of, 891
- Parasites, 3
- Parasitic cysts, 246
- Parasitic theory of tumour
 formation, 269
- Parasymphilitic affectious,
 141, 140
- Parathyroids, 1053
- Paronychia, 84
- Parosteal lipoma, 215
- Parotitis, epidemic, 947
- Paroxysmal hemoglobin-
 uria, 105
- Parrot's nodes, 498
- Passive movements in treat-
 ment of tuberculosis, 118
- Patella, absent, 272
 congenital displace-
 ment of, 272, 273
 dislocations of, 343,
 344
 fractures of the, 406, 409
 recurrent dislocation of,
 344
 rudimentary, 272
- Pathogenic organism, clas-
 sification of, 1
- Pathological fracture, 105
- Pelvic abscess, 622
- Pelvi-rectal abscess, 757
- Pelvis, dislocation of bones
 of, 339
 fractures of the, 452
- Penetrating ulcer, 658
- Penis, absence of, 1169
 complete amputation
 of, 1175
 congenital abnormali-
 ties of, 1169
 diseases of (Chapter
 XXXVII.), 1168,
 1170
 double, 1160
 injuries of, 1168
 neurosis of, 1175
 new growths of, 1173
 partial amputation of,
 1175
 webbed, 116a
- Peptic ulcer, 654
- Perechloride of mercury, 38
- Perforating ulcer, 157
- Perforation in duodenal
 ulcer, 670, 671
 of carcinomatous ulcer,
 664
 of gastric ulcer, 656,
 658
- Peri-anal abscess, 754
 fistula, 754
 suppuration, 753
- Peri-arthritis of wrist-joint,
 gonorrhœal, 585
- Pericardium, injuries of,
 1033
- Periculitis, 670
- Perigastric adhesions, 656
- Perineal hernia, 742
 lithotomy, 1120
 operation, 74
 prostatictomy, 1141
- Peri-onychia, 85, 403
- Periosteomyelitis, 482
 acute, 935
 pyogenic, 484
 staphylococci, 484
 chronic staphylococci,
 490
 complications of infec-
 tive, 488
 pyogenic, due to direct
 infection, 492
 serous, 491
 streptococcal, 492
 typhoid, 492
- Periostitis of tibia, 166
 syphilitic, 190, 197
 tubercular, 493
- Perithelioma, 228
- Peritonæum, diseases of, 610
 new growths of, 630
- Peritonism, 638
- Peritonitis, acute infective
 general, 616
 localized, 621
 gonococcal, 627
 non-infective, 630
 pneumococcal, 626
 tuberculous, 627
- Peri-urethral abscess, 1147
- Pernio, 393
- Peroxide of hydrogen, 49
- Pes arenatus, 290
 cruris, 290
 treatment of, 288
- Petit's tomahawk, 191
- Phagedonic ulceration, 1172
- Phalangeal joints, disloca-
 tions of, 545
- Phalanges, fractures of, 452,
 479
- Phantom tumours, 356
- Pharyngotomy, 1010
- Pharynx, affections of, 982,
 988
- Phelps's box, 880
 operation, 283
 in talipes, 289
- Phimosis, 1169
 acquired, 1171
- Phlebitis, 326
 infective, 327
- Phlebolith, 329
- Phrenic nerve, injury of,
 383
- Physiological enlargement
 of thyroid gland, 1045
- Pieces of tissue removed by
 operation, examination
 of, 116
- Pigmentation, varicose, 330

- Piles, 763. *See* Hæmorrhoids
 Pinna, abscess of, 1002
 affections of, 1002
 Pityriasis rubra, 15
 Plantaris, rupture of, 351
 Plasmodium, 15
 Plaster jackets, Sayre's
 method, 887
 of Paris bandage, 598
 splints, 422
 Plating in compound fractures, 426
 Pleura, injuries of, 1031
 tumours of, 1041
 Plexiform angioma, 331
 of scalp, 809
 neuroma, 218
 of scalp, 809
 Pneumatocele, 831
 Pneumocœle, 1031
 Pneumocœcal arthritis, 558
 peritonitis, 626
 P. pneumocystis, 15
 pneumonia, septic, 91
 pneumothorax, 1030
 Poli myelitis, anterior, 285
 treatment of, 287, 280
 Polycystic disease of kidney, 1105
 Polydactylism, 262
 Polymazim, 1657
 Polyorchism, 1181
 Polypi, nasal, 920
 Popliteal aneurysm, 324
 Poroplastic splints, 422
 Posterior tubercle, fractures of, 479
 Pott's disease, 879
 fracture, 475, 478
 flat-foot caused by, 294
 Prepatella bursa, 362
 Preputial calculi, 1173
 Pressure diverticula, 901
 Pressure in treatment of chronic inflammation, 32
 Priapism, 1175
 Primary hæmorrhage, 181
 arterial, 182
 capillary, 183
 venous, 182
 Proctitis, 750
 Profeta's law, 142
 Prolapse of liver, 788
 of lung, 1032
 of rectum, 758
 Properitoneal hernia, 734
 Prostate, chronic enlargement of, 1156
 congenital abnormalities of, 1152
 diseases of (Chapter XXXVI.), 1152, 1166
 fibrosis of, 1165
 inflammation of, 1152
 injuries of, 1152
 neurosis of, 1165
 new growths of, 1163
 syphilis of, 1156
 tuberculosis of, 1155
 Prostatectomy, perineal, 1161
 suprapubic, 1160
 Prostatic calculi, 1154
 Prostatitis, acute, 1152
 chronic suppurative, 1153
 Prostatorrhœa, 1165
 Protopathic sensibility, 367
 Protozoa, 15
 Pruritus ani, 768
 Pseudo-arthritis, 428
 Pseudo-cysts of pancreas, 784
 Pseudo-hermaphroditism, external, 1179
 Pseudo-hermaphroditism, internal, 1178
 Pseudo-leukæmia, 343
 Pseudo-tumour of brain, 857
 Psoas abscess, 893
 Pubic dislocation, 541
 Pubis, fracture of the, 452
 Pulsating exophthalmos, 321, 1000
 Punctured wounds of arteries, 303
 Pus, 27
 Pyæmia of sacro-iliac joint, 586
 portal, 91, 790
 in appendicitis, 710
 Pyæmic arthritis, 601
 Pyelitis, 1080
 calculi, 1099
 of pregnancy, 1087
 Pyelonephritis, 1088
 Pylephlebitis, 790
 Pylorotomy, 663
 Pyloric obstruction, 665
 Pylorus, acquired stenosis of the, 666
 carcinoma of, 661
 congenital hypertrophic stenosis of, 665
 stenosis of, 666
 Pyogenic affections of jaws, 954
 arthritis, 579
 organisms, general infection by non-specific, 89
 infecting wounds, 69
 Pyonephrosis, 1088
 Pyopericardium, 1041
 Pyorrhœa alveolaris, 951
 Pyothorax, 1034
 Quadriceps extensor, rupture of, 350
 Quinsy, 983
 Rabies, 103
 Radial aneurysm, 322
 Radial nerve, injury of, 386
 Racheular odontome, 963
 Radium in treatment of lupus, 399
 Radius, fractures of, 446
 Ranula, 945
 Rashes, 89
 syphilitic, 136, 139, 144
 Ray fungus, 104
 Raynaud's disease, 164
 Reaction, inflammatory, after injury, 50
 Reactionary hæmorrhage, 181, 183
 Recurrent dislocation, 535
 Recti, divarication of, 740
 Recto-vaginal fistula, 758
 Recto-vesical and recto-urethral fistula, 758
 Rectum, diseases of, 750
 fibrous stricture of, 961
 foreign bodies in, 749, 750
 inflammation of, 750
 injuries and diseases of, 746-775
 inoperable cases of new growths of, 775
 new growths of, 768
 prolapse of, 758
 submucous abscess of, 757
 tistula of, 757
 ulcers of, 751
 Reduction by downward traction, 533
 by Kocher's method, 533
 by outward traction, 533
 Regeneration of bone, 482
 Reidel's lobe, 788
 Reid's base-line, 858
 Removal of nasal and nasopharyngeal tumours, methods of, 923
 of spleen, effects of, 786
 Renal calculus, 1094
 colic, 1097
 Rena mobilis, 1080
 Resolution in inflammation, 26
 in contusions, 37
 Rest in treatment of inflammation, 22, 24
 of tuberculosis, 116
 Retention cysts, 245
 of urine, acute, 1146

- Retina, 231
 Retraction of nipples, 1958
 Retroperitoneal new growths, 631
 Retropharyngeal abscess, 987
 Roverdin's method of skin-grafting, 155
 Rhabdomyomata, 222
 Rheumatic gout, 569
 myositis, 353
 torticollis, 908
 Rheumatism, acute articular, 560
 Rheumatoid arthritis, 569
 Rhinitis, acute, 913
 atrophic (ozena), 915
 chronic hypertrophic, 914
 sicca, 915
 Rhinoliths, 911
 Rhinophyma, 913
 Ribbert's theory of tumour formation, 209
 Ribs, dislocation of, 1029
 fracture of, 1027
 Richter's hernia, 721, 738
 Rickets, 252, 258, 269, 509, 513, 514
 fetal, 515
 Ringworm, 15
 Rodent ulcer, 244, 401, 819
 Rolando, fissure of, 858
 Röntgen rays in aneurysm, 313
 in diagnosis of coxa vara, 270
 in diagnosis of fractures, 468, 411
 in lymphadenoma, 345
 in lymphadenitis, 339
 in treatment of chilblains, 394
 in treatment of lupus, 398
 in treatment of moles, 395
 ray treatment in rodent ulcer, 402
 Rouge's operation, 923
 Roughton's splint, 477
 Round-celled sarcoma, 225
 Round shoulders, 259
 Rupia, 132, 137
 Ruptured aneurysm, treatment of, 317
 Rupture, extraperitoneal, 673
 intra-peritoneal, 672
 of abdominal muscles, 613
 of aneurysm, 313, 314
 Rupture of arteries, complete subcutaneous, 302
 partial subcutaneous, 301
 subcutaneous, 301
 of a solid organ or large blood vessel, 611
 of a tubal gestation, intra-peritoneal, 644
 of gall-bladder, 612
 and bile-ducts, 795
 of intestine, 672
 of liver, 789
 of membrana tympani, traumatic, 1004
 of oesophagus, 989
 of part of alimentary canal, 611
 of spleen, 785
 of stomach, 646
 of ureter, 1078
 of urethra, 1130
 of urinary bladder, 612, 1108
 Sac, hernial, 716
 Sacculated aneurysm, 311
 Sacro-iliac joint, diseases of, 585
 Sacrum, fracture of the, 452
 Saddle nose, 912
 Sahli's test, 777
 Saline infusion in shock, 203
 Salivary calculi, 947
 fistule, 946
 glands, affections of, 945
 inflammation of, 947
 injuries of, 945
 new growths of, 949
 Salvarsan ("606") in treatment of syphilis, 127
 in treatment of congenital syphilis, 147
 Saprophytes, 3
 Sarcoma, 223-228, 641
 endosteal, 503
 treatment of, 505
 intermediate types of, 226
 of abdominal wall, 614
 of alveolus, 958
 of appendix, 711
 of bladder, 1122
 of bone, 502
 of breast, 1068
 of intestine, 683
 of jaw, 959
 of joints, 579
 of kidney, 1104
 of larynx, 1018
 of liver, 793
 of mediastinum, 1043
 of nose, 922
 of omentum, 632
 of pancreas, 782
 of penis, 1175
 of pleura, 1043
 of prostate, 1163
 of rectum, 770
 of salivary glands, 949
 of scapula, 809
 of skull-bones, 834
 of spine, 896
 of testis, 1192
 of thoracic wall, 1043
 of thyroid, 1052
 of tongue, 973
 of tonsil, 986
 parosteal, 507
 periosteal, 504
 treatment of, 505
 retroperitoneal, 632
 round-celled, 225
 secondary, 508
 spindle-celled, 226
 treatment of, 227
 varieties of, 225-227
 Sayre's treatment of fracture of clavicle, 432
 Scab, healing under a, 55
 Scalds, 169-175
 Scalp, cellulitis of the, 84
 injuries and diseases of (Chapter XXIV.), 806-862
 wounds of, 807
 Scapula, congenital elevation of, 260
 fractures of, 435
 Scarlet fever arthritis, 559
 Scars, 64-68
 excessive contraction of, 65
 malignant disease from, 68
 painful, 65
 pigmented, 67
 weak, 67
 Scar tissue, 52
 Schede's operation, 1039
 for varicose veins, 331
 Schlatzer's disease, 469
 Sciatic nerve, injury of, 388
 Scirrhus carcinoma, 684
 Scirrhus, 241
 of breast, 1070, 1075
 Scissor gait, 270
 Selavo's serum, 14, 100
 Sclerosis in tertiary syphilis, diffuse, 141
 of bone, 483
 Scoliosis, 250-258
 adolescent, 253
 causes of, 251, 252
 treatment of, 255-257

- Scrotal hernia, 726
 Scrotum, elephantiasis of, 346
 inflammatory conditions of, 1179
 sebaceous cyst of, 1180
 Scurvy rickets, 514
 Sebaceous adenomata, 305
 cysts, 394
 in neck, 903
 of scalp, 808
 on scrotum, 1180
 horus, 394
 Secondary hæmorrhage, 181, 184
 treatment of, 194
 malignant growths on, 1180
 nerve suture, 370
 suturo in muscle rupture, 350
 Semimembranous bursa, 362
 Senile gangrene, 162, 163
 Sepsis, prevention of, 117
 Septic arteritis, 306
 moist gangrene, 159
 myositis, 353
 Septicopyæmia, 89
 chronic, 93
 Sequestra in jaws, 955
 Sequestration dermoids, 248, 249
 Sequestrum, 483
 period of separation of, 486
 removal of, 489
 Serotherapy in treatment of ulcers, 152
 Serous cysts of breast, 1065
 of scalp, 809
 membranes, inflammation of, 90, 93
 Serum, antipneumococcic, 14
 antistreptococcic, 14
 therapy, 117, 1136
 curative, 12
 in treatment of inflammation, 22, 32
 treatment for tetanus, 97
 Sex-cell theory of tumour formation, 210
 Shaft of humerus, fracture of, 439
 Shafts of radius and ulna, fracture of, 449
 Shock, 199-204
 in fractures, 412
 methods of preventing in severe operations, 201
 operations during, 203, 204
 treatment of, 201-204
 Short-circuiting, 701
 Shoulder complicated by fracture of surgical neck of humerus, dislocation of, 533
 congenital dislocation of, 200
 joint, diseases of, 581
 Shoulder-joint, diseases of, 581
 dislocation of, 531
 unreduced dislocations of, 534
 Shoulders, round, 259
 Sigmoidoscopy, 687
 Sigmoid, volvulus of (the), 692
 Silk, to sterilize, 46
 Silkworm gut, 46
 Simple fracture, 406
 Sinus formation, 73
 Sinuses of nose, accessory, 924
 Sinusitis, lateral, 1012
 Skin, affections of (Chapter XXII.), 390-404
 dermoids, 248, 249
 grafting, 155
 of animals used for grafting, 156
 preparation of, for operations, 44
 tuberculous disease of, 399
 Skull, diseases of, 831
 effects of gunshot wounds on, 59
 fractures of base of, 828-831
 fractures of vault of, 824-828
 gunshot wounds of, 61
 operations on, 861
 repair of fractures of, 831
 Slough, 158
 "Smoker's patch," 969
 Snake-bites, 64
 Soft corns, 391
 fibroma, 217
 papillomata, 233
 Sores, soft, 149
 syphilitic, 149
 Spastic paralysis with deformity, 289
 Special dislocations, 529
 Specific infections (Chapter V.), 108
 of wounds, 93
 Spermatic cord, diffuse hydrocele of, 1199
 diseases of, 1196
 hæmatocoele of, 1202
 torsion of, 1183
 Spheroidal-celled carcinoma, 240
 Sphincter, artificial, 775
 Spina bifida, 875
 occulta, 876, 877
 Spinal accessory nerve, injury of, 382
 concussion, 864
 cord, new growths of, 897
 jackets, 257, 258
 meningitis, acute, 896
 myelitis, 897
 nerves, injury of, 383
 Spindle-celled sarcoma, 226
 Spine, deformities of, 250
 inflammatory conditions of, 878
 injuries and diseases of (Chapter XXV.), 863-896
 wounds of, 866
 Spirilla, 1
Spirochaeta pallida, 15, 30, 120, 124, 138, 143
 Spleen, effects of removal of, 787
 enlarged, 787
 floating and dislocated, 787
 injuries and diseases of, 785-788
 in lardaceous disease, 76
 new growths of, 785
 Splints in genu valgum, 273
 in talipes equino-varus, 281
 uses of, 419, 421-423, 425, 477
 Spondylitis deformans, 894
 traumatic, 895
 Spondylolisthesis, 875
 Sponges, to sterilize, 46
 Spontaneous fracture, 405
 Spore formation, 3
 Sprains of spine, 863
 Sprengel's deformity, 260
 Squamous-celled carcinoma, 239
 Stabs of spine, 866
 Staphylococcus, 702
Staphylococcus albus, 30, 244, 393
 pyogenes, 179, 180
 Status lymphaticus, 1059
 Stenosis of anal canal, 748
 of cardiac orifice, 654
 of intestine, congenital, 673
 of pylorus, congenital hypertrophic, 665
 Stenson's duct, wounds of, 945
 Stephen Smith's amputation, 163

- Sterility, 1176
 Sterilization, 41-47
 of air of operating-room, 40
 of hands, 41
 of instruments and drainage-tubes, 44
 of ligatures and sutures, 45
 Sterno-clavicular articulation, 580
 Sterno-mastoid, rupture of, 351
 Sternum, fracture of, 431, 1026
 Stiff neck, 353
 Still's disease, 571
 Stings of insects, 63
 on tongue, 965
 Stokes-Critt's amputation, 163
 Stomach, acute dilatation of, 668
 burns of, 647
 carcinoma of, 660
 dilatation of, 665
 foreign bodies in, 647
 injuries and diseases of the (Chapter XIX.), 646-671
 rupture of, 646
 wounds of, 646
 Stomatitis, 942
 Stone impacted in cystic duct, 800
 in bladder, 1116-1120
 in kidney, 1094-1100
 in ureter, 1100-1103
 Strangulated hernia, 691, 720
 femoral, 737
 Strangulation of piles, 765
 Strapping, 153
 Streptococcus, 702
Streptococcus erysipelatus, 227
 pyogenes, 336
 Streptothrix group, 2, 107
 Stricture of common duct, 803
 of cystic duct, 803
 of intestine, cicatricial, 678
 of oesophagus, fibrous, 994
 malignant, 995
 of rectum, fibrous, 761
 of urethra, 1140
 of urethra in female, 1150
 Striped myomata, 222
 Strohmeier's cushion in compound fractures of the humerus, 444
 Subastragaloid dislocation, 547
 Subclavian aneurysm, 321
 Subcutaneous bursa, 363
 Subcutaneous lipoma, 214
 rupture of arteries, 301
 Subdeltoid bursa, 363
 Subdiaphragmatic abscess, 623
 Subdural hemorrhage, 823
 in newly-born, 824
 Subluxation of head of radius, 538
 Subpatella bursa, 362
 Subserous lipoma, 215
 Substernal goitre, 1040
 Subsynovial lipoma, 215
 Subungual exostosis, 404
 Sun-burns, 175
 Superficial palmar arch, wound of, 196
 Suppuration, 37
 clinical features of acute, 28
 following acute inflammation, 27
 in a serous or synovial membrane, acute, 29
 in fractures, 413, 425
 in sheaths of the flexor tendons, 86
 of aneurysm, 314
 on a mucous membrane, acute, 29
 perianal and perirectal, 753
 resulting from tubercular inflammation, 113
 results of long-continued, 74
 Supracondyloid fracture, 441
 Suprapubic lithotomy, 1120
 Prostatectomy, 1160
 Surgeon and his assistants, the, 41
 Surgery of neck (Chapter XXVI.), 899-909
 Surgical neck of humerus, fracture of, 430
 of scapula, fracture of, 436
 Sutures, 29
 of skin wounds, 49
 Swabs, to sterilize, 47
 Swelling in fractures, treatment of, 418
 Sylvius, fissure of, 858
 Syme's operation, 977
 for stricture of urethra, 1143
 Syncope, local, 165
 Syndactyly, 261
 Synovial membranes, inflammation of, 90
 Syphilis, 120-148
 bacillus of, 120, 124
 Syphilis, congenital, 142
 curability of, 145
 extragenital chancres, 123
 Hunterian chancre, 122, 124
 immunity from, 122
 incubation period of, 121
 late secondary, intermediate, or remifer stage, 136, 137
 local manifestations in secondary, 131
 lymphatic infection, 124
 mercurial treatment of, 126
 mode of infection, 121
 multiple chancres, 124
 of bones, 495-501
 of breast, 1062
 of jaw, 957
 of larynx, 1016
 of lips, 938
 of nipple, 1058
 of nose, 916
 of prostate, 1156
 of testis, 1189
 of thyroid gland, 1045
 of tongue, 960
 of tonsils, 985
 primary, 122
 prophylactic treatment of, 125
 rashes in, 136, 139
 remifer stage, 136, 145
 salvarsan in congenital, 147
 "606," in treatment of, 127
 secondary, 131
 soft sores, soft chancres
 Dunbar's infection, 148
 tertiary, 138
 the question of vaccination, 136
 transmission to the third generation, 146
 treatment of, 125, 136, 140, 147
 Wassermann's reaction in inherited, 143
 reaction in primary, 127
 Syphilitic affections of arteries, 137, 106
 of bones, 133, 144
 of eye, 137
 of glands, 136, 140
 of hair, 132
 of joints, 133, 144
 of mucous membranes, 132, 137, 140, 144

- Syphilitic affections of
 muscles, 353
 of nervous system, 137
 of teeth, 146
 of tendons, 358
 of testicles, 137
 arthritis, 567
 choroiditis, 145
 disease of œsophagus, 903
 of skull, 833
 of spine, 893
 endarteritis obliterans, 137
 epididymitis, 1189
 epiphysitis, 144
 inflammation of bone, treatment of, 498
 interstitial keratitis, 145
 iritis, 145
 meningitis, 842
 orchitis, 1189
 osteochondritis, 144
 osteomyelitis, 497
 otitis interna, 146
 periostitis, 496
 rashes, 136, 139, 144
 sores, 149
 ulceration of the anus, 752
 Syringomyelia, arthropathy in, 577
 Syringomyelocœle, 976
 Tabes dorsalis, 142
 arthropathy of, 576
Tænia echinococcus, 246
 Talipes, 278
 acquired, 284-289
 causes of, 285-287
 calcaneæ valgus, congenital, 284
 calcaneus, 278
 treatment of, 288
 compensatory, 290
 equino-varus, 278-284
 treatment of, 280, 284, 288
 equinus, 278
 plantaris, 290
 valgus, 278
 varus, 278
 Talma-Morrison operation, 794
 Tapping lateral ventricle of brain, 860
 Tarsal bones, fractures of, 478
 Taxis in hernia, 722
 Taylor's brace, 889
 Teeth, in inherited syphilis, 146
 Temporo-maxillary articulation, 579
 Tendo Achillis, rupture of, 351
 Tendon, dislocation of, 352
 lengthening, 360
 ossification in, 354
 sheaths, diseases of, 356
 new growths of, 359
 shortening, 359
 transplantation, 360
 Tenosynovitis, fungating, 357
 gonorrhœal, 356
 gouty, 356
 septic, 356
 syphilitic, 358
 traumatic, 356
 tubercular, 357
 Tenotomy, 288, 359
 in contraction of muscles, 418
 in talipes equino-varus, 281
 Terato-blastoma, 245
 Teratoid growths, of testis, 1192
 Teratomata, 244, 245, 636, 770
 Testes, congenital abnormalities of, 1181
 in children, tuberculosis of, 1188
 inflammation of, 1184
 injuries and diseases of, 1180
 neuralgia of, 1195
 new growths of, 1191
 syphilis of, 1189
 Testicles, syphilitic affections of, 137
 Tetanus, 93
 acute, 94
 bacillus of, 93
 chronic, 96
 effects of muscular spasm in, 95
 hydrophobicus, 96
 Tetany, 667
 Thermal gangrene, 169
 Thiersch's method of skin-grafting, 155, 156
 Thomas's double splint, 886
 hip splint, 596
 knee splint, 605
 Thoracic aorta, aneurysm of, 318
 cavity, new growths of, 1043
 duct, wounds of, 335
 walls, new growths of, 1042
 Thoracotomy, 1036
 Thorax, inflammatory diseases of, 1034
 injuries and diseases of, 1025-1044
 Thrombosis, 308
 infective sinus, 847
 in varicose veins, 330
 of lateral sinus, 1012
 of sinuses of dura mater, 840
 Thrush, 15, 943
 Thymic asthma, 1056
 Thymus gland, diseases of, 1056
 Thyro-glossal duct, cysts of, 903
 Thyroid, absence of, 1045
 dislocation, 541
 gland, congenital abnormalities, 1045
 diseases of (Chapter XXXII.), 1045-1055
 mixed enlargement of, 1046
 physiological enlargement of, 1045
 inflammation of, 1045
 tumours, 980
 Thyroidectomy, 1050
 Thyroiditis, acute, 1045
 Thyroids, accessory, 1045
 Thyrotomy, 1020
 Tibiæ, curved, 469
 Tibia, fractures of the, 469
 operations on, 276
 rickety curve of, 276
 Tibial arteries, aneurysm of, 324
 Tic douleureux, 379
Tinea microsporon, 15
trichophyton, 15
 Toe-nail, ingrowing, 41
 Toes, overlapping, 209
 Tongue, affections of (Chapter XXIX.), 963-998
 congenital abnormalities of, 966
 effects of removal, 978
 inflammations of, 966
 injuries of, 965
 Tongue-tie, 966
 Tonsillitis, 982
 Tonsillotomy, 985
 Tonsils, affections of, 982-988
 chronic enlargement of, 984
 method of removal of malignant disease of, 987
 Tooth socket, hæmorrhage from, 196
 Torsion of gall-bladder, 795
 of great omentum, 633
 of spermatic cord, 1183
 treatment in hæmorrhage, 192
 Torticollis, 907-910

- Torticollis, rheumatic, 353
 Tourniquets, 190, 191
 Towels, to sterilize, 47
 Toxæmia and its effects, 76
 Toxic delirium, 204
 Toxins, 6
 Trachea, fractures of, 902
 hernia of, 905
 Tracheotomy, 1020
 after-treatment of, 1022
 tubes, 1022
 Traction diverticula, 991
 downward, 533
 outward, 533
 Transfusion, 189
 Transmission of micro-organisms from mother to fetus, 14
 Trans-sacral operation, 774
 Traumatic cephalalgia, 817
 delirium, 204
 fever, aseptic, 20
 gangrene, 161, 162, 186
 late apoplexy, 823
 myositis, 352
 neurasthenia, 864
 neurosis, 373-375
 rupture of membrana tympani, 1004
 spondylitis, 895
 Trays, to sterilize, 47
 Trendelenburg's operation for varicose veins, 331
 Trigeminal nerve, injury of, 379
 Trigger finger, 263
 Trismus neonatorum, 96
 Trochanter, bursa over the great, 363
 fracture of the, 459
 Trochlear nerve, injury of, 379
 Trophoblast, tumours in connection with, 244
 Trusses, bubonocolo, 730
 direct inguinal, 733
 femoral, 728, 736
 for infants, 730, 731
 indirect inguinal, 730
 inguinal, 728, 729, 730, 734
 interstitial, 734
 scrotal, 731
 umbilical, 739
 Trypanosomes, 15
 Tubal gestation, intra-peritoneal rupture of, 644
 Tubercle bacillus, 108, 702
 Tubercular abscess, 118
 cystitis, 114
 dactylitis, 495
 fistula, 119, 120
 meningitis, 842
 myositis, 353
 osteomyelitis, 494
 Tubercular periostitis, 493
 ulcer, 118-119
 Tuberculin, use of, for diagnostic purposes, 115
 Tuberculosis, 108-120
 acquired predisposition to, 109-110
 acute miliary, 928
 affecting various portions of spine, 891
 chronic, 628
 inherited predisposition to, 109
 laboratory methods of diagnosis of, 115-116
 local treatment in, 117-118
 modes of infection, 110
 of appendix, 711
 of breast, 1062
 of intestines, 676
 of jaw, 957
 of kidney, 1089
 of larynx, 1017
 of nose, 917
 of prostate, 1155
 of testis in children, 1188
 of thyroid gland, 1045
 of tongue, 970
 of tonsils and pharynx, 985
 of urethra, 1151
 operative treatment of pulmonary, 1041
 pathological anatomy of, 111
 resulting in fibrosis, 112
 in gangrene, 114
 in suppuration, 113
 treatment of, 116
 Tuberculous adenitis of mesenteric glands, 634
 arthritis, 561-579, 580, 581, 583, 584, 585, 587, 599, 603, 609
 disease of arteries, 306
 of bone, 493-495
 of joints, amputation for, 567
 of lymphatic glands, 336, 338
 of skin, 396-400
 of tendons, 357
 empyema, 1039
 epididymo-orchitis, 1186
 inflammation of bone, treatment of, 495
 of cesophagus, 933
 osteomyelitis of spine (Pott's disease), 879
 Tuberculous peritonitis, 627
 ulceration of anus, 751
 of intestines, 678
 volsclulitis, 1167
 Tuberosities, fracture of, 439
 Tubo-ovarian cysts, 638
 Tubulo-dermoids, 240
 Tumours and cysts (Chapter VIII), 208-249
 arising in connective tissue, 213-229
 cause of, 209
 cerebellar, 852
 cerebral, 849
 classification of, 213, 214
 congenital sacroco-cygeal, 878
 sterno-mastoid, 906
 connected with bone marrow, 231
 with central nervous system, 231
 with teeth, 233
 containing pigment, 229
 etiology of, 210
 fatty, *See* Lipoma in brain, 855
 innocent, 211
 of epithelial origin, 233
 malignant, 211
 of epithelial origin, 236
 methods of removal of nasal, 923
 mixed, of salivary glands, 949
 of abdominal wall, phantom, 613
 of alveolus, 958
 of callus, 430
 of carotid gland, 905
 of body of jaws, 959
 of lungs, 1043
 of mediastinum, 1043
 of neck, 905
 of orbit, 1001
 of pleura, 1043
 of testis, dermoid, 1193
 ovarian, 635
 solid, 640
 thyroid, 980
 varieties of, 211
 villous, 233
 Tunica vaginalis, diseases of, 1196
 hydrocele of, 1196
 Typhoid arthritis, 558
 cystitis, 1110
 spine, 894
 stomach, 205
 ulceration, 677

- Ulcer, callous, 152
 chronic, after-treat-
 ment of, 156
 cratoriforia, 402
 dental, 971
 due to deficient in-
 nervation, 151
 due to interference of
 blood-supply, 150
 due to interference of
 venous return, 150
 due to interference
 with wound contrac-
 tion, 151
 due to want of cleanli-
 ness, 151
 duodenal, 669
 dyspeptic, 972
 eczematous, 157
 gastric, 649
 perforation of
 acute, 656
 perforation of
 chronic, 658
 irritable, 156, 157
 malignant, 157, 239
 non-specific, 150
 of anus, 751
 of rectum, 751
 operative treatment of
 varicose, 156
 Ischiopubic, 654
 perforating, 157
 of foot, 301
 rodent, 244, 401
 treated by sero-
 therapy, 152
 tubercular, 118, 399
 varicose, 152, 331
 Ulceration, acute, 151
 anemic, 150
 and gangrene (Chapter
 VI.), 150-180
 causes predisposing to,
 151
 chronic, 152
 due to specific bac-
 teria, 157
 dysenteric, 751
 in carcinoma, 238
 in malignant tumours,
 212
 in whooping-cough, 972
 of anus, syphilitic, 752
 tuberculous, 751
 of intestines, tuber-
 culous, 676
 phagedenic, 1172
 typhoid, 677
 Ulna, fractures of the, 445-
 446
 Ulnar aneurysm, 322
 nerve, dislocation of,
 388
 injury of, 387
 Umbilical granulomata, 616
 hernia, 129, 738
 Umbilicus, diseases of, 615
 Union of fractures, 426-429
 Unna's bandage, 153
 Ununited fractures, 427
 Upper extremity, deformi-
 ties of, 260-264
 Urachal cysts, 614
 fistula, 615
 Ureter, congenital abnor-
 malities of, 1079
 extra, 1080
 injuries of, 1077
 operative injury of,
 1078
 rupture of, 1078
 stone in, 1100-1103
 Urethra, congenital abnor-
 malities of, 1133
 foreign bodies in, 1132
 injuries and diseases of
 (Chapter XXXVI.),
 1128-1152
 inflammation of, 1134
 new growths of, 1151
 rupture of, 1130
 stricture of, 1140
 complications of,
 1146
 treatment of, 1143
 tuberculosis of, 1151
 Urethritis, 1134
 chronic, 1138
 treatment by serum
 therapy, 1136
 Urinary bladder, rupture of,
 612
 fever, 1150
 fistula, 1150
 Urine, acute retention of,
 1146
 extravasation of, 1148
 Uterus, hernia of the, 745
 Vaccines, 12
 treatment by, 244
 Vagus, injury of, 382
 Varicocele, 328, 1202
 Varicose aneurysm, 324,
 325
 ulcer, 152
 veins, 328
 complications of,
 330
 of oesophagus, 993
 operative treat-
 ment of, 156
 Varix, aneurysmal, 320
 Vascularization in healing
 of wounds, 51
 Veins, entrance of air into,
 305
 inflammation of, 326
 injuries of, 304-306
 open wounds of, 305
 Veins, subcutaneous rup-
 ture of, 304
 varicose, 328
 Venous hemorrhage, treat-
 ment of, 193
 return, interference of,
 150
 Ventral hernia, 740
 Verruca, 395
 necrogenica, 400
 Vertebral artery, wound of,
 185
 Vesiculae seminales, inflam-
 mation of, 1166
 Vesiculitis, acute, 1166
 chronic gonorrhoeal,
 1166
 tuberculous, 1167
 Vicious union of fractures,
 428
 tumours, 233
 Vincent's angina, 82
 Virchow's theory of tumour
 formation, 209
 Vitelline duct, lesions in
 connection with, 615
 Volkmann's foot-rest, 462
 ischemic contracture,
 355, 456
 Volvulus, 692
 of caecum, 693
 Von Pirquet's reaction, 115
 Von Recklinghausen's view
 of neuromata, 218
 Wagstaffe's fracture, 470
 Wardrop's operation for
 aneurysm, 316
 Warts, 233, 395
 Wassermann's reaction in
 inherited syphilis,
 143
 serum reaction in
 primary syphilis, 125
 Water for making lotions,
 47
 Weak foot, 295
 Webbed fingers, 261
 Wheelhouse's operation for
 stricture of urethra, 114
 White corpuscles, 18
 Whitehead's excision
 pile-bearing area, 70
 operation, 977
 Whitlow, periosteal, 88
 subcutaneous, 85
 subepithelial, 84
 thecal, 86
 Whooping-cough, necro-
 tion in, 972
 Wolfe's method of sk
 grafting, 156
 Woolf's law, 250, 253, 2
 287
 Woolsorter's disease, 99
 Wounds, accidental, 53

INDEX

1227

- eons rup-
 4
 age, treat-
 93
 erence of.
 740
 400
 y, wound of.
 ales, inflam-
 66
 te. 1166
 gonorrhoeal.
 s. 1167
 of fractures.
 233
 na. 82
 ry of tumour
 209
 t, lesions in
 with. 6f5
 ot-rest. 462
 contracture.
 66
 2
 a. 693
 s reaction. f15
 ghausen's view
 ata. 218
 fracture. 470
 operation for
 3f6
 395
 t's reaction in
 ited syphilis.
 reaction in
 ary syphilis. 125
 making lotions.
 295
 gera. 261
 e's operation for
 of urethra. 1146
 uscles. 18
 a excision of
 -bearing area. 767
 tion. 977
 periosteal. 88
 itaneous. 85
 ithelial. 84
 l. 86
 g-cough. nlcera-
 972
 method of skin-
 g. 156
 law. 250. 253. 264.
 er's disease. 99
 . accidental. 55-55
- Wounds, acute abscess. 71
 antiseptic treatment of.
 38
 aseptic. 38
 chronic abscess. 72
 clinical aspects of heal-
 ing of. 53
 containing foreign
 bodies. 62
 contusions, scars
 (Chapter III.). 36-68
 drainage of, aseptic. 49
 erysipelas from in-
 fected. 77
 first-aid treatment of
 accidental. 56
 from bites of animals.
 64
 from snake-bites. 64
 from stings of insects.
 63
 gunshot. 58-62. 6f2
 healing of. 50
 infected (Chapter IV.).
 69. f07
 by pyogenic organ-
 isms. 69
- Wounds, incised. 303. 405.
 f168. 1181
 in surgical operations.
 aseptic. 40
 interference with con-
 traction of. 151
 lacerated. 523
 non-specific. infection
 of. 69
 of abdominal wall. 612
 of arteries. 303. 304
 special. 195. 196
 of bladder. 1f09
 of brain. 820
 of bursa. 360
 of cranial sinus. 196
 of ear. f002
 of gall-bladder. 796
 of heart. f033
 of joints. 522
 of lip and face. 941
 of lungs. 103f
 of orbit. 999
 of pancreas. 776
 of penis. 1168
 of pericardium. f033
 of scalp. 807
- Wounds of spine. 866
 of Stenson's duct. 945
 of testis. f18f
 of thoracic duct. 335
 of tongue. 965
 of veins. 305
 operation infection by
 pyogenic organisms.
 69
 punctured. 523
 results of long-con-
 tinued suppuration
 of. 74
 scars from healing of.
 64-68
 septic conditions of
 infected. 70
 specific infections of.
 93
 treatment of gunshot.
 69
 Wright's solution. 154
 styptic. f94
 Wrist-joint, diseases of. 584
 Wrist, dislocation of. 538
 congenital. 260
 Wry-neck. 807

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FIG. 30.—INCISIONS FOR AMPUTATION OF A TOE AND A TOE WITH ITS METATARSAL BONE.

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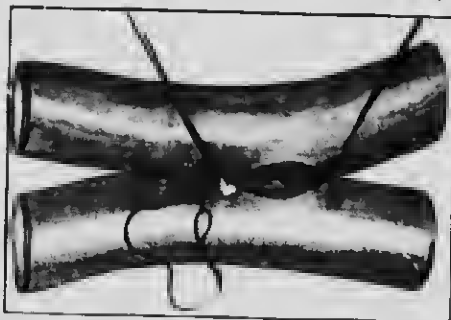


FIG. 52.—ECK'S FISTULA, SHOWING OPERATION NEARING COMPLETION.

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FIG. 121.—CASE OF CLAW-HAND FROM RUPTURE OF FIRST THORACIC ROOT, FOLLOWING A DISLOCATION OF THE RIGHT SHOULDER.

Note the atrophy of intrinsic muscles of the right hand; also the pseudo-phosis on that side due to atrophy of cervical sympathetic.

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FIG. 58.—SPORADIC CRETINISM. Treatment with thyroid extract began late, and caused but little improvement.

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