CIHM
Microfiche
Series
(Monographs)

ICMH
Collection de
microfiches
(monographies)

Technical and Bibliographic Notes / Notes technique et bibliographiques

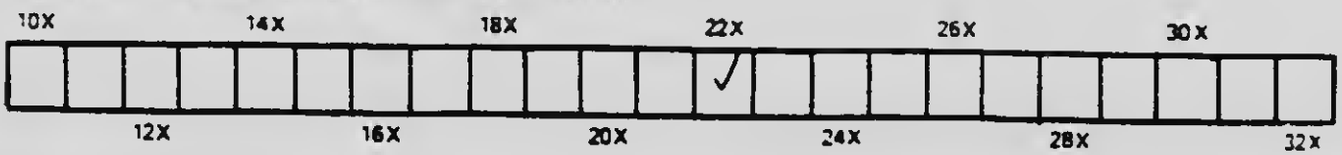
The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

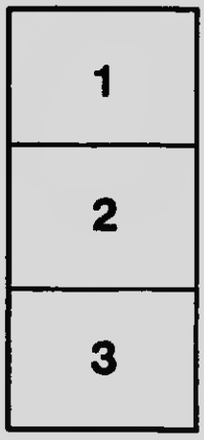
- ☐ Coloured covers / Couverture de couleur
- ☐ Covers damaged / Couverture endommagée
- ☐ Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- ☐ Cover title missing / Le titre de couverture manque
- ☐ Coloured maps / Cartes géographiques en couleur
- ☐ Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- ☑ Coloured plates and/or illustrations / Plenches et/ou illustrations en couleur
- ☐ Bound with other material / Relié avec d'autres documents
- ☐ Only edition aveilable / Seule édition disponible
- ☐ Tight binding may cause shadows or distortion along interior mergin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la merge intérieure.
- ☐ Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ejoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- ☐ Additional comments / Commentaires supplémentaires:

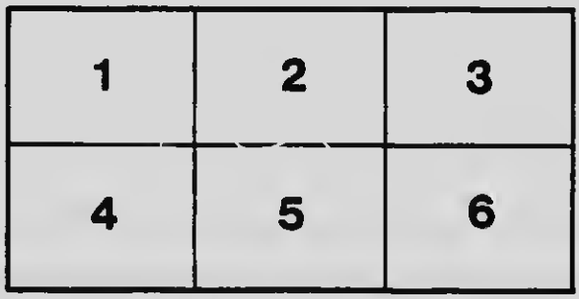
L'Institut a microfilmé le meilleur examplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modifications dans la méthode normale de filmage sont indiqués ci-dessous.

- ☐ Coloured pages / Peges de couleur
- ☐ Pages damaged / Pages endommagées
- ☐ Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- ☑ Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- ☐ Pages detached / Pages détachées
- ☑ Showthrough / Transparence
- ☐ Quality of print varies / Qualité inégale de l'impression
- ☐ Includes supplementary meterial / Comprend du matériel supplémentaire
- ☐ Pages wholly or partially obscured by errata slips, tissues, etc., heve been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possiole.
- ☐ Opposing pages with verying colouration or discolourations are filmed twice to ensure the best possible image / Les pages s'opposant ayent des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleur imege possible.

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

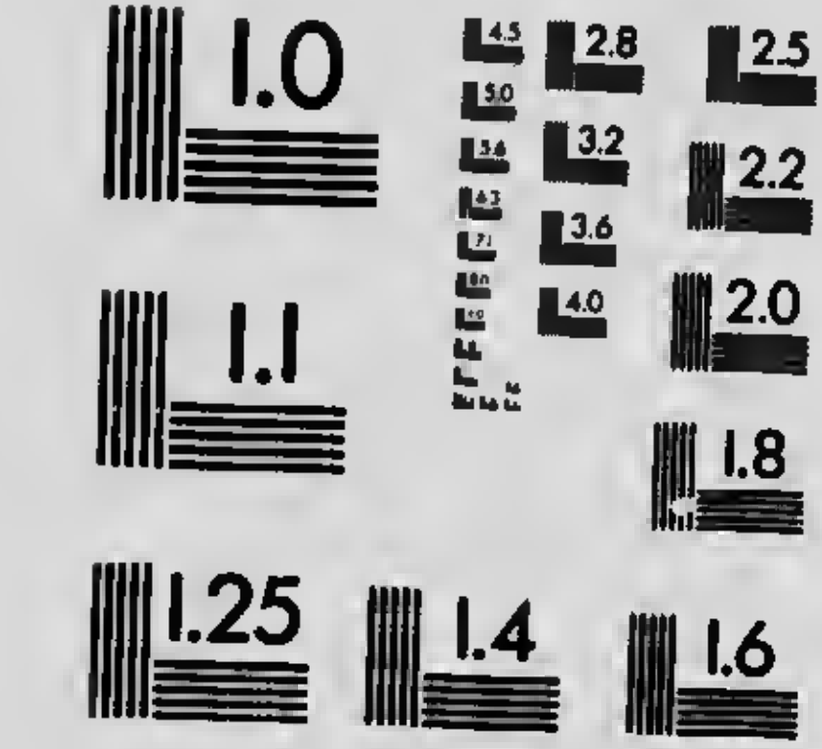






MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

F. E. Thompson
1912

PYE'S SURGICAL HANDICRAFT

PYE'S
SURGICAL HANDICRAFT:

A MANUAL

OF

SURGICAL MANIPULATIONS, MINOR SURGERY, AND OTHER MATTERS CONNECTED WITH THE WORK OF HOUSE SURGEONS AND SURGICAL DRESSERS

EDITED AND LARGELY REWRITTEN BY

W. H. CLAYTON-GREENE,

B.A., M.B., B.C. (Cantab.), F.R.C.S. (Eng.)

Surgeon to St. Mary's Hospital; Lecturer on Surgery in the Medical School, &c.

Sixth Edition

FULLY REVISED, WITH SOME ADDITIONAL MATTER AND ILLUSTRATIONS

Vel de minimis curat chirurgicus

TORONTO:

THE MACMILLAN COMPANY OF CANADA, LTD.,

1912

PREFACE TO THE SIXTH EDITION.

In the revised edition of this work an attempt has been made to maintain the character and style as originally adopted by the late Mr. Walter Pye.

It has been my aim to complete a book which will cover most of the common details and complications of treatment occurring in the course of surgical practice.

I have been very fortunate in obtaining the assistance of my friends and colleagues who have had special experience in the different branches of the subject. I heartily thank them for their admirable treatment of the special chapters.

I am under a deep obligation to my friend, Mr. Ivor Back, not only for his painstaking correction of the proof sheets, but also for many valuable suggestions.

W. H. Clayton-Greene.

32, Devonshire Place, W.
October, 1912.

PREFACE TO THE FIRST EDITION.

IN this book I have endeavoured to describe the details of surgical work as it appears from the point of view of house surgeons and dressers in surgical wards.

My aim has been, further, to present this work to them, as to men apprenticed to a skilled labour, in which excellence can only be attained by the acquisition of manual skill or handicraft; for although surgery is doubtless becoming more scientific day by day, and although it may even now have come to pass that with the increasing recognition of its higher aims, its manipulative side is unduly overshadowed, nevertheless Chirurgery can never be false to its etymology, χειρ ἐργον, will never cease, that is, to be a skilled labour, nor will surgeons ever cease to be handicraftsmen.

This main idea I have wished to express in the title I have chosen, and it has been very far from my desire to write in any sense an elementary work on theoretical surgery. Still, I am conscious of having been forced in some places to treat of abstract surgical questions, and to sacrifice absolute consistency if by so doing I could better explain necessary manipulations.

WALTER PYE.

4, SACKVILLE STREET, W.
September, 1884.

TABLE OF CONTENTS.

SECTION I.

Of the Arrest of Hæmorrhage.

SECTION II.

Of Apparatus for Restraint and Support (Bandages, Splints, etc.)

SECTION III.

Of Fractures, Dislocations, and Sprains.

SECTION IV.

Of Wounds, Ulcers, and Burns.

SECTION V.

Of Cases Requiring Prolonged or Mechanical Treatment.

SECTION VI.

Of Minor Surgery and Kindred Subjects.

SECTION VII.

Of Special Cases connected with the Head and Throat.

SECTION VIII.

Of Certain Emergencies, Surgical and General.

SECTION IX.

Of the Administration of Anæsthetics.

SECTION X.

Miscellaneous.

LIST OF ILLUSTRATIONS.

SECTION I.

The Arrest of Hæmorrhage.

SECTION II.

Apparatus for Restraint and Support—Bandages.

SECTION IV.

Wounds, Ulcers, and Burns.

SECTION V.

Cases requiring Prolonged or Mechanical Treatment.

SECTION VI.

Minor Surgery and Kindred Subjects.

SECTION VII.

Special Cases connected with the Head and Throat.

Treatment of the Teeth.

SECTION VIII.

Certain Emergencies, Surgical and General.

SECTION IX.

Administration of Anæsthetics.

SECTION X.

Miscellaneous.

PLATES.

SURGICAL HANDICRAFT.

SECTION I.

OF THE ARREST OF HÆMORRHAGE.

CHAPTER I.

OF HÆMORRHAGE GENERALLY.

WHEN the blood-vessels are divided or torn across, blood escapes in varying quantities—this is primary hæmorrhage; and according to the character of the vessel injured such hæmorrhage or bleeding will be capillary, venous, or arterial.

While the hæmorrhage which results from injuries to the capillaries and veins is rarely serious, there are certain conditions which render it extremely dangerous: these will be considered later. Arterial hæmorrhage must always be regarded as urgent, and in most instances active surgical measures will have to be undertaken to deal with the accident.

Hæmorrhage may be arrested by **Natural Means,** but in the case of the larger vessels such an arrest is usually called **Temporary,** and requires to be reinforced by such measures as will ensure complete and permanent closure of the wounded vessel.

The process of temporary arrest is brought about by several factors: (1) Cut vessels, and especially torn vessels, tend to contract, this contraction occurring much more readily in the case of veins than arteries; (2) Effused blood coagulates, especially if exposed to the air, the coagulated blood blocks the mouth of the vessel and acts as a fibrinous plug; (3) Hæmorrhage depends upon the force and velocity of the blood-stream, and is therefore much freer in the case of arteries than veins.

After a certain quantity of blood has been lost, syncope comes on. This is a state of faintness, with depression of the heart's action, produced by hæmorrhage and shock, and within certain limits is a fortunate occurrence, since the slackening of the circulation allows time for the formation of clots and for the contraction and retraction of the vessels within their sheaths. Moreover, the coagulability of the blood increases after a certain quantity has been shed.

Permanent Arrest may occur purely as the result of natural processes, but, as has already been said, in cases where the larger arterial

or venous trunks have been injured, active measures will have to be undertaken before the condition is free from danger; these will be studied under the head of "Arterial Hæmorrhage" (Chapter II).

This permanent arrest depends upon the process of organization of the clot which has formed: (1) In the lumen of the vessel; (2) In the torn ends of the vascular sheath; and (3) Upon changes in the wall of the vessel itself. Gradually new connective tissue cells grow from the vessel's wall into the clot, which may be regarded as a species of scaffolding—these new-formed cells are slowly transformed into mature fibrous tissue, which indissolubly blends clot and vessel wall together until all that is left of the injured end is a tapering fibrous cord. Not until this final stage is reached is the period of danger from recurrent hæmorrhage safely passed, and many are the factors which may intervene to prevent this successful issue. When a vessel has been tied, or when any of the various expedients to be presently described have been made use of, there is always a risk of the bleeding coming on again unless the natural process of organization progresses unchecked, and it must therefore be clearly understood that tourniquets, pluggings, and even ligatures only act in bringing about a favourable state of things in the vessels so that coagulation, organization, and fibrosis may proceed unchecked.

The immediate measures which should be taken to arrest primary hæmorrhage are:—

1. Prompt pressure, digital or otherwise, over the bleeding point or the main arterial channel.

2. Provision for free venous return from the injured part, so that there is no congestion in the damaged capillary area.

3. The recumbent position, unless, as in nose bleeding, a more favourable attitude can be assumed.

Chapter II.

THE ARREST OF ARTERIAL BLEEDING.

THE proceedings to be taken for the immediate arrest of bleeding have naturally to be adopted on the spur of the moment, before detailed examination of the injury, and with the single object of stopping the loss of blood and maintaining the heart's action.

In most instances it will be found that serious bleeding, when it follows a recently inflicted wound, comes chiefly from one or more arteries; and that unless these can readily be arrested by direct pressure of a pad or plug upon their torn or divided ends, they must be secured by some form of ligature tied round their mouth; or some other of the plans of constriction, presently to be described, must be adopted. But in many cases of accidents this is not immediately possible; while in that of vessels being divided or wounded in the course of a surgical operation, it would be often inconvenient; so that it is a frequent practice to cut off the blood-supply from the limb or part of the limb which is concerned by compressing the trunk of the vessel against the bone, or in some similar way.

We will begin then by considering four special means of arrest of arterial hæmorrhage by compression.

I.—ARREST BY DIGITAL COMPRESSION.

The procedure which of all is the simplest, in most cases the most efficient, and the readiest in cases of severe arterial bleeding, is the compression of the trunk vessel with the finger above the seat of the injury, against some neighbouring bone. It is of course only applicable in cases of hæmorrhage in certain places, such as in the limbs, the neck, and some parts of the head and face. Moreover, unless relays of capable assistants can be procured, it cannot, in consequence of the fatigue it produces, be continued for more than ten minutes or a quarter of an hour. Long before that time, however, help may have arrived, or some improvised tourniquet (*vide infra*) may be applied.

The great value of digital compression lies in the fact that it can be applied at once.

With regard to the compression itself, practical experience and an intimate knowledge of anatomy alone will enable the surgeon with

absolute confidence to place his finger on the spot beneath which the artery is beating, and in the performance there are one or two points to attend to.

He should endeavour as far as possible to compress the vessel only. Great pain is caused by bruising large nerves against the bone, and if in pressing the artery he at the same time compress the large venous trunks, or with the hands partially strangle the limb, the venous congestion, and therefore the general bleeding, is increased.*

In compressing we should get the artery fairly against the bone, and press directly upon it. In this way a very moderate amount of pressure will suffice.

Fig. 1.—Position of Hands Compressing an Artery.

The position of the hand and finger to be employed will vary, but as a rule the thumb had better be used to make the pressure (*Fig.* 1), and be reinforced if necessary by that of the other hand. The limb must always be raised.

The Position and Compression of Particular Arteries.—The following directions for the digital compression of particular arteries will serve also for their compression by the various forms of tourniquets, whether improvised or of the regulation patterns.

The Arteries of the Head and Neck.—In cases of injury to the scalp, the underlying skull affords an admirable resisting surface for compression, and in speaking of scalp wounds this will be again referred to; but the compression of a main trunk (such as the temporal or occipital on the head), at a distance from the wound, is not often effectual, in consequence of the extremely free anastomosis existing all over the surface. Nevertheless, in some cases compression of the trunk of one of these vessels may be useful. In such a case they are readily found, and a very slight pressure against the bone with the fingers will suffice.

The Occipital Artery on the scalp at first lies behind the mastoid process, and higher up may be felt pulsating, and may be compressed half an inch behind, and on a level with, its base.

---

*At the same time it may be mentioned that in the case of a child, or a small limb, it is often not a bad plan to grasp the whole limb firmly with one or both hands and strangulate everything completely. It is the middle course which is here the most unsafe.

The Temporal Artery splits up into its main divisions soon after it passes over the zygoma, and should therefore be compressed against that process of bone immediately in front of the tragus of the external ear. Some of its branches may also be felt, and may be compressed higher up on the frontal bone.

The Arteries of the Face, like those of the head, anastomose so freely that the compression of their trunks only incompletely arrests the circulation in their branches. It is, however, frequently necessary to compress either the facial trunk or its coronary branches, as they encircle the mouth. The trunk of the facial artery may be easily found an inch in front of the angle of the jaw, and may be compressed there.

The Coronary Arteries form an exception to the rule of making digital compression against bone, for they are best compressed between the fingers introduced into the mouth, and the thumb on the face. They run round the mouth close beneath the mucous membrane and about a third of an inch from the border of the lips. Their compression is often required in cases of operations or cuts about the lips, and may then be effected between the blades of a pair of bulldog forceps, or by the use of special "harelip" forceps, of which there are one or two patterns.

In the centre of the neck the only artery which ever has to be compressed is the **Common Carotid,** and the operation requires considerable care, in consequence of the proximity of structures which may not themselves be safely pressed on, such as the vagus nerve, jugular vein, or trachea.

The thumb should be placed over the artery at the level of the transverse process of the sixth cervical vertebra, which is about 1½ inches above the sternoclavicular articulation; pressure should then be made *inwards* and backwards. In this way the artery is forced away from the vein and nerve, and is compressed against the transverse process or the "carotid tubercle."

The Third Portion of the Subclavian is the only one which it is possible to compress satisfactorily, and it is here sometimes very difficult, sometimes very easy to occlude.

The bone against which it is to be pressed is the upper surface of the first rib, immediately outside the tubercle for the insertion of the scalenus anticus. In children or thin people, pressure behind the clavicle downwards and *backwards*, at the inner margin of the subclavian triangle, will control the circulation, no matter what the position of the limb and neck may be; but in even moderately fat people it will be necessary to depress the clavicle and shoulder, to bring the artery near enough to the surface. This is usually easy enough to do, but it occasionally happens, in the course of operations about the axilla or shoulder, that the limb is required by the surgeon to be raised, while the assistant in charge of the vessel would prefer that it should be kept depressed. Especially does this happen in amputation at the

shoulder joint, where just at the moment when efficient pressure is most required (i.e., just after the limb has been removed), the clavicle, freed from the downward drag of the arm, rises in the neck in a very exasperating fashion.

Various devices, such as the handle of a door key, properly padded, or a surgical "key" of a somewhat similar form, have been devised to meet the difficulty, and it is sometimes advisable to divide the skin, platysma, and fascia over the triangle, so that the finger may be placed effectually on the artery. This may be readily done by dragging the skin downwards, and dividing it on the clavicle, as in the first stage of the operation for ligature of the subclavian.

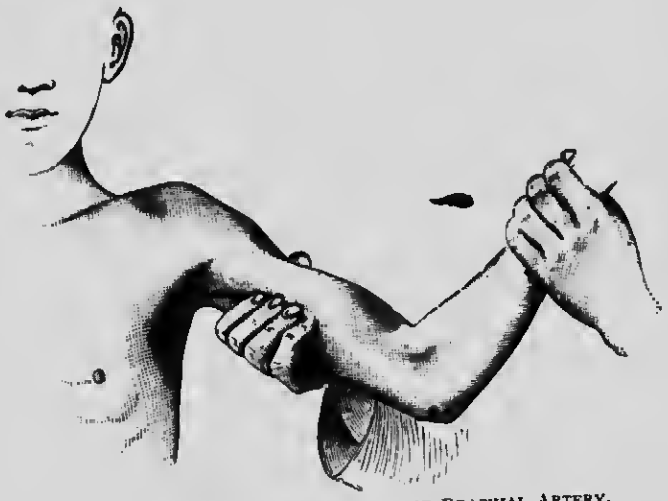


Fig. 2.—Digital Compression of the Brachial Artery.

This incision is sometimes, no doubt, absolutely necessary, but with regard to the use of the key, nothing is so effective a compressor as the thumb, if it be put in the right place. The mistake which is generally made is either making the pressure far too much outwards, near the acromion, or else not sufficiently backwards as well as downwards.

Axillary Artery.—The first portion can hardly be reached for compression except after incision below the clavicle. The lower half of the second, and the third parts, however, are tolerably superficial, and can be compressed in the armpit, if that region be exposed by raising the arm. The pressure is made against the humerus in the same manner as in the following instance, and the vessel can be localized quite easily, as it crosses to the outer side of the axillary space, and then lies amidst the trunks of the brachial plexus, with the coracobrachialis to its outer side.

Brachial Artery.—This artery probably more frequently requires compression than all the others put together, by reason of the great number of accidents to which the upper limb is liable.

It may practically be said to be subcutaneous in its whole length, and may be compressed very readily against the humerus. The inner edge of the biceps, which overlaps it in the middle third, is the guiding line for the vessel.

It is inadvisable to follow the advice given in some text-books, viz., that the inner seam of the coat sleeve is a guide to the brachial artery of the wearer.

The method usually employed is shown in *Fig.* 2.

In flexion, too, of certain of the joints, we have a most valuable means of stopping arterial bleeding.

The positions of the brachial artery at the elbow, of the popliteal behind the knee, and of the femoral at Poupart's ligament, are such that forcible flexion of elbow, knee, or hip joints, combined with placing a firm pad in the hollow of the joint, will, in many cases, completely stop the blood-supply to the limb.

The flexion must be forcible, and may he maintained by fixing the limb with a bandage. An example of its application will be adduced *apropos* of bleeding from the palm of the hand.

At the bend of the elbow the artery may be compressed by the fingers, but not easily, and therefore arrest of hæmorrhage by flexion is preferable.

In the forearm also, except at the wrist, the circulation in the **Radial** and **Ulnar Arteries** can hardly be controlled by any means short of strangulation. At the wrist, however, both arteries become superficial, the radial somewhat more so than the ulnar. The former lies between the tendons of the flexor carpi radialis and the supinator longus, the latter between the radial border of the flexor carpi ulnaris and the flexor sublimis, and here they may be readily compressed. The digital compression of the palmar arches is inconvenient, and the pressure is usually made in other ways. (*See* "Wounds of Palmar Arch," p. 20.)

Abdominal Aorta.—The digital compression of this artery is in some cases not so extremely difficult as is often supposed. It can generally be effected in children unless they are very fat, and in adults if they are thin, have lax abdominal walls and a bold anterior vertebral curve, and in women, especially those who are sparely nourished and have borne children.

The spot where this compression should be made is a point three-quarters of an inch above a line drawn across the abdomen from one iliac spine to the other (the level of the aortic division into the two iliacs), and a little to the left of the middle line. But before pressure is made, the exact position of the artery should be ascertained, for frequently it is in the middle, or may even deviate somewhat to the right.

The digital compression is best and most readily made by the middle and forefinger of one hand, beneath which a small pad of lint should be placed, reinforced by the pressure of the fingers of the other hand. Pressure on the inferior cava trunk must be avoided as much as possible.

Compression of the abdominal aorta is employed by some surgeons during the operation of amputation at the hip-joint. The best method, in our opinion, is that of Macewen. An assistant, standing on a chair, out of the way of the operator, places a pad of lint on the abdomen in the position of the lower part of the abdominal aorta; he then places his hand—or, in a stout subject, his closed fist—on the pad, and, bending down, brings his right knee on to the compressing hand. In this manner sufficient pressure can be brought to bear on the vessel without fatigue, and with due care no harm can result.

Of all the methods devised for the control of hæmorrhage during amputation through the hip-joint this appears to be the most certain. Wyeth's pins are known to slip frequently. Davy's lever has been the cause of such serious injuries that it has fallen into disuse; while even preliminary ligation of the common femoral fails to be quite effective, since it has no control over the gluteal and sciatic vessels.

The actual time during which compression of the abdominal aorta is required cannot be at the outside more than five minutes; and during that period the whole blood-supply to the lower extremity is checked, and if ordinary care be exercised in the compression of the vessel no damage will be done to the viscera: we have seen this method used with the greatest success.

Absence of pulsation in the common femoral will indicate that the compression is sufficient.

Common Femoral Artery.—The compression of this artery as it lies over the arch of the pubes is frequently required. In this situation the circulation may be completely controlled by making pressure directly downwards, i.e., at right angles to the surface, midway between the pubic symphysis and iliac spine.

Care must be taken to avoid pressure on the vein as far as possible; this is best done by putting a small pad of lint underneath the finger. Frequently, however, even when they come through into the thigh, the vein is so far behind the artery that it cannot escape the pressure.

The inguinal glands, too, as they lie parallel with Poupart's ligament, must be avoided, and if they are enlarged, this is sometimes very difficult.

The line of the *Superficial Femoral Artery* is one taken from the point above mentioned, between the symphysis and anterior superior iliac spine, and the adductor tubercle of the femur.

When the knee is slightly flexed, and the thigh rotated outwards, firm pressure all along this line will generally succeed in stopping the current of blood; but as the artery gets deeper in its course, more and more force will be required. The artery cannot be pressed directly against the bone.

Popliteal and Tibial Arteries.—As in the case of the brachial artery at the bend of the elbow, so with the popliteal, digital compression is very inefficient, while the circulation may be readily stopped by flexion. If a firm pad, about the size of a hen's egg, be placed in the hollow of the knee, and the knee be then bent up on it, the circulation will be quite stopped.

By any means short of complete strangulation of the limb, it will not be found possible to compress either the *anterior or posterior tibial* vessels in the legs; but the posterior one becomes quite superficial as it lies a little internal to the middle of the hollow *between the heel and the inner ankle*, going with the nerve beneath the annular ligament, between the common flexor of the toes and the special flexor of the great toe.

The Dorsal Artery of the Foot, the continuation of the anterior tibial, may be felt and compressed against the astragalus, scaphoid, and cuneiform bones, between the extensors of the big toe and of the other toes.

II.—ARREST BY STRANGULATION OF THE LIMB.

Esmarch's Bandage and Tube.—The process, generally known by the name of Esmarch's bloodless method, consists in first of all emptying

Fig. 3.—Esmarch's Bandage and Tube applied.

the limb of its blood by rolling a long indiarubber bandage from below upwards to the spot where it is wished to control the circulation. At this spot a stout indiarubber tube two feet long, with a hook at either end, is passed round the limb, sufficiently tight to strangulate all the vessels, and the ends of the tube are then hooked into each other (*Fig.* 3). The indiarubber bandage is then removed, and the limb, thus rendered bloodless, will remain so until the tube is taken off.

This method is simple enough, and with ordinary care all chance of bleeding is prevented. It is especially useful in such operations as the removal of sequestra, scraping or gouging carious bone, etc., where it is important to have the exposed parts as dry and bloodless as possible; but it will also serve in the place of a tourniquet in amputations, or in other cases where it can be applied at some little distance from the seat of operation.

The strangulation by this method is so complete, veins, arteries, and capillaries being all compressed, that it is not safe to allow the tube to remain on long. Its use therefore is not fitted for the restraint of accidental hæmorrhage, except as a temporary measure, and indeed in some very prolonged operations it is wise to remove the tube before the operation is finished.

When the Esmarch's bandage has been used during an operation, and only general oozing is expected to occur in the wound, it is generally convenient to apply the dressings, using such pressure as may be required, *before* the tube is taken off, for the absolutely bloodless condition of the small vessels causes a temporary loss of tone in their walls, so that when the blood current is allowed to flow into them again, they are for a time much dilated, the whole limb becomes injected, and unless the wound has already been bandaged up, and pressure applied, there may be a very brisk flow of blood, and a corresponding delay in the dressing. This applies only to the smaller vessels; arteries large enough to give trouble should be secured by forceps and ligatured before taking off the tube.

There has been latterly an increasing desire to simplify Esmarch's procedure, and to do away with the indiarubber bandage, while retaining the tube. It is found, if the limb be raised and the larger veins emptied of blood by the passage of the hand along the limb towards the trunk, that the latter may be rendered nearly bloodless, and that the application of the tube alone is able to keep it so.

The limb should simply be raised, before putting on the tube, in cases of septic inflammation or malignant growth, as morbid products may be forced into the blood-stream if pressure be applied over the affected area.

The tubes used for encircling the limb should always be tested before they are used, for they are very liable to crack or break unexpectedly, especially at the ends where the hooks are fastened.

In cases of operation about the shoulder or hip the tube may very usefully be put on in the form of a figure of 8, and in this way even such operations as amputation at the shoulder or hip joints have been rendered almost bloodless. The plan succeeds best where there is much emaciation.

III.—ARREST BY TOURNIQUETS.

A tourniquet is, properly speaking, an apparatus for screwing down a pad upon a vessel. Practically, however, the term is applied to any means by which pressure can be put upon a vessel and mechanically maintained.

The **Improvised Tourniquet** is an efficient and ready improvement on the time-honoured method of stopping bleeding from any part by tying something round it, somewhere between the wound and the heart, tightly enough to strangulate all the tissues.

In the improvised tourniquet special pressure is put upon the main

artery, and therefore the force required is very much less, and the venous return is at least not wholly obstructed.

Its manufacture and application are simple enough. A handkerchief is taken, folded up like a cravat, and a piece of cork or wood, or a pebble, is inserted between folds, so as to act as a pad. This pad is placed over the artery, and the cravat *loosely* knotted round the limb, the knot coming on its outer side (*Fig.* 4). An umbrella, or ruler, or any moderately strong rod or stick, is then passed between the limb and the knot, and twisted round. The leverage thus obtained is

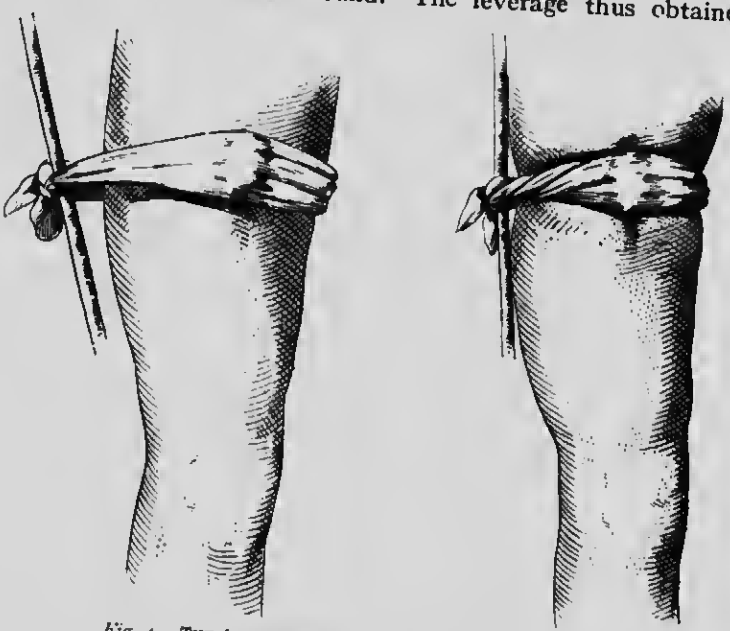


Fig. 4.—The Improvised Tourniquet or "Garrot."

very great, and the amount of compression must be estimated, or it may be afterwards found to have been damaging the tissues. Care should also be taken that the skin is not pinched at the point where the twisting is done.

This form of tourniquet is known also by the names of the "Garrot," or the "Spanish Windlass."

Elastic Tourniquet.—In addition to the elastic band used in Esmarch's method, which has been already described, an improvement has lately been introduced, viz., a small piece of wood with a groove in it, smaller in calibre than the elastic band. After one firm turn has been taken round the limb, the band, while stretched, is passed into the groove from either side. The relaxation and swelling of the indiarubber holds the band quite securely.

If more than one turn round the limb is required, care should be taken that the skin is not pinched between the turns of band. It was partly

to do away with this latter objection that Mr. Pollard introduced a *Flat Rubber* tourniquet, which has the additional advantages that

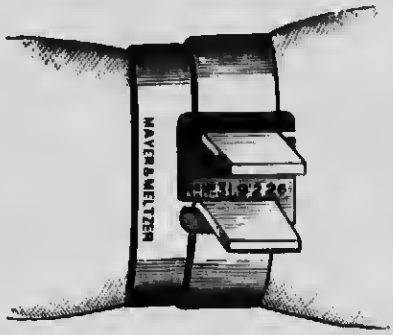


Fig. 5.—Flat Rubber Tourniquet.

it does not constrict the deeper tissues so extensively nor cause any abrasion of the skin (*Fig.* 5).

IV.—ARREST BY LIGATURE OF VESSELS.

It would be difficult to mention an improvement in the art of surgery greater than the introduction of the practice of tying the mouths of vessels. This was introduced and advocated by Ambrose Paré,* to whom the credit of the advance is due, although he admits the idea was suggested to him by some observations of Galen.

There are three principal methods of putting a ligature on a divided artery :—

1. Seizing it, and it only, with a pair of forceps, holding it up and tying a ligature of some kind round its mouth in a reef knot (*Fig.* 6). In catching the vessel it should be taken up as cleanly as possible, with none of the surrounding tissue, and slightly drawn upon. The ligature should then be thrown round the forceps, slipped on to the vessel, and tied tightly in a reef knot ; this will be referred to later.

---

* Paré, when serving as barber-surgeon in the French army in Lombardy, circa 1536, began the practice. In his account he says : "Wherefore I earnestly entreat all Chirurgians that they would (being admonished) give over that cruel and butcherly kind of curation, and practise this which I have prescribed, taught me, as I interpret it, by the suggestion of some good angel. For I neither learned it of my masters, nor of any other man, only I read in Galen, in the first book of his 'Methods,' that to stay a fluxe of blood, there is no remedy so present as to tie up those vessels that bleed, towards their roots, that is towards the liver and the heart. Now I conceived that this doctrine of Galen's for the binding and sewing of veins and arteries in fresh wounds might well be used in the like vessels after a dismembering, and so I put it in practice."

2. Passing a sharp curved needle in a handle, called a tenaculum, beneath the vessel as it lies in the tissues, and then, after raising up the vessel and its surroundings, putting a ligature around all, below the needle, which is itself withdrawn after the knot has been tightly tied.

3. A third way (*Filo-pressure*) consists in passing an eyed tenaculum beneath the vessel near its open mouth. The needle may be threaded, before or after it is passed, with a catgut or silk ligature, which may then readily be tied over the vessel and the small amount of tissue which will be included in the noose, as shown in *Fig. 7*. These two latter methods are very serviceable in bleeding from scalp wounds, where the relation of the vessels to the tough tissue of the scalp renders simple ligation a matter of difficulty.

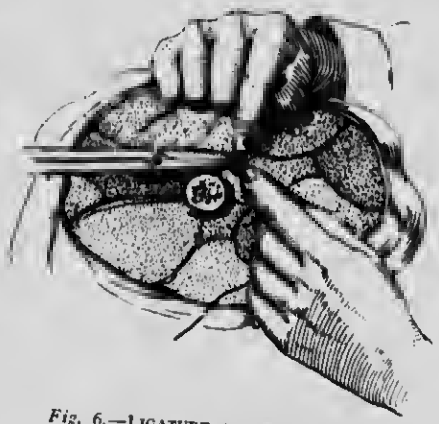


Fig. 6.—Ligature of an Artery (Position of Hands).

Forci-pressure.—This name more especially designates the use of a pattern of self-closing forceps suggested by Sir Spencer Wells, for the purpose of checking temporarily the bleeding from small arteries and arterioles in the course of an operation. Of recent years many modifications have been suggested. Lawson Tait brought in the use of

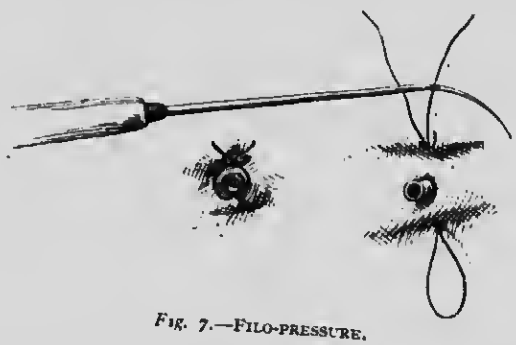


Fig. 7.—Filo-pressure.

sharp-pointed forceps, by which the accidental inclusion of the blades by the ligature is more readily avoided; while Greig Smith introduced the plan of making the teeth run parallel to the outside of the blades, by which he claimed greater holding power, and less liability to slip.

In spite of these claims, however, the pattern which goes by the name of its inventor, Spencer Wells (*Fig.* 8), is in almost universal use. Not only may these instruments be used to check bleeding from small vessels during the course of an operation, but in the case of arterioles the pressure exerted is usually sufficient to prevent any further bleeding, without the necessity for the application of a ligature. Again, the method of *Torsion* may be applied by means of these forceps, which have therefore superseded a special form of torsion forceps at one time employed solely for this purpose ; and, lastly, they are sufficiently powerful to be of use in seizing a large trunk vessel during an amputation, the vessel being secured with a ligature after the limb has been removed.

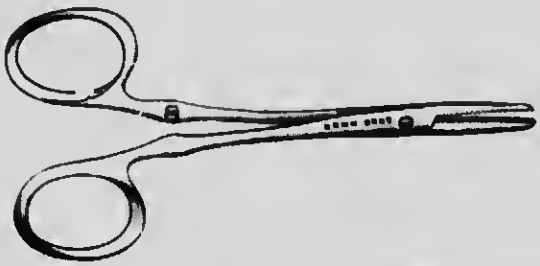


Fig. 8.—Spencer Wells' Forceps.

Torsion.—In machinery accidents, where a limb has been very badly injured, or, it may be, completely torn from the body, it generally happens that there is little or no bleeding from the large arteries divided across ; and if these are examined they may often be seen pulsating quite down to their extremities, which yet are as firmly closed as if they were ligatured.

The explanation is that the vessels have been *pulled* asunder, and tbat in this pulling, the two inner coats have first parted, while the external coat has only yielded after considerable extension. The aperture of the tube is therefore narrowed before it finally gives way and the vessel comes in two. The outer coat afterwards retains its narrowed condition, and the elastic ones inside retract. These inner coats therefore will be thickened to such an extent that their sides will come into contact within the narrowed outer coat of the vessel, and will effectually close it up.

These properties possessed by the coats of the vessels were first applied to their artificial closure when divided by Amussat in 1829, and soon afterwards by Velpeau, since whose time it has been known as the method by " Torsion."

In this proceeding the vessel is not pulled asunder, but the end is *twisted round* many times. The inner and middle coats are thus broken across, and by retracting become thicker, as above described.

The narrowing of the outer coat of the vessel is effected by the continuous twisting. The value of this method of arresting hæmorrhage is now well established.

For small vessels it is only necessary to seize the vessel fairly with "torsion forceps," and rapidly to twist the end round and round six or eight times.

Limited Torsion.—For large vessels the operation requires more care. The vessel should first be separated from its sheath and pulled out of it for about one-third of an inch. At the point of its exit from the sheath it should be held with a pair of narrow forceps, and then, its end being held in the torsion forceps so as to leave as much as possible of the artery free for twisting, this should be quickly done, the forceps being held parallel to the long axis of the vessel.

Some surgeons twist the vessel until the part in the forceps comes away; others give six or eight turns only, probably the preferable plan.

For this treatment to succeed, *the arterial coats must be free from disease*, such as atheroma, or those more insidious forms of arteritis present in chronic syphilis or gout. When first introduced in the days of the old silk ligature, the advantage of having no foreign body hanging out of the wound was very great; nowadays the twisted end of the vessel is in just the position of a catgut ligature cut short: both, in healthy wounds, will be absorbed, and neither can be regarded strictly as foreign.

The Materials used in Ligation are silk, hemp, catgut, and some other animal materials, as kangaroo tendon, or ox aorta. At the present time silk, catgut, and kangaroo tendon alone need to be considered.

Silk was in former times the most esteemed as being the easiest of application, and is still extensively used: most commonly, the variety known as Chinese twist It is made in several sizes, but those most frequently employed are the ½, 2, 4, and 6.

The preparation of silk should be as follows:—

1. Placed in ether for twelve hours.
2. Placed in alcohol for twelve hours.
3. Boiled for ten minutes in 1–1000 colourless neutral solution of corrosive sublimate.
4. Wound with clean hands round spools.
5. Spools boiled in 1–1000 sublimate solution for ten minutes just before operation.
6. Ligatures are then handed out of the sublimate solution in which they were last boiled (*Kocher*).

Catgut and *Kangaroo Tendon* are rendered sterile in the following way: Several pieces of the required length are placed in a bottle with pure oil of juniper berries, taking care that they are completely covered. In this they are left for twenty-four hours, the bottle being well corked; when removed they are put into 95 per cent alcohol, in which they can

be kept till required. It is as well, however, to keep constantly supplying fresh lengths rather than to make a large quantity at a time (*Kocher*).

Von Bergmann recommends the following method of preparation. Soak the gut in ether for twenty-four hours to remove the fat, and then in a solution composed of corrosive sublimate 10, absolute alcohol 800, distilled water 200. Renew this at the end of twenty-four hours, and again in forty-eight. The gut is kept in alcohol if it is required stiff; 20 per cent of glycerin is added if a softer variety is wanted.

Probably the most satisfactory way of preparing catgut is by the xylol method recommended by Mayo Robson, or the more modern formalin method.

Xylol Catgut.—Raw catgut is placed in xylol in a metal box with a screw cap—Mayo Robson's cylinder. The cylinder is screwed up tightly, and then put into boiling water for thirty minutes. The cylinder is unscrewed, and the catgut placed in 5 per cent phenol in spirit. Catgut so prepared is sterile, but is very soft.

Formalin Catgut.—Raw catgut is soaked in ether for twenty-four hours, and then in 5 per cent formalin for a like period. It can now be boiled in water for ten minutes, and after the boiling is kept in 5 per cent phenol in spirit.

Iodine Catgut is now largely employed. It is prepared as follows. Take raw commercial catgut, wash in ether for twenty-four hours to remove fat. Then wind on glass plates and place in solution made up as follows:—

Potassium Iodide	1 part	Water	100 parts
Iodine	1 part		

Keep the catgut for eight days in the solution before use, and prepare only small quantities at a time, as it gets brittle if kept too long.

KNOTS.

Among the smaller but necessary accomplishments of the complete surgeon must be reckoned the art making a "**Reef,**" "**Bow,**" or "**Slip-knot,**" or "**Clove-hitch,**" neatly, quickly, and firmly. The importance of this need not be insisted on, for in surgery very literally and very often it happens that life hangs on a thread, and the results may be disastrous if this be insecure. But we believe that to describe in words the actual movements of the fingers in making these knots would be only waste of time; it is a knowledge which each student must acquire for himself by practice after he has been shown how to do it.

Fig. 9 shows a cord tied in (I) a *Reef-knot*; (II) a *Granny*; (III) a *Clove-hitch*, which in the left is half made, and in the right is shown completed, by placing the loop *a* in front of loop *b*; (IV) *Surgeon's knot*. Where firmness is wanted, as for the ligature of a vessel, and

for all ordinary purposes of knotting, the *Reef* is the one for surgeons to use—the *Granny*, never—and the dresser must go on practising the manœuvres until his fingers acquire a perfect automatic skill, so that he never has to think of their individual movements. The *Clove-hitch* is very useful when a pull upon any part is required; as, for example, in dislocations of the shoulder, when a jack towel is fastened by this knot round the arm. Its great advantage is that it gets firmer the more it is pulled upon, yet it can be loosened in a moment. Moreover it has no tendency to slip. There are one or two ways of making it, all practically coming to the same thing, but the main idea and purpose of the knot can be gathered from the figure.

Neither time nor space need be wasted in discussing the virtues of the bow or half-bow; other knots well known to sailors or builders, as the carrick bend, bowline, weavers' knot, etc., are not used in surgery, but what is known as the **"Staffordshire Knot"** is a very

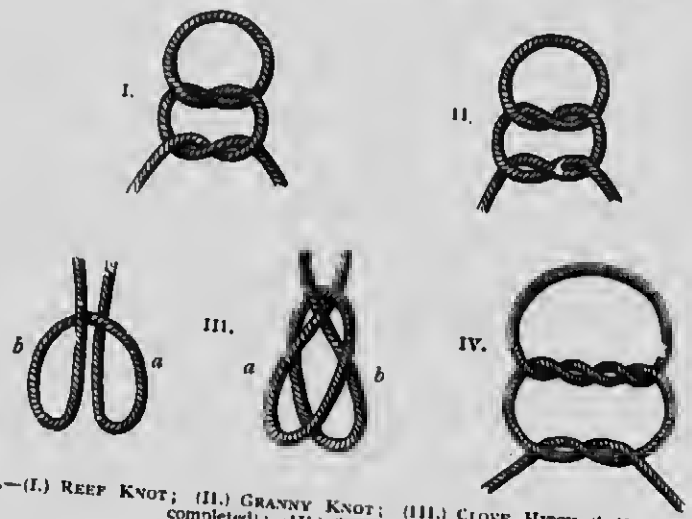


Fig. 9.—(I.) REEF KNOT; (II.) GRANNY KNOT; (III.) CLOVE HITCH (half made, and completed); (IV.) SURGEON'S KNOT.

useful one for securing the cut end of a vascular pedicle by transfixing it with a double-threaded needle on a handle, and slipping the loop over the stump down to the entrance of the threads into it (the needle having been withdrawn). One of these entering threads passes over and the other remains under the loop, so that they can be tightened, one first and then the other, and lastly must be tied in a reef knot, so that both halves of the stump are simultaneously but separately constricted by the single string and knot (*Fig.* 10).

In Tying any Artery the following rules are to be followed:—

1. The artery is to be cleaned carefully and with as little damage to the walls of the vessel as possible, since, if the artery is stripped too

freely from the surrounding sheath, healing will not take place so readily, and hæmorrhage may occur. For this reason it is better, when using an aneurysm needle, to pass it unthreaded round the vessel, to thread it, and then withdraw it.

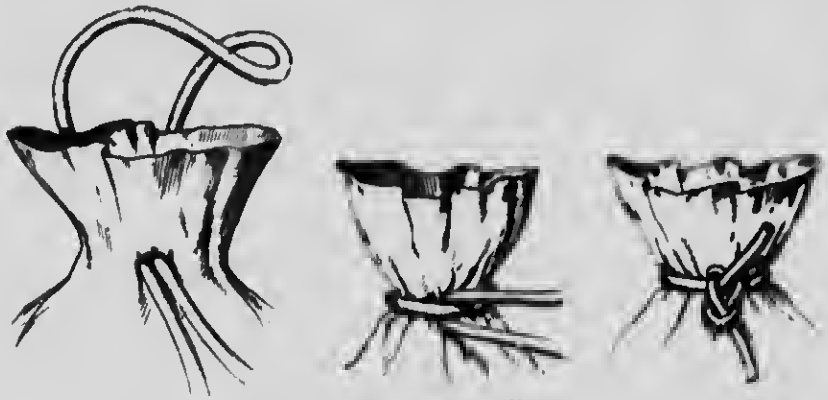


Fig. 10.—Staffordshire Knot.

2. If the artery is tied in "continuity," a moderately stout ligature should be used, and in the case of large arteries the ligature should be tied so that the lumen of the vessel is obliterated without rupture of the inner and middle coats.

The modern method of ligaturing the vessel in two places, and dividing it between these points, in order to put an end to the "anatomical tension" of the vessel, must be employed with caution. Unless the ligatures are very carefully applied they may slip, and if this accident occurs in a deep wound, there may be great difficulty in securing the vessel.

3. A surgeon's knot should be used, the double turn preventing the ligature from slipping before the knot is completed.

Chapter III.

Of Certain Special Kinds of Hæmorrhage and their Arrest.

Capillary hæmorrhage is rarely serious; occasionally when inflamed and highly vascular tissues are divided there may be a furious rush of blood from the congested vessels. Free irrigation with a weak antiseptic or the proper application of pressure is nearly always sufficient to bring about its arrest. In some rare cases special measures will have to be adopted (see "Hæmophilia").

Hæmorrhage from an Imperfectly Divided Vessel.—If this form of bleeding be not efficiently arrested it is always troublesome, and sometimes even dangerous. It most commonly occurs on the scalp, or from a wound in the cleft between two fingers, or from the artery of the frænum. Again, when the transfixion method of amputation was more common than it is now, the vessels were apt to be split, instead of being cleanly divided by the knife. This was a frequent cause of secondary hæmorrhage.

The bleeding is obstinate, because the process of its natural arrest is interfered with; for the cut edges of the wound in the arterial coats retract as far as they can, and this retraction keeps open the orifice in the vessel, instead of tending to close it. The tube thus being only half cut across cannot retract its ends within the sheath as it is wont to do when completely severed.

In all cases the thing to do is to enable the natural arrest to go on by completely dividing the vessel. In the case of an *imperfect division of a digital artery* between the fingers, the bleeding is sometimes very troublesome. In such a case the vessel should be cut down upon and carefully exposed without injury to the neighbouring nerve trunks. A ligature should be placed above and below the wound in the vessel, and then it should be divided. An Esmarch band previously applied will make the dissection more easy; the dressing should be put on, and the fingers tied together, before the indiarubber band is removed.

The Artery of the Frænum of the penis is sometimes ruptured during coitus. If it be torn right across, the bleeding is slight, but if only half divided it is sometimes very profuse. In this case all that is necessary is to divide it completely with a pair of scissors, and then to apply moderate pressure.

Wounds of the Scalp often bleed very freely, especially at first. In dressing them the hair should be cut off all round the wound, which

itself should be well washed. Even if the spouting vessels are plainly to be seen, it is almost always waste of time to try and pick them up for the purpose of ligature. A good firm compress, secured with a knotted bandage, will, by ensuring pressure against the underlying bone, arrest any ordinary hæmorrhage.

Wounds of the Palmar Arch are very troublesome, and the bleeding from them is very apt to recur. This is due partly to the intimate anastomoses of the arteries, and partly to the difficulty of applying efficient pressure, the vessels themselves lying beneath, and protected by, the thick bands of the palmar fascia.

Although it is difficult to apply pressure, in most cases it is necessary to do so, for other means would tend to cripple the mechanism of the muscles and tendons of the palm. Sometimes, no doubt, it is advisable to dissect out the bleeding vessel in this crowded region and put a ligature on it, but as a rule the hazards of this proceeding outweigh its obvious advantages.

In applying pressure to the palm of the hand, a firm smooth pad must be used, and the palmar fascia must be relaxed. These two conditions are well fulfilled by bending the fingers over a round piece of wood, like a ruler, covered with three or four layers of lint, or over a tight roller bandage. If this be firmly grasped, and the fingers bandaged over the cylinder, very good pressure will be made (*Fig.* 11). As an alternative the *graduated compress* may be tried. This is effected by cutting a series of pads of lint of similar form but diminishing in size (the smallest, about the size of a shilling, applied directly to the wound), placed one on top of the other until a flat-topped pyramid of lint is made with its apex towards the bleeding point. Over this the fingers are flexed and bandaged firmly. Should the bleeding still continue, the forearm should be forcibly flexed at the elbow, with or without the addition of a pad of lint in the flexure of the joint. This will almost always stop the bleeding, but should it fail (and it is wonderful how this form of bleeding will persist) it will be necessary to compress the radial and ulnar arteries at the wrist. This is best done by laying two pieces of wood, e.g., portions of a lead pencil, over two small pads placed on the arteries, and fastening them firmly with strapping, the hand, forearm, and arm being firmly bandaged from below upwards.

Fig. 11.—THE HAND BANDAGED FOR A CUT IN THE PALM.

But it may happen that even yet the bleeding recurs, and by this

time, as several expedients have been fruitlessly adopted, the patient may be getting exhausted by loss of blood. A tourniquet or digital compression of the brachial artery can be adopted as a temporary expedient at any stage of the proceedings; but this cannot be kept on for long, especially in this exsanguine condition of the patient.

On the whole the best plan seems to be, first of all to open up and thoroughly examine the wound, and if it appears feasible by dissection to find and tie the bleeding vessel or vessels, and failing this to tie the brachial artery high up in the arm—a somewhat desperate remedy truly, and one which can very rarely he required if the milder measures before mentioned have been thoroughly carried out.

It should be borne in mind that the tourniquet can always be put on for an hour or two, so that the visiting surgeon can be sent for; and also that bleeding so obstinate as this may probably be associated with a morbid condition of the blood or its vessels. (*Vide* "Bleeders," *infra*.)

In cases of hæmorrhage from sloughing wounds of the palm, *no attempt must be made to apply compression*. No treatment is worse than the application of pressure to an inflamed and sloughing surface. Sloughing cavities are to be *lightly* packed with antiseptic gauze, but no pressure is to be exerted, or the sloughing will extend.

In these cases, the wound must be opened up, and a search made for the bleeding point; sloughs must be cut away, and the whole wound cleansed with peroxide of hydrogen. If the attempt to secure the vessel fails, the choice will be between trying compression of the radial and ulnar arteries with flexion at the elbow, and ligaturing the brachial. When the bleeding is profuse it will be wise to perform the latter operation.

Hæmorrhage from Canalized Vessels.—Either veins or arteries may be so connected with the surrounding tissues that, when divided, their walls neither contract nor retract. Their mouths are thus kept open, and they are said to be *canalized*.

Thus the jugular and other veins at the base of the triangles of the neck are so bound down by the cervical fascia, that if they are divided, and especially if divided in the angle of a wound, they gape and bleed. This is especially dangerous in this situation, not from the hæmorrhage, but from the *danger of entry of air into the blood current* going right to the heart.

But canalized vessels may give trouble in other situations besides the root of the neck, especially at the angle of a wound held open by its gaping in tissues which are the seat of fibrous thickening or chronic inflammation, or when vessels, themselves atheromatous, are inelastic and rigid.

For vessels at the *Angle of a Wound* the best way is to extend it slightly, when they will retract. But those running through *Tissues, the seat of chronic inflammation*, are often troublesome, as in amputations for long-standing disease, when almost every vessel, insignificant

though its size may be, requires a ligature, because it will not retract.

This also is the case with *Atheromatous Arteries*, but there is this additional difficulty, that because of the disease of the arterial walls, a ligature is very apt to cut through them, so that great care and well softened ligatures will be required.

Venous Bleeding.—For ordinary venous bleeding the first thing to see to is that there is nothing hindering the return of blood to the heart, next to remember that almost all venous bleeding will cease on raising the limb, and thirdly to bear in mind that pressure will always effectually stop the flow of blood, if it be applied to *the wound itself*.

Bleeding from a burst Varicose Vein is often one of the most furious, and yet one of the most easily arrested of hæmorrhages. It is important rightly to understand it, for many lives are thrown away every year in consequence of the foolish, unreasoning conduct of would-be assistants, when this accident happens.

No one can be long in a hospital casualty department without seeing some such case as the following: A man who for a long time has had varicose veins, and subsequently a condition of chronic eczema and ulceration of the legs, stupefied by cold or drink, subjects the legs to some slight violence, so slight that often it is hardly noticed. Presently he is aroused by the sensation of something warm trickling down the ankle, and looking down he sees his boot and stocking full of blood, which is coming from the position of the ulcer. He then becomes faint and falls. A crowd collects, and (the prone position on the ground being the safest for him) he is immediately lifted and made to sit up. The bystanders then get some brandy, and proceed carefully to choke him while he is unable to swallow. Someone then sees the blood trickling along the floor or ground, and taking his handkerchief ties it tightly somewhere round the leg, which is still allowed to hang down. The patient being then put into a cab, is driven off to the hospital, perhaps to die before he gets there, as the blood is escaping from his leg all the time.

All this might have been easily avoided by the exercise of common sense. Since the recumbent position is the best for syncope, the patient should not be raised from the ground until a suitable stretcher is provided. Then, the leg being raised a foot or so, the bleeding surface should be exposed, and any constriction round the limb on the "heart" side removed. In all probability the bleeding will practically cease immediately the limb is raised, and a small pad and bandage being placed on the wound, it will not recur while the patient is lying down.

It should be remembered that the blood comes principally from the *proximal* end of the ruptured vein, the valves of which have been rendered incompetent by the dilatation.

If, however, the patient *must* walk soon after he has had a hurst vein, the leg and foot should be firmly bandaged from the toes upwards, to

a little above the bleeding point, on which there must have first been placed a pad and bandage. It is also necessary to keep the patient warm; the loss of blood is often very great, and such patients cannot bear it well, so that it sometimes happens that after the bleeding has been stopped, they get a sudden failure of the heart's action, and die because they have been allowed to get too cold.

Hæmorrhage from Deep Wounds or Cavities.—Owing to the inaccessibility of the vessels which feed the part, digital pressure may be impossible, and we must then have recourse to pressure applied in other ways. This form of pressure is usually called "*plugging*," and is a very important part of surgical treatment. Plugging to be effective must be carefully applied; harm can only come of tying up a wound in a half-hearted way, laying on covering after covering with the idea of hiding the danger rather than of mastering it. On the other hand, a furious rush of blood, such as may come from the depths of a ruptured liver, a wounded artery, or from a torn sinus in the skull, may be controlled for a time by firm and judicious plugging of the wound, followed hy pressure over it. Gauze is the material most generally employed for this purpose, and it must be carefully packed with a director or forceps into the very depths of the wound, so that pressure is exerted either on the main vessel, or at least on the actual hleeding points. Later, if necessary, as in the case of a wounded artery, measures may be taken to deal with the injured vessel by ligation. *Care must be taken that the deeper parts of the wound are plugged, as well as the superficial.* The wound when plugged requires a firm compress bandage to support it.

How Long should Plugs or Pads remain Untouched? — This will largely depend upon the locality in which they are employed. In the case of the rectum it has been advised to leave the plugs untouched for a week or so. It must, however, be remembered that there is a tendency for all plugs to become impregnated with organisms after a very short time, and a plug inserted under what appear to be the most perfect surgical conditions becomes abominably offensive at the end of twenty-four or forty-eight hours. This is most undesirable; and the tendency in modern surgery is to change the plugs in twenty-four to forty-eight hours in nearly all cases where they have been used to check hæmorrhage. In most instances the hæmorrhage will have been checked, and a light plugging can replace the original; but should bleeding recur, it will be necessary to reinsert a firm plug, and again change it in forty-eight hours. In plugging cavities it is very essential to see that the material used goes to the very bottom of the cavity, otherwise the hæmorrhage may continue beneath the compress, and cause considerable destruction of the surrounding tissues. All cavities which have been treated in this way must he allowed to heal slowly by granulation.

Nose Bleeding is either idiopathic or traumatic, and is venous or capillary in character. It is of all kinds and degrees of severity, and

may require for its arrest a number of expedients, some very simple, some requiring considerable skill.

But it is *often desirable not to check the bleeding* at all, as when it occurs in children in good health, and young adults of a lusty habit; or in some cases in young women in whom the hæmorrhage is vicarious to the menstrual flow.

Idiopathic Epistaxis may be roughly divided into two classes: the one in which it depends on simple congestion of the mucous membrane of the nose, occurring in healthy people, and the other in which it is a strictly passive congestion, caused by cardiac or hepatic disease.

The hæmorrhage in the first class tends to stop of itself, when the congestion is removed by the bleeding; but in the second the cause is constant, and the longer the epistaxis goes on, the more difficult it is to stop, in consequence of degenerative changes taking place in the blood. The bleeding in these cases is not a brisk flow accompanied by a good pulse and other signs of a strong circulation, but is rather a feeble dribbling, sometimes stopping altogether, and then being again a little more rapid. In this way a great deal of blood may be lost by those who cannot spare it, and the bleeding, instead of being a relief, is accompanied by great depression, a feeble fluttering pulse, shallow respiration, etc.

A little experience of the aspect of sick people will enable the student to recognize those who are suffering from visceral disease, whether it be morbus cordis, or cirrhosis of the liver, or chronic Bright's disease, or a malignant growth, and to separate sharply in his own mind those in whom moderate epistaxis is rather a relief, from those in whom it is certainly an alarming symptom, and may be a source of danger. In these latter it should always be promptly checked; in the former, delay is never hurtful, and may be useful. It must be remembered that epistaxis is often caused by a new growth of the nasal fossæ or the parts around them, and a careful examination of the nares is essential in most cases, with a view both to diagnosis and treatment. In children, a foreign body, such as a pea or a piece of cinder, may be the starting-point of a mucopurulent discharge, and this is sometimes masked by a smart attack of epistaxis from the ulcerated mucous membrane.

In cases of epistaxis in children, bear in mind the possibility of a foreign body being present.

The patient should be made to sit up with the head thrown back, a towel being spread like a bib around the neck to prevent soiling of the clothes. Frequent blowing of the nose must be prevented, as it only tends to aggravate the bleeding. If in addition to this position the venous return to the chest be promoted by loosening all the clothes round the neck, and in women by unlacing the stays, the bleeding will in most cases cease; at the same time, if it persists, raising the arms above the head so as to lower the intrathoracic pressure will most likely prove effective.

The application of cold, either externally to the nape of the neck and the bridge of the nose, or internally in the form of an iced nasal douche, may be tried if the above measures fail.

Cautery.—But while all these devices have the value of being readily applied and of a domestic nature, it is unwise in any given case to persist with them when a short trial has failed. In the majority of cases the bleeding comes from a small spot on the septum within a short distance from the anterior nares, called "Kiesselbach's spot," or from a hypertrophied, turgid, inferior turbinate bone. Both these points are easy of access, and it is often the simplest matter to touch the bleeding point with a cautery and stop the hæmorrhage entirely. For this purpose it is well to insert a plug of cotton-wool soaked in 10 per cent solution of cocaine and adrenalin into each nostril, and to leave it *in situ* for five minutes; although the bleeding may continue (in some cases the application of the adrenalin is sufficient to check the hæmorrhage), the cocaine, which is a vasoconstrictor, is beneficial, and will anæsthetize the part sufficiently to enable the operator to apply the cautery without pain. The nasal speculum is now inserted into the nostril, and by means of a reflected light the bleeding point may be seen; some small swabs of cotton-wool should be prepared to mop up the blood and so clear the field. If there are a large number of clots, the nares should be well washed out by means of a nasal douche. When the bleeding vessel is seen, the cautery at a dull red heat is pressed against it for several seconds, and if the operator has not got an electric cautery at hand, a probe heated in a spirit lamp will be quite as satisfactory.

No method is at once so thorough and certain as the above, for it not only enables the operator to deal with the actual bleeding point directly, one of the first axioms in the treatment of hæmorrhage, but it enables him at the same time to inspect the anterior nares and so detect other conditions which may give rise to hæmorrhage.

Styptics.—Very little will be said on this subject, since they have nearly disappeared from modern surgery: they are messy, unpleasant, and uncertain. If for any reason the above treatment cannot be applied, then a plug of lint soaked in adrenalin chloride 1–5000 should be inserted into the nostril and pushed well back; this styptic is probably the least unpleasant of those recommended, but although it is now easily obtainable its action is not as certain as that of the cautery.

Plugging.—In cases of continued failure—and they will not be numerous—we fall back on the last resource of plugging the bleeding nostril. This may be done from the front; the method of plugging the posterior nares is unsatisfactory and unsafe.

Plugging from the Front.—To plug from the front, a strip of lint or gauze 18 inches long and a third to half an inch wide, and a stiff director are required. The strip must be packed right on to the bleeding point. Under no circumstances must small detached pieces

be used, as they may be pushed back out of reach and cause considerable trouble; a long end of the plug must always be left outside the nostril to facilitate its removal. This removal is aided by syringing at the end of twenty-four hours with some weak antiseptic, such as peroxide of hydrogen, so as to moisten the plug. It *may* be left in longer, but this is rarely advisable, since the plug frequently becomes exceedingly offensive.

Special forms of Epistaxis.—Two forms are not very uncommon in medical practice. The first is a rather brisk attack, and comes on at a critical phase of some *Acute Fever*, such as pneumonia. In such an illness it not infrequently happens that about the sixth day an attack of epistaxis comes on, and coincidently the temperature falls, the pulse slows, and other symptoms of defervescence are manifested. This epistaxis may truly be called "critical," and may be compared with the profuse sweating or diarrhœa which often heralds a crisis.

The necessity for checking this bleeding will vary in each case, and no general rules can usefully be laid down. At first at all events, it does not call for active measures. The condition of the pulse will be the best guide as to when such interference is required.

In Exhaustion.—The second form resembles the first, in that it occurs in the course of a severe illness, but in this point only, for it is a sign of a well-nigh hopeless condition. It is due to a general breaking down of capillaries, as in purpura. It is associated with bleeding from the gums, the formation of bullæ containing blood-stained serum, and with ecchymoses. It seldom calls for any special treatment.

Bleeding from the Socket of an Extracted Tooth—This occurs very rarely indeed to any troublesome extent, considering the enormous number of extractions performed. When it does happen, it is almost always in patients who are either in very feeble health, or else who are affected with some form of the hæmorrhagic diathesis, or scurvy.

Sometimes, indeed pretty frequently, the socket of the tooth goes on bleeding for some hours, in consequence of the nutrient vessel being unusually large or unable to contract. In such a case, the bleeding comes from one or two points, and it is not at all dangerous. In the really serious cases, from the whole gum and lining of the socket there appears a general welling up of blood, and this is sometimes hard to check. An "alveolar tourniquet" has been invented for the purpose, but it is now hardly ever used, and reliance is placed on conscientious plugging and the actual cautery.

Plugging the Socket.—Lint or cotton wool is generally used, either plain, or dipped in some styptic, such as turpentine, carbolic acid, creosote, alum, or adrenalin. In any case it must be packed away very firmly indeed, filling the whole socket, and a little more, so that the plug may be kept in proper position by the opposite tooth, if the jaws be closed with a four-tailed bandage.

A method which we have never known to fail was suggested to us by Sir A. E. Wright. It consists of filling the cavity in the gum with

a mixture of formalin and gelatin. If the latter be used alone, it is soon washed away by the stream of blood, but the combination of formalin and gelatin forms a solid mass which is excellent for this purpose. Gelatin is a valuable styptic, clean and pleasant, but care must always be taken to obtain a pure sterilized specimen. This warning is a very necessary one, since ordinary commercial gelatin often contains the spores of the *B. tetani*, and many cases have been recorded where the application of gelatin has led to the development of tetanus. It is now, however, possible to obtain without difficulty a sample of bacteriologically sterile gelatin, and this can be used without fear.

For the purpose of checking hæmorrhage from a tooth socket the procedure is as follows: Place a test tube containing the gelatin in a bowl of water sufficiently warm to melt the gelatin. Care must be taken that the water is not too hot, for, if overheated, gelatin loses its power of solidifying when cooled. When the contents of the tube are fairly fluid, add to them $\frac{1}{20}$ part of pure formalin, i.e., if the test tube contains 40 c.c. gelatin, add 2 c.c. formalin. Shake the tube so that the two mix. Now, with the patient's mouth wide open, sponge away the blood with gauze or wool pledgets until the socket is fairly dry, and then, soaking a thin strip of gauze in the mixture in the test tube, press it well home to the bottom of the cavity. Keep it thus for one or two minutes, withdraw it, and pour in the mixture of gelatin and formalin, which is now nearly solid. A little care will enable the operator to fill the whole socket with this valuable styptic, which soon solidifies.

Hæmorrhage from the Rectum.—The bleeding *from parts inside the Rectum* which can be seen, or felt with the finger, may here be considered. It may be due to simple congestion of the mucous membrane, piles, fissure, prolapsus ani, the passage of some hard body, ulceration of the surface of a growth (usually malignant), or dysentery; or it may be the result of the division of some vessel or vessels in the course of an operation. Hæmorrhage from the rectum is often caused by lesions some distance up the bowel from the anus, and the reader is advised to familiarize himself with the various forms of rectal specula and the sigmoidoscope, which will be referred to later.

Hæmorrhage from Simple Congestion.—This occurs in consequence of the turgidity of hæmorrhoidal plexuses, which is in its turn due to obstruction to the portal circulation. The portal obstruction may take place in the liver itself, and may be due to temporary or permanent changes there, or in the lungs or heart.

As in the case of epistaxis, bleeding from this source is often a great relief to the circulation, and is sometimes imitated by the application of leeches to the anus. It hardly ever requires treatment, unless it be desirable to increase the flow, which may be done by sitting in a bath or tub of warm water. Usually the bleeding stops immediately the congestion is relieved, but if it be desirable to arrest it, an enema of

thin starch, with 20 to 30 minims of laudanum in it, or an injection of cold water, or the following :—

R Calcium Chloride ℥iiss | Water ℥ iiiss
Inject five drachms into the rectum by means of a small syringe.

Piles must be looked upon as being due to an extension of the same morbid processes which cause simple congestion of the mucous membrane. Only those which are covered entirely or partially with mucous membrane (internal piles) ever become so turgid with blood as to bleed. These, however, may do so very profusely, and even dangerously. The bleeding usually occurs when the patient is on the stool, and up to a certain point may relieve the portal circulation. It not infrequently, however, becomes necessary to arrest it without loss of time, for it belongs to that form of hæmorrhage which manifests itself as frequently recurring losses of blood, no one of which is of consequence, but which, collectively, are very important. *The preventive Treatment must be both Local and Constitutional.* The bowels should not be allowed to become confined, but the motions kept pulpy by early morning doses of the confection of senna, or the confection of sulphur, or of some saline aperient. Very careful dieting and a recumbent position are advisable, with warm light clothing, and in women the removal of stays or anything which compresses the body. Cane chairs, too, are better than upholstered ones.

Locally, the piles must be returned at once when they come down, and the opportunity may be taken to smear them over with the ointment of hamamelis (P.B.). A *continuous douche* of cold water from an enema syringe is very useful, as also are astringent injections of iron or alum. Another very commonly used injection is made by dissolving a drachm of alum in a pint of the decoction of oak bark, or the solution of chloride of calcium may be used.

If on the other hand the bleeding is important from the actual quantity which is being lost at the time, it will not be found difficult to stop. An ordinary astringent injection should be tried first. If it fails, the rectum should be cleared out by a thorough syringing of ice-cold water, and then a suitable lump or two of *Ice* may be introduced, and pushed tolerably high up, the patient lying in bed lightly covered and with the buttocks raised on a pillow. This treatment hardly ever fails to arrest the bleeding, but if it should continue, recourse must be had to *Plugging*. This may be done with sponges, or with the "petticoated plug" (as will be described directly). Again, if the patient be in a fairly good condition for operation, the hæmorrhage may be stopped and the pile cured by an operation for its removal—that one being chosen which gives the least shock.

The Mucous Membrane of the Anus, partially strangulated as it is when prolapsed, frequently bleeds. This, however, readily stops by returning the prolapse, and syringing the part well with cold water, or with alum and oak-bark lotion.

The Passage of something hard, or rough, or pointed, such as a cherry stone or a fish bone, is often enough not attended by any trouble until the rectum is reached, and then, in consequence apparently of the greater expulsive force employed, the mucous membrane becomes torn or scratched, and bleeding occurs. This is very frequent in children, and is easily checked by injecting a little cold water up the rectum. Although the bleeding is of little moment, there is good reason for holding that fish bones or splinters do sometimes, by burrowing, or being forced out of the rectum, cause fistulæ.

The ulceration of a *Growth within the Rectum* is generally associated sooner or later with serious hæmorrhage. These tumours are usually malignant, and in the later stages of their growth, the constant drain, by repeated bleedings, may be the immediate cause of death. The principles of treatment must be the same as for internal piles, with the addition that the effect of preparations of opium, as local applications, is often very striking.

The restraint of hæmorrhage from *Dysenteric Ulceration* of the rectum hardly comes within the province of the surgeon's work; but inasmuch as the locality of the bleeding may be the same as that of losses of blood requiring treatment on strictly surgical lines, it is mentioned here. The loss of blood in this disease, when itself a cause of danger, is generally combated by starch enemata, to which should be added laudanum or a similar preparation of opium, or by morphia suppositories.

Bleeding from the rectum, in consequence of *the Division of Large Vessels*, is extremely rare as a result of an accident; but it is common enough in the course of operations, such as those for fistulæ, internal piles, or during the larger planned operations for removal of portions of the gut.

For practical purposes the rectum may be divided into a safe and a dangerous region, so far as the use of the knife is concerned. The *safe region* is the last two and a half inches, the blood-vessels in which, though very numerous, are all of them small, being the terminal anastomosing branches of the hæmorrhoidal arteries.

The *dangerous region* is all the rectum that can be reached above the place (three inches from the anus) where the superior hæmorrhoidal branches, about six in number, pierce the muscular coat, and lie between it and the mucosa. These vessels are of a considerable size, and bleed very freely when injured.

Bleeding, then, from the lower part of the rectum, after any operation, although at first often brisk enough, speedily stops; in this situation, moreover, pressure can be easily applied, or, if necessary, the vessels may be tied.

But the case is very different if one of the vessels higher up in the gut has been divided, especially if the part has been the seat of inflammation which has indurated the tissues and thus causes the mouth of the vessel to be kept patent. The situation and warmth favour

a rapid flow of blood, while it is very difficult to get any exposure of the part.

The hæmorrhage can always be temporarily stopped by the pressure of one finger; and, indeed, pressure and plugging will in most cases be the procedure resorted to in the end. Nevertheless, if it be possible to get a ligature round the vessel, a great deal of trouble will be saved. The surgeon should remember that by a free division through the sphincters transversely across the ischiorectal space, he may safely let a flood of light upon the scene, provided, of course, that there are no internal piles or other hindrances in the way. The sphincters will readily heal, and the incision will be amply justified if by its means a ligature can be placed on the vessel.

If for any reason, after an operation for hæmorrhoids, when bleeding is taking place, the surgeon is unable to dilate, and secure the bleeding point, the rectum must be plugged. One method is to use sponges, somewhat compressed, and with a string tied round each one, or passed through them all, so as to provide for their recovery, but the best way to plug the rectum is to use a "petticoat" (*Fig.* 12), the shape and object of which are rendered sufficiently obvious by its name. The space between the petticoat and the central stick or piece of catheter is filled with lint, or better with cotton wool, the plug having been previously put into position in the rectum. With a large gum-elastic catheter, No. 14 to 16, and a piece of lint 12 inches square, an excellent petticoated tube can be made, if the lint is secured to the catheter by means of a stitch passing through the tube. The catheter allows the flatus to pass, and is therefore less troublesome to the patient than a bag or plug which completely blocks the bowel. Although some surgeons advise that the plug be left alone for days, we are of opinion that it should never remain longer than forty-eight hours.

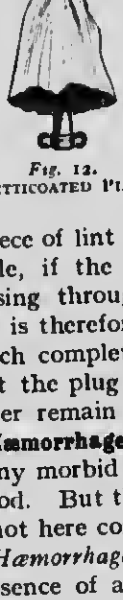


Fig. 12.
PETTICOATED PLUG.

Hæmorrhage from the Genito-urinary Tract.—As might be expected, many morbid conditions of the renal tissue are associated with loss of blood. But the treatment of hæmorrhage from the kidneys or ureters is not here considered.

Hæmorrhage into the Bladder, if serious, is generally due to the presence of a new growth, enlarged prostate, or varicose veins, but a calculus or a purpuric condition may cause it, or it may be traumatic. In any case the bleeding comes distinctly under the surgeon's care, and calls for active treatment. Bleeding from the prostate, again, is not uncommon, and may require to be promply dealt with, but in the majority of cases it is simply congestive, and stops when that condition is relieved.

Generally speaking, in any of these cases, rest and relief of all con-

gestion in the neighbouring viscera, as by clearing out the rectum, will prevent hæmorrhage into the bladder or from the prostatic vessels assuming a serious character. But if in consequence of the vascular nature of a new growth, or from some similar cause, severe hæmorrhage should occur, it will be found to be somewhat difficult to treat. *Locally*, ice may be applied to the perineum and hypogastrium, or inserted into the rectum, or an enema of iced water may be given. The indications for *internal* treatment generally point to the employment of such styptic drugs as turpentine, tannic acid, lead acetate with opium, ergot, or hazeline. If the bladder becomes distended with blood-clot, it may happen that the urine is retained. In this case a large catheter, such as is used in lithotrity after Bigelow's plan, should be employed. After the clots have been gently broken up with a sound or coudé catheter, the catheter should be connected with an aspirating apparatus (Clover's or Bigelow's), by means of which enough clot may be removed to allow of the passage of the urine, and with this relief the surgeon should be content.

If this treatment fails—and in cases where the bleeding is profuse, failure is common—the bladder must be opened above the pubes and the clots turned out. The bladder cavity must then be washed out with hot water, 120° F., containing 1 oz. of extract of hamamelis to the pint. This irrigation is usually successful, but, if not, the bladder must be plugged. The introduction of plugging into the bladder, although a simple enough proceeding, may cause a great amount of pain, and it must only be undertaken as a last resort.

Presuming that the viscus has been opened above the pubes, it is usually sufficient to pack down strips of gauze, 30 inches long, 4 to 6 inches wide, on to the bladder base. If the bleeding comes from the prostatic region, as for instance after removal of the prostate, it may be necessary to "tamponade" the cavity. This is done as follows: A catheter is passed through the urethra into the bladder, and is made to protrude through the suprapubic wound; several pieces of gauze of varying sizes are threaded together on a stout silk thread doubled so as to form a "graduated compress" (*see* p. 20), the thread which leaves the apex of the compress is fastened to the eye of the catheter, and the catheter is withdrawn, carrying with it the silk threads, which now project from the external meatus. By gentle traction on these threads, aided by manipulation at the suprapubic wound, the whole compress can be drawn down to the bladder base and fixed there, and the threads tied round a piece of gauze at the meatus. To facilitate the removal of the plug, which should always be undertaken in *twenty-four hours*, it is well to have the *base* of the plug also attached to two stout silk threads which pass out through the suprapubic wound. When the threads at the meatus are untied, traction on the suprapubic threads will easily effect the removal of the whole compress. This method is rarely required, but it is entirely effective when employed.

The question of the management of *Rupture of the Urethra* will be considered later. In all ordinary cases the bleeding, although it may be rather free at first, is easily arrested by rest, and cold to the perineum. But a very furious bleeding into the urethra may occur in consequence of *Rupture of the Bulb* or corpus spongiosum from external violence; in these cases the blood pours from the erectile tissue and escapes from the meatus urinarius at a rate which will quickly exhaust the patient unless it be arrested. Pressure is the only means of arrest, but pressure here is very difficult to make effectually; the best way is to pass a full-sized catheter and to make compression in the perineum upon it, at first digitally and later by pad and bandage.

Bleeding from Granulations occurs when they are injured, even when absolutely healthy, and may then readily be stopped by pressure. But if the granulations spring from the base of a hæmorrhagic ulcer, or occur in wounds or sores of patients who are extremely feeble, or who are scorbutic, the hæmorrhage sometimes is difficult to arrest. In these cases, as in others, the sheet anchor of treatment must be pressure, but much may be done by constitutional treatment* and stimulating lotions, such as Lotio Arg. Nitratis gr. v to x to ℥j of water, Lotio Zinci Sulph. gr. iv to ℥j of water, etc.

A treatment which is very frequently successful is *to scrape the Granulations* completely away with the edge of a scalpel, or with a "Volkmann's spoon," such as is used for the eradication of lupus. Another good plan is to apply Martin's or Esmarch's indiarubber roller, without the strangulating cord, to the whole limb, including the bleeding sore, for not more than twenty-four hours. Or, finally, recourse may be had to cauterization with fuming nitric acid, or with the actual cautery.

Hæmorrhage from Sloughing Phagedæna.—That extremely rapid form of destructive inflammation known as *Sloughing Phagedæna* or *Hospital Gangrene* must be mentioned here only as being sometimes a cause of hæmorrhage. The disease is peculiar, inasmuch as in the manner of its invasion of the tissues it resembles the course of a malignant ulceration, and does not spare the blood-vessels, but, affecting their coats, may cause the most furious bleeding. It is, however, so rare since the introduction of the antiseptic or aseptic treatment of wounds that it is probable a surgeon may never see a case during his career as a student or in after practice.

Vessels may, of course, frequently be destroyed by ulceration without bleeding, from previous obliteration of their lumina. It is therefore in the most rapid forms only of this disease that bleeding takes place; this is also true of a hæmorrhage from a somewhat similar cause, namely, that which is due to the destruction of large vessels by the formation of abscesses in dangerous regions. In such cases bleeding would be far more frequent but for the fact that time is given for the plugging of the vessels. It does, however, occur.

* *Vide* "Bleeders," p. 38.

When, therefore, in a case of hospital gangrene, the disease invades the neighbourhood of a large vessel (e.g., in sloughing phagedæna of the groin), the greatest watchfulness must be exercised, and some form of tourniquet be ready to be applied instantly if the vessel gives way, so that time may be gained to send for assistance.

It is often very hard to decide upon the best means to adopt for the permanent arrest of this form of bleeding. If the vessel be small the thermo-cautery or nitric acid may be sufficient, but if it be a main trunk, it must be ligatured, and in that case the surgeon will have to choose between the difficulties of securing a vessel itself diseased, in the midst of sloughing tissues, and the risks of securing the trunk higher up by a separate operation.

Hæmorrhage from Malignant Growths.—Like sloughing phagedæna, most malignant tumours do not spare the vessels in the tissues among which they spread, and one of the most frequent causes of death in these cases is haemorrhage from a vessel which is involved in the course of malignant ulceration. This would be more frequent still, were it not that the vessels are so often previously obliterated. The arrest in these cases, and the precautions to be taken, are precisely those which have been mentioned for phagedæna, with the simple exception that it will never be right to attempt to put a ligature on the vessel at the seat of hæmorrhage, that is, in the substance of a malignant growth. But in addition to this form of bleeding by invasion of vessels, malignant tumours are themselves generally very highly vascular, and in the later stages of their growth, break down, and then their ulcerated surfaces are apt to bleed, sometimes very profusely, as may readily be imagined, since the blood-supply of some of the softer sarcomata is abundant enough to cause the whole mass to pulsate.

A variety of methods may be adopted for the arrest of this form of bleeding. Moderately firm pressure, cold, as by applications of ice or the ether spray, the use of styptics such as adrenalin chloride, alcoholic solutions of hamamelis, or gelatin and formalin: all or any of these may in different cases be found efficient. In certain cases, ligature of the main vessel of supply is indicated, as of the lingual artery in some cases of epithelioma of the tongue: but the actual cautery will hardly ever be advisable.

When the ulcerated surface of a malignant growth is apt to bleed, a good application is a powder of equal parts of crude opium and cinchona bark, which may be dusted on the part, though there is no more satisfactory application to the surface of a malignant tumour which is fungating than a 5 per cent solution of cocaine, followed by the preparation of formalin and gelatin described above.

Hæmorrhage from an Aneurysm.—Occasionally, but very rarely, an aneurysm ruptures externally, and causes violent bleeding, and there are even one or two cases on record in which the occurrence has resulted in the cure of the disease. It is not within the scope of this work to discuss the surgical proceedings which should be taken for the

permanent arrest of this bleeding, hut we must consider the measures for stopping it at first.

Contrary to what one would expect in sueh cases, the giving way of tlie tumour occurs insidiously ; the aneurysm *leaks* rather than bursts (we are speaking of those on the external surface of the body) ; the skin hecomes irregularly ulcerated over it, and the first appearance is rather that of a superficial bleeding sore. The blceding, too, is intermittent, and at first, apparently not serious. The loss, however, at each attack becomes greater and greater, and soon there is a general yielding of the skin, which is now all that restrains the flow, and a gush of blood, which may be immediately fatal, takes place.

Treatment.—What should be done in the first instance ? We will take as an example an aneurysm of the superficial femoral, say, in Hunter's canal. If the condition be that of a slight intermittent oozing from one or two apparently superficial ulcers, in the reddened unhealthy skin lying over the pulsating tumour, the leg should be raised and carefully bandaged from the foot upwards. A Martin's indiarubber bandage is best, and this should be carried somewhat more firmly over the tumour, a folded piece of lint being placed between the skin and the bandage. Some form of tourniquet, e.g., Esmarch's indiarubber cord (*Fig.* 3) should then be adjusted, so that it can be tightened up in an instant if required. This being done, there is little immediate danger, and time will be given to the visiting surgeon to determine whether he will turn out the eontents of the aneurysm after opening it freely, and then proceed to ligature both ends of the vessel ; whether he will pass a ligature round the femoral or external iliac arteries ; or whether he will adopt any other proceedings for the permanent cure of the disease.

But supposing the case has been allowed to drift on, until there comes a furious gush of blood from a considerable yielding of the skin and sac ? There will be no time for deliberate bandaging, but the finger must at once he placed on the main artery (in this case the common femoral) and retained there until replaced by a tourniquet. The bleeding cavity must then be packed most carefully and firmly with gauze or strips of lint, until it is absolutely full, and then pressure made on it from above with a firm ordinary bandage, or an indiarubber one, over a pad.

Finally, it may be necessary, in some situations, to put the finger into the cavity which is bleeding, to feel for the place whence the rush of blood proceeds, and to arrest it by keeping the finger on the spot till help arrives.

The wound once effectually plugged and compressed, the tourniquet may be gradually slackened, and if the bleeding does not recommence, should be left loose, but in position : the further treatment must be left in the hands of the visiting surgeon.

We have been particular in describing the temporary arrest of this form of hæmorrhage, although it is rare, because it serves as an example.

that *a man should never be allowed to bleed to death from any external hæmorrhage*, inasmuch as it may always be arrested, first with the finger placed on the bleeding point, or on the main artery, and then by plugging and pressure.

Hæmatemesis.—Although generally speaking hæmatemesis, or bleeding from the stomach, is regarded more as a medical than a surgical affliction, a surgeon is often called upon to treat this condition. It may be at once acknowledged that actual operative interference for the hæmorrhage while it is continuing is rarely called for, and rarely successful when practised, though the occurrence of *repeated* hæmorrhages renders surgical intervention imperative in the interval between the bleedings.

In a given case of hæmatemesis, when the bleeding is fairly profuse, the patient must be put to bed and a full dose ($\frac{1}{4}$ gr.) of morphia administered hypodermically; *no food must be given by the mouth;* an ice-bag should be placed over the epigastric region.

Hæmostatic drugs—ergot and tannic acid—*should not be administered.* Adrenalin and chloride of calcium have not been very successful, but gelatin, as in other cases of hæmorrhage, has been of great service. A jelly is made as follows:—

Gelatin			
Sugar	℥j	Syrup of Lemons	℥j
	℥j	Water	℥vj
	℥ij o. h.		

It should be given with ice, and is very pleasant to take. The above treatment is usually efficient. During the attack, and for some days subsequently, the patient must be fed by nutrient enemata, and mouth feeding must be restarted with the greatest possible care.

Hæmoptysis, or bleeding from the lung, the blood being coughed up, and not vomited as in the preceding variety, also comes under the notice of the surgeon in connection with injuries to the thorax.

Active operative interference may be required where, in addition to the injury to the lung, there is free bleeding into the pleural cavities, but this will be considered later. In the meantime, for the actual hæmoptysis it is always advisable to get the patient to bed (on to the injured side if possible, so as to allow the uninjured lung to work freely), to adminster ‡ grain of morphia, and to apply a large ice-bag over the damaged area. As there is no interference with the stomach, ergot ($\frac{1}{2}$ dr. of the liquid extract) can be given every four hours.

Secondary Hæmorrhage.—A bleeding is called *Secondary* when it comes on at some period subsequent to the division or injury of the vessels maimed, either by an accident, or in the course of an operation. It is divided into *Recurrent Hæmorrhage*, and *True Secondary Hæmorrhage*.

Recurrent Reactionary Hæmorrhage is that form which comes on as soon as the period of lowered cardiac action and partial collapse, which is occasioned by the shock of an operation, or of an accident, passes off, i.e., within four or five hours of the injury. By this time, too, the contraction occasioned by the exposure and division of the vessels has largely passed away. There is then present a condition

of increased cardiac activity and relaxed vascular walls, so that it is not surprising that very frequently there is free general oozing from a wound, which at the time it was done up appeared quite dry. The bleeding is chiefly capillary, or proceeds from small arterioles, which had been so firmly contracted as not to declare their presence at the former examination. Larger trunks which have not been tied firmly enough (which should never occur), may burst their bonds and bleed freely.

Treatment.—Much will depend upon the discretion and common sense of the house surgeon in these cases. While it is a most serious error to overlook a case of active reactionary hæmorrhage, it is at the same time needlessly distressing for a patient to have a painful wound opened up—often in the middle of the night—for a slight oozing which pressure would have checked. The house surgeon must be guided by the nature of the operation performed, i.e., whether large vessels have been divided, as in the case of an amputation, and by the condition of the dressings, whether the "coming through" of the dressing is due to serum and a little blood, or a quantity of blood and a little serum. In this connection he may remember that with a fairly large dressing, a serous exudation is more likely to appear at the end of the stump in cases of amputation, and forms a yellowish-green zone several inches wide round a red centre, whereas in hæmorrhage proper the blood will be found at the most dependent part of the dressings—that is, in a case of amputation of the lower extremity, on the under aspect of the stump, trickling towards the buttock, and the surrounding stain of the serum will be faintly marked. Lastly, he must be guided by the condition of the patient. If the pulse is good and full, and there is no feeling of faintness, he may, in conjunction with the considerations given above, rightly decide to pack the wound and wait. To pack a wound under these circumstances, the outside bandage should invariably be removed. It has been in contact with the bedclothes and other materials which are not sterile, and to bury it under a large pad of wool is, in our opinion, most unwise. When the bandage has been removed, a large pad or pads of wood wool should be placed on the top of the original dressing and the whole region *firmly* bandaged. If this be properly done, and if the house surgeon has been right in his selection of the case for the application of this treatment, there will be no more trouble.

But, on the other hand, where he suspects that there is serious bleeding, or perhaps where he has had recourse to packing and it has failed, what is to be the next step? All preparations must be made to open up the wound, and these preparations must be undertaken as carefully and as methodically as for the original operation. Too often the carelessness of hurry in the anxiety of the moment causes grave omissions in our technique of asepsis. An anæsthetic is to be administered, either in the ward or the theatre, wherever the operation is to be performed, and we would insist most strongly on this point. If

the house surgeon has decided that packing is out of the question in a given case, then he must be prepared to go to all extremes to check the hæmorrhage which is occurring, and nothing is more unsatisfactory and distressing for all parties than to see a house surgeon endeavouring, with insufficient light, to secure a vessel in a struggling, shrieking patient. The first object is undoubtedly to check the hæmorrhage, but unless there is some very good reason to the contrary an anæsthetic should be given.

Then, without hurry or the infliction of pain, the wound is opened up, irrigated with hot saline, 120° F., and a search made for the bleeding points; no difficulty will attend this search if proper preparation has been made. They must be secured with ligatures, the wound cleared of clot, and the edges brought together again. If a large amount of blood has been lost, it will be necessary to inject some saline solution into the tissues or the vein (*vide infra*).

After reactionary hæmorrhage has once occurred, the patient should be carefully watched.

True Secondary Hæmorrhage rarely occurs earlier than a week or ten days after the injury or operation, and its cause is almost always some ulcerative or sloughing condition of the walls of the larger vessels. Thus it may come from an artery which has been ligatured in its continuity in consequence of the coats near the ligature taking on an unhealthy action; or it may come from a lacerated wound at the time of separation of the sloughs, or from ulceration of a vessel ligatured in the flaps of an amputation wound.

The single exception to this form of hæmorrhage proceeding from a morbid inflammatory process is in those cases in which an animal ligature has become absorbed too quickly (a rare occurrence with the well-prepared catgut at present in use), or a silk one has cut the coats or come untied, so that the arterial coats, weakened by the tying, will then give way.

A form of hæmorrhage which may be classed under this heading, since the treatment is similar, is that resulting from ulceration of a large vessel, either from the destructive process of phagedæna or from the proximity of an abscess.

Secondary hæmorrhage is very serious. It constitutes a most formidable complication, and in considering the means for its arrest, questions of amputation, re-amputation, or ligature of main vessels, have to be weighed by the visiting surgeon; but for us the subject is narrowed to the best ways for its immediate arrest.

It has been customary to look upon secondary hæmorrhage as occurring in two varieties: (1) *With warning*; (2) *Without warning*. In the first type a little dribbling will be noticed when the wound is dressed, about the ninth or tenth day after the operation. The wound will have become sloughy and septic, and there will have been considerable destruction of the tissues. No time must be lost in putting a tourniquet round the limb and preparing for further treatment, and

it may be taken as an axiom *that when arterial bleeding occurs, independently of probing, under the above conditions all measures for the treatment of secondary hæmorrhage must be taken.* Unfortunately this warning is occasionally neglected, and the trifling hæmorrhage is regarded contemptuously, until a sudden violent gush of blood depletes the patient and possibly determines a fatal issue.

Whether the amount of blood lost in cases of secondary hæmorrhage is large or small, steps must be taken to bring about its immediate arrest.

If the hæmorrhage be from an *Artery Ligatured in its Continuity*, the steps which ought to be taken immediately, and which may suffice in some cases for its permanent arrest, are precisely the same as in the case of an aneurysm which has undergone external rupture, and to these the reader is referred (*see* p. 34).

Treatment.—If hæmorrhage occurs from *an Amputation Stump*, it must be arrested in the first instance by elevation, and compression of the main artery by the fingers or a tourniquet. The means to be adopted for the permanent arrest will depend on the condition of the stump; whenever practicable, the most satisfactory proceeding is to open up the flaps, and tie the artery. A little blunt dissection will nearly always permit of the artery being seized with forceps and drawn down so that a ligature can be applied to a portion of the vessel that is healthy. It is better to use a stout ligature, and on the whole kangaroo tendon seems the best material. If this is not possible from the sloughing condition of the parts, then the choice will lie between re-amputation and ligature of the trunk-vessel higher up.

If the hæmorrhage proceeds from *Extensive Sloughing* of a lacerated wound, it takes place about the time of the separation of the sloughs; in dressing bruised wounds, therefore, great care should be taken about the tenth day not to tear the sloughs away before the vessels have become occluded by natural processes. The bleeding is generally arrested by plugging and compression, but any vessel that will hold a ligature should be tied. The actual cautery may be used with good effect, but styptics, especially the perchloride of iron, should be avoided.

Secondary hæmorrhage is now of rare occurrence, but the house surgeon is likely to meet with it after removal of the tongue, the bleeding coming from the lingual artery. The same principles should be applied in this instance, and it is the best treatment to secure the vessel with forcipressure forceps and ligature; but as a temporary measure, and one which may have permanent effect owing to the small size of the vessel, a firm gauze plug should be packed down on to the bleeding point.

In cases of secondary hæmorrhage when sepsis is present, the wound is to be freely opened, and well washed with peroxide of hydrogen.

"Bleeders."—Reference has been made several times to the constitutional conditions known as the "*Hæmorrhagic Diathesis*," or *Hæmophilia*, and those possessing this diathesis are generally called "bleeders." It is in a very marked degree hereditary, and is transmitted by both

the male and the female sides, but it affects males far more frequently, the most common transmission observed being through the females, who do not suffer, to their sons.

"Bleeders" manifest their complaint either by spontaneous hæmorrhages from such parts as the gums and palate, the rectum, or the bladder; or by persistent bleeding from some wound, large or small, or by the effusion of blood or blood and serum into the synovial and serous cavities or subcutaneous tissues.

In the case of wounds the importance of the case only gradually develops; there is no furious gush of blood, but a general "weeping" of the whole surface, which looks as if it only required a little time to stop of itself, but at the end of twenty-four hours the position of affairs is precisely the same, with the exception that the loss of blood, continuous as it has been, has caused a distinct constitutional effect, while very probably the pressure employed in futile attempts to check the drain has produced sloughing of the edges of the wound, and hence an enlargement of the bleeding surface. And so matters go on. The blood, natural in its appearance at first, becomes thin and watery, while the patient is exhausted to the last degree, and seems likely to die, it may be from such a trivial injury as an extracted tooth or a cut finger. Death may occur, but occasionally, just when the case looks most hopeless, the wound takes on a healthy action, the bleeding ceases, and the patient begins to repair the enormous drain on his resources.

The chief change in the blood seems to be a deficiency of fibrinogen, and the danger can be gathered from the statistics of Litten, who found that 60 per cent of patients die before the age of eight, while only 12 per cent live to twenty-two and over.

Treatment.—In considering the best means of checking the bleeding, constitutional as well as local remedies must be thought of; hence it is important to find out, in any case of unusually prolonged bleeding, whether the patient be a genuine bleeder or not. Enquiry will generally elicit a history either of some previous injury, in which the bleeding "seemed as if it would never stop," or of a father, brother, or uncle who had shown similar characteristics.

Local Treatment.—The character of the bleeding puts the idea of trying to ligature any of the bleeding vessels out of the question, and a little reflection makes it plain that the ligation of a trunk-vessel will only substitute two bleeding wounds for one.

Compression should be applied to the bleeding area with either 1–5000 adrenalin solution or the formalin and gelatin mixture in addition. In some cases the actual cautery may be tried. The local effects of subcutaneous injection of ergotine are sufficiently marked to indicate its employment.

Constitutional Treatment.—Absolute rest should be imposed on the patient, and 1 dr. daily of chloride of calcium should be ordered. Reverdin recommended sulphate of soda (2 gr. every two hours),

A prolonged use of dried extract of pig's liver and chloride of calcium is the best preventive treatment.

According to Wright, the inhalation of CO_2 for a few seconds, which increases the venosity of the blood, will always check the bleeding in hæmophilia.

Perchloride of iron is more useful in the later stages, while for a dangerous anæmia produced by the bleeding, if this has been checked, the injection of saline solution into the rectum may be advisable.

The action of *Opium* in quieting and regulating the circulation gives it great therapeutic value as an indirect hæmostatic in this form of bleeding, when the heart's action becomes feeble and the pulse empty and jerky.

From our account of the diathesis it must not be supposed that every injury to a "bleeder" is necessarily followed by extreme consequences, nor, on the other hand, that every case of troublesome capillary bleeding stamps the patient as an example of the condition. There are borderland cases, and also cases which simulate the diathesis, either through simple flabbiness and laxity of the vascular walls or from the presence of some other constitutional vice, such as leucocythæmia, or scurvy, or the condition commonly known as "scurvy rickets."

Chapter IV.

OF SOME PRINCIPAL FORMS OF INTERNAL HÆMORRHAGE, AND THEIR ARREST, AND OF TRANSFUSION.

INTERNAL HÆMORRHAGES.

THE important points to be attended to in promoting the arrest of *Internal Hæmorrhage* may here be briefly considered, those cases only being taken into account in which the loss of blood is sudden and is the prominent symptom at the moment, whether the cause of the loss be a traumatic or a constitutional one.

Thus apoplexy will be considered under another heading, while for chronic hæmoptysis, renal hæmaturia, etc., the reader is referred to works on the practice of medicine.

Whenever a large quantity of blood escapes from the blood-vessels, whether it flows away from the body, or into one of its cavities, the prominent symptoms are those of cerebral anæmia. There is a sudden feeling of nausea and giddiness, with a buzzing in the ears, then the sight goes, and the patient falls to the ground and becomes insensible. In such a case there is sometimes a superficial resemblance to an epileptiform or apoplectic seizure, but as a rule the extreme pallor and the fluttering pulse, which is often nearly extinguished at the wrist, will be sufficient indications of what has happened.

The recognition and treatment of cases of internal hæmorrhage are the most difficult problems that the house surgeon has to face; and it may be said at once that although on paper we are able to draw many distinctions between this condition and that of shock, it must be borne in mind that these two states are often present together, and absolute reliance on any single symptom is most fallacious. In coming to a conclusion the whole aspect of the case is to be considered. What is the kind of case the house surgeon has to treat? A man has been crushed between the buffers of a train, or has been run over by a heavy dray; he is brought into the hospital profoundly shocked as the result of damage to his solar plexus. He has probably sustained a fracture or two, and he may have received an injury which has ruptured his intestine. We are here considering only the results of hæmorrhage, which may take place into the pleural or peritoneal cavities, or into the cellular tissues of the loin after injury to the kidney.

It is obvious that the house surgeon has a very difficult case before him.

The patient must be taken to the ward, put to bed with the head low, and hot bottles placed all round the body and limbs, and a careful systematic examination made of the three regions indicated above, with as little exposure as possible.

Examination of the thorax may reveal broken ribs, surgical emphysema, and dullness, denoting blood in the pleura with or without pneumothorax. If this appears to be the only region injured, the patient should be placed on his back, or on the affected side, so as to leave the uninjured lung free to expand. Ice-bags should be placed over the injured spot as soon as the initial shock is passing away. As a rule, no operative interference is called for unless the collection of blood and air is of such a size as to embarrass the uninjured organ, when the thoracic cavity should be aspirated with all aseptic precautions.

The abdominal cases are the most difficult. Here shock is profound. How are we to say whether hæmorrhage is taking place into the peritoneal cavity or not? In hæmorrhage alone the pulse has often a large wave with no tension: the so-called *hæmorrhagic pulse;* in shock it is usually small and feeble. Unfortunately the combination of shock and hæmorrhage gives us a weak, feeble, often rapid pulse, of no diagnostic value. In both conditions the patient is cold, the skin surface and the mucous membranes are blanched, and the pupils may be dilated. The respirations in shock are usually shallow or effortless; but in hæmorrhage they are peculiar: there is a distinct gasp or catching for air, owing to the amount of blood available being insufficient for the oxygenation of the tissues. This "air hunger" is a point of importance. In hæmorrhage also there is usually marked restlessness, and consciousness is present, though the patient complains of a feeling of faintness, dizziness, spots floating before the eyes, and may suffer from convulsive attacks due to the anæmia of the brain. These form some of the distinguishing features of internal hæmorrhage.

We must admit that most of these only appear in the later stages when a fatal issue is imminent, and therefore in many cases of abdominal injury it is not possible to say at once whether there is or is not evidence of internal hæmorrhage *until the case has been watched.*

We have now reached the crucial point of our investigations. The patient must be watched with the utmost care—and the greatest responsibility rests with the watcher, since he is often the only one in a position really to decide whether hæmorrhage is occurring. *Under no circumstances, therefore, must stimulants be given or transfusion resorted to unless the condition is so serious as to permit of no delay;* both are most injurious if hæmorrhage is occurring, since they will tend to increase it; both are misleading, since they may cause a temporary improvement which is entirely deceptive. *If, after the patient has been put to bed, well covered up, and warmed with hot-water bottles, the head being kept low, there is no improvement or even a change for the*

worse, it is practically certain that hæmorrhage is going on: the abdomen should be bandaged firmly, the visiting surgeon summoned, and all preparations made for performing abdominal section.

As soon as the diagnosis has been made, and all is in readiness for the operation, saline transfusion can be employed if required.

Lastly, a word on the examination of the abdomen. Hæmorrhage occurring into the peritoneal cavity may give rise to a shifting dullness in the flanks, i.e., a line of dullness which varies with the position of the patient, and, if present, this is of some value in determining the diagnosis; but it is just one of those signs which, if relied on too implicitly, will bring one to grief. We have seen the peritoneal cavity swamped with blood, but the percussion note was resonant all over the abdomen, while a loaded movable colon may give some of the physical signs of free fluid.

If the hæmorrhage is occurring from an injured kidney, the blood may be effused into the loin or into the peritoneum.

After the abdomen has been carefully examined, as a routine the urine must be withdrawn by a catheter to show whether, from renal injury, blood is being passed down the ureter into the bladder.

Such, then, is an example of cases frequently encountered. The timely recognition, by careful examination, of a source of internal hæmorrhage may result in the saving of the patient's life; delay may sacrifice it. Hasty operations in patients profoundly collapsed will be followed by disaster. Although the responsibility of the final decision as to an operation rests with the visiting surgeon, this decision will be greatly assisted by a careful report of the progress of the case while under the house surgeon's observation.

Immediate Treatment.—The immediate treatment of severe internal hæmorrhage, apart from operative measures, is sufficiently simple. It may be summarized thus:—

(1) To prevent further loss of blood; (2) To keep the circulation quiet; (3) To keep up the blood supply of the nerve centres in the brain for circulation and respiration.

1. *Measures for Preventing further Loss* will vary in different cases, but the chief ones are—absolute rest, local application of cold, and lowering the functional activity of the organs affected as much as possible. Thus, if the bleeding be from the lungs, the patient should be kept lying flat, with very light and loose clothing; be made to suck ice, and enjoined not to speak. In this way the lungs are placed at rest as far as it is possible for them to be.

2. *To Keep the Circulation Quiet.*—The absolute rest will greatly help this, but the administration of ½ gr. morphia will be found of great value.

3. *To Maintain the Blood Supply to the Brain.*—The fulfilment of the third indication—the blood supply of the respiratory and cardiac nerve centres—is best attained by lying flat. We all know that this is the best position for syncope, because then the feeble heart can most

readily drive out its scant supply of blood to the brain. Placing a patient head downwards, when the breathing has stopped during the administratinn of chloroform, is only an extension of the same principle.

But in *Very Severe Hæmorrhage*, position alone may be insufficient, and we may see the syncope getting nearer and nearer to death, from the bloodless condition of the base of the brain. In the first place, all the blood that is in the body should be utilized fnr the purpose of brain supply. To do this effectually, the head must be lowered and the pelvis raised; the arms held so that the veins tend to empty themselves into the heart; while the legs should be raised, and bandaged from below upwards—an elastic bandage (Martin's) is best—so as to squeeze all the blood out of them, as far as possible. All these proceedings are sometimes called "autotransfusion."

Artificial Respiration.—In extreme syncope from bleeding, as from any other cause, the surgeon must be prepared for complete failure of the breathing, and must be ready to begin artificial respiration (q.v.) whenever he sees the movements of the chest becoming suspiciously shallow.

TRANSFUSION.

But further, there can be no doubt that, rather than allow a patient to simply die from want of blood, the deficit ought to be supplied from elsewhere; the difficulties of transfusion of blood from one person to another, and the satisfactory results obtained from the administration of a solution of sodium chloride, have resulted in the practical extinction of all other methods.

This treatment is based upon the fact that in severe hæmorrhage the patient suffers from loss of quantity rather than of quality, and that if a sufficiency of fluid isotonic (that is, having roughly the same percentage of salts, ·9%) with the blood, be introduced into the circulation the crisis can be tided over.

Although, strictly speaking, this saline solution or "artificial serum" should have the following composition:—

Potassium Chlorate	0·03	Calcium Chloride	0·01
Sodium Chloride	0·6–8	Water	100

and can be readily obtained in the form of tabloids or powders; still, in a case of emergency, a solution containing 1 drachm (1 teaspoonful) of salt to 1 pint of boiled water is satisfactory.

There are three recognized ways of administering this saline solution for the treatment of severe hæmorrhage or shock: (1) Into the veins; (2) Into the subcutaneous tissues; (3) Into the rectum; but the selection of the appropriate method must depend upon the urgency of the case. Where an immediate crisis is impending, the venous route should always be selected.

Certain general principles must govern the injection of saline, whether into the veins or the subcutaneous tissues.

First, the most rigid asepsis is to be observed. An operation of this kind, frequently undertaken in a hurry, is often performed without proper regard to this all-important detail.

Secondly, the fluid must reach the body at a temperature above the normal 98·7° F. In hæmorrhage and shock the temperature is subnormal, and the injection of a large quantity of fluid which may tend to lower the body temperature still further is positively harmful. Whatever apparatus be used, due allowance must be made for the cooling of the fluid as it passes along the tube; and if an irrigator be used with six feet of tubing, the temperature of the fluid in the irrigator should be at 110° F.

Thirdly, the fluid must not be injected too quickly. In the cases where it is injected into the subcutaneous tissues a too rapid injection can be readily detected by the swelling of the tissues, since, if injected at the proper rate, the fluid is almost immediately absorbed. On the other hand, when the injection is made into the vein, there is no such indication, and if the saline be forced or pumped in at too great a rate there is a risk of causing failure of the right side of the heart. The average rate should be 1 pint per ½-hour into the subcutaneous tissues; 1 pint per ¼-hour into the veins.

Fourthly, the quantity. Except in children it is no use injecting a smaller quantity than two pints, but it is often advisable to inject considerably more than this; four, six, and even ten pints have been injected with benefit during a period of twenty-four hours. Starting with two pints as a minimum, the amount can be increased until the state of the pulse shows a satisfactory condition. Provided the fluid is injected slowly the quantity produces no ill-effects. It is the "rate" of the injection that matters.

The greatest care must be taken to exclude the entrance of air.

Apparatus and Technique.—

Intravenous Apparatus.—Two forms are in common use:—

1. A pump with a two-way tap, connected to the cannula by a short length of rubber tubing.

2. A glass irrigator, holding half a pint, connected by six feet of rubber tubing.

Instruments in use with both: Cannula, scalpel, scissors (sharp pointed), forceps (one pair toothed), director, and aneurysm needle.

Everything connected with the operation must be boiled.

Of the two forms of apparatus we prefer the simpler irrigator, which has no taps or nozzles to get out of order. With regard to cannulas there is a large assortment, all of which are sufficiently serviceable; but we strongly recommend a very simple instrument made for us by Messrs. Weiss, of Oxford Street. The special peculiarities of this instrument are a hollow shaft bent at an obtuse angle on the connecting portion, the shaft tapering to a solid blunt point with an opening at half to one inch from the end (*Fig.* 13). The blunt tapering end greatly facilitates the introduction of the instrument, while the

tapering shaft allows it to plug the opening in the vein, there being no necessity for the use of ligatures.

The *technique* is as follows:—

The cannula is connected to the irrigator by six feet of rubber tubing, this length being necessary in order to start the flow into the vein in those cases where the circulation has failed. The irrigator, tube, and cannula are all filled with hot saline, and held in readiness, a clip or a finger being applied to the tube close to the cannula.

The skin over the vein selected—usually the median basilic or median cephalic—is carefully cleansed, and if the vessels are very collapsed a bandage is placed round the arm to distend them.

A small oblique cut is made through the skin over the vein, and a few touches of the knife allow of the vein being cleared sufficiently to enable it to be grasped with toothed forceps. Traction is now made on the vein with these forceps, so that an angle is formed at the point where the forceps hold it. With a sharp-pointed pair of scissors a small snip is made into the vessel a quarter of an inch *distal* to the

Fig. 13.—Cannula for Intravenous Transfusion.

forceps, and the flow of blood from the vein shows that the lumen has been reached.

The cannula, already filled, is now introduced through the opening made into the vessel, and pushed on proximally, i.e., towards the shoulder, until the larger calibre of the shaft completely blocks the opening. The irrigator is raised, and the fluid is allowed to enter at the rate advised.

Should there be a smart flow of blood on opening the vein, traction on the wall will almost always arrest it. Needless to remark, before the saline is allowed to flow, the bandage must be removed from the arm. As soon as the flow has been started, the irrigator should be lowered so that the fluid passes slowly into the vein.

While the injection is being made, one or two silkworm-gut sutures are introduced into the edges of the incision, to be ready for tying when the operation is concluded.

As soon as a sufficient quantity has been injected, the cannula is withdrawn, an assistant presses over the distal part of the vein, the sutures are tightened, and the application of a pad and bandage to the wound with the elbow flexed completes the proceedings. We claim for this method absolute simplicity, no difficulty in the introduction of the cannula, and no need for any ligatures: the wound is treated

as an ordinary venesection wound. A considerable experience of this modification of the operation has verified our expectations. It can be done under local anæsthesia with the greatest ease.

If the older and more complicated method be adopted, it is first necessary to see that the two-way syringe is in proper working order, as it is exceedingly liable to get out of gear.

The end *c* (*Fig.* 14) is placed in a reservoir containing the saline solution, and the stopcock *b* (two-wayed) is turned so that the end *d* does not communicate with the interior of the cylinder, but only the tube *c*. The piston is slowly drawn out at *a*, so that the fluid fills the interior of the syringe. When it is full the tap *b* is turned so as to shut off the tube *c*, and to place *d* in direct communication with the chamber; pressure on the piston will force the saline along *d* and out of the cannula.

The vein is exposed as before described, but in this instance it is necessary to completely isolate it, and to place two ligatures around it

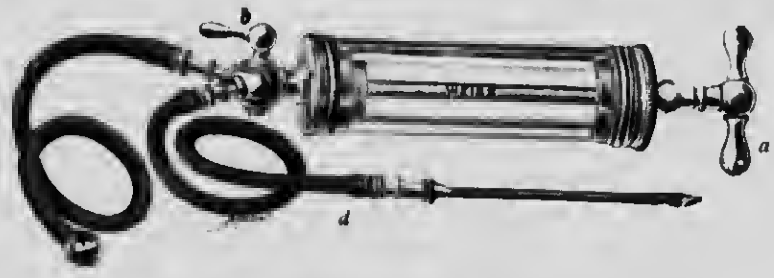


Fig. .—Two-way Syringe for Intravenous Transfusion.

distally and proximally, about an inch of vein intervening. The distal ligature is tied.

The vein is opened either with scissors or a knife, and the point of the cannula inserted. If the ordinary cannula be used there is often some difficulty in getting it into the lumen. The proximal ligature is now tightened, so fixing the cannula in the vessel, and the fluid is forced into the circulation by the pump, the manœuvre described in connection with the filling of the chamber being repeated when it has been emptied. After a suitable quantity has been injected, the cannula is withdrawn, the proximal ligature is tightened, and the wound closed with silkworm-gut sutures. The chief advantage of this method is the accurate way in which both the amount and rate of the injection can be gauged, but we consider it unnecessarily complicated.

Subcutaneous Injection.—In this method we nearly always make use of the irrigator, but attached to the rubber tubing we have a sharp exploring needle of fine calibre. Both the irrigator and the tubing are surrounded with packing to preserve the heat, and it is a good plan to stand the irrigator in a bowl of hot water on a shelf or table above the level of the patient.

An ingenious apparatus can he made out of a large glass flask, a tripod, and a nightlight, and the saline can be kept at a uniform temperature.

A convenient spot is selected, usually the submammary region, and the needle is thrust sharply into it. If it has been properly introduced the fluid will soon start running, and the rate must be controlled by raising or lowering the level of the irrigator.

Careful watch must be kept on the chest, so that the tissues are not unduly distended; but if the injection is allowed to run slowly it is usually possible to get in about three to four pints without much inconvenience to the patient. We insist strongly on the fact that if pain is caused it is because the fluid is running too quickly. If it is necessary to repeat the operation, the opposite breast or region of the huttock may be selected.

Injection per Rectum.—Fluid introduced into the rectum is readily absorbed, and we make use of this channel for the introduction of saline under a number of circumstances which will be referred to

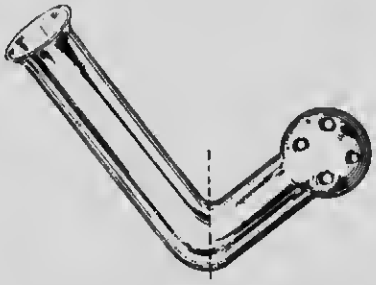


Fig. 15.—Cannula for the Administration of Saline per Rectum.
(Only the portion beyond the dotted line lies within the lumen of the bowel.)

later. For the present it will be sufficient to indicate the two chief ways by which the injection is effected.

Interrupted Injections.—Plain enemata of one to two pints slowly introduced into the bowel and allowed to remain.

Continuous Irrigation into the rectum by means of an irrigator and tube, as in the preceding operation, a soft rectal tube or catheter being substituted for the needle. Saline given in this way is extremely valuable in cases of collapse, hæmorrhage, or toxæmia, and it is surprising how readily great quantities can be absorbed, and with what benefit to the patient.

Raising of the pelvis not only assists the introduction of the fluid, but it helps the patient to retain it.

The method of injecting saline into the rectum in a continuous manner is now largely employed in the treatment of cases of peritonitis, with excellent results. The patient is propped up in bed in what is called "Fowler's position," and a glass tube bent to a right angle three

inches from the rounded end (*Fig.* 15) is introduced into the rectum. The tube is connected to an irrigator, or some other form of apparatus which maintains the saline at a temperature of 103–110°, according to the length of tubing through which it has to pass. The saline is then allowed to flow slowly into the bowel, from which it is absorbed and carried into the circulation. As much as seven or eight pints may be absorbed in twelve hours, but the flow must be regulated so that the fluid does not distend the bowel, only to be ejected later.

This treatment may be maintained with advantage for several days. In some cases it will be found that the saline cannot be retained at all—the prognosis is very grave in these circumstances, the patient rarely recovering,—but as a substitute for the rectal method that of subcutaneous injection should then be employed.

It is better to use a rounded glass nozzle with several perforations than a rubber catheter, and during the interruption that may be required in the administration of the saline the nozzle may remain *in situ*.

The calibre of the tube must, however, be small, or else it will irritate the sphincter and the patient will reject the saline. We find that the most convenient size is one corresponding to a 16 Eng. catheter gauge.

Later Treatment.—In cases of hæmorrhage we have—(1) To promote rapid formation of new blood; (2) To prevent waste of tissue as far as possible.

1. *To Make Fresh Blood.*—By the introduction of saline we are able to make up for deficiencies in quantity; the quality, however, remains poor. To improve this, we must feed our patient on highly nutritive foods: strong beef extracts and jellies, burgundy and other stimulants. Iron or iron and arsenic should be given as soon as possible in the form of hæmatogen, hæmaboloids, and later, the tartrate and perchloride may be substituted for them. One important point is to see that the patient *has plenty to drink*.

2. *To Prevent Tissue Change*, or work of the body of any kind, is also important. Absolute rest and quiet must be kept up for some days; in many cases moderate doses of opium will be found very useful.

Chapter V.

OF SYNCOPE, SHOCK, AND COLLAPSE.

MUCH confusion has existed regarding the exact meanings of these terms and the pathological changes which bring about these conditions. The recent observations of Crile and Mummery have certainly given us a better idea of some of the factors which are important in producing them. Generally speaking, there is much clinical similarity between the three, but the causes which lead to the individual variety, and the results of treatment, are vastly dissimilar.

Syncope is a temporary inhibition of the vital functions, produced, it appears, by an anæmic state of the brain. Whether this anæmia is the outcome of changes in the pial vessels or of loss of blood which has been poured out into the splanchnic area, is not clear, nor is it of much importance.

Practically an attack of syncope or fainting is a temporary condition, soon recovered from if simple measures are resorted to. These measures consist in lowering the head below the level of the body, or in forcing it between the patient's knees when he is sitting down. Some stimulant—a drachm of the spiritus ammon. aromat., or half an ounce of brandy in water—is sufficient. As the attacks are likely to recur, the patient should rest for the remainder of the day.

Sometimes a condition similar to this occurs under anæsthesia, and has been called chloroform syncope. How far this has been confused with shock it is difficult to say, but undoubtedly we meet with cases of transient failure of pulse and respiration before any operative procedures which can produce shock have been attempted; and as is well known, elevation of the head of the patient while under the influence of chloroform is often serious owing to the anæmia of the brain which is caused thereby.

The general treatment of such cases will clearly be on the same lines as when no anæsthetic has been administered, but the danger is considerably greater under such circumstances, since the various systems of the body do not so readily react when under the influence of an anæsthetic. The head should be lowered, artificial respiration performed, and strychnine administered hypodermically. In addition to these measures, a very hot compress applied to the head will be found effective.

Shock appears to be a condition of lowered blood-pressure of gradual onset and prolonged duration, brought about by exhaustion of the vasomotor centres. It is chiefly produced by violent or prolonged manipulation of the contents of the abdomen, or by damage to the nerves or the great nerve trunks of the body. The injurious impulses thereby generated appear to act upon the central nervous system, so that the vasoconstrictor centre ceases to exert any effect upon the peripheral vessels of the body; a great fall of blood-pressure results and death may occur.

Collapse appears to be a *sudden* failure of the vital functions; or as Crile puts it, "immediate depression or death." There are many causes which bring about this condition—injury to the heart, damage to the respiratory mechanism, *profuse hæmorrhage, anæmia of the vasomotor centres as the result of sudden dilatation of the splanchnic vascular area.* All these conditions which produce collapse are important in influencing the incidence of shock at a later date.

Briefly, we may say collapse comes on suddenly; there is great depression, but if appropriate remedies are adopted it will soon pass off. Shock, on the other hand, comes on later; its development is often favoured by a previous state of collapse; it is of longer duration, is much more serious, and is more difficult to treat.

Preventive Treatment.—Before proceeding to the general treatment of these accidents after they have occurred, we must see what precautions may be taken to avoid them. Clearly the preventive treatment for collapse is to check all bleeding as soon as possible, from whatever source or under whatever conditions it may occur.

With shock, on the other hand, we may adopt a number of measures which are of undoubted prophylactic value.

1. Before any severe operation the patient must be well wrapped up, and the exposure during the operation be reduced to a minimum.

2. The patient should be kept as dry as possible. Too often one sees him swamped with lotions, which soon cool down and chill the surface.

3. An injection of morphia $\frac{1}{6}$ to $\frac{1}{4}$ gr., and atropine $\frac{1}{150}$ to $\frac{1}{100}$ gr., should be given.

4. All lotions used for the patient during the operation should be at or above the normal temperature of the body.

5. Purging and starvation, which form part of the routine preparation of a patient before operation, should be curtailed. Often it is advisable to feed a patient a few hours before the performance of a serious operation.

6. Injections of saline with the addition of adrenalin may be given either into the veins or the submammary tissues, or a 6 per cent solution of glucose may be substituted for the saline.

7. It may be advisable to inject a 4 per cent solution of cocaine into the main nerve trunks of a limb previous to the performance of the operation—a procedure which is said to be very valuable in blocking

the nerve trunks and preventing the injurious impulses from affecting the higher centres.

Remedial Treatment.—When once shock has supervened—as shown by the slow, weak, often imperceptible pulse, the blanched surface, the feeble respirations, the loss of control over the bladder and rectal sphincters—remedial measures must be adopted. Allowing that our explanation of the cause of shock is correct, clearly we must endeavour to raise the blood-pressure, and trust to the final recovery of the higher centres if we assist them in their work, as we apply artificial respiration until the respiratory centre continues of its own accord.

The most valuable form of treatment is the injection of saline as before described, and in addition to the three methods of injection described in the last chapter, we may, in abdominal operations, make use of a fourth route for the administration of this fluid, by injecting it into the peritoneal cavity, from which it is soon absorbed.

The addition of adrenalin to make a solution of 1–50,000 to 1–100,000 has a marked, but unfortunately transient, effect.

Two-grain doses of Parke Davis's aseptic ergot may be added with advantage to the saline. The effect of the drug is more lasting than that of adrenalin. In addition to these measures, the head should be kept low, the limbs bandaged, and the abdomen, when possible, tightly compressed with a broad binder.

Pituitary extract is also used to raise the blood-pressure. This is a valuable drug, sold in glass ampoules; but it must be used with great caution (see under "Meteorism").

The value of strychnine in cases of shock, either as a preventive or remedial measure, is difficult to estimate. Custom has sanctioned its use, and many of us are hardly prepared to forswear our allegiance to a drug which we believe to be of value. The results of experiments on animals are not absolute indications of what may occur in the human subject, and for the present we confess that we have confidence in strychnine and advise its use, both before and after the appearance of shock; at the same time we are strongly of opinion that its value is enormously increased after the injection of saline. Oxygen inhalations are exceedingly valuable.

The treatment of collapse is similar to the above, but owing to the more transient character of the vasomotor paralysis, a quicker response and a better result are to be anticipated.

The similarity between the collapse after an internal hæmorrhage and the shock of a severe abdominal injury can now be more fully appreciated, and the difficulty in deciding on the diagnosis and treatment will be more obvious. Clearly, until such diagnosis has been made, active treatment must be suspended, but we would again insist that, when the patient's condition is so serious that a fatal issue seems imminent, the various remedies for shock suggested above must be adopted even in the absence of a decided opinion.

Chapter VI.

OF STYPTICS AND OF THE ACTUAL CAUTERY.

IN former editions of this work many pages were devoted to the consideration of styptics, or substances which, by their application to a bleeding surface, had some effect in promoting coagulation. Formerly, many such drugs were freely employed by the surgeon, some being very unpleasant, painful, and even harmful, and it is no longer looked upon as good surgery to make use of the messy preparations of iron and tannin that were once employed. We shall therefore briefly consider here only a few styptics which are now applied.

Mechanical Styptics.—*Collodion*, prepared by dissolving one part of pyroxylin in a mixture of thirty-six parts of ether and twelve parts of rectified spirit, is extremely useful in cases of wounds about the face, in which, if a scar has to be avoided, the edges have not only to be brought together, but must be held together firmly enough to prevent blood being effused between them. This is readily done by painting three or four coats of this collodion over the wound with a camel's-hair brush, or by saturating a piece of lint in it and applying it to the wound. The collodion as it dries contracts, and thus the required pressure is kept up.

Flexile collodion, prepared by adding to 12 oz. of collodion ½ oz (by weight) of Canada balsam and ¼ oz. (by weight) of castor oil, may be used instead of the above. It is not so liable to crack, but is not so contractile as ordinary collodion.

Gauze Wool acts as a hæmostatic—the fibres giving numerous points from which the process of coagulation can start. When impregnated with some antiseptic body it is very generally used.

Drugs.—Four drugs are of service when applied locally to a bleeding surface, and they are the modern survivors of a long list of twenty or thirty varieties of past decades:—*Adrenalin Chloride*, *Antipyrin*, *Gelatin*, *Hamamelis*. These are fairly efficient styptics in many cases; they are not messy or painful, and in the case of antipyrin there are certain analgesic properties which are very valuable.

Hamamelis is the least satisfactory of the three, and can still be accused of being somewhat dirty and unpleasant. It is of value in washing out a bleeding cavity such as the bladder, one ounce of the extract being added to a pint of hot saline.

Adrenalin Chloride is prepared from the medullary part of the suprarenal capsule, and contains the active principle of the gland,

which, according to the experiments of Oliver and Schäfer, even in minute quantities causes an increase of the blood-pressure by constricting the arterioles. This property renders it of considerable service in cases of shock (*vide supra*).

Locally, it acts upon the vessels, causing them to contract, and so it checks the hæmorrhage. It is used most frequently in operations upon the eye and nose, when it is combined with cocaine. It can now be obtained in standard 1–1000 sterilized solution, and for use should be diluted 1–5000 to 1–10,000 according to the amount of bleeding and the size of the bleeding surface. In large doses it is toxic.

Antipyrin is largely used by several French surgeons, who speak highly of its value. It can be applied in powdered form, or made up into an ointment with an antiseptic basis.

Gelatin has been described. It is one of the best styptics we possess.

With regard to the general application of the above we would say, *never rely on a styptic when any simple surgical procedure can be employed as an alternative.*

The Application of Cold to a bleeding part has always been recognized as one of the most valuable means of arrest. Free exposure to the air is often alone sufficient to promote coagulation of the blood and constriction of the blood-vessels. This may be seen in cases of recurrent hæmorrhage after an amputation or any other large cutting operation, when a few hours after the operation the wound or the flaps become distended with blood, which may be dripping away at quite an alarming rate. In such a case, if the flaps be opened and the clots cleared out, so that the air can get to the surface of the wound and to the ends of the vessels, the bleeding will very probably cease without anything further being done, provided, of course, that no big vessel has been overlooked.

A very efficient way of applying cold is by means of the *Ether Spray*. The effect of this spray should not be pushed so far as to cause the parts to be absolutely congealed, if this can be helped, for they become very painful on thawing, and the blood-vessels being partly paralyzed the bleeding is apt to recur.

By means of this spray we have seen furious bleeding from a fungating cancer of the breast completely arrested in less than fifteen seconds.

Hot Water.—As a converse to this method of freezing, another way of stopping general oozing is the application of lint wrung out of water as hot as can be borne by the skin, i.e., about 120° F. to 130° F., but not so thoroughly as to be quite dry, and applied immediately. The mode of action would seem to be a direct stimulation of the vasoconstrictor nerves, or perhaps of the musculature of the arterioles, as a temperature of 100° to 105° is known to produce a tonic contraction of muscular tissue. The effect of hot-water injections on uterine hæmorrhages is very well understood by obstetricians, and for bleeding from a cavity or an extensive surface a hot irrigation may be employed.

When it is a mere question of choice between heat and cold, or hot water and cold applications, for checking hæmorrhage, heat should

always be chosen. The prolonged application of an ice-bag or cold water may seriously injure the vitality of tissues, while the irrigation of a large surface or cavity with ice-cold water, after much blood has been lost, will often bring on severe shock.

Actual Cautery.—We come now to "that cruel and barbarous method" of stopping bleeding which Ambrose Paré denounced, and which is rarely employed in modern surgery.

The principal forms of apparatus for the application of the actual cautery are the galvano-cautery and Paquelin's thermo-cautery.

Galvano-cautery.—This apparatus is a great advance upon the cautery irons, and is itself well enough adapted for the arrest of bleeding.

Fig. 16.—PAQUELIN'S THERMO-CAUTERY.

The principle on which it depends is that platinum, a metal of high resistance and great infusibility, will become red or white hot if a galvanic current of sufficient intensity be passed through it. Though frequently heated, platinum does not become oxidized.

The wires from a cautery battery are connected by binding screws to the handle of the galvano-cautery instruments. In the handle the wires are continued to the joints which receive the platinum terminals or rheophore. One of these wires is broken, so that only when the knob is pressed or the trigger pulled is the circuit complete. In this way the current passes through the rheophore when the current is brought into action, and then only, whether it be a

noose of wire or some other burner. The resistance to this current in the platinum is so great that heat is generated sufficient to cause the wire to become of a dazzling whiteness. If the rheophore used be of the kind known as the *Galvanic Ecraseur* the wire to be heated is so arranged that it can be shortened up like a snare.

Two great advantages are possessed by the galvano-cautery. The first is that a very small pointed rheophore may be used to a limited bleeding surface without its losing heat before it can be well applied. The second is that the wire as a noose can be fitted with the fingers round whatever requires cauterization, before the knob is pressed and the wire becomes hot. This, as may be imagined, is very often an enormous gain. The difficulty of its use lies in keeping the temperature of the wire low enough, when once contact has been made.

The introduction of electricity for lighting purposes has rendered the use of the galvano-cautery much more available, for by suitable apparatus it can be attached to the mains and is thus always ready.

Paquelin's Cautery is a very serviceable means of employing heat. It depends on the principle that when the vapour of benzoline or some other hydrocarbon is driven over heated platinum, its rapid incandescence is sufficient to maintain this heat very perfectly. In *Fig.* 16 it will be seen that with an ordinary Higginson's syringe and safety ball to give a continuous blast, atmospheric air is blown over the surface of the benzoline, and then, being saturated with its vapour, passes on through the tube and the holder, and thence into the platinum point, which contains some spongy platinum.

The platinum point having been first heated in a spirit flame until it just begins to glow, the ball of the syringe is worked by hand, and the air, charged with benzoline, undergoes active combustion as it passes through the point, and thus not only maintains its heat, but increases it to whiteness.

The readiest way to heat the platinum is to use the spirit lamp as a blow-pipe flame, for which it is generally arranged. As before, the heat to employ as a styptic is a dull, almost invisible, red.

The cautery should be in charge of an assistant who has nothing else to do to distract his attention, and care must be taken that the benzoline is quite pure.

Chapter VII.

OF SOME OF THE PRINCIPAL DRUGS USED INTERNALLY FOR THE ARREST OF BLEEDING.

A LIST of all the drugs which have been administered with the intention of directly or indirectly arresting hæmorrhage would be found to comprise a very large section of the Pharmacopœia. Such a list, however, unaccompanied by full descriptions of all the cases in which the drugs might individually be indicated, would only be useless. But those now to be mentioned have all proved themselves hæmostatics of more or less power, and a knowledge of their comparative activity is very necessary to the practitioner.

It is, naturally, in cases of internal hæmorrhage that hæmostatic drugs are most often used. It seems unnecessary to employ constitutional remedies when the loss of blood can be mechanically restrained, and so it happens that those remedies which affect the vessels, the vasomotor nerves, the blood, or the cardiac activity, and which may effectually restrain a loss of blood from any part, are brought into service only when the bleeding comes from parts out of reach of surgical interference.

Iron heads the list of the internal remedies for bleeding, and the employment of the perchloride has been so often mentioned that it is unnecessary to do more than remind the student that, as a hæmostatic, the doses must be full, say 30 or 40 drops of the liq. ferri perchlor. It is, however, exceedingly unpleasant to take.

Acetate of Lead, especially when combined with opium, is of frequent use in hæmoptysis and similar bleedings. A common preparation is the pil. plumbi c. opio, in 2- to 4-gr. doses. The proportion of the lead salt in the pill is large (three-quarters of the whole); therefore, although at first it may be necessary to repeat the dose at short intervals, it must not be persevered with for more than two or three days. It is also useful in hæmorrhages from the bowels in enteric fever.

Opium or Morphia has also been used alone in hæmoptysis, given in small and frequent doses, and with very good results. For example, the hypodermic injection of $\frac{1}{6}$ gr. of morphia, followed by injections of $\frac{1}{8}$ gr. at intervals of three hours, is often very successful.

Turpentine is sometimes employed—in doses of 5 to 10 min.—and has been highly recommended for hæmorrhage from sloughing cavities;

gauze soaked in turpentine being packed into the wound, which rapidly cleans under the influence of this drug.

Ergot and Ergotine –The active principle of ergot of rye has a very powerful effect on all organic muscular fibre, and especialty on the walls of the blood-vessels, and the uterus. There is no doubt that the dry gangrene, caused by eating bread made from "spurred rye," is due to the prolonged spasm of the arterioles of the extremities. As might be expected, therefore, preparations of ergot are powerful hæmostatics; the principal ones used are the liquid extract of ergot and ergotine. The former is given by the mouth, in doses of 20 to 40 min., or a drachm, the latter in 1- to 5-gr. doses, generally hypodermically. The liquid extract is most commonly used, but to be trustworthy it must be freshly prepared. The Pharmacopœia of 1898 has added to it an injectio ergotæ hypodermica. It is prepared from the extractum ergotæ liquidum of 1898 (which is made with 90 per cent of alcohol instead of rectified spirit), and the dose is 3 to 10 min.

More recently preparations of the active principle of ergot, ergotinine citrate, have been put forward, which can be administered hypodermically in doses of from $\frac{1}{10}$ to $\frac{1}{5}$ gr. It has given good results.

For the special action of ergot on the uterus, and the indications for its employment in hæmorrhage therefrom, and as a stimulant to its muscular contraction, the student is referred to works on midwifery; in hæmoptysis, epistaxis, enteric hæmorrhage, the hæmorrhagic diathesis (*vide supra*), and in purpura it may be successfully administered. A combination of ergot and opium is very useful in the hæmaturia caused by growths of the bladder.

℞ Ext. Ergotæ Liq. ℥ss | Inf. Buchu ad ℥j
Tinct. Opii ♏v |
℥j t.d.s.

Digitalis, whose constitutional action on the arterioles in many ways resembles that of ergot, may also be used as a hæmostatic, especially in hæmoptysis, menorrhagia, and in some forms of recurrent nose-bleeding. It must be given with the same precautions as when employed in other cases. The *tincture* and the *infusion* are the most useful preparations, and there appear to he certain advantages in using a mixture of these, e.g., 10 min. of the tincture with ½ oz. of the infusion for a dose.

Most of the acids used as therapeutic agents, but especially **Sulphuric Acid,** are useful in checking bleeding from various internal organs; thus the *dilute sulphuric acid,* or the *aromatic sulphuric acid,* in doses of 10 to 30 minims, is found useful in hæmoptysis.

In addition to these principal drugs, the following should be mentioned as having a reputation as hæmostatics, but which do not require a detailed description, namely, preparations of **Alum, Gallic** and **Tannic Acids, Ipecacuanha, Creosote,** and **Hamamelis.** This last, prepared from the witch hazel, restrains bleeding of all kinds, internal and external.

It is useful in bleeding piles and dysentery, or in hæmaturia, in doses of about 20 minims to a drachm of the tincture. The value of gallic acid, however, rests on a much surer foundation, especially in cases of hæmaturia. During the last few years **Chloride of Calcium** has been strongly recommended as a hæmostatic, and its use has been referred to already. It is given in doses of 10 to 15 gr. three times a day, but it should not be employed continuously over a long period, as in large and continued doses it appears to diminish, not to increase, the coagulability of the blood.

SECTION II.

OF APPARATUS FOR RESTRAINT AND SUPPORT (BANDAGES, SPLINTS, Etc.).

CHAPTER VIII.

OF BANDAGES.

THE first part of this section deals with the several kinds of **Bandages,** and the second part with **Splints** in their varieties and modes of application.

On all sides the tendency of modern surgery is towards greater simplicity in dressing wounds, and in other procedures which involve the use of bandages. The number of distinct "patterns" of bandages now in use is very much less than we find described even in recent books on the subject, and infinitely less than classical authors considered it necessary to describe and figure. Only those ways of applying bandages which are now in constant use will here be described.

Bandages may be roughly divided into Triangulars or Scarfs, Rollers, and bandages of special form, such as the T, the H, or the Many-tailed. The material of which they are made is usually grey shirting, i.e., unbleached calico, but roller bandages are often made of flannel, or of some woven material, for greater elasticity or strength; or of muslin for holding plaster-of-Paris, etc. These, with some other forms of special bandage, will be described later.

The choice of the **Form of Bandage,** and of the **Material,** will depend on consideration of such points as these:—

The Amount of Restraint or Support required. Thus, a simple triangular bandage will serve best to keep a dressing on the scalp, while a twisted or knotted roller will be required to restrain the hæmorrhage from a recent wound there.

The Effect of the Bandage on the Skin and Circulation of the part. Consideration of this point leads to the selection of the material, care as to its tightness, and choice of the best method of applying it. Thus in a limb likely to swell, an elastic pattern, such as a "figure of 8," will be chosen, while if firmness be most required, the "turned" bandage should be used.

The Length of Time the Bandage will have to be kept on. If the

bandage be for a temporary purpose only, there will not be the same elaboration required as if it were meant to be kept on for some time: in the latter case the particular plan will often be settled from considerations of future cleanliness.

THE TRIANGULAR BANDAGE.

The Triangular or Scarf Bandage is the half of a square of 36 inches, and is usually made of unbleached calico.

The first and most obvious use of this bandage is to simply tie it round where it may be wanted with a reef knot, it having been previously folded up into a *Cravat*. In a case of venesection, or the arrest of the venous circulation, or the incision may be effected by means of this bandage.

Fig. 17.
PLAN OF BANDAGE.

The *Sling* is another very useful bandage, and very quickly put on; indeed, of all the applications of the triangle it is the most frequently required. Although its application may be shown in a few seconds, a written description of it, as with other bandages and knots, is more complicated.

Fig. 18.—The Sling.


Fig. 19.—Forearm Slung, with the Elbow Hanging Free.

Let the right-angled corner (*Fig.* 17) be called A, and the upper and lower acute-angled ones B and C respectively. Standing in front of the

patient, corner **A** should be placed in the axillary line on the affected side, midway between the axilla and the ilium ; **B** should reach up to and hang over the opposite shoulder. The line **B** to **C** will then hang diagonally across the body, and between it and the arm to be slung. The arm should be placed in the required position, and **C** brought up over the shoulder on the affected side and tied with **B** in a bow behind the neck. The elbow should then be kept in position by pinning **A** round it as shown in the figure (*Fig.* 18.)

In *Slinging the Fore-arm* the sling should be made just short enough to slightly elevate the shoulder, or the patient will not trust all the weight of the limb to it. The hand should be a little higher than the elbow. Sometimes, as in fractures of the humerus, the weight of the forearm is used as an extension, while the hand and wrist alone are slung by the bandage folded up into a cravat, three or four inches wide, and tied behind the neck. *In this case the positions of the ends of the sling should be reversed, the anterior going over the shoulder of the unaffected side* (*Fig.* 19).

THE ROLLER BANDAGE.

To bandage neatly is to bandage well, and to be able to bandage well is essential to the practical surgeon. The art of using the roller bandage properly is one not to be learned without practice, even though it be freely allowed that the subject has been quite uselessly complicated by needless rules and patterns.

Materials.—Regarding the materials for these roller bandages, it has been said before that a strip of any stuff which fulfils the conditions of sufficient strength, with lightness and softness, will do. The length of the strip varies from 4½ to 6 yards, the width from 2 to 4 inches ; 2½ and 3½ inches being the commonest sizes ; the larger sizes, 6 inches, are known as " rib rollers."

For the purposes of description roller bandages may be divided into **Elastic, Semi-elastic,** and **In-elastic** kinds.

Elastic bandages, of which there are several kinds, woven, india-rubber, etc., will be found described in Chap. IX.

The *Semi-elastic* bandages are either woven in a special manner, or made of a somewhat elastic material. Under this heading come all flannel bandages, domette, cotton or silk net.

The application of these bandages is much more simple than that of the in-elastic, for they will lie smoothly if they are merely rolled on firmly, so that they hardly ever require turning or other manipulation. They should be rolled up rather loosely before use.

The *In-elastic* or common bandages are the most frequently used, especially in hospital, where the other kinds would be too expensive, even if they were firm enough for the requirements.

They are usually made of " grey shirting " or unbleached calico, or the same bleached ; or, for bandages about the eyes or face, a very cool light bandage may be made of finer cotton stuff or linen. Very

old worn damask linen is not infrequently used for covering pads or cushions, and speaking generally, it may be said that washed stuffs are better than new, which are apt to contain a stiffening dressing. They should always be torn, and no selvage retained.

The general rule is to use the 2½-in. bandage for the arms and head, the 3½-in. for the legs and pelvis, and the 4½-in. width for the chest and abdomen. Except for the trunk, however, it will be found that the narrowest bandage is the easiest and the most comfortable to apply in all cases.

Fig. 20.—Leg Bandaged with a Simple Spiral Roller.

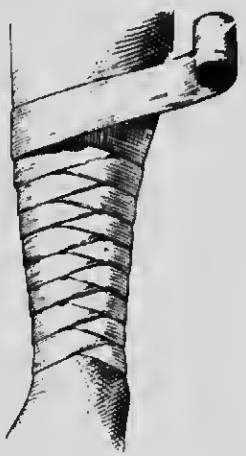


Fig. 21.—Leg Bandaged with the "Reversed" Spiral.

The latter grasps the limb evenly, the former does not.

Fig. 22.—Forearm Bandaged Above with a "Reversed," Below with a Simple, Spiral.

Application. — In order to apply the *Common Roller Bandage* to any part of the body, the first thing to learn is how to judge of the firmness and support required, and to distribute the pressure evenly about the limb. For this purpose the bandage must always be kept rolled up (dropping it is a sure sign of a bungler or beginner), and held

(as in *Fig.* 23) three or four inches away from the part, while the finger and thumb are used to retain the bandage in its place when it is being applied. The next point is the manipulation known as *turning* or *reversing*, by means of which the bandage is turned over on itself while it is being applied. The object of this turning is that the bandage may lie smoothly, and be firm as well, for inasmuch as all parts of the limbs, etc., are constantly varying in diameter, and the edges of the bandage will not stretch to make one side longer than the other, it follows that if it be simply rolled on in a spiral fashion, only the largest diameter of the limb covered by each turn of the bandage will be grasped by it, and the bandage will be loose elsewhere, as in *Fig.* 20 and the lower part of *Fig.* 22.

Fig. 23.—Application of the Reversed Spiral.

Fig. 24.—Reversed Spiral of Foot and Leg.

To avoid this the bandage is, when necessary, *turned over* as in *Fig.* 21, and by this means the upper and lower edges are frequently changed, so that the whole width of the bandage grips the limb. This turning requires a little knack, but is easily learned. The secret of doing it well consists in having the portion in the hand (*Fig.* 23) quite loose, so that by bringing the roller down it naturally falls over. The thumb must, therefore, be holding the turn of the bandage last applied during this manœuvre. Moreover, the bandage should be brought across the limb with a good slope upwards, say 45° to the long axis, and the reverse similarly be brought boldly down, so that the bandage is well doubled over, otherwise some of the fold will appear on the other side of the limb when the bandage comes round.

The most common fault is that of screwing the roller round on its own axis, instead of allowing the bandage to fall over into position, as it should do almost of its own accord.

As a rule it is best to turn every time the bandage comes round, and the turns should be made in the same straight line, which should lie on the outer aspect of the limb. But these points are not essential, and indeed both depend rather on the æsthetics of bandaging, than on any practical advantage.

General Rules for Bandaging.—Bandage from below upwards, and always have the upper part of the bandage looser than the lower.

Bandage smoothly without irregularities or creases.

Start bandaging from within outwards, except in fractures of the femur and Pott's fracture at the ankle.

Do not bandage a limb underneath splints. There are exceptions to this rule, as will be seen later.

Pass the end of the bandage obliquely across the limb at the start, and fix it with one or two turns round the limb so that it does not slip.

Before applying the bandage, wash and shave the limb and dust it with starch and boracic powder.

The roller bandage with reverses is the commonest of all the ways of bandaging. It may be applied to the trunk or limbs (as in *Figs.* 23 and 24), to fasten splints, and on an infinite number of other occasions. Nevertheless it is somewhat liable to slip, is not elastic, and is not suited for the neighbourhood of joints.

Fig. 25.—Double-headed Spiral with Reverses.

In its stead, a pattern of roller bandage which is hardly ever used in England might well be employed more frequently, namely, the **Double-headed Spiral with Reverses** (*Fig.* 25). Its description, like that of many other bandages, is more complex than its application. The bandage is a combination of a simple spiral roller with a reversed spiral, so that whilst one head of the roller is applied spirally, each of the turns thus made is covered and fixed by a reversed turn made with the other head. Inasmuch as even compression can always (other things being equal) be more efficiently made with a double-headed than with a single roller, the value of this pattern lies in the firmness with which it can be applied to a limb, while it is nearly impossible for it to slip. The heads must, of course, be of unequal length, that used for the reverses being the longer. The pattern requires some practice to apply with ease, but the labour will be well spent.

A pattern which is at once firm and elastic, and which can be applied over most articulations, is the **Figure of 8** (*Fig.* 26). This bandage, when applied to the length of the limb, or over a joint so as to cover it completely, presents much the same appearance when finished as the spiral roller with reverses (compare (*Figs.* 24 and 26), but in its application it is entirely different. The illustration will give a better idea of its application than any words can do. The great point to bear in mind is to make the loops of the 8 as open as possible, by going boldly up the limb and coming down again as far as the bandage will allow.

As has been implied, this bandage may be employed in almost all the cases in which the turned bandage is generally used, and it is often really preferable, being not less firm and yet more elastic, but as a rule its employment is confined to the neighbourhood of joints, so

Fig. 26.—APPLICATION OF THE FIGURE OF 8 BANDAGE TO A LIMB.

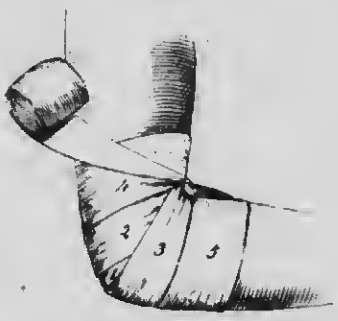


Fig. 27.—FIGURE OF 8 FOR BEND OF ELBOW.

that if a limb and a joint or joints have to be bandaged, say the ankle, leg, knee and thigh, there would be a turn or two placed round the foot, then the ankle would have the figure of 8 (leaving the heel), the leg the turned (see *Fig.* 24), the knee the 8, and the thigh the turned bandage again.

One practical reason for this changing is that the figure of 8 requires twice as much bandage to cover a limb as the turned spiral.

The 8 bandage is also used for *Joints*, simply as one or two turns, crossing over the centre of the flexor aspect of the joint (*Fig.* 27). This pattern is useful in a number of cases which need not be mentioned in detail.

The Point of the Heel and the *Point of the Elbow*, with their respective joints, may be completely covered by a series of enlarging figures of 8.

starting from the centre, having the crossing placed over the front of the joint, and the loops above and below the line drawn from the middle of the front of the joint to the heel or the olecranon, and getting always more and more open, and further away from the middle line, as the bandage progresses. In this way the elbow may be conveniently bandaged. The heel pattern is nearly or quite the hardest one to adjust of all the common forms. It is very neat looking, but it is seldom worth the trouble of its application, save as an exercise in bandaging.

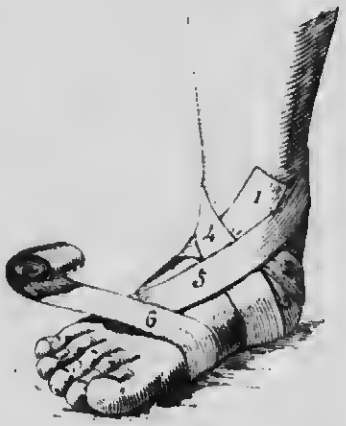


Fig. 28.
BANDAGE TAKING IN THE HEEL.

The Spica (Spike or Spathe, a botanical term applied to heads of seeds arranged as in an ear of wheat) is extremely useful for applying firm pressure to joints, or fastening dressings over them. The pattern is the same, whether the bandage be applied to the shoulder, groin, thumb, or great toe, and is that of a figure of **8**, combined with a firm attachment to a limb in the neighbourhood of the joint—the wrist for the thumb, the arm for the shoulder, the thigh for the groin, and the ankle for the great toe. Taking the *Spica of the Groin* as an example (*Fig.* 29), the bandage begins by two or three reversed turns from within outwards (or

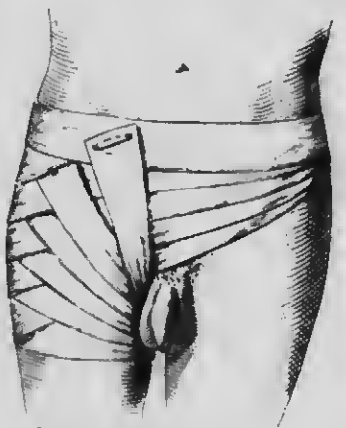


Fig. 29.—SPICA OF GROIN.

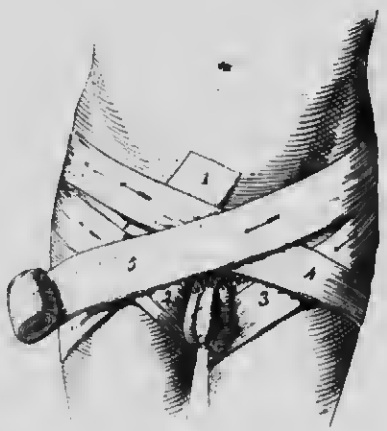


Fig. 30.—DOUBLE SPICA.

overlapping 8's) round the top of the thigh. The bandage is then carried outwards over the groin to just below the anterior spine of the ilium, and then round the back, taking care to keep just

below the iliac crest. The bandage is then brought obliquely across over the symphysis pubis, crossing over the starting-point to reach the outer part of the top of the thigh, and is then passed round it, and brought up ready to repeat the roll, but this time a little lower down, and so on till the groin and hip are sufficiently covered. The hip should be very slightly flexed at the time, and care must be taken not to slip on to the abdomen with the bandage as it is passed round the brim of the false pelvis.

Double Spica.—With a long bandage the spica may be easily enough applied to *both groins*, starting from one side and repeating every manœuvre on the other before returning (*Fig.* 30); but in practice this is a bandage very rarely used, and requires mention only.

The principle of the spica being understood, a detailed description of the different applications of the pattern is not called for, and the

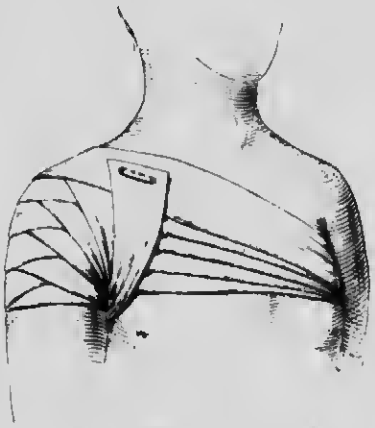


Fig. 31.—SPICA OF SHOULDER.

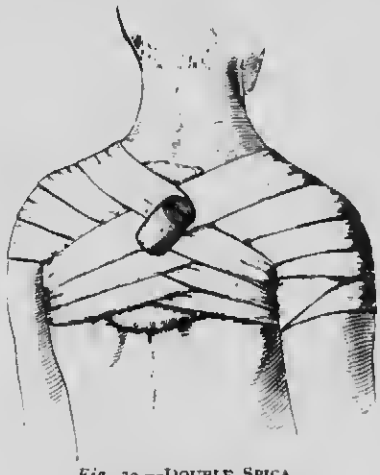


Fig. 32.—DOUBLE SPICA (useful in fracture of the clavicle).

especial points only will be noticed. *The Spica of the Shoulder* is an extremely firm bandage (*Figs.* 31, 32); the starting-point is taken from the upper arm, the turns being rolled round as high as the axillary folds will allow. The bandage is then brought through the axilla, over the shoulder and round the chest, passing under the opposite armpit, and the crossing of the first turn should go as high up upon the shoulder as the bandage will lie. This pattern requires a long bandage, and it may, as in the case of the groin spica, be doubled for both shoulders if required.

The Spica of the Thumb (*Fig.* 33) is the regular bandage for the common sprain of that joint. As with the bandages for the phalanges, the roller must be quite narrow, not more than three-quarters of an inch wide. The spica is begun with a few turns round the wrist, from within outwards, if the outside of the thumb is to be the most supported,

and the reverse if the ball be the part requiring the firmer pressure. It is then taken round the thumb as high as the bandage will lie, and the succeeding turns lower and lower (as in all spicas) till the ball is covered. It is then fastened round the wrist either by a safety pin, or by splitting the end of the bandage into two tails, which are tied together. *The Spica of the Big Toe* (*Fig.* 33) is applied in precisely the same way, the ankle standing in the place of the wrist. It is,

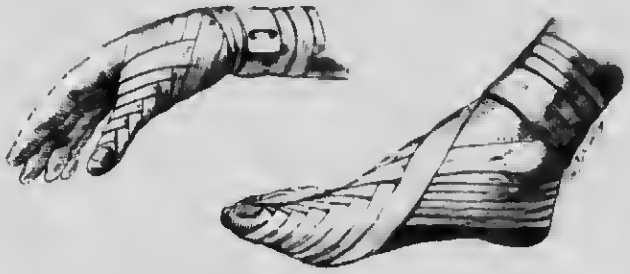


Fig. 33.—Spicas of the Thumb and Big Toe.

however, more difficult to apply without getting an awkward quantity of bandage material between the toes.

The Fingers may sometimes be sufficiently covered with a simple spiral bandage, or with reverses or 8's, using a narrow bandage with neat edges, commencing at the tip, and finishing off at the root of the finger.

The *Bandage for a Stump* (*Figs.* 34, 35) is a pattern known as the **Recurrent Bandage.** The roller for this should never be more than

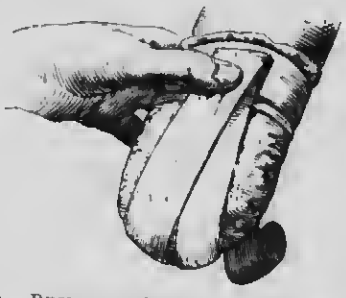


Fig. 34.—Recurrent Bandage for Stump.

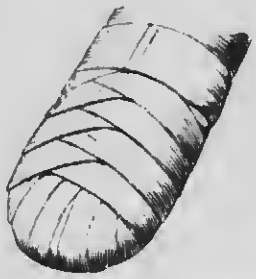
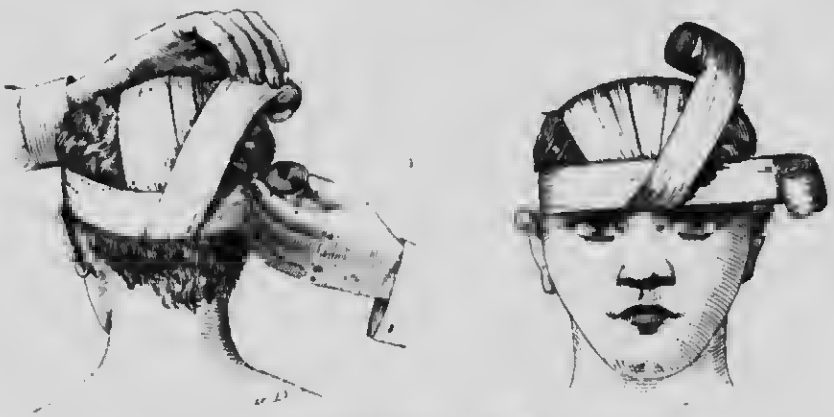


Fig. 35.—The Bandage Complete.

two inches wide, and for an amputation of the arm, or for a "Syme," it may well be still narrower. The bandage is first attached three or four inches above the stump by one or two circular turns, and then, the thumb being placed over the middle of these turns in front and the forefinger similarly behind, it is brought right over the face of the stump from the middle line in front to the same point behind.

This reverse is kept in its place behind by the forefinger, and the bandage is brought back again, now a little to one side of the middle, but converging to that point when it reaches its starting-point. This is then fixed by the thumb, and the bandage is brought over again, passing this time to the other side of the middle line, and converging to it behind. These reverses are continued till the whole stump is covered, and then by one or two firm circular turns they are fixed in the position in which they were held by the thumb and finger, as shown (*Fig.* 35). It is often wise to make a circular turn or two in the course of making the reverses, so as to fix those already made. This pattern may also be put on so as to cover half or all the head (*Fig.* 36), but to be secure the circular turns must be kept low down on the forehead and well below the occipital protuberance.



Figs. 36, 37.—Double-headed Roller, or Capeline.

Amputation Stumps and also the *Head* may be bandaged by a method which, although it results in a pattern which looks like the recurrent, is yet different in principle, and firmer—namely, by the use of a **"Double-headed" Roller** i.e., a bandage, both ends of which are rolled up towards each other in the centre. This is the bandage which when applied to the head is known as the **"Capeline"** (*Figs.* 36, 37). The application for a stump is the same in all respects. To put on the capeline it is more convenient for the patient to be sitting. The surgeon standing behind takes one head of the roller in each hand, and places the middle of the bandage on the forehead. The two parts are then brought round and crossed below the occiput. One of the ends is then continued round, and the other, which is lying below it, is turned up and brought over the head as in the "recurrent" bandage. It is now met by the other half of the bandage which has gone round the head, while this half has gone over it, and the former continued round fixes the bandage so that it can again be brought over the head, when the manœuvre is repeated. In this way, by adjusting the subsequent

turns of the bandage alternately to one side and the other of the first one, which was in the middle, either half (*Fig.* 38) or the whole of the head may be covered with folds converging to the middle line in front and behind, and a somewhat attractive bandage is made. Its appearance is, however, almost its only good quality. It is firmer than the simple recurrent bandage, but is still liable to slip unless very carefully put on. It is troublesome to apply, hot, and if at all tight round the head, apt to become painful, while it fulfils few indications which cannot be at least as well met by the more homely, but far more comfortable, triangular bandage. When applied to a stump, however, it may sometimes be useful.

Fig. 38.—Capeline for Half the Head.

Fig. 39.—Twisted Bandage for Head.

The **Twisted or Knotted Bandage** for the head (*Fig.* 39) is generally described as one which requires a double-headed roller, but this is not at all necessary or desirable. It is an extremely useful bandage, and is easy to apply. For example, taking the neighbourhood of the temple as the situation in which the pressure of the twist is required, the bandage should be unrolled for about a foot, and the end held in the right hand, which is kept close to the temple. The roller is then carried round the forehead and occiput, so that it comes back to the unrolled end at the wound. The roller is then twisted round sharply as shown in the figure, and is carried down below the chin and round to the vertex. On coming to the temple again the same twist is made, and the roller is once more passed round horizontally; when sufficient pressure is obtained the bandage is fixed by knotting the two ends together.

In discussing the treatment of fractures of the lower jaw the **Four-tailed Bandage** will be again referred to, but it may properly be described here. It is a very useful pattern, and serves for the attachment of dressings in wounds about the chin or face, as well as for fractures. For the bandage a piece of shirting four or five inches wide and two feet

long is required. It is then doubled on itself and torn down, until a piece four inches long only is left undivided in the middle. In the middle of this a slit two inches long is generally cut, in which the point of the chin is inserted, but this is sometimes omitted.

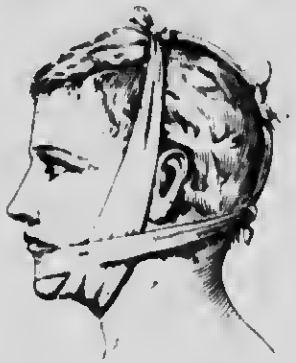


Fig. 40.
THE FOUR-TAILED BANDAGE APPLIED.

The middle of the undivided part is placed over the chin (*Fig.* 40), and the under pair of the four tails made by tearing the bandage are then brought up over the side of the face in a line with the masseter muscle, and loosely knotted or held half an inch in front of the vertex of the skull. These pass underneath the other pair, which are brought round to just above the occipital protuberance, and firmly tied together with a reef knot. The first pair on the vertex are then tied with sufficient firmness to fix the lower jaw against the upper one; and finally the vertical part is kept from slipping forwards, and the horizontal from slipping downwards, by tying the four tails together (as shown in the figure). In adjusting this bandage it is necessary to see that the length of the undivided part fits the jaw to which it has to be applied, and this can only be done by trying it on before it is finally fixed.

In *Bandaging the Chest* there is a tendency for the bandage to slip down on account of the decrease in size of the thorax from above down. This is best overcome by using a brace and bandaging from below upwards. A piece of bandage should be split in the centre and the head passed through the opening so that one end hangs down in front and the other behind (*Fig.* 41). The bandage should be applied over this, being fixed by one or two turns round the chest, and then carried up with a reverse in each turn, thus overcoming the tendency to form an open spiral. Finally, the two ends of the brace should be brought up and fixed.

Fig. 41.—BANDAGE FOR CHEST AND FOUR-TAILED BANDAGE TO JAW.

For *Bandaging the Breast* the roller is first fixed by a couple of turns round the chest, starting from and below the affected gland; it is then

carried upwards over the lower part of the breast and the opposite shoulder, descending across the back to the original starting-point, then horizontally round the chest. These turns are then repeated,

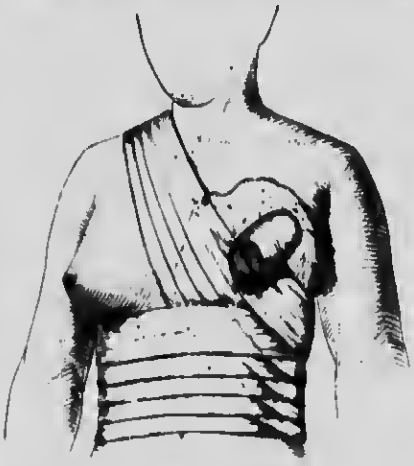


Fig. 42.—Breast Bandage.

Fig. 43.—Applied to Both Breasts.

each oblique turn being fixed by the succeeding horizontal one, and rising higher on the breast until it is covered. It is important always to bandage from the affected side (*Fig.* 42).

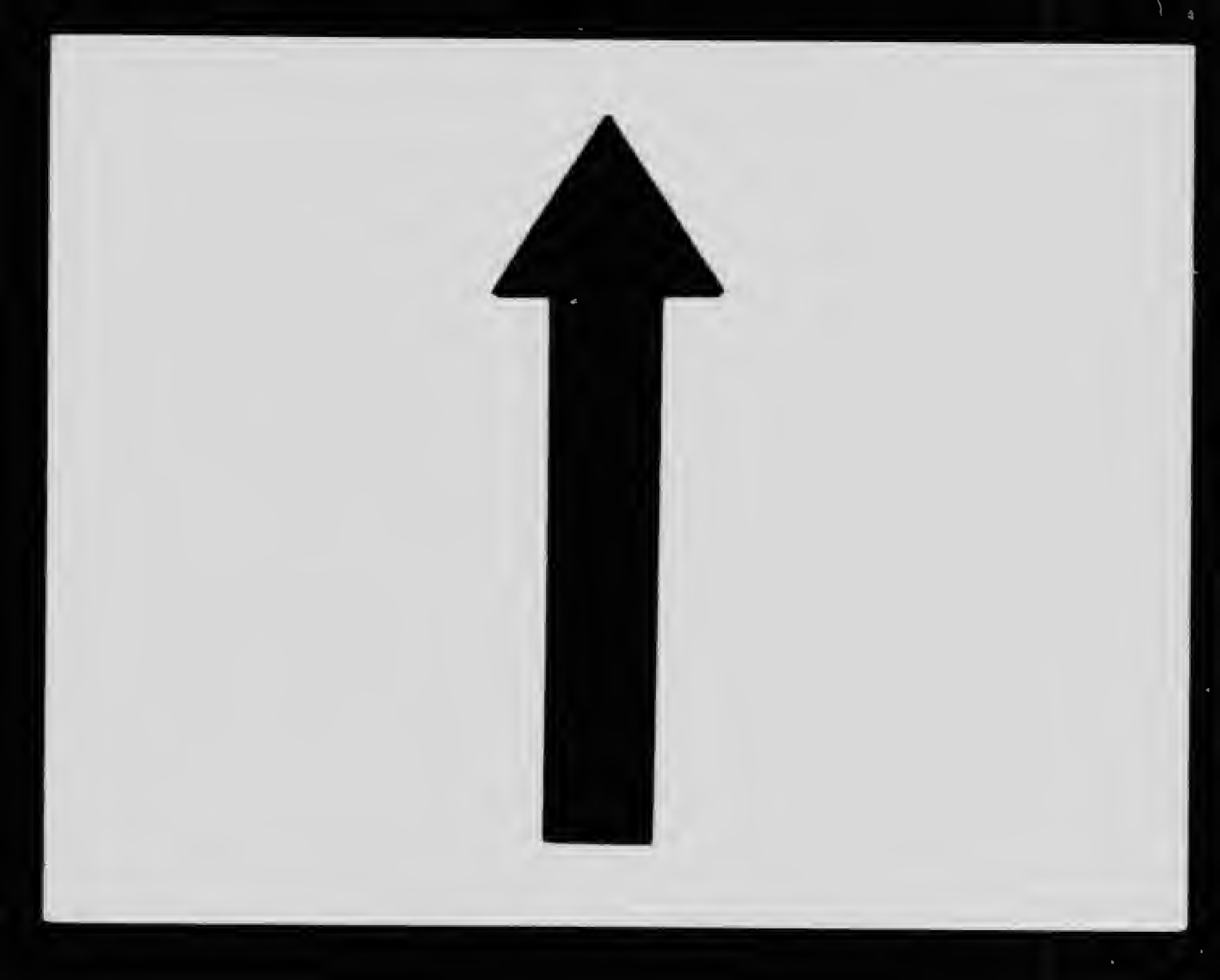
The **Single T Bandage** (*Fig.* 44) is most frequently used for fixing dressings to the *perineum*. Its application there is simple enough. The horizontal part being fixed round the waist, the other end is brought round between the legs and fastened in front.

This bandage can also be applied to the head and elsewhere. For the perineum a good average size is five feet for the horizontal piece and three feet for the vertical; it should be about three inches wide.

Fig. 44.—Single T Bandage.

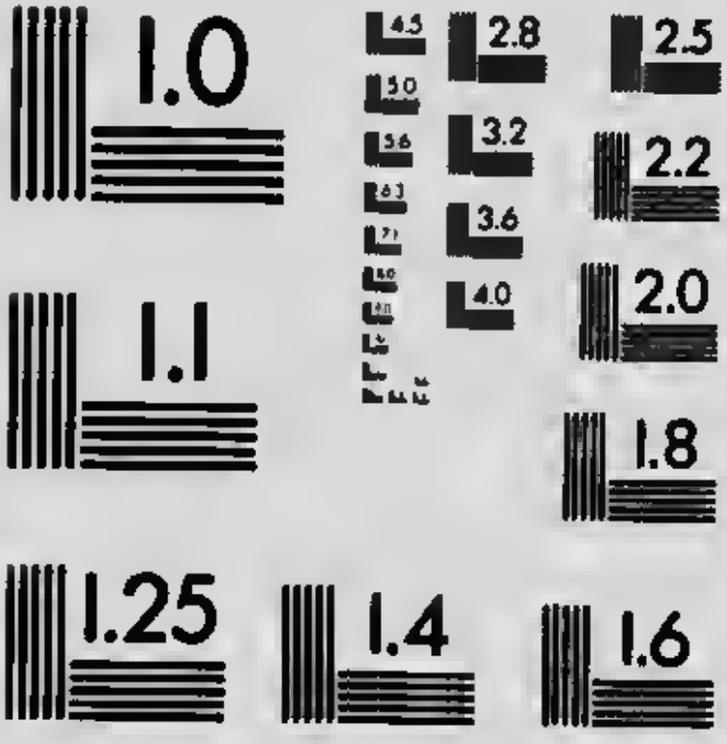
For the perineum, a better pattern is the **"Double T"** complete (*Fig.* 46), or incomplete (*Fig.* 45). The latter is made from the single one by tearing the perpendicular portion into two tails, except for five inches behind. By using either of these bandages the awkwardness of bringing up the single vertical piece in the middle line in the front is avoided.

This will be a fitting place to describe a perineal bandage, which is very convenient for keeping dressings upon the *Pubes* and *Perineum* without the necessity of displacement for the performance of the natural functions.



MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

The principle of its application can be easily understood from the following illustration (*Fig.* 47), and it is known as the "**St. Andrew's Cross.**"

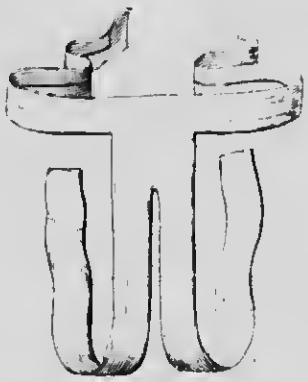


Fig. 45.—THE DOUBLE T INCOMPLETE.

Fig. 46.—THE DOUBLE T COMPLETE.

If, as in the illustration, the bandage is to be put on from the patient's right side to the left, from the front, or standing over him if he be lying down, the bandage is first fixed by a turn or two round the pelvis from right to left (1), then carried from the right anterior spine of the ilium diagonally downwards across the left groin (2), then around the left thigh upwards between the thighs to the right spine (3), then

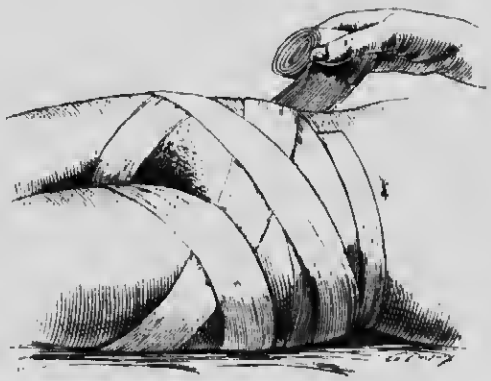


Fig. 47.—BANDAGE FOR THE PERINEUM.

around the pelvis posteriorly to the left spine, from which point it is carried down between the thighs (4), around the right buttock, and upwards across the right groin to the left spine (5), and around the pelvis to its starting-point at the left iliac spine; these turns are then repeated.

The T bandage is also a very good one to apply to the head to retain dressings. If used *for the Head* the vertical slips should be two feet long, and the horizontal one about a yard and a half, to allow of its going round the head twice or thrice. The width should be three-quarters of an inch. *For the Nose* a good bandage is the double T, or the single T with a slit in the vertical part of the requisite size to partly admit the nasal prominence; while if, in addition, a slit be made in the middle of the horizontal part of either the single or double T for the mouth, it becomes a good bandage for the application of dressings *to the Lips*.

The single or double T, or a T with a small triangular piece inserted at the junction of the vertical and horizontal portions, makes a good bandage for the *Ear*, and other modifications may be easily imagined.

Fig. 48.—Many-tailed Binder.

The many-tailed binder (*Fig.* 48) is a form of bandage frequently used in abdominal surgery, when security combined with easy application is desired. It consists of a broad band of flannel, which should extend from the lower border of the thorax to the pubes. Each end is divided into a number of strips, which may be tied separately when the bandage is in position, or, better still, may be secured by a process of overlapping the strips in series from below upwards.

Chapter IX.

OF ELASTIC BANDAGES, AND TRUSSES.

Elastic Bandages may be employed simply for support, or for some more definite object, as for promoting the absorption of fluid or the subduing of inflammation. It must be borne in mind that continued compression will surely bring about wasting, and if the circulation be interfered with, this wasting by absorption may be very great.

The Indiarubber Bandages, brought into notice by Martin, mark a distinct advance in the treatment of several morbid conditions, especially those due to impaired venous circulation, as *Varicose Eczema*, or *Ulcers of the Legs*, or of *Œdema* elsewhere. They are used also in the treatment of more active inflammatory swelling, and in the dressing of operation wounds, as, for example, after an excision of the breast when it is desirable to make a firm but gentle pressure upon the parts. These bandages are made of a special kind of rubber, and are of the lengths and widths of ordinary rollers. Before applying them the limbs should always be raised for some time. The hour of rising is, therefore, the best time to put them on. These bandages are put on in the same way as the common forms, but it is easier to apply them too tightly than the reverse, for they stretch so readily that the amount of compression actually exercised is apt to be underestimated. They should never be applied directly to a moist eczematous surface, or to an ulcer. Oil speedily rots them.

There are several varieties of **Woven Bandages** which are more or less elastic, and may be used for the purposes above mentioned fairly satisfactorily. All these may be applied as simple spirals without reverses.

The introduction of the **Crêpe Velpeau Elastic Bandage** has practically superseded the old elastic stocking or knee-cap. When a firm support is needed, as for a leg swollen with varicose veins or a joint distended with fluid, nothing is better than a well-applied crêpe Velpeau (*see* "General Rules for Bandaging," p. 65).

Of **Suspensory Bandages** there are several patterns in silk and cotton, and no directions as to their choice are necessary, further than that care should be taken that they fit, and that there is no chafing between the scrotum and the groins.

Although they are frequently worn by people who do not require them, they are useful in cases of simple laxity of the dartos tissues so common in hot weather, or in slight cases of varicocele. They

should be worn in all cases where hydrocele is present, to prevent the unpleasant dragging of the distended tunica vaginalis. They also certainly prevent the sac from filling as quickly as it otherwise would do.

Abdominal Belts.—In London, and probably elsewhere, a bad habit prevails among labouring men of wearing a broad webbing belt, stiffened with steel or whalebone, round the abdomen, with some hazy idea that they thereby save the muscles of the back. Of course, any result in this direction must be a weakening, by impeding free muscular play, but these belts are, in addition, very important agents in the causation of hernia by concentrating the outward pressure of the contents of the abdomen upon the weak places in its walls. Where, however, the abdominal walls are lax and pendulous, especially in fat women, a well-made abdominal belt is often necessary, and is far better than any form of stays. In fitting the belt, the points to be attended to are that it should be so applied that the line of support is *upwards*, and that some elastic material form a part of the belt, so that there is nowhere a rigid constriction. These belts should always be laced, and to prevent their slipping up, it is advisable to order a perineal band.

Trusses.—This will be a convenient place to speak of these very important surgical appliances, which every student should know how to measure for and apply; for, while a well-fitting truss should in most cases absolutely remedy the inconveniences and dangers of a rupture, a badly-fitting or a badly adjusted [illegible] is a positive risk to the wearer.

Broadly speaking, a truss is a pad connected with a spring, by means of which an aperture or weak place in the abdominal walls or elsewhere is rendered as strong as the rest, or by which (as in cases of irreducible scrotal rupture) a portion of the contents which have protruded may be supported and guarded from injury.

Putting aside the question of *operative* interference, it may be said that every hernia of the intestines through any part of the abdominal walls calls for the support of a truss, however slight may be the protrusion; but does occasionally happen that great difficulties exist in the way of their application through the hernia being complicated with a malposition of the testis.

Trusses may be divided into ordinary and special forms. The ordinary form of trusses are *Inguinal*, *Femoral*, and *Umbilical*, and the two former may be double or single. The special forms are *Scrotal*, *Obturator*, *Vaginal*, *etc.*

Fitting Inguinal, Inguino-scrotal, and Femoral Trusses.—To measure a patient for a truss, make him lie down on a couch; pass a measuring tape round the buttocks two inches below the iliac crest, passing over the region of the hernia and making the tape meet at the centre of the symphysis pubis. The number of inches corresponds to the size of the truss, but it is usual to order a size slightly smaller, so that if the measurement is 35 inches, and the hernia a right inguinal, one would order a right inguinal truss 34½ inches. But it is not sufficient

for the surgeon to content himself with taking the measurement, and then to order a truss; nor should he leave the question of the kind and strength of the instrument to a surgical mechanician. He should be able to state precisely the sort of truss required, and the best kind and shape of pad, and should, further, not only be able to recognize when a truss does not fit, but to know exactly where and in what the failure consists.

There are very many varieties of trusses, differing from each other in the shape and substance of the pad, in the nature of the spring, in their covering material, and so on, but putting aside fantastic patterns, they will all be found to consist of a circular spring made of one piece of tempered steel, with a pad attached directly to it. In only one form in common use, the *Moc-main*, is the principle of the circular spring absent, and this kind is not recommended. The spring must be light and elastic, and of just sufficient strength to retain the rupture, neither allowing it to descend behind the pad, nor exercising such pressure as might serve to weaken the hernial aperture. The spring must further fit and *cling* round the pelvis just below the iliac crest,

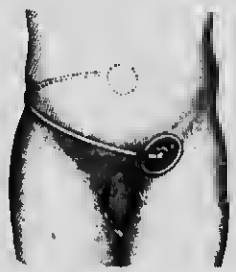


Fig. 49.—Single Truss (Salmon's).

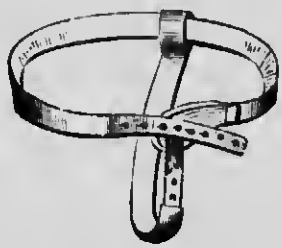


Fig. 50.—Ordinary Circular Spring Truss.

and above the fleshy parts of the glutei, which, by their working, would move it up and down if it were in contact with them. It must especially fit flat to the base of the sacrum when the pad is in position against the rupture.

According to some patterns it here terminates in a flat pad (*Fig.* 49), in others the spring is continued round until two-thirds of the pelvis are encircled, as in *Fig.* 50 (we are speaking of single trusses only), but in either case the circle of the pelvis is almost always completed by a leather strap which comes round and is fastened to the upper of two studs which are found on the pad.

It will be seen, therefore, that the truss spring, though it be termed *Circular*, must never be a segment of a circle, but must consist of a combination of curves, different in different patients. A man with large muscular buttocks, with the glutei coming right up to the top of the crest, will require the spring to be more open round the ilium, and to take its bearing chiefly from the base of the sacrum, while in a spare person it should lie close up against the bone everywhere.

The *Strength* of the spring will vary according to the ease with which the rupture can be restrained, the presence or absence of habitual cough, and the occupation of the wearer. A city clerk will not require one of the same strength as that suited for a porter or a navvy. Speaking generally, the spring must exert a sufficient, but only sufficient, pressure inwards when the wearer is at rest, but this pressure must quickly and greatly be increased with any increase of the outward pressure of the rupture.

Although the shape and strength of the spring must differ in different people, most cases will be found to fall into one of two or three types, so that an instrument maker who understands the principles of truss-fitting will not require to make one specially for every patient; but in all cases of difficulty or peculiarity the spring must be hammered up to the shape of the wearer previous to a final tempering. If any alteration be required it is easy to render the metal again sufficiently malleable to effect the change, and once more to stiffen it

The *Pad* should be firmly attached to the spring, and its upper edge should be a continuation of the down sloping line which the truss should take from the bend below the front iliac spine. The direction and shape of the rest of the pad vary according to the size of the

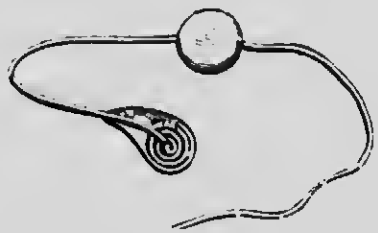


Fig. 51.—COLES' TRUSS, SHOWING SPIRAL PAD.

aperture, and its position, i.e., whether it is inguinal or femoral, but it is generally pear-shaped, about two and a half inches long, and two inches wide. Upon its outer surface are two studs, the upper one for the attachment of the encircling strap, the lower one for the thigh strap. The inner surface of the pad should be nearly flat, and must in most cases be directed slightly upwards.

There are a great number of pads in use, differing more or less from each other. For labouring men and hospital patients probably the best is a leather cushion well stuffed with hair. Coles' trusses have a coiled spring within a metal shield which yields to the movements of the wearer, and itself exerting pressure enables the truss spring to be very light; it is a very good pattern both of truss and pad (*Fig.* 51). Other pads again are made of solid indiarubber, cork, or wood, or of indiarubber inflated (air pads) or filled with glycerin.

The truss generally, but especially the pad, should be *easily kept clean*, and must not absorb the sweat. In warm weather, adults as

well as children will find starch, iolet powder, or fuller's earth very useful applications for the skin. Another good plan is to have a set of cotton covers made to slip over the pad, which can be changed and washed as often as may be required.

The *Thigh Strap*, an important part of the truss, is intended to prevent the pad slipping up when the wearer is moving. It should be fastened round the spring just behind the bend of the "shoulder" (i.e., below the front of the iliac crest), and running in the fold of the buttock come up in front through the fork and be attached to the lower of the two studs on the pad, as before mentioned. It should be adjusted so as to be just felt to be tight when the wearer is standing upright.

The special points to pay attention to in connection with trusses for *Inguinal* and *Inguino-scrotal Herniæ* are, to see that the pad presses over the internal abdominal ring and over the canal, as far as, but not beyond, the external ring, and that the surface of the pad directly opposes that of the protrusion, which will vary in different cases, but will generally be downwards and inwards. Under no circumstances should the pad ever touch the pubes, and if for any reason it has to extend over that bone it must be fashioned with an indentation to avoid contact.

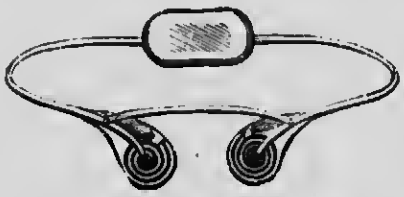


Fig. 52.—Coles' Double Truss.

Fig. 53.—Rat-tailed Truss for Scrotal Rupture.

In trusses for *Femoral Herniæ* the chief characteristic is in the direction of the pad; instead of being directed obliquely downwards and inwards, it falls almost vertically, so as to lie along the femoral canal; the encircling spring also should fall more decidedly from the "shoulder" below the iliac spine. The top stud, for the attachment of the belt which completes the circle of the spring, must be placed quite at the top of the pad, or upon the spring itself, and the thigh-piece must have its stud at the bottom of the pad, so as to keep the latter well down; it must not press on the femoral vein.

It was formerly not an uncommon practice for *Double Trusses* to be worn for single herniæ with the notion that the development of a possible second hernia was thereby prevented. The practice is a bad one, for pressure where it is not required only weakens the part by absorption. If symptoms of hernia, however, are present on both

sides, the principles of the application of a double truss are the same as those we have just stated, but the spring will now run round from one pad to the other, and the two will be connected by a small cross strap. Two thigh straps will be required, one for each side.

Trusses must be worn continuously during the day (unless the patient be lying down) and taken off only on getting into bed. In cases of chronic cough it may be advisable to wear the truss day and night, and in this case it should be taken off morning and evening and the skin powdered.

In cases of rupture where the hernia is very large, and descends through a large aperture into the *Scrotum*, a truss with a specially made supporting pad will have to be employed. The exact shape and direction of the pad will vary in each case, and the truss has to be made much stronger than for ordinary ruptures. Further, it will often be found that the rupture is not returnable, in part or altogether: it is then termed irreducible, and a cup-shaped pad must be fashioned for its support.

If a hernia is very voluminous and irreducible, a hinged cup truss or a strong bag must be fitted so as to support the hernia. A good deal of ingenuity is required in fitting a support on a large scrotal rupture which, while keeping the hernia back or affording it sufficient support, does not chafe the skin or exert undue pressure. We are considering only those cases where, for some serious reason, an operation is contraindicated—for in all favourable cases an irreducible hernia should be subjected to operation, as it is a potential cause of strangulation.

The question of fitting trusses *on very Young Infants* is often a difficult one to decide. Undoubtedly some infants badly ruptured are too weakly to bear even the moderate pressure of a truss, but we believe that if the instrument be light, and properly fitting, this will very rarely be the case, and it should be borne in mind that in infants a good truss is frequently a means of cure, that, indeed, cure generally takes place if the rupture be the ordinary congenital hernia into the vaginal process. At no age is a truss contraindicated, though undoubtedly in newly-born children great care will have to be taken to prevent chafing, in consequence of their incontinent habits. The trusses for infants should either be "Coles'" or some similar light pattern, covered all over with indiarubber, or of a kind which has been recently introduced, in which a flexible indiarubber *belt* (no spring) goes round the pelvis, and is connected with an air pad, of which there are different shapes.

It has just been stated that many cases of infantile hernia get well of themselves, and that others will get well under spring trusses, or mechanical trusses of other kinds. There is no surgeon of any experience of these cases who does not know that if infantile ruptures are continuously retained completely within the abdomen they will get well, and that very quickly, whatever form of truss

is adopted—unless some persistent cause exists which favours the descent of the hernia, such as whooping-cough, phimosis, calculus, or prolapsus ani.

But mechanical trusses have undoubted drawbacks in the quickness with which, by the rapidity of infantile growth, they are rendered inefficient; in the difficulty with which they can be kept clean; their liability, if spring trusses, to break, and the ease with which the tender skin becomes sore from their use.

Two great *Predisposing Causes of Rupture in Infants* may here be mentioned. One is the foolish habit of sewing a tight abdominal "binder" round the unfortunate baby; the other is the frequent occurrence of phimosis. It will often be found that a rupture will undergo spontaneous cure after circumcision, and although on this account the application of the truss should not be postponed, still the operation, always advisable in phimosis or when the foreskin is long, becomes the more urgent when the child is also ruptured.

Though it may seem superfluous, it will be found not infrequently necessary to caution mothers against putting on a truss over the neck of a rupture when it is down, instead of returning it first.

Umbilical Hernia in Infants is extremely common; in children it is less often met with, and in adults, especially in corpulent women, it is not infrequent. In the latter, however, it is more common to find the bowel coming through a little to one side of the true umbilicus.

In Children this condition can usually be cured readily enough by wearing a spring truss, or what is much more common, a belt with a pad in front.

Umbilical Hernia in Adults should always be supported by a truss, for though the aperture is generally large, it is as liable as others to *become strangulated*, and the mortality after herniotomy for this condition is very high.

An unusual form of hernia may be mentioned, requiring a truss of a different kind, namely, the protrusion into the vagina of the *Walls of the Vesico-vaginal Pouch*. In this hernia there is generally no definite sac; it occurs in childhood, and tends generally to get well of itself, but if support be required it must be given, as in prolapsus ani, by a pad in the vagina, attached behind to a perineal strap fastened to the middle of a belt, and ending in two straps in front, which pass along the folds of the groins on either side, to opposite the iliac spines.

When an **Undescended Testis** has never entered the inguinal canal at all, nothing requires to be done, but when, as often happens, it lies in the course of the canal, it will there be very liable to injury and consequent inflammation, unless some hollowed pad be placed over it for its protection. This, though not a truss proper, is fashioned like one, and will have to be specially made.

In adult cases the testis usually remains within the abdominal cavity, but sometimes becomes engaged in the internal ring, giving rise to pain, or to the more acute symptoms of strangulation. In these cases it is

generally advisable to treat this descent of the testis as an ordinary inguinal hernia, and to keep it up with a truss out of harm's way, but it will be wise to remove the organ if the irritation persists.

In certain cases of undescended testis where the gland lies outside the external abdominal ring, but is liable to be withdrawn into the inguinal canal and cannot descend fully into the scrotum, a Woods' truss with an opening to allow the testicular vessels to remain free from pressure may be used. It is said that by the application of this truss the structures in the cord are gradually lengthened until the organ can be properly retained in the scrotum.

In the female, too, **Hernia of the Ovary** into the neighbourhood of one of the labia, not uncommon in childhood, requires a light inguinal truss, which almost invariably effects a cure.

The rarer kinds of hernia, such as the **Obturator**, the **Ventral**, the **Lumbar**, etc., cannot usefully be considered fully here. They will generally be treated by trusses or belts of special form, but made on the same principles as those for more common ruptures. The first two kinds are well known but rare; the third, the *Lumbar* hernia, or protrusion of abdominal contents through the loins, is very rare, and may be best treated by a belt, though the question of operation should be considered.

It may finally be mentioned that in cases of *Spina Bifida*, or *Meningocele*, which are indeed herniæ, some form of truss, or of support and compress combined, is sometimes indicated.

Chapter X.

OF THE USE OF ADHESIVE STRAPPING.

THE use of adhesive strapping in surgical dressing for the purposes of mechanical support is steadily increasing, and the number of medicated plasters is being almost daily added to. Of these latter very little need be said, for, with few exceptions, their value is still undecided. One or two, however, are certainly of great service in appropriate cases.

The ordinary **Adhesive Strapping,** diachylon or lead plaster (*emplastrum plumbi*), is the form which is still in most general use, and unless otherwise mentioned must be understood to be the material employed. It is sometimes spread on paper, when it is almost useless, but is generally laid on linens of varying fineness. No good purpose is served by using a fine linen, and the best strapping for all ordinary occasions is what is known as "Leslie's Hospital quality," sold in rolls eight inches wide.

Other kinds of plaster are often spread upon *Chamois Leather*, or on *White Basil*, and, as will be mentioned directly, *Leather* may be employed when pressure is required, as in strapping an inflamed joint, by reason of its stretching powers.

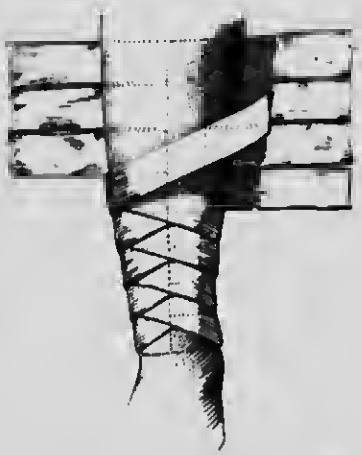


Fig. 54.—Strapping applied to a limb.

A very useful form of strapping, the basis of which is indiarubber, has been introduced, namely, Seabury & Johnson's **Rubber Adhesive Plaster.** Its advantage is that no heating is required, the adhesive surface being protected by a layer of coarse muslin until it is used.

Another very good kind, for small surfaces, is the **Isinglass Plaster,** made by painting thin silk with that material. It requires wetting only, and is very cleanly.

For clean cut wounds about the face, and in other cases where great nicety is required, **Court Plaster** or **Gold Beater's Skin** (a thin film of collodion) is generally used.

No detailed description is required of the ways in which strapping may be cut into strips, and used to fasten splints or dressings. The

oft-reiterated warning must be repeated, that if unyielding strapping is applied to encircle a limb, strangulation of the parts may result and serious complications arise. Such a disaster may even occur if the plaster be spread on any kind of leather, though this, for economical reasons, will not often be used; and it may be taken as a rule to be followed almost invariably, that strapping should be put on either spirally, or obliquely, so as to form the half of an **8**.

If strapping is to be applied round a limb, it should be cut in strips and put on so as to secure an even, steady pull from both ends; otherwise the skin may be painfully wrinkled. It should always be thoroughly warmed first, for which purpose cylindrical hot-water tins are generally used, or some gas apparatus. Sometimes strapping is softened by dipping it for a moment in very hot water; this makes it more pliable, and not much less adhesive.

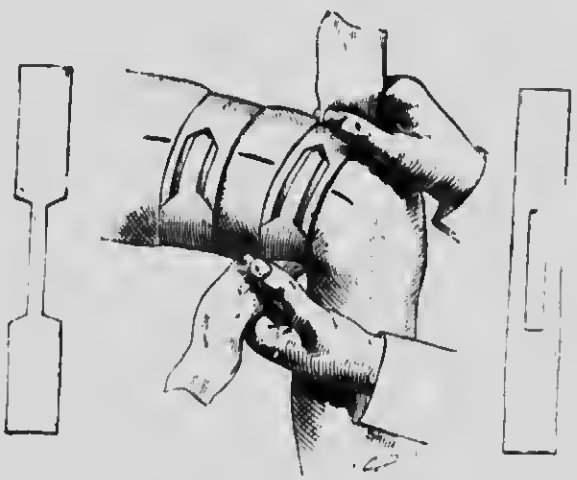


Fig. 55.—STRAPPING APPLIED TO CLOSE A WOUND ACCURATELY.

When the strapping is required to *adjust accurately* or support the edges of wounds, amputation flaps, or the like, the strips should never be stuck first on one side and then pulled over to the other, or "cockling" will certainly occur, but should be cut in pairs, and applied as in *Fig.* 55, or on some similar plan. One strip is placed on one side of the wound and the other on the other; the middle parts are slipped the one within the other, and then an even regular pull can be made simultaneously on both sides.

Some Special Cases in which strapping is a common plan of treatment will here be shortly described.

The case of **Fractured Ribs** will be again referred to. Not only in fracture, but where the thoracic walls have been badly bruised, it is often desirable to place them as completely at rest as possible. This

may be done very effectually by strapping them as if they had actually been broken. (*See* " Fracture of the Ribs," p. 139.)

Enlarged Phalangeal Joints may often be strapped with common plaster or with the iodine strapping to be hereafter mentioned. The method of doing this is the same as for the larger joints, and does not require a separate description.

The Wrist, either for simple sprain or for the common tenosynovitis of the extensors of the thumb lying over it, may be strapped with strips of linen or leather plaster, applied in the same manner as for the knee, *Fig.* 56.

Every dresser should know how to strap the **Knee Joint** efficiently, for it is one of the principal methods for the treatment of chronic derangement of this articulation. The usual plan is to apply strips of the plaster, overlapping each other, from below upwards in half loops of 8, until the whole joint is covered. This may be done well with the plaster spread on the linen or holland, if care be exercised.

Provided the adhesive material be well spread and well warmed, it will be found quite easy to firmly envelop the whole joint with one piece. It should be oblong, and large enough to go round the knee

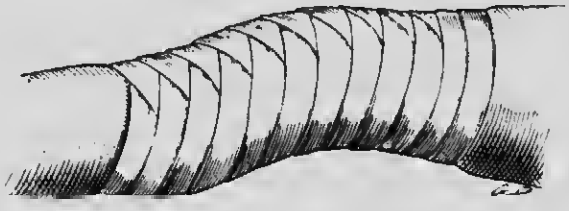


Fig. 56.—KNEE STRAPPED (ordinary way).

and overlap about one inch, and should be from ten to fourteen inches long. After warming it well, the centre of the strapping must be very evenly applied to the skin in the popliteal space ; one-half of it must then be drawn over the inside and front of the knee, with force enough to produce the pressure required ; the other half is then brought quickly and firmly over the other side. If the strapping has been properly warmed, it will reach so as to overlap for nearly three inches, and the plaster will be applied so closely to the skin that it will follow every wrinkle in it when the knee is flexed, and yet a firm, even compression will be attained.

The **Ankle,** likewise, may be strapped by narrow strips of linen, the middle of which is applied to the sole of the foot, and the two ends brought up and crossed in a figure of 8 over the front of the foot, and round the malleoli. (*See* " Sprains.")

For an **Enlarged or Inflamed Breast,** long strips of adhesive, or diachylon strapping, may be usefully employed to support and, to a moderate extent, compress it. The centre of the strips must be placed

below and the ends crossed above, working from below upwards, the breast being thus supported by the overlapping plaster. But, as a general rule, this kind of support can be more easily and comfortably maintained hy the use of " Martin's " rubber bandage.

An Enlarged Testis is difficult to strap efficiently, unless the organ be very large. The art, however, must he acquired, as the compression thus produced is a most valuable method of treatment in cases of inflammatory exudation. The look of a properly strapped testis may he gathered from *Fig.* 57, but it is always difficult to make a neat job of it. First of all, the parts having been shaved, the testis must be fixed down in the scrotum by a long strip passed round and round its upper part. The body of the gland may then be compressed by overlapping strips put on circularly, that is, horizontally, from below upwards, or vertically, to produce the same appearance as in the recurrent bandage for a stump, or with a combination of these two ways. In truth, nobody ever straps two testes in the same way, or obeys any fixed rules, so long as the compression is attained. Another good way of applying even compression to an enlarged testis is to envelop the gland in a layer of cotton-wool, and then to stretch over this a square piece of thin indiarubber sheeting (the best is that used hy dentists, but that similar to Martin's bandage material will do), securing it at the top by slipping on an indiarubber ring.

Fig. 57.—ENLARGED TESTICLE — STRAPPED.

Medical Plasters.—It has hitherto been assumed that the strapping has been employed simply for the purpose of mechanical support, or of compression. But frequently the adhesive material possesses in itself (or is applied over ointment possessing) medicinal properties. As examples of these special plasters, the *Emplastrum belladonnæ*, *E. opii*, and *E. menthol* are frequently used for their anodyne properties ; the *E. hydrargyri*, or *hydrarg. c. ammoniaco*, and *E. potassii iodidi* for promoting absorption.

As a stimulant, the *E. picis* (poor man's plaster) is supposed to have merits, as to which we may he allowed to be a little sceptical, while the use of the milder cantharides plaster, *E. calefaciens*, as well as the *E. cantharidis*, is obvious.

Lastly, in addition to the soap and lead preparation, the *Emplastrum ferri* (called also *E. roborans*, but omitted in the 1898 British Pharmacopœia) has great adhesive power and is often applied to the lumbar region, with the idea of strengthening the muscles of the hack.

Of the anodyne preparations, the *Belladonna Plaster* is most frequently used for the purpose of allaying pain in the breast, and for arresting the lacteal secretion, but it is a good anodyne for general use.

For strapping joints, etc., the *E. hydrarg. c. ammoniaco* will be found on the whole to be the most useful. Another extremely useful strapping is the iodine plaster, but it loses its activity on keeping, and so should be freshly prepared and kept in a tin case.

One of the most effective modes of treatment of *enlarged joints, inflammatory bursal enlargements, chronic orchitis*, etc., is to cover strips of lint with some absorptive ointment, to lay them over the part, and then strap it up firmly with soap or lead plaster. The ointments most commonly used are the various mercurial ones, all the *Iodine, Iodide of Lead*, and *Iodide of Potassium* preparations, but especially the *Camphorated Mercurial Ointment*, the well-known *Scott's Dressing*.* The strapping, with the ointment beneath it, should be left on until the latter is absorbed, or until the parts below have shrunk so as to make it loose; it may then be re-applied if necessary.

When strapping has been applied to any part of the skin which is hairy, its removal is always painful, sometimes very much so, unless the adhesive material be softened. This may be done with very hot water, but a better way is to soak a pledget of lint in spirits of turpentine, and to soften and dissolve the plaster from the hairs, as the strapping is turned gradually back.

---

* So called from the name of the surgeon who introduced it. It is composed of Mercury ointment, 6; Yellow wax, 3; Olive oil, 3 (by weight); Camphor, 1½.

Chapter XI.

OF SPLINTS—CONSIDERED GENERALLY.

DEFINITION. A splint is a contrivance or apparatus possessing absolute or relative rigidity, which when attached to some part of the body increases its natural stiffness, or remedies undue mobility caused by disease or injury.

It will be seen, therefore, that the subject of the application of splints is a very wide one, and even a simple list of the various arrangements devised by surgeons from time to time, to fulfil the requirements of disease or injury, would be a catalogue as long as it would be useless and wearisome. We propose, in the first place, to give only a general description of the principal methods of splinting, and of the common forms of splints, postponing a more exact account of many of them until the various fractures and injuries which require their employment come to be discussed.

Natural Splints.—In many parts of the body, an *uninjured bone* in the neighbourhood of one that is broken will often serve to keep the fragments of the latter in their place, and in other parts the attachment of ligaments will serve the same purpose. Thus, in fractures of the fibula, the tibia, if unbroken, will make a very efficient splint for it. The same may be said of the ribs, where the muscles and ligaments, which form, with them, the cage of the thorax, very often prevent serious displacement. A fractured lower jaw, again, may often be kept in good position by keeping the fragments close against the upper jaw; and many other instances might be adduced.

Improvised Splints.—There is hardly a limit to the number of the materials which may be pressed into the service of the surgeon, to form temporary splints in cases of fracture or of some other injury.

The usefulness of cardboard, book-covers, newspapers, firewood, and many other things familiar in daily life, will be mentioned in this connection under the heading of "Immediate Treatment of Fractures." But the list is only limited by the ingenuity of the surgeon concerned. It will be convenient here to give a short classification of the splints and splint materials which are recognized as belonging to the surgical armament.

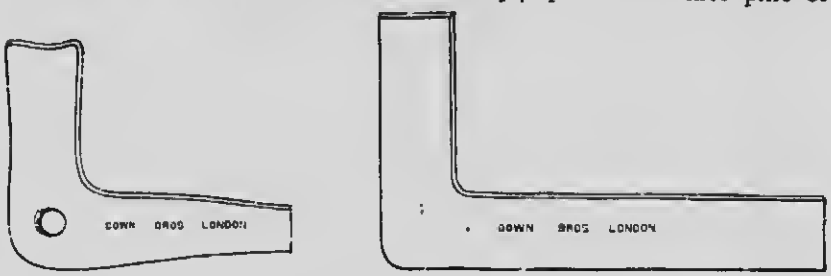
Surgical Splints may be divided into those of some *fixed form and shape*, and of some rigid material, as wood or iron, to which the trunk or limbs may be attached by bandages or strapping; and those which are capable of being *Moulded* to injured or diseased parts, to give them

the needful support or to remedy deformity. All of these latter possess the property of being soft when applied, and then of setting or hardening.

RIGID SPLINTS.

These are for the most part of wood or iron, though other materials, such as vulcanite, etc., are sometimes used. They may be subdivided into those of a simple, and of a complicated form.

Plain **Wooden Splints** are the simplest of all, and will need little description. In most cases they are simply pieces of white pine of



Figs. 58, 59.—Simple Angular Splints.

various lengths and breadths, planed, and with their edges rounded off. They are used for fractures of the limbs, or to prevent flexion of joints, as in the common "patella splint," etc. Not infrequently they are made of strips of wood lined with canvas, on the plan of the kettle-holder or Gooch's splinting to be presently mentioned, and other materials, such as rattan and cane, have been used from time to time. The pistol-shaped splint, again, is an example of a simple

Fig. 60.—Wooden Angular Splint with Hinge.

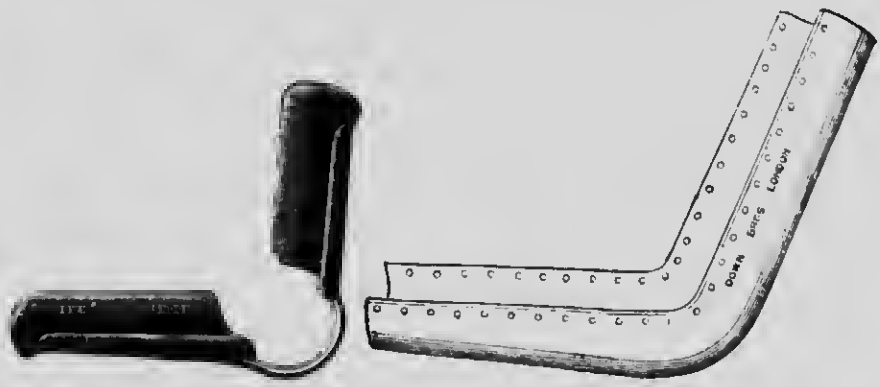
wooden splint, the use of which will be explained, with other forms, in considering Colles's fracture, and similarly, the use of Cline's or of Liston's splints will be described in relation to the conditions they are devised to remedy.

Angular Splints (*Figs.* 58 to 62), with or without a hinge at the elbow, are very useful in various injuries of the arm, and, like other forms

of wooden apparatus (e.g., the back splint for the knee), are far more comfortable if they are somewhat hollowed out, a proceeding which adds but little to their expense.

Figs. 61 and 62 illustrate an angular metal elbow splint for compound injuries of that articulation; it is very simple, effective, and cheap.

Of the more complicated splints, in which wood is the principal material employed, the chief are "Bryant's" for excision of the hip



Figs. 61, 62.—ANGULAR METAL ELBOW SPLINTS.

or fracture of the thigh, "Thomas's" for the treatment of genu valgum, splints for fractured patella, and the double inclined plane; these and others will be noticed in their places.

Interrupted Splints.—It is often necessary, in cases of compound fracture or after excision of joints, where we must be able to get at a wound, which therefore must not be covered by the splint, to make an *Interruption*, as it is termed, and although this is done in iron

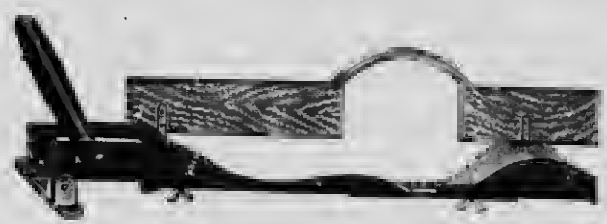


Fig. 63.—INTERRUPTED SPLINT.

as well as in wooden splints, it is far more easy in the latter. In making such a splint, it is best to choose one as if the necessity for the interruption did not exist, and then to saw away the parts required to be removed, *after* having fastened on the iron supports.

Iron Splints may be simple or complicated: as examples may be mentioned the common angular elbow splint, generally having a hinge

at the elbow; the simple back splint for the leg and thigh with foot-piece (*Fig.* 64), commonly used for fractures of the leg, generally called "*Neville's Splint*"; and the different patterns of that very

Fig. 64.—IRON BACK SPLINT.

useful splint, "*M'Intyre's*," modified by Liston (*Fig.* 65), which consists of a movable foot-piece, and leg- and thigh-pieces, with a joint between them, and with some mechanical arrangement of screws or

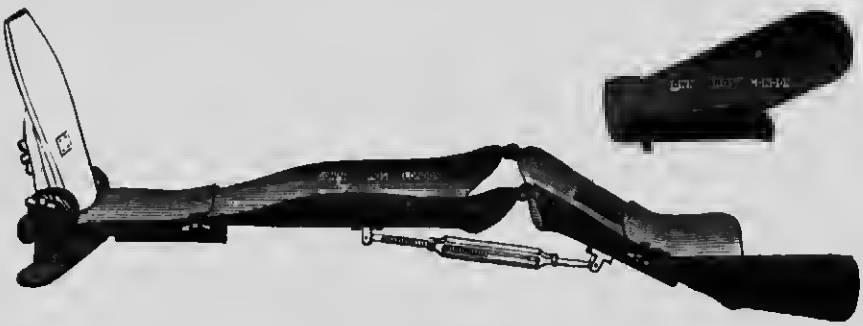


Fig. 65.—M'INTYRE'S SPLINT.

rack and pinion, to alter the angle at the knee. These can be adjusted for limbs of different lengths by means of the movable foot-piece.

All splints for fractures of the leg should be furnished with cross-pieces, as shown in *Fig.* 66, to enable the limb to be swung from a cradle.

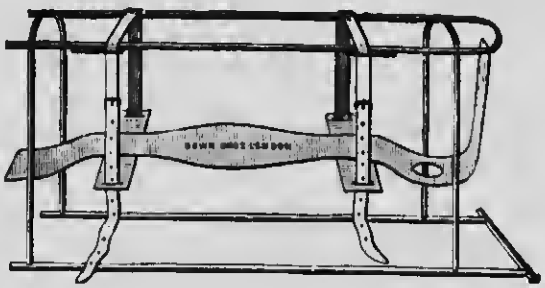


Fig. 66.—SPLINT SLUNG IN CRADLE.

There are numerous patterns of splints used after excision of the wrist, elbow, and knee, of which examples are given in *Figs.* 63, 64.

Flexible Splints.—Splints are also made of tin or some other flexible metal which can be readily bent into any required shape. These are often used in the treatment of talipes (*q.v.*).

"Kettle-holder" or **"Gooch's Splinting"** is made by attaching long thin strips of wood to canvas or leather with strong glue. It is made in large sheets, and splints of different patterns can be cut or sawn out of it. Its great merit lies in the fact that it is flexible in one direction and rigid in the other. It is especially used for fashioning splints to partially encircle a limb, as in fractures of the arm, or in combination with a back splint in broken thighs.

Padding Splints.—All splints, before they are applied, should be padded to avoid injury of the softer parts. This may be done in several ways, and with different materials. Of all paddings, however, the most elastic and convenient is *Tow*, well teased so that the fibres lie all one way, and with no lumps in it. Soft linen, such as old napkins, makes the best covering for the tow.

For the simple forms of splints, the pads should be made like miniature pillows, and either sewn on with a lace stitch at the back,

Fig. 67.—PAD, SEWN OR STRAPPED UPON A SPLINT.

which is best, or fastened—but as a makeshift only—with bands of strapping very smoothly applied (*Fig.* 67). Pads should always be complete cushions, not layers of tow laid upon the splint and covered.

Next to tow as a stuffing comes *Cocoanut Fibre*, and last of all *Cotton Wool*, which is very apt to work into hard lumps. Very good but extravagant pads may be made of several *Folds of Lint*.

In all cases where moist dressings or the discharge from wounds can possibly soil the pads, they should be covered with some form of *Oiled Silk* or with *Gutta-percha Tissue*. The former must be sewn on, but the best and neatest way of fastening the latter is to moisten the edges with a piece of lint dipped in chloroform, when they will readily adhere.

Iron Splints are usually perforated for the sewing on of the pads, but if not they must be managed like the wooden ones. Before padding them it should be seen that the metal is not exposed by the wearing off of the lacquer, or the cover will be iron-moulded.

In *Jointed Splints* the pads should be made separately for each part, and special pains must be taken to have them very smooth and of the proper thickness where they have to protect prominences of bone, such as the trochanters or malleoli. This is particularly true of the heel, under which the pad should be firm and rather thin, while the tendo Achillis immediately above it should be well supported with a

thicker pad. A "sore heel" is a surgical disgrace to the dresser of a fractured leg or thigh.

Too much pains cannot be taken to select perfectly fitting splints and such as are in good condition. They should, in almost all cases, be a little wider than the limb for which they are chosen; if this be attended to, partial strangulation through their being put on too tight is almost impossible.

Attachment of Splints.—With regard to the various methods of attachment of splints, we need only mention here, that strapping, bandages, and buckled straps of webbing are the chief agents employed; any one or all combined may be found most suitable, in each particular case. In bandaging the same rules apply as have already been given, but whatever way of attachment is selected, it should if possible be so managed that the limb can be examined from time to time without disturbing the whole apparatus, and in the case of the extremities, the fingers or toes should be easily got at, in order that the condition of the circulation may be noted. Lastly, complaints of pain, or even of discomfort, in parts which are covered by splints, should never be neglected or thought lightly of.

SPLINTS FASHIONED OUT OF PLASTIC MATERIALS.

These splints fall naturally into two divisions; in the first are placed all those which are fashioned accurately to the part, out of a mass or sheet of material which can be moulded when softened (generally by heat), and which is then allowed to set. The second division comprises those made by enveloping the part to be splinted with pieces of flannel or other suitable material of the desired shape, or with rollers saturated with a material, liquid at the time of application, but which afterwards hardens.

Division I. In this division are included splints moulded from *Leather*, *Felt*, *Gutta-percha*, or *Cardboard*, the skilful fashioning of which is an important branch of mechanical surgery.

Leather Splints.—Far too often money is thrown away with very unsatisfactory results, through the mistaken notion that the making of these splints is either below the surgeon's or dresser's dignity, or above his mechanical powers. There can be no doubt that a leather splint for such a case as a chronic enlargement of the knee, or a fractured patella, will be more efficient, if made by one who understands the surgical necessities of the case, than by an instrument maker who must, from the nature of his trade, proceed in a beaten track and according to a fixed pattern. Something of finish and appearance will no doubt be sacrificed, but the one splint will do its work, the other, very often indeed, will not. With a little care a dresser may easily turn out a very good-looking leather splint without giving any inordinate time or trouble to it. The best leather for the purpose is ordinary *sole leather of medium thickness*, arm splints requiring a lighter kind than those for the leg. In all cases the leather should be

carefully examined for flaws. The piece being chosen, it must, before softening, be cut out to the required pattern with a very sharp knife.

Patterns for the chief kinds of moulded splints are given in *Fig. 68*, but in all cases the shape should be first *cut out in paper* and fitted as nearly as possible to the limb. The figure should then be marked out on the leather before cutting.

Splints may be made of leather for the ankle, knee, hip, spine, shoulder, elbow, wrist, and jaw. The question of spinal splints will be considered in a separate chapter, and inasmuch as among the rest, those for the elbow and knee are by far the most common, and as many of the directions for making them will hold good for splints fashioned out of other plastic materials, these two will be described in detail.

The *Back Splint for the Knee* is one often required for the treatment of fractured patella in the later stages of union, or for chronic disease of that joint, or after its excision has been performed. The pattern should first be cut in paper (of the shape shown in *Fig. 68, No. 5*), of such a length as firmly to grasp the leg and thigh, and of a width such as will allow an interval of about half an inch between the two sides of the splint in front. The paper pattern must be carefully fitted to the part, and the leather then cut out from it. This must then be thoroughly softened in a bucket of cold water, which will take from twenty-four to forty-eight hours; if it should be desirable to shorten this time, a tumblerful of vinegar or of dilute acetic acid may be added to the water, when three or four hours will be enough to soften the leather. The splint should then be applied to the limb, which has previously been covered with a flannel bandage, or what is far better, to a plaster cast of the limb, and bandaged firmly, while it is at the same time moulded to fit the curves with all the exactness possible. Too much care cannot be exercised in this, the most important stage of the work. When it is done, the leather must be allowed to "set" on the limb, a process which will take some hours, when it may be carefully taken off and allowed to dry thoroughly. It is then fit to be trimmed and finished by cutting away whatever leather is redundant, or where the edges seem as if they might chafe. The edges too must be bevelled on the inside with a very sharp knife. If it is considered advisable further to strengthen the splint with an iron backing, this may now be riveted on by a smith.

The *Lining* is best done with *Chamois Leather*; it must be cut out from the same shape as the splint, but large enough to overlap it everywhere for about half an inch. The inside of the splint is now brushed over with very hot thin glue, and the chamois leather stuck on. It will adhere very firmly, and the edges must be turned over and similarly fastened down, and then trimmed to an even width.

The finishing touch is given by punching the necessary holes for lacing and inserting the brass eyelets with the proper bootmaker's tool. If it be desired to polish the leather outside, this may easily be

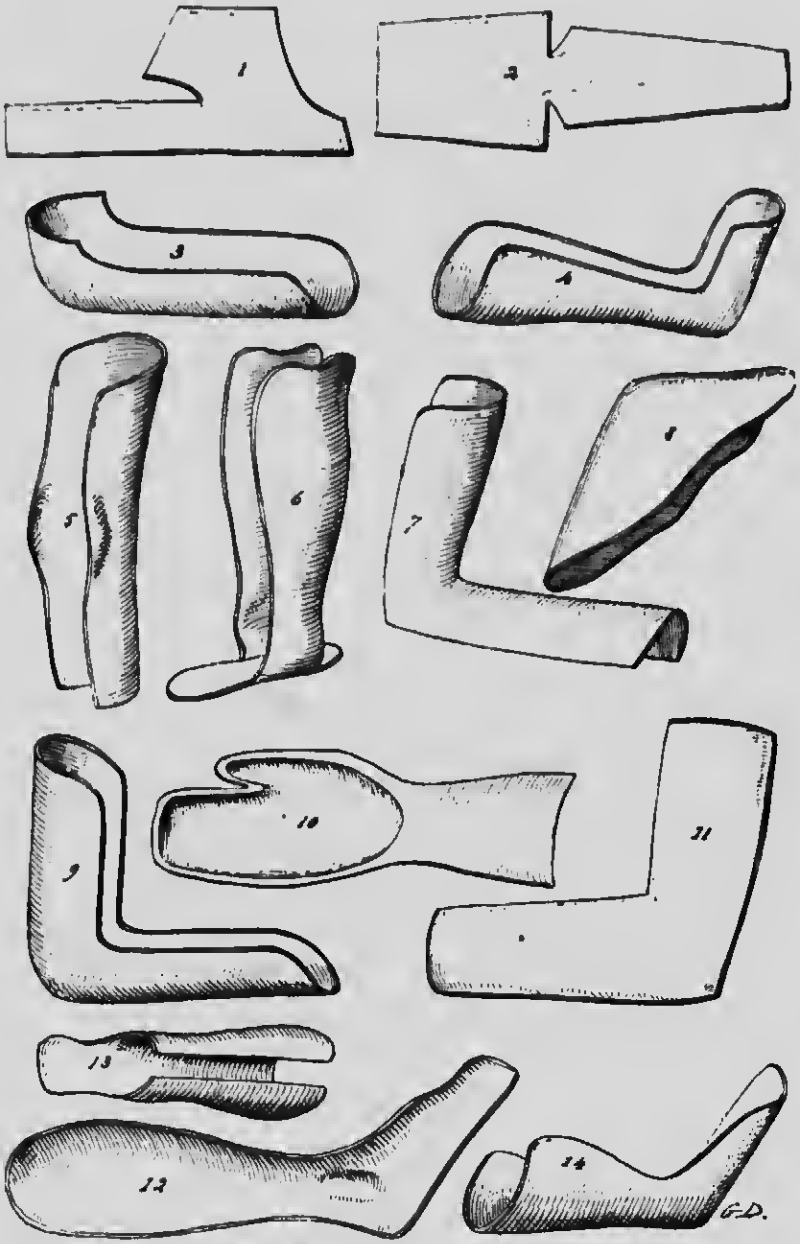


Fig. 68.—PATTERNS FOR THE PRINCIPAL FORMS OF MOULDED SPLINT.

(1) For Hip and Thigh; (2) For the Elbow; (3) For the Shoulder; (4) For the Elbow; (5) For the back of the Knee; (6) For the Ankle; (7) For the front of the Arm; (8) For the Shoulder; (9) For the back of the Elbow; (10) For the Hand; (11) For the Elbow; (12) For the Leg; (13) For the Wrist; (14) For the Ankle.

done with beeswax and oil melted together, rubbed in while warm with a flannel.

In *Fig.* 69 is shown an ordinary knee splint, finished and applied.

There are two principal ways of *moulding an angular splint to the elbow*, both about equally efficient. The pattern for the first is as in *Fig.* 68, *No.* 2, the arm-piece being cut long enough to reach to the axillary fold, and that for the forearm to the wrist. The leather is softened as before, and then, by bending the armpiece up at right angles to that for the forearm, they will overlap each other at the elbow, the arm edges going outside. The splint thus bent is moulded by bandaging it on in the same way as for the knee, and may be trimmed, lined, and finished, as has just been described. The pieces at the elbow

Fig. 69.—Moulded Back Splint for the Knee.

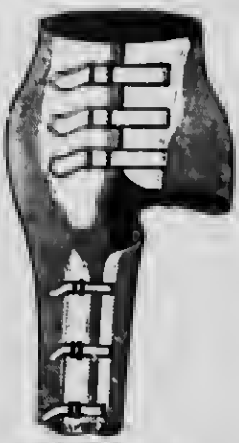


Fig. 70.—Ditto, for the Hip.

are fastened together by a few stitches of whipcord, or by passing through, and bending over, some of the common clips used to fasten papers. This splint, it will be seen, is made of one piece, and may be laced along the middle line in front, or fastened there by two or three webbing straps. It is shown finished in *Fig.* 71. In the other pattern, two pieces of the shape of *No.* 11, *Fig.* 68, are cut out, softened, and moulded to the outer and inner sides of the arm and forearm. They may, when finished, be simply fastened round the limb by webbing or leather straps, or a neater way is to glue the two halves along the back to a broad piece of tape or soft leather, so as to make a hinge; they can then be laced together along the front. The advantage this splint has over the other is that it may be put on and off very readily, but it is more troublesome to make, and is not quite such a firm support.

It often happens that joints, suitable in other ways for leather splints, are too tender to bear the necessary manipulation of moulding. In

this case it would be better to make the splint of **Poroplastic Felt,** which is easily moulded and sets quite as hard as leather.

This material closely resembles leather in its mechanical properties, but is more easily applied, and has now to a great extent superseded it for moulded splints, both large and small. It consists of felt saturated with some resin, in such a way that, while it preserves its porosity and is but slightly increased in weight, it is rendered quite plastic by heat, but becomes again extremely stiff when cold. The advantages it possesses over leather are its lightness and porosity. Its disadvantages are that it is not so strong, and is more liable to crack or break. The fact that it sets very quickly cuts both ways, being sometimes useful, sometimes embarrassing. It is sold in sheets of various thicknesses and qualities; the medium quality is the best.

Fig. 71.—Moulded Splint for the Elbow.

As with leather, the description of the use of this felt in spinal cases is given later. For other splints, the patterns in *Fig.* 68 are those in most common use; most of them may be had ready made, or they may be cut out of sheets of the material. *The best way of softening* is by means of a steam chamber made for the purpose, but an oven will do very well if the felt be first thoroughly moistened; in many cases water, nearly boiling, will serve. If softened in this way, the felt must be laid flat and quickly pressed between the folds of a towel to remove the superfluous water, before it is applied to the limb.

The method of moulding is in all respects the same as for leather, save that in consequence of the extreme rapidity with which it sets, the manipulation has to be very quickly performed. These splints may be lined, and eyelet holes may be punched as in the leather, but care must be taken not to break the edges. If required, portions of the splint may be left unstiffened, or the resin may be removed from such parts after moulding by soaking in methylated spirit.

Gutta-percha Sheeting comes next in usefulness to poroplastic felt, and is even more readily moulded. It is not, however, porous, and is not so comfortable as felt or leather, while in durability it is far inferior to them; on the other hand it admits of much more complete softening, so that it can be moulded more easily to tender parts, or to parts of a complicated shape.

The sheeting, of about the thickness of sole leather, having been cut out, is softened in water as hot as can be borne by the hands, and rapidly moulded to the part, which should first be moistened. If the water be of the proper heat, some care will be required to keep the sheet from losing its shape through undue softening, and if it be too hot this will certainly happen, while on the other hand, water merely "hot" (e.g., 100° F.) will not render it sufficiently pliable. The splint will set sufficiently quickly to allow it to be removed without losing its shape, and it should then be plunged into quite cold water, which will give it greater rigidity than it would have if allowed to remain on continuously. It may then be trimmed, and if desirable, lined, and punched for lacing as before. It will, however, generally be best simply to put it on the limb over a piece of soft lint, and to secure it with webbing straps and buckles, for the gutta-percha is rarely durable enough to make the former proceedings worth the trouble.

Cardboard may, in the absence of leather, felt, or gutta-percha, form a fairly efficient moulded splint. After having been cut out of very stout board to the required form, the splint must be thoroughly softened in water; and the details of manipulation are similar to those for plastic felt. In most cases, however, the best support will be obtained by cutting the millboard in strips, about 1½ inches wide, softening and then applying them to the limb, one or two at a time, while a roller is at the same time applied, so as to mould them and fix them as well. In this way the strips come to be within the layers of the bandage, and give considerable rigidity to the limb. The splint thus applied must remain on, and cannot be finished up like the preceding ones, and for this and other reasons the cardboard splints are now nearly superseded by felt.

There remain to be mentioned one or two materials occasionally used in general or special surgery, as, for example, *gutta-percha* in mass, *vulcanite*, and *gum resins*. All these are principally used in dental surgery, and their employment in cases of fractured jaw will be described under that head; but the student may be reminded that for splints of delicate construction, materials such as these may be used; so, too, metals, other than those already mentioned, may sometimes be found useful, e.g., *Lead*, *Silver*, or *Aluminium*, the last being especially valuable for its lightness, although its cost prevents its extensive employment.

Division II.—Moulded Splints made of *Bandages, saturated with a Plastic Material*.—Whatever be the stiffening agent used, the principle is the same for all the splints described in this division, namely, that the part required to be supported must be covered with bandages, into the interstices of which there may be introduced some material which, soft at the time of application, becomes afterwards hard, so that the part is enclosed in an accurately fitting case.

The materials in common use for this purpose are *Plaster-of-Paris*,

Gum and *Chalk*, *Silicate of Potash*, *Stearin*, and *Starch*; *Glue* mixed with spirits of wine, to enable it to dry, has also been used. These will be described in the order mentioned.

Plaster-of-Paris is the best and the most commonly used material for both kinds of splints, for injured limbs, and also for one important variety of spinal support. It is a fine white powder, obtained by burning, and thus expelling the water of crystallization from *gypsum*, a peculiar form of sulphate of lime. Its value depends upon its power of quickly reabsorbing this water and solidifying.

In surgery it is used (*a*) As a means of *stiffening roller bandages*, as will be described below; (*b*) As a means of giving a similar *stiffness to pieces of coarse flannel*, which, having been shaped and immersed in the plaster, are then moulded to the limb; (*c*) For *making casts* on which splints or other material can be blocked, and for a variety of other purposes.

Whichever plan is adopted, bandage or shaped flannel, the skin must be protected from direct contact with the plaster; for example, if a plaster roller were required for the leg and foot.

Application.—The part to be splinted should be first evenly covered with a soft flannel bandage, or some well-fitting flannel clothing. The bandages, which should be about two-thirds the length of an ordinary roller, and 2½ inches wide, are made of a very coarse muslin, to which the name of *crinoline* is generally given.

They are prepared by rubbing the dry plaster powder well into the meshes, and then rolling up loosely. When made they should be kept lying on their sides in a tin box till required. They should be prepared fresh for each case, as the plaster seems to lose its power of setting satisfactorily after it has been kept for any length of time.

To make the splint it is only necessary to put the bandages in water till all the plaster is well soaked, and then to roll them on the limb, allowing them to take their own course to a great extent, avoiding reverses, and not attempting to form any regular pattern. The more oblique the general direction of the bandage is, and the more figures of 8 are made, the better. Three layers of the bandage are generally enough to make a firm case.

In all cases where a stiff bandage is applied to the leg, *great care must be taken to keep the foot at right angles*. This is easily done by passing a clove-hitch round the big toe with a long piece of bandage, which may be fastened to the head of the patient's bed, or round his neck. When the case has been applied, it must be kept quite still until it has set; this will require from half-an-hour to three hours, according to the weather, the dampness of the bandages, etc. The setting may be hastened by hot-water bottles or placing the patient before a fire.

Sometimes it is desirable to *retard the setting*; this can be done by soaking the bandages in mucilage and water. When this plan is followed, some surgeons cut the saturated and moistened bandages

PLATE I.

Fig. A.

Fig. B.

APPLICATION OF A MOULDED PLASTER SPLINT.

To face page 100

PLATE II.

Fig. C.

Fig. D.

APPLICATION OF A MOULDED PLASTER SPLINT.

into strips, which are laid down, overlapping each other; the limb is then laid upon them and they are brought round it in order, and the ends crossed in front in a spiral fashion so as to produce the appearance of a figure of 8 bandage (see *Fig.* 26). This mode will be alluded to again under the head of "Spinal Jackets."

In all cases where plaster-of-Paris is used, while the bandage is being put on, a moderate amount of the plaster, moistened, should be rubbed into it, and the hands, well wetted, should be passed up and down to distribute the plaster evenly, and to rub it into the bandage thoroughly.

How to use Plaster-of-Paris.—A few words as to the manner in which plaster should be practically handled, when used for purposes of support, or any other surgical objects, may be useful.

It should be recollected that, except when used on a very small scale, it is always a very messy thing to apply, and also difficult to clean up afterwards. Clothes, carpets, and everything that is upholstered should be protected or removed. Aprons and sleeves (or bare arms) will be wanted also.

If the roller bandage is the method chosen, the dry plaster, in powder, must be distributed as evenly as possible on the unrolled bandages a short time before they are wanted. But they will keep a week if they are put in a tin in a dry place.

The best way to *charge the bandages* from end to end with the powder, is to pass them over a table or board with a heap of loose plaster upon it, and then to sprinkle them with it, rubbing it lightly into their meshes; passing them on from left to right, and rolling them up at the end of the table.

The manner of *wetting the bandages* has been already mentioned. It may be added that the vessel in which they are immersed must contain water sufficient to cover them. None must be put in water until everything else is ready. Then one only is to be thoroughly wetted through and the air expelled, and as it is taken out of the basin to be applied, an assistant puts another into the water. The times of application and of soaking will then coincide in a convenient fashion.

It will be seen that there is no regular rule given here for the amount of water to be taken up by the roller, and practically as much will be taken up by the powder as it lost as gypsum in the furnace, and no more.

But a little more accuracy and practice is required if the second way of applying the plaster is adopted, namely, by so adding the dry powder to the water that the mixture is a complete and creamy fluid, in which the pieces of coarse house-flannel, already shaped as required, can be immersed and saturated with it, and still be flexible enough to be moulded to the limb before setting.

The best way is to take a quantity of water, in a basin or bucket, equal to about two-thirds of the quantity of plaster cream which is estimated to be wanted; then, taking the powder and gently and

slowly scattering it all over the surface of the water, let it sink by itself. This it will do very quickly at first, and then more slowly, until the plaster ceases to sink, but remains on the top of a cone of thoroughly moistened plaster in the water. The contents of the basin must now for the first time be stirred, and this is best done by the hand at the bottom, and quietly, so that there are no surface bubbles; it will soon become uniformly thick, and can be used at the consistency of rather thin cream. At the end of the setting it hardens very quickly. The cream for taking solid casts, as of the limbs or trunk, is used rather thinner than for stiffening flannel; that is, it is used as soon as it is mixed.

Sometimes the plaster may be used as a *mass moulded between two shaped bandages*. This is, indeed, the original **"Bavarian Splint."** These splints are usually made for cases of simple fracture of the leg, but are not confined to these injuries.

Application.—Taking the leg as an example: Two pieces of flannel or stout canvas are cut out to a pattern which can be got accurately by cutting open a stocking which would fit the patient, along the front of the leg and foot, and then spreading it out; or more roughly by making "a double" of *No.* 12 in *Fig.* 68. The pieces of flannel or canvas are then laid one on top of the other (*Plate I., Fig. A*) and stitched down the middle line. The limb being laid upon them, the piece next to the leg and foot is brought round these parts and fastened along the front with safety pins (*Fig. B*). The outer piece of flannel is spread out evenly on one side, and a layer of plaster, about half an inch thick, is spread over it, care being taken to see that the plaster goes well up to the seam, both outer and inner surfaces being thoroughly covered. This side is then folded over the limb and the same procedure followed on the other side (*Plate II., Figs. C and D*). When the whole is set it may be removed for inspection of the limb, the seam acting as a hinge, and herein lies the advantage of this splint: it is held in place by a bandage over it. After the splint has hardened it should be removed and left for twelve hours in front of a fire; this will make it much firmer.

The next step is to trim it. Trimming is performed with stout scissors—all rough, uneven parts are removed from the edges, and the corners rounded off. Strips of strapping well warmed are now applied round the edges of the plaster, like braid trimming to a coat. This step will prevent the edges from cracking and fraying, and imparts a neat, workmanlike appearance to the whole structure. It can be fixed on with strapping and bandages, can be readily removed, and lasts a long time.

This splint is much the same as that known as Croft's, which is described under "Fractures of the Leg" (Chapter XVI).

The plaster in this and all other cases must be very dry; it is therefore a wise precaution to have it put into an oven for an hour before it is wanted.

The **Silicate Case** is made with ordinary bandages and a saturated solution of silicate of soda, with or without the addition of a little chalk or whiting; it is applied in precisely the same way as the gum and chalk one, so that one description will do for both. In their mechanical properties, also, the two cases are very similar. The silicate is slightly heavier, and perhaps not quite so durable; on the other hand, it sets rather more quickly, taking from three to four hours, while the gum and chalk take from twelve to eighteen.

Gum and Chalk.—A sufficient quantity of dry powdered chalk, free from lumps, is mixed in a basin with mucilage, until it is of the consistence of gruel. The limb being first bandaged with flannel (and in the case of the leg or thigh, the foot fixed at right angles, with the heel elevated on a block), is carefully bandaged with a common calico roller, the flannel roller extending beyond it for about half an inch. The mixture is then rubbed into the bandage with the hands, so as to permeate it thoroughly. Another bandage is then put on and treated in the same way, and generally a third will be found necessary. The case is then left to dry.

The advantages of a well-made gum and chalk case are many. It is lighter when dry than plaster-of-Paris, and though abundantly strong, has a certain flexibility which prevents it cracking. On the other hand, it requires more time and patience in application, and the length of time it takes to set is sometimes inconvenient. It is, however, generally preferred by those accustomed to put it on.

The **Stearin Case** suggested by Lawson Tait is very clean and very rigid, but it is liable to crack. It is most suitable for limbs which require to be fixed upon splints for some length of time while the patients are confined to bed, or at least have not to move much. Thus it is a very good way of fixing the leg and thigh on to the splint in cases of resection of the knee. The paraffin is cut into small chips and heated in a vessel placed in a saucepan full of boiling water, for the wax itself should not be heated above 212° F. Gauze bandages, similar to those used in antiseptic dressings, are then immersed in the melted wax. The paraffin takes about two minutes to thoroughly penetrate to the centre of the roller. The bandages must then be applied to the limb over a flannel bandage while they are as hot as the operator's hands can bear.

Starch is the least efficient material for making a supporting case, but, on the other hand, it is one which is always ready to everyone's hand. It is applied like gum and chalk, by rubbing starch paste into the interstices of ordinary bandages. Four, or even five thicknesses will be required for any useful degree of support. The limb must be kept very still while the case is drying. The chief drawback of the starch case is the shrinkage which occurs as the splint dries on the limb, which is not present when other materials are used. This may even produce gangrene, and must prove a source of anxiety, necessitating careful observation of the circulation until the splint is dry.

It may here be mentioned that a common roller bandage (e.g., one used for securing fracture splints) has a more neat appearance, and is less liable to be disturbed, if a little thin starch paste is brushed or rubbed over it after it has been put on.

Spicas.—Plaster-of-Paris, or gum and chalk spica bandages are very frequently used in early or convalescent cases of hip disease, or in fracture about the neck of the femur. They are applied like the ordinary spica, but require a rather firmer and longer hold on the thigh. That part of the bandage which goes round the pelvis does not require to be so much stiffened as the rest.

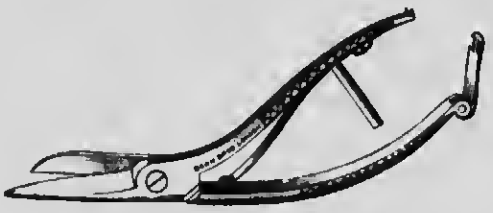


Fig. 72.—Seutin's Cutting Pliers.

It is often necessary to apply a *stiff bandage or case to some part where there is a wound.* If the discharge from this be extremely small it will be sufficient to cover it with dry lint; but if not, an opening or "trap-door" must be made. This is best done with a very sharp knife after the splint is firmly set, a careful note being taken at the time of application as to the exact position of the wound.

It will happen, every now and again, that through chafing or some other cause, a sore develops underneath one of these splints. In such a case no time must be lost in *cutting away the chafing part.* This may be sufficient, but very often the whole splint will have to be removed, and the sore allowed to heal. It is therefore very evident that every care must be taken while applying the case to avoid creases or constrictions in the bandages, which may lead to such serious consequences. Another common act of carelessness which may lead to the above result is that of leaving pins within the folds of the bandage.

Removal.—When plaster or gum and chalk cases have to be removed, a pair of strong cutting pliers (Seutin's) may be used (*Fig. 72*); or an instrument devised by Davy (*Fig. 73*), which is a combination of a knife and saw, and which is very suitable for the purpose, if the splint is to be cut up along the middle line without other damage so that it may be used again; in other cases a strong jack knife will do. On the other hand, if the limb be very tender, it may be best to soak it and the splint in water until the plaster or chalk is sufficiently softened to allow of the layers of bandage being peeled off.

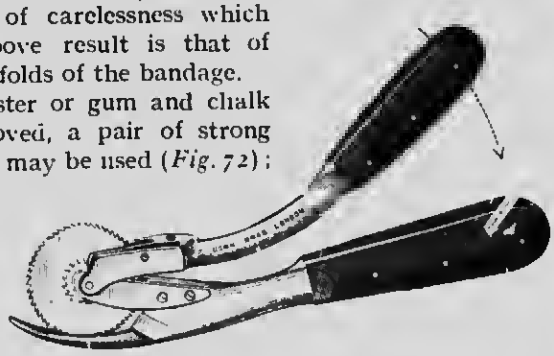


Fig. 73.—Bandage Saw.

SECTION III.

OF FRACTURES, DISLOCATIONS, AND SPRAINS.

CHAPTER XII.

OF THE IMMEDIATE TREATMENT OF FRACTURES, IMPROVISED SPLINTING, ETC.

IN this section, only such fractures as require manipulative surgical treatment will be considered, and of these only such as the dresser or house surgeon may reasonably expect to meet with, and which he must learn to treat, during his hospital experience. With regard to apparatus and manipulations, we shall describe chiefly those which are commonly used in this country.

But before proceeding to the treatment of fractures individually, there are certain general points which must be understood.

Extent of Injury.—The first time a student makes a post-mortem examination on a recent case of fracture, however simple, even if there be to outward seeming only a very slight amount of injury, he cannot fail to be astonished at the extent to which the tissues have really suffered, at the amount of bruising and disorganization of the muscles, and at the infiltration of all the softer parts with extravasated blood. And yet, provided that such a fracture be simple, or if compound, that septic forms of inflammation are successfully warded off, it is astonishing how quickly tissues, bruised and hurt as these are, will recover.

A further examination of a recent fracture on the post-mortem table will show that the injury of the soft parts has been, to a large extent, due to the working of the sharp, splintered fragments among the more yielding tissues; indeed, in fractures by indirect violence, this is the only cause of their injury.

In considering, then, the general line of conduct in cases of fracture, the student should think of the condition of the limb inside the skin, and appreciate the fact that it is probably much worse than appears upon the surface; and further, he should recollect that between the time of the occurrence of the fracture and its being set, careless or improper handling may do much mischief, so that it not infrequently happens that, by movements on the part of the patient or of his friends, a simple fracture is converted into a compound one; or, though much more rarely, an important vessel or nerve is seriously injured.

It will therefore be seen that there are many points for consideration in the treatment of a case of fracture, in addition to the actual and, so to speak, permanent setting of bones.

So long as the patient can be left lying, little further harm can come to the broken bones, so that there need be no hurry.

The *chief points in the immediate treatment* of fractures are:—

1. The prevention of further injury: (*a*) hy means of some improvised support or splint; (*b*) By proper precautions in transport.

2. The arrangement of the bed on which the patient has to lie, probably for some weeks; the getting him into it; and the general management of affairs in the interval which must elapse before the setting.

1.—MEASURES FOR PREVENTION OF FURTHER INJURY.

I. Improvised Splinting.—This is desirable when there is any appreciable movement between the fragments, any painful spasm of the muscles, or whenever the patient has to be moved to any distance. The ways in which more or less efficient splints may be made are very numerous so that in this matter the principles of the improvisation being indicated, the details must be left to the individual readiness and energy of the surgeon. Whatever comes first to hand will of course be used first, as *firewood, matchboarding, cigar boxes, book covers* or *paper*, and it will hardly ever be found difficult to give sufficient support to any fracture. Even a *newspaper* will be of great service, if it be folded often enough, especially if it be bent round so as to form a portion of a hollow cylinder. *In fractures of the leg or thigh of one side*, the use which may be made of the *opposite sound one* as a splint, by tying the two limbs together, should always he remembered.

Fig. 74.—Illustration of Improvised Splinting.

Fig. 74 has been drawn to show a few of the ways in which common materials, such as firewood, towels, and handkerchiefs, may be used for the temporary support of fracture of the collar-bone, humerus, and of the bones of the leg.

As a rule *Removal of Clothes* is unwise until the patient is about to be put into bed, when it can be done deliberately, and so as to cause

as little pain as possible, but if the fracture be badly compound, or if there be serious hæmorrhage, the clothing must be removed for more careful examination of the parts. These cases of hæmorrhage in connection with fracture are always serious, and the necessity of attending to this condition will take precedence of the question of supporting broken bones.

Improvised splints should always be put on in a way which will allow of their ready removal, and in applying them no effort need be made to replace the fractured parts accurately, but merely in a general and gentle fashion to reduce the deformity and give support.

The following directions will serve as examples of what may be done in some of the more common accidents involving fracture of bones, in the way of a rough and ready splinting, it being understood that they are *examples* only.

1. **Fractured Lower Jaw.**—This is a result of some direct violence, and there will be a good deal of bruising of the soft parts. All that will be required in the first instance will be to tie up the lower jaw against the upper one with a soft handkerchief, passed under the chin and over the vertex of the skull. The patient must not talk, and if any nourishment has to be taken it should be poured slowly into the mouth at one of the angles.

2. **Broken Collar Bone.**—This may happen in adults from direct violence, as by a bullet or any severe direct blow; in such a case the symptoms will be well marked. Or it may occur at birth or in young infants, by rough handling or slight drags or falls, in which case it may often be overlooked. But it is generally the result of an indirect shock, as by falling on the shoulder, or on the outstretched hand. The patient instinctively supports the elbow and forearm of the injured side with the other arm, and so pushes up the shoulder, which would otherwise droop. If the patient can be conveniently put to bed on a hard mattress, *flat on the back*, with a small pillow between the shoulders, and a very small one (or none at all) under the head, the fragments of the clavicle will come absolutely into apposition. But often when this accident happens the sufferer has to travel for some distance, and although by merely slinging the arm all risk of any great additional damage will be avoided, a better plan is to use a couple of towels or triangular bandages in the way now to be described. With these the arm can easily be fixed in a position which will give complete comfort, and indeed, in many cases will bring the fragments into sufficiently good position to enable union to take place without any noticeable deformity. This method is also suitable for the permanent setting, and is mentioned later on under that head.

The Indications to be fulfilled in cases of fractured clavicle are—that the shoulder must be pushed well up, the arm must be fastened to the side with the elbow behind a vertical line dropped from the point of the shoulder, and that the shoulder joint should be forced away from the thorax by a pad placed in the axilla, to counteract the tendency

of the broken ends of the clavicle to overlap. A way in which this may readily be done is shown in *Fig. 75* (and also in *Fig. 74*). A soft but firm pad, of about the size of the fist, is made, as with a cricketing cap or a newspaper, and is placed in the axilla; the forearm is crossed over the chest, with the hand pointing to the opposite shoulder, the point of the elbow being held well back. A towel is then folded as a broad scarf, the elbow is settled into the middle of it, and then, by tying the ends over the opposite shoulder, the hand and forearm being covered by the scarf, the arm on the injured side can be pushed well up. The other towel is then brought round so as to fasten the arm, forearm, and hand firmly to the trunk, and the ends are knotted or pinned beneath the opposite armpit. A reference to the figure will explain, better than words can do, these simple but efficient arrangements.

Fig. 75.—Treatment of Fractured Clavicle with two Towels, or Triangular Bandages.

3. **Fracture in the Neighbourhood of the Shoulder Joint.**—For this, inasmuch as both the displacement and mobility of the fragments are often either slight or obscure, a well-adjusted sling is all that is required at first, or during removal.

4. **Fracture of the Shaft of the Humerus.**—Here the displacement may be considerable, and the ends of the broken bone, by moving on each other, may cause much pain and muscular spasm. The weight of the forearm must be utilized to prevent overlapping of the fragments and a little gentle traction may be made at the elbow. Some short pieces of firewood or cardboard should then be tied round the limb, outside the sleeve, with handkerchiefs, or something of the kind, care being taken that those on the inside are so short that the circulation is not impeded at the elbow (*see Fig. 74*). The hand and wrist should then be slung in a towel folded scarf-wise.

5. **Fractures about the Elbow Joint.**—The forearm should be slung, but it will be unwise to attempt any reduction of the fracture, which is often complicated with dislocation, till arrangements have been made for its regular setting.

6. **Fracture of the Bones of the Forearm.**—The limb should be supported by two splints, which need not he very rigid (brown paper folded several times will do very well), placed along the front and back of the hand and forearm, and reaching from the elbow to beyond the tips of the fingers. The hand should be placed midway between pronation and supination, with the thumb upwards; the splint on the flexor side must not embarrass the brachial artery when the arm is

bent. The splints may be tied on with handkerchiefs, and the arm supported with a broad sling.

7. **Colles's Fracture at the Wrist.**—A simple sling is all that will generally be necessary, but sometimes, when there is a painful spasm of the flexors of the fingers, relief is afforded by a soft splint along the front of the hand and forearm, lightly tied on. The fracture should always be set as soon as possible, in one of the ways to be described later.

8. **Fractured Ribs.**—When an accident has happened, which in the nature of things may have caused one or more ribs to give way, and the injured person complains of a stabbing pain or "catch" in the breath on inspiration, with other signs of embarrassment of the breathing movements, it will not be necessary in the first instance to distinguish whether there has been a bruising or an actual fracture of the thoracic walls. In the majority of cases it will be found that immediate relief is afforded by placing the hands on either side of the chest, and compressing the thoracic walls gently, but firmly. Very often the patient will have found this out, and may even have tied his scarf tightly round his body. Until a more complete support can be given to the thorax by strapping and bandaging, something in the way of a scarf or towel must be tied round the chest with the tightness which will give the greatest amount of relief.

A patient with broken ribs may thus be able to get home without much suffering, but he should be cautioned against any movement which would require any but the shallowest respiration, for though he may be comfortable enough so long as the diaphragm alone is concerned in the performance of breathing, his pain would be much aggravated by any effort which would bring the chest walls into play.

9. **Fractured Spine.**—Whenever, or under whatever circumstances, the back appears to be broken, no question of splinting can arise, but the harm, or rather the disaster, which may be wrought by rough or careless handling, cannot be too thoroughly realized.

The symptoms of fractured spine being present, the injured person should be placed in the supine or prone position, on the ground, with the trunk as straight as possible under the circumstances. In the absence of a stretcher, a gate, hurdle, shutter, or some other rigid platform should be procured, and placed close to the patient, who must be placed on it with the least possible alteration of position. (For the methods of transportation, see page 111.)

10. **Fractured Pelvis.**—This may occur from a fall, but in most cases the cause will be the passage of some crushing weight, as the wheels of a wagon. Little requires to be done in the first instance; but relief may be given by tying a broad scarf or belt round the pelvis, and the patient must be quickly placed on a stretcher or its substitute. It sometimes happens, even after a severe injury to the pelvis, that the patient is able to walk after a fashion, but this must never be allowed.

11. **Fracture of the Neck of the Thigh-bone.**—(*a*) *Fracture in old people.* This will only require that the patient be moved with gentleness on a stretcher; no other precautions are necessary. (*b*) *Fracture with violence*, and injury to the softer parts around. This is usually extra-capsular, and generally occurs in adults. In any case precautions must be taken to prevent further damage in removal; these, however, will be practically the same as are required in the following case.

12. **Fracture of the Shaft of the Femur.**—In consequence of the length and strength of this bone, its fracture may be attended with great disorganization of the surrounding parts, and the injury is very easily made more serious still by rough or unskilful handling. In these cases the principal difficulty is that of transport, and the reader has only to imagine what might be the consequences of ill-advised efforts to move a heavy man with his thigh broken in the middle and unsupported, to see at once that no attempt should be made to move an adult thus injured till the limb has been rendered fairly stiff by improvised splinting. The end desired is practically to make the patient's body rigid from the armpit to the ankle, so as to prevent all risk of a bending or buckling up of the broken ends of the bone, which would otherwise readily occur. The patient should be kept lying *absolutely flat on the back*, and search should be made for something long and strong enough to serve as a "*girder*" *to run the whole length of the body* (a rifle or a broomstick will do admirably). This must then be laid along the injured side, the top going beneath the axilla, and the limb should be very gently straightened, since by this time it will probably have become much abducted, and rotated outwards. Then, with numerous handkerchiefs, towels, etc., this long splint must be fastened on, passing the bandages round the thorax and pelvis. Along the inner side of the leg *a short splint*, say an umbrella, should then be placed, and a back splint of thin board, or stiff paper folded, may be placed along the back of the thigh. These supports must then be fastened round the thigh, leg, and foot, as can best be managed. Finally, *the injured limb must be tied to the sound one in two or three places.*

If these proceedings have been thoroughly carried out, it should be possible, although it would be unwise, to carry the patient simply by the head and heels, without any bending.

13. **Fracture near the Knee Joint.**—Here the risk of injury is very much less, and one of two plans may be adopted. If the limb be lying fairly straight, an inside and an outside splint, as two walking-sticks, should be tied on with several handkerchiefs, avoiding the actual seat of fracture; or what will be found more comfortable, especially if the limb be bent, will be to place beneath the joint a thick pillow or other support, keeping it in the flexed position with a few bandages tied round all.

14. **In a Fractured Patella,** the great indication is to avoid increased separation of the fragments and further damage to the knee joint

beneath. This will best be done by a strong back splint of umbrellas or boarding, running behind the whole length of the thigh and leg, and tied on firmly with handkerchiefs.

15. **Fractures of one or both Bones of the Leg** generally occur from direct violence, and because the skin is so thin over the shin bone they are very apt to become *secondarily compound*, and may be so from the beginning. These fractures are thus often extremely severe injuries, and require much care and gentleness in handling. If the limb be very much crushed, with comminution of the bones, whether the fracture be compound or not, probably the best plan will be to take a soft pillow and arrange the stuffing so as to form a trough, lay the limb in it, and tie it up with soft bandages. In slighter cases, splints long enough to reach below the feet must be put on both the outer and inner sides, or on the outer one only (*Fig. 74*). If the boot can be easily taken off, as by cutting up the side springs or laces, this should be done, but it should be left alone if it seems that removal could cause the slightest damage.

16. **In Pott's Fracture with Dislocation at the Ankle Joint,** it is unwise to use any force to rectify the deformity, which is often considerable. The boot should be cut off, and a splint, extending from the knee to below the foot, should be put on the inner or the outer side, as seems best, with handkerchiefs. The foot should be placed in as nearly a natural position as it will readily come to.

Finally, in those cases of **Compound Dislocation of the Ankle,** or of a *general crush* of the parts about the foot caused by great violence, little can be done, except to tie the parts up in a pillow, or to use such other materials for soft support as the circumstances of the case will admit.

II.—Method of Transport of Cases of Fracture, and Precautions to be taken therein.—In military surgery it naturally happens that great stress is laid upon the best ways of moving people, helpless from injury, whether through fracture or otherwise. A regular stretcher drill is laid down, and other plans for lifting and carrying are carefully considered; but in civil practice, and in connection with the proper work of house surgeons and dressers, elaborate descriptions of the different kinds of stretchers and of kindred details would be out of place; still, it is desirable that all civilian dressers, surgeons, or porters, who have to do with helpless people, should have some acquaintance with the best ways of lifting and moving them, and one or two of these ways will here be mentioned, supposing always that the injured person is unable to walk at all. (The case of children need not here occupy our time.)

If two people only, A and B, are available for the transport, and the person is able to sit up a little, the best way to manage will be for them to make a "sedan chair" by crossing their arms. Of this "chair" there are three patterns, but one only is figured because it is the best for general use.

In the *First* of the other two plans, the fingers of the right hand of A and the left hand of B are interlocked to form a seat, while A's left hand is placed on B's shoulder, and *vice versa*, to make a back support.

In the *Second* plan both A's and one of B's hands are joined to form a triangular seat, and B's other hand rests on A's shoulder, forming a chair back.

But the *Third* way (*Fig. 76*) is the best, where both pairs of hands are used, locked together to form a seat, and where the patient supports himself by his hands placed upon the bearers' shoulders.

If the patient be quite Helpless or Senseless, whether he has to be carried any distance, or has only to be lifted on to a stretcher or bed, the assistance of three people is desirable, two, A and B, to do the lifting, and the third, C, to look after the injured limb and the patient generally.

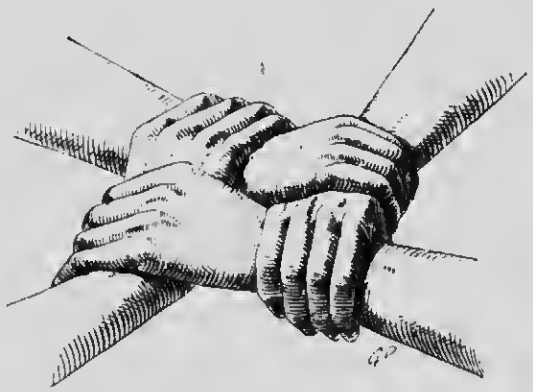


Fig. 76.—Hands forming Sedan Chair.

A and B take up a position on the opposite sides of the patient, near his haunch bones, facing each other; they then stoop down, and each gradually gets one hand under his back, near the shoulder blades, till they meet and are clasped; the other hands are then passed and locked under the breech.

Having secured a firm grasp they rise together from the stooping posture with the patient, and are ready to move. It is not advisable for either to kneel, unless they cannot stoop low enough, but if one does, both must.

A patient lifted in this way can readily be placed on a bed, or be lowered on to a stretcher for more convenient carriage. In lifting a stretcher the taller of the bearers should go to the head, and should give the directions as to the time of lifting. The head should always be lifted a little before, and lowered a little after, the feet. *In carrying anyone* on a stretcher, the bearers should *not keep step*, but the left foot of the one must be put forward with the right of the other, to avoid swaying. It is not here considered necessary to give an account of the actual stretcher drill, where the bearers are numbered off, and

have their several duties sharply defined, for the purposes of military discipline.

With regard to *Conveyance in Cabs*, a four-wheeler is much better than one with two wheels. If the injury be very severe the patient should be lying down if possible, either from seat to seat, or if that space is insufficient, a stretcher may be laid across the floor of the cab, both doors being opened.

Lifting Patient to Bed.—When a patient has been brought to the bedside, the bed being ready, he should, if completely disabled, be very gently lifted on to it, and the knowledge of how to do this properly and with the least discomfort to the patient does not come naturally.

The stretcher, or whatever the patient has been carried on to his bedroom, is placed on one side of the bed, say the left side; those about to lift him kneel on one knee on the patient's left, and after carefully inserting their hands and forearms well under him, at a given signal rise to their feet and lift him gently. An assistant then draws away the stretcher, and the lifters taking a pace forward gently deposit the patient in the centre of the bed. With a sufficient number of assistants this manœuvre may be done expeditiously and without pain.

It may also be done by placing the stretcher with the patient's head at the foot of the bed. The assistants kneeling on either side insert their arms well under the patient, and at a given signal rise to their feet and lift the patient up. By moving along sideways the patient is brought over the bed and gently deposited.

This method is not so good as the former, but it allows of more assistants being employed, which is convenient in the case of heavy people. The lifters may either lock their hands under the patient, or, still better, grasp each other's wrists.

The patient having been placed on the bed, the clothing should be removed, cutting off the boots and ripping up the seams of the clothes, if this has not been done before, the sound arm or leg being the one which should first be slipped out of the sleeve or trouser. As a rule, everything in the shape of temporary splints may now be taken off, and the limb should be placed in the most natural position in which it will easily lie, on a pillow fashioned into a kind of trough. *Sandbags* are very often useful in restraining spasmodic movements or in steadying the limb. All pressure of the bedclothes must be taken off by a *regular cradle*, or one improvised out of some such thing as a bandbox split open. If the case be a severe one, especially if there be much spasm, a hypodermic injection of morphia will now be found extremely useful.

2.—OF FRACTURE BEDS.

There are certain points to be looked to with regard to the bed on which a patient with a fractured limb will have to lie, and inasmuch as it is probable that once there, any further movement will be hurtful, they should be considered and met *before* the patient is placed on it.

The Essential Qualities which the bed should possess are, that there should nowhere be any " sagging " or possibility of giving way, that the surface should be evenly smooth and comfortably elastic, and that the foot of the mattress should be somewhat higher than the head.

In practice it will be found that very few bedsteads fulfil these requirements ; even the best (the wire-woven beds, or those with interlaced iron bands) will allow of a certain giving way where the greatest weight of the body comes, while this occurs to a much greater extent in sacking, or sofa spring beds. The evils of this yielding and the formation of a hollow under the patient are not so apparent at first as they afterwards become ; the patient gradually slips down, the head and shoulders are pushed forward, and the heels come up, until, instead of lying in a straight line, the body forms two sides of a triangle, the apex of which is at the ischial tuberosities, to the grievous alteration of the parts about the seat of fracture, and to the great risk of the formation of bedsores.

Fortunately the remedy is easy, and involves no apparatus, all that is required being a light wooden frame or a few light boards placed on the bedstead, underneath the mattress. If the mattresses are of the kind to be described directly, no discomfort will be felt after a very little time from the rigidity of these boards, even by those who are accustomed to lie softly, while they are quite as efficient as any special bedsteads that have ever been devised.

A big bed is a misfortune in all cases of sickness, but especially in fractures. The *best size* is that of the ordinary single bed, as found in hospitals and elsewhere, namely, 6ft. 6in. by 3ft. or 3ft. 6ins.

It is of great importance that the *Mattresses* in fracture cases should possess the qualities of smoothness and elasticity in perfection, and for this reason any form of " bed," either of feathers or other material, is quite inadmissible. Flock mattresses are objectionable, as, even if well made, they tend in time to form knots or lumps. The best combination of all is a straw palliasse, and over that, one or two horse-hair mattresses, $3\frac{1}{2}$ in. to 4 in. thick. Over the mattress one blanket is generally found useful. The sheets require no particular directions, save that, if a draw-sheet and mackintosh are required, they should be arranged before the patient is put to bed.

In cases of fracture of the lower extremities, or of the spine, *all* pillows or bolsters are harmful, except the merest cushion beneath the head, at any rate in the early stages of union ; and if the patient can be induced to lie thus flat, the position will not produce discomfort after the first day or two. Any pillows should be small and firm, and covered with separate slips.

Chapter XIII.

OF MASSAGE, MANIPULATION, AND PASSIVE MOVEMENTS IN FRACTURES.

(See Graham on Massage.)

ALTHOUGH the value of massage was recognized by ancient writers on surgery, and although it was widely applied with satisfactory results by the Greek and Roman physicians, its introduction into our surgical treatment is comparatively recent. The introduction of a mode of treatment of unquestionable benefit in the treatment of sprains and fractures has led to a swinging of the pendulum of surgical opinion in a direction very opposite to that of some twenty-five to thirty years ago.

At this period the routine treatment of fractures, sprains, and dislocations was rigid confinement by some retentive apparatus until such time had elapsed as was considered necessary for the repair of bone or for the removal of the exudation. This period extended over several weeks, with the result that when the splints were removed the joints were stiff, the muscles wasted, and it was long before the affected limb recovered.

No sooner was the beneficial effect of massage generally recognized, than some pioneers of this method of treatment advocated its adoption in the case of fractures and other injuries, to the entire exclusion of splints and other apparatus designed to keep the parts at rest.

It is not our business to enter at length into this question, but we would state clearly that both massage and passive movement can be overdone: this without for one moment disparaging the treatment under proper conditions.

We are further of the opinion that fractures and severe sprains are best treated at the start by those principles which govern us in the treatment of any extensive injury, namely, rest and fixation; it seems to us inconsistent not to keep parts quiet which have been subjected to considerable bruising and laceration. Further, while we admit that the treatment of fractures without retentive apparatus has given some excellent results, we cannot advise it as a routine, especially for hospital cases, where daily inspection may be difficult. The same may be said with regard to passive movement. Doubtless the cautious and well-regulated practice of passive movement in cases of fracture is to be highly commended, but the greatest care is required in its application. Unless a surgeon realizes this, he may often do more

harm than good in attempts at passive movement. Certain recommendations as to the method of performing these movements will be given below, but we may remind our readers that passive movement may easily displace the two surfaces of a broken bone which have been brought into apposition with some difficulty.

It may be well to point out the manner in which massage and passive movements act. Massage is of special value in getting rid of the effusions which have been poured out as the result of injury. These effusions are pressed into the lymph-stream and readily carried off by the manipulations described.

Both massage and passive movement are of value in preventing the formation of intra- and extra-articular adhesions. In many text-books the student gathers that adhesions are formed in the joints alone, but this is by no means the case.

When a fracture (or sprain) has occurred in the neighbourhood of the ankle, the joint may or may not be damaged, but the tendons which lie in relation to the lower end of the tibia are involved in a plaster of extravasated blood and lymph. If they are allowed to remain in this state, organization will occur, and they will become matted together and almost immovable. The application of massage, passive and (at a later period) active movements, is the very best means at our disposal for the prevention of this complication. Should such adhesions form in spite of treatment, they must be broken down under an anæsthetic.

Finally, both massage and movements improve the tone of the muscles and of the vessels of the limb. When a limb, especially the lower extremity has been fixed immovably on splints for any length of time, an attempt to use the part after removal of the apparatus is usually followed by painful swelling and œdema. The same occurs in some patients after simple confinement to bed for a long period. This swelling is due to loss of tone of the vessels, so that, as soon as any extra strain is thrown upon them, transudation takes place into the tissues.

The muscles are thrown out of action by long fixation on a splint; they waste, and as a result, when the fracture has healed and the patient is ready to get about, the atrophied muscles are incapable of doing their work, and convalescence is thus delayed until they recover. The importance of muscular wasting in association with sprains and damage to joints is best illustrated in the case of the knee joint. When this region has been damaged and the part immobilized on a splint for any length of time without massage, the quadriceps muscle wastes considerably. As soon as the patient begins to walk about he finds his joint weak and liable to give way. He therefore applies an elastic supporting bandage, which further induces muscular atrophy. Now one of the functions of the quadriceps is to keep the synovial membrane of the knee under control during the movements of the joint. When the muscle has atrophied, the joint capsule and

synovial membrane are lax, and folds of synovial membrane get between the articular surfaces (especially the folds on either side of the alar ligament) and are nipped. The result of this is an attack of synovitis, for which a splint is again applied, and so the patient goes on until the joint passes into a state of chronic synovitis with serous effusion, or a condition of permanent weakness (called by Bennett

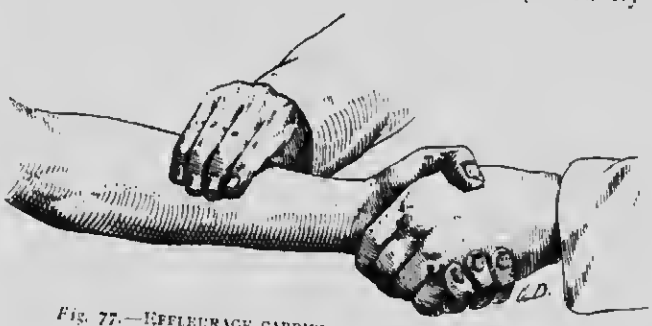


Fig. 77.—Effleurage carried out with the finger-tips.

" wobbly joint "). All this may be prevented by the early use of massage and passive movement. The muscles are exercised, and a free circulation through their capillaries is induced.

Massage, from the Greek *μασσω*, I knead or handle, has many forms. For our purpose we shall only consider two: *effleurage* or *stroking*, friction of the limb towards the trunk or in the direction of the lymph

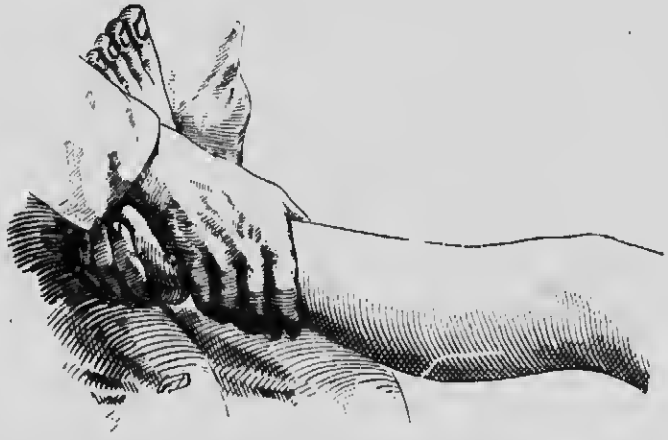


Fig. 78.—Effleurage performed with the entire palm of the hand rapidly moved towards the knee.

flow, and *pétrissage* or *kneading*, deep massing or palpation of the muscles by gentle squeezing of the part by the palm of the hand and fingers. The other varieties are more elaborate, and do not concern us here.

Effleurage.—In practising this operation some neutral powder or even some greasy preparation (this is not very pleasant) is applied to the patient's limb, and if the limb is very hairy it may be shaved. The operator, usually seated, gently strokes the surface of the affected limb with the palmar surface of the hand with a rhythmical movement, in a direction towards the trunk (*Figs.* 77, 78)*; he should employ

Fig. 79.—Petrissage of the Arm Muscles with Vibratory Movement.

as large a surface of his hand as possible, and the hand should never press heavily. The fingers are treated by taking them between the finger and thumb and stroking gently towards the palm.

Pétrissage is performed somewhat differently. As large a grasp of the limb as possible is taken with both hands, and the thenar portion

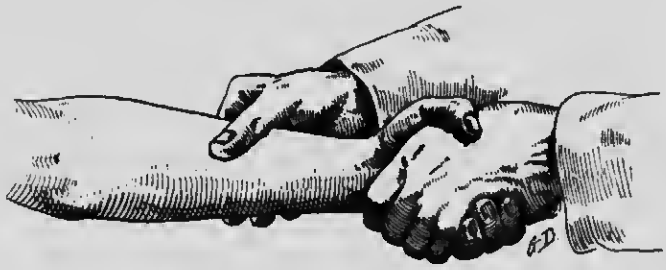


Fig. 80.—Petrissage with a single Finger or Thumb, to remove Inflammatory Exudates.

of the palm is pressed into the tissues, by alternate movements of the two hands (as the right contracts and compresses the muscles the left relaxes). The long axis of the operator's hand should lie parallel with

* *Figs.* 77-80 are from "Natural Therapy," by T. D. Luke, M.D. (Bristol: John Wright & Sons Ltd.), by kind permission of the Author.

the long axis of the patient's limb, and the thumbs should be directed towards the patient's trunk. Working in this manner, and starting at the distal extremity of the limb, the operator approaches gradually the proximal end (as for example the shoulder in the case of the upper extremity), and then starts again at the fingers or distal end (*Figs.* 79, 80).

This very brief description of the varieties of massage and their application is only intended to assist house surgeons in treating their own cases, since a general description of massage is beyond the scope of this work. The best plan is to watch a masseur at work, but if the above instructions are followed out, the dresser or house surgeon will often be able to help his fractures, and get some practice in the application of massage which will be very useful to him.

It is important to appreciate where massage should be started in cases of fracture and sprain. If the operator start at or just below the seat of injury, considerable pain will be caused. In all cases it is advisable to start *above* the injury—that is, nearer the trunk. Taking as an example a bad sprain of the ankle, begin in the middle of the leg and work up to the thigh, starting each successive time nearer the point of injury, until it is finally reached. The object is, first, to assist the vessels in carrying off the exudation, and secondly, to gradually accustom the bruised tissues to the movements.

As soon as the massage has been completed immediately above the injured area, the operator should turn his attention to the distal extremity, and beginning with the digits work cautiously upwards towards the damaged part. He will now find that gentle friction over this area will be tolerated by the patient, and finally, at the end of the sitting, he will most probably be able freely to massage the bruised tissues.

Passive Movement.—This is a movement of a joint in the neighbourhood of a fracture or sprain undertaken by the operator, the patient being passive, i.e., keeping his muscles as far as possible relaxed, and taking no part in performing the movement. Not only does this movement tend to improve the nutrition of the muscles, but it also prevents the formation of adhesions.

In performing passive movement in the early stages of treatment, the greatest care must be taken not to displace the fragments, which must be held steady in some way. In cases of fracture about the elbow, a hinged splint may be fitted, which will permit flexion and extension without the limb being removed from the apparatus.

In other cases the fractured bone must be held by one hand of the operator, while the other gently begins the movements required, usually flexion and extension.

In the case of Colles's fracture, the fingers can be freely moved without removing the palmar splint, and when it becomes necessary to move the wrist, the fracture must be held by the one hand, the thumb being placed on the back of the lower fragment, and the fingers on the front of the upper fragment.

In performing passive movement it is necessary to have an accurate knowledge of the situation of the fracture, and the direction in which displacement is likely to occur.

The range of movement must be very limited at first, but be gradually increased. If carefully applied it should be practically painless, and the infliction of pain should be looked upon as an indication that the movements are too vigorous.

Injuries produced by too energetic Passive Movement.

Displacement of fragments: This has already been alluded to.

Traumatic Synovitis.—If a joint has been severely damaged and passive movement overdone, it is not uncommonly found that the joint becomes swollen and acutely tender after the manipulations have been completed.

Non-union.—It is an open question whether movement leads to non-union; some authorities maintain that movement of the fragments on one another is beneficial, and that union takes place more readily under these conditions.

Active Movements and Movements against Resistance.— These movements are not to be allowed until there is fairly firm union between the broken ends. Such union is present about the third week in most fractures.

In movements against resistance, as opposed to passive movements, the operator endeavours to flex and extend the limb against the contraction of the muscles voluntarily exercised by the patient. In the later stages of treatment these movements are especially valuable in keeping muscles and tendons exercised.

Free active movements may be permitted some weeks before retentive apparatus is discarded, and in cases of Pott's and Colles's fractures the patient should be encouraged to move the foot and ankle or fingers and wrist some time before attempting anything in the nature of walking or carrying.

The duration of each application of massage should be from fifteen to thirty minutes, and the treatment should be continued every day, or every other day, until function is restored.

Chapter XIV.

OF THE PERMANENT SETTING OF FRACTURES.

FRACTURES are at once the most frequent and the most important of the accidents with which a house surgeon may have to deal. Apart from the great difficulty in arriving at an exact diagnosis in certain cases, so many problems present themselves during the treatment, and so many complications may ensue, that the student will do well to study examples of these injuries with the greatest care during his time as a dresser.

Bad results, which are unfortunately too common, can only be avoided by the exercise of constant attention during the after-treatment. A bad result is often considered a reproach to the surgeon attending the case, and in some cases he must be regarded as responsible for it. At the same time, if he has conscientiously followed out an appropriate treatment with every care, although in many instances his results may not be perfect, he cannot be regarded as in any way to blame. Fractures among the working-classes are very serious injuries. The patient is of necessity kept from work for a long period, and if the bones have united in a bad position, or if a joint has become permanently stiff, the wage-earning capacity of the sufferer may diminish to vanishing point.

It is necessary to say a few words about the diagnosis of fractures before considering the main principles which should govern our treatment. In many cases the classical signs of fracture are so obvious that an unpractised observer will have no difficulty in at once deciding on the nature of the injury. We briefly state the main points.

Signs of Fracture—

1. *Signs of local injury*, such as bruising of the limb or superficial wounds.

2. *Deformity.* Alteration in the natural outline of the part as compared with the opposite side. *When possible, in the case of any injury of the extremities, shoulder, or hip, a careful comparison with the sound side should be made.*

3. *Local tenderness* over the seat of the fracture.

4. *Shortening*, the fragments in complete fractures tending to ride over one another owing to the contraction of the muscles.

Measurements should always be made between two prominent bony points, and compared with similar measurements made on the opposite side—as, for example, a measurement from the acromion process of the scapula to the external condyle or the olecranon, in cases of injury to the humerus.

A word of warning may be given on the subject of these measurements. It is by no means uncommon to observe a great discrepancy between the measurements obtained by two separate observers, this being due to: (*a*) Inaccuracy in applying the measuring tape to the bony prominences; and (*b*) Failure to put the sound limb in a position as nearly similar as possible to that of the injured one (*Fig.* 81).

The subcutaneou bony points of the body used for measurement are not by any means exact. In the case of the anterior superior spine of the ilium, an area of at least an inch can be called subcutaneous, and it is easy to see how a measurement carelessly made may fail to reveal a shortening of half to one inch. A good rule to follow is this—*Before measuring, mark with a skin pencil or with ink, as accurately as possible, the exact points on the two sides between which the measurements are to be taken.*

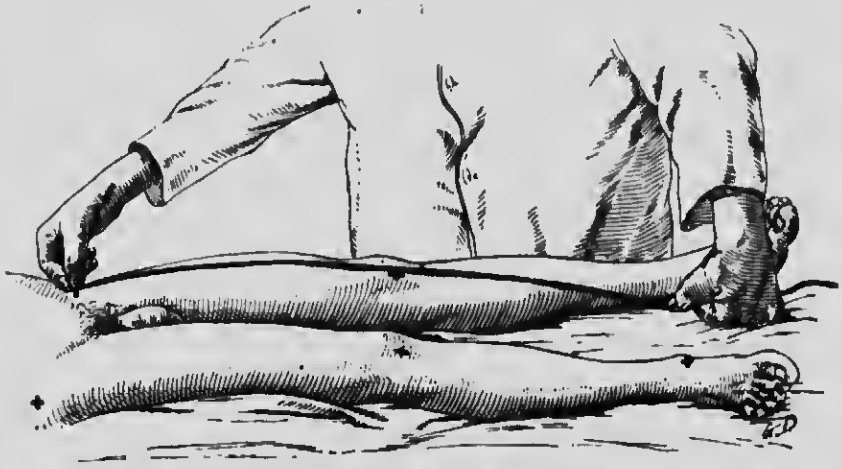


Fig. 81.—Measurement for Injury about the Hip.

With regard to (*b*), we will instance injuries round the hip joint. If in these cases the measurements are made with one limb in adduction and the other in abduction errors are bound to arise. In adduction there is a greater distance between the anterior superior spine of the ilium and the external malleolus or external condyle than there is in abduction.

5. *Alteration in the position of certain bony processes to one another.*—This is best illustrated in Colles's fracture of the radius, where the position of the styloid processes of the two bones to one another is changed.

6. *Abnormal Mobility* of the limb or part owing to the loss of continuity of the shaft of the bone. In some cases where the fracture is comminuted or splintered the lower part hangs loosely and uselessly from the rest of the limb.

7. *Crepitus.*—A peculiar grating caused by the rubbing of the fractured surfaces on one another, communicated to the hand of the surgeon when he is examining the case. Although a sign of the greatest value in indicating clearly the presence of a fracture, the utmost care must be taken in eliciting it, since the endeavour to do so may not only cause intense pain, but may damage the soft parts.

But while any or all of these valuable signs may be present in a given case, there are many examples where most of them are absent, and the case then may present the greatest difficulty.

In fractures near joints, swelling may mask all the bony prominences. Deformity may be absent from the fracture being incomplete, or from other reasons. Crepitus may not be obtained owing to impaction of the fragments. Pain, however, is rarely absent.

In such cases as these, it is clear that the diagnosis cannot easily be made, and we would suggest the following rules.

Rules for Diagnosing Fractures.—

1. In cases of injury where it is possible that a fracture has been sustained, treatment appropriate to a fracture, if present, should be undertaken; and the case considered to be one of fracture until further investigation has proved the contrary.

2. Never in a doubtful case say "There is no fracture;" but rather, "I find no evidence of fracture at present."

3. When possible, submit every case of *recognized* or *suspected fracture* to the *X*-rays, before and after setting.

The introduction of the *x*-rays has shown us that fractures are more frequently present than we suppose. Many cases mistaken for sprains have been revealed as fractures in a skiagram; and, in many instances, the timely application of the rays has allowed an unrecognized deformity to be rectified, which if left would have seriously affected the patient.

4. In cases of doubt, unless there be some special contraindication, administer an anæsthetic and examine thoroughly. It is not until all these investigations have been completed in an obscure case that the surgeon can say with confidence "There is no fracture."

In the setting and treatment of fractures there are three main indications.

Indications for Setting and Treatment.—

1. To get the bones into a position as near the natural as possible. Considerable force may be required for this, and therefore in most instances an anæsthetic should be given.

Reduction of any deformity will be effected by extension and counter-extension, i.e., pulling on the limb below the fracture, while the part above is steadied and held firm by an assistant. This pulling should be carefully performed; its object is to overcome the muscular contraction which is producing the deformity.

Many fractures do not require this treatment. In fractures of bones of the face manipulation only will be necessary. In fractures without

displacement no formal setting need be undertaken (as in the case of some impacted fractures where the position is good). Measurements must be carefully made to see that all shortening has been overcome.

2. After the bones have been brought into as good n position as possible, some apparatus (*see* "Splints") must be applied in order to keep them in that position.

3. Every effort must be made to restore the function of the part.

Since with a fracture there is damage not only to the bones but also to muscles and tendons, and often nerves and joints, care must be taken in the after-treatment to see that these do not become useless from prolonged fixation. It is of little service to a patient to have perfect union between the ends of a broken bone if the nearest joint be locked and the muscles of the limb wasted and infirm. These accidents can be prevented by the early use of massage and passive movements.

But while the above form the general rules upon which fracture treatment should be carried out, there are certain other details which should be attended to.

The Best time for Setting a Fracture is as soon as possible after the injury has been inflicted; but if it has not been possible to arrive at a correct diagnosis, or if there be so much swelling that setting is out of the question, a few days must elapse before an attempt is made to get the fragments into apposition.

During this Period of Waiting the Patient Must be Kept in Bed. Attend to his general condition, and bear in mind that the course of a fracture is influenced by any constitutional disease, such as syphilis or Bright's disease.

Compound Fractures.—While ordinary or simple fractures are in themselves sufficiently serious, compound fractures are the worst injuries that one is called upon to treat. Not only is there a fracture present which requires its special treatment, but there is a lacerated wound, often contaminated with dirt and likely to suppurate, which interferes with the proper treatment of the fracture, and itself introduces a number of complications. Some fractures, in virtue of the position of the affected bone, are almost invariably compound, as in the case of a fractured jaw (these will be dealt with below). In the case of the extremities a compound is much rarer than a simple fracture, and usually requires more violence to produce it. A fracture of the tibia is often compound, owing to the subcutaneous position of the bone.

While the general rules formulated above are applicable to those fractures which are compound, much has to he said about the special treatment of these complex cases.

We may roughly divide compound fractures into three groups:—

1. The fracture is compound, i.e., the skin is broken, but no bone, or at most a small spicule, protrudes through the opening; the wound is not obviously contaminated. There is no need to open up the

wound; in most cases it would be meddlesome surgery to attempt it. Apply an antiseptic dressing after carefully cleaning and shaving the skin round the opening, and treat as a simple fracture. If the edges of the wound become inflamed, and if the temperature rises, then it will be necessary to open up the wound thoroughly and drain.

2. Ordinary compound fractures, with laceration of the skin, frequently with comminution of the bones, and considerable contamination.

3. Bad compound fractures, with serious injuries to the soft parts, joints being opened, muscles, vessels, and nerves torn, and the soft parts stripped up from the bone of the limb.

In this latter group the question of amputation will have to be considered; but as it is no part of a house surgeon's duty to decide this point, little will be said about the indications for performing a radical operation. In most instances, however bad the injury, some attempt may be made to save the limb, but in bad smashes of this nature, when the visiting surgeon must be summoned, it is very advisable for the house surgeon to obtain permission from the relations of the patient, or from the patient himself, for the performance of an amputation should the surgeon deem it advisable.

Treatment of Ordinary Cases of Compound Fracture.—As soon as the patient has reached the hospital he should be admitted to the ward: the clothes should be cut off, if this has not been done already; he should be packed round with hot bottles and well covered up. No prolonged examination should be made, and if a temporary splint has been applied satisfactorily it should not be removed until the patient has been anæsthetized.

It must be borne in mind that considerable shock accompanies a compound fracture, and undue exposure and unnecessary manipulations are to be condemned. Three points must be attended to. First, the fracture must be looked at, in order that some idea of the necessary treatment may be formed. Secondly, any serious bleeding must be checked by a tourniquet, or by other measures. Thirdly, any obvious complication must be looked for, i.e., other injuries—to spine, head, or abdomen, or to nerves in the region of the fracture. It is well to be careful over this latter point, since neglect of it may lead to a nervous lesion being overlooked when the patient is under an anæsthetic.

Transfusion may be required.

When the patient has been anæsthetized, any remaining clothes are removed, and the temporary splint is taken off. The wound is quickly syringed out with peroxide of hydrogen, and then lightly plugged. Next, the skin all round the wound is washed and shaved: if the tibia be fractured, the whole leg and foot should be treated in this way. The skin should be scrubbed with ether soap, and, after this has been washed off, with a solution of biniodide in spirit, 1–1000, or any strong antiseptic. Care must be taken during this stage that the wound is kept well covered up, so that washings from the limb do not get

into it. The limb being now rendered as far as possible antiseptic, attention is directed to the wound and the fracture. The wound is again syringed out with hot peroxide of hydrogen, and is then subjected to the following toilet. All ragged bits of skin are cut away from the edges, and the margins generally trimmed up with scissors; if necessary the wound is enlarged with the knife. All dirt and foreign bodies are cleared away. A free irrigation with alternate solutions of hot (120° F.) saline and peroxide of hydrogen is the best for this purpose, but sharp spoons and forceps may be required, or if the wound is badly contaminated with dirt, 1–40 carbolic, 1–2000 perchloride or biniodide may be used. Any detached muscle tendon or fascia which may slough, is cut away. All loose fragments of bone, and any material that lies between the broken fragments, are removed. Any bleeding point or torn vessel (which may not be bleeding at the time) that can be seen is secured with a ligature. Any nerve or tendon that has been severed is united by direct suture by its two ends.

The bones are manipulated, with the assistance of extension and counter-extension, into the best possible position, and, if necessary, they may be wired.

The responsibility of a decision as to whether wiring should or should not be undertaken generally rests with the visiting surgeon.

The wound is finally irrigated with peroxide and saline, and drainage tubes are inserted. As a rule few or no sutures will be required. Any incision that has been made can be sutured, but experience has shown that sutures inserted into bruised tissues are always harmful. A dressing is applied, and the limb is fixed on appropriate splints.

Chapter XV.

ON THE AFTER-TREATMENT OF FRACTURES, AND THE MORE USUAL COMPLICATIONS WHICH WILL REQUIRE ATTENTION.

THIS chapter will deal mainly with the after-treatment of cases of fracture which have been admitted to the wards, but as certain details demand attention in the treatment of fractures among out-patients, they will be considered first.

AFTER-TREATMENT.

All Fractures must be seen the day after the injury. At this, the first visit, the splints must be carefully inspected: if they have slipped, they must be readjusted. The fingers or toes must be examined for swelling or numbness, and if these complications are present, or if the patient complains of severe pain, the splints must be taken off and the parts examined. The further treatment of uncomplicated cases consists in seeing the patient two, three, or four times a week, according to the nature of the injury, and in the regular performance of massage and passive movement. There should be no hesitation in "taking a fracture down;" in fact, within reasonable limits the more often this is done the better, since it gives the surgeon frequent opportunities of examining the part and correcting any deformity that may be present before firm consolidation has taken place.

The time that should elapse before the splints or other apparatus are dispensed with depends upon the nature of the fracture and upon the individual. Certain directions will be given later concerning special varieties of fracture, but we may say at once that some protection should be provided until all chance of refracture or bending of the callus is passed. It is wiser to prolong the use of splints than risk such accidents, since if the recommendations on massage and passive and active movements have been carried out, the use of splints for an additional week or two can have no injurious effect.

Complicated Cases, with special reference to Compound Fractures.—When the patient has been brought back into the ward from the operating-theatre, it is the duty of the house surgeon to see that certain arrangements are made for his (the patient's) comfort.

If the limb is slung in a cradle it should be adjusted carefully, so that the splint swings free above the bed, and that all exposed parts are well covered up. Sometimes patients suffer a good deal of inconvenience from undue exposure.

A middle diet—fish or milk—should be ordered to start with, and it is always advisable to administer a purge to the patient the first night of his stay in the hospital. Confinement to bed causes sluggishness of the intestines in many people. The patient will probably require a sedative.

Although we appreciate the warnings uttered against a too free use of hypnotics, we see no reason for withholding them in cases of fracture, and we advise a hypodermic injection of $\frac{1}{6}$ to $\frac{1}{4}$ gr. of morphia in all cases of severe fracture unless specially contraindicated. Not only does the patient pass a good night, but the spasm of the muscles is markedly diminished. The further treatment of these cases is similar to that advised above.

COMPLICATIONS.

Rise of Temperature is not uncommon the next day. This rise has been explained as being due to the absorption of blood extravasated round the fracture. It is probably due to tension, and the splints should be slightly slackened. In cases of compound fracture a rise of temperature of several degrees will be an indication of septic changes, but it must be remembered that such a rise is a gradual one, and it is not until the end of the second or third day that the symptoms of sepsis are pronounced, except in some rare fulminating cases. A rise of temperature on the day following the injury in cases of compound fracture makes us suspicious, but it does not necessarily imply sepsis. The case must be carefully watched.

Sepsis.—When this has supervened the diagnosis will be easy. The temperature will have risen to 102° or 104°, the wound will have become foul and sloughy, with considerable redness and surrounding œdema.

The wound must be thoroughly opened up, and free drainage provided, several counter-openings being made in dependent parts, and the dressings must be frequently changed. Probably the best application is a moist cyanide gauze dressing, but we still incline to fomentations (carbolic), or to constant irrigation with very weak permanganate of potash solution. Sepsis is a very serious complication, and amputation may be required. This is a matter, however, for the visiting surgeon to decide, though much may be done by prompt and thorough treatment in the form of irrigation and counter-drainage. The general treatment of sepsis will be considered later.

Hypostatic Pneumonia commonly attacks old people, especially those who are somewhat emphysematous. It is more a congestion than an actual inflammatory process, and its onset is favoured by keeping these patients on their backs. The rule, therefore, in treating fractures in elderly people should be never to allow them to remain flat on the back; unless there is some very special reason to the contrary, they should always be well propped up with pillows. The first symptoms of this complication are usually cough, slight dyspnœa, and possibly some cyanosis and signs of consolidation at the lung bases.

Treatment.—Stimulants and expectorants must be given freely: brandy, ½ oz., every three hours or oftener if required. A good prescription is as follows:—

℞ Ammon. Carb.	gr. v	Tinct. Scillæ		℥xv
Spiritus Ætheris	ʒss	Aq. Menth. Pip.	ad	ʒj
Vini Ipecac.	℥x			

Every four hours. (*Cheyne and Burghard.*)

As there is often cardiac failure as well as pulmonary congestion, both digitalis and strychnia are of great value. Strychnia is a respiratory stimulant and an expectorant.

As a rule a steam kettle is unnecessary, but if the bronchial tubes are clogged with a viscid mucus it affords relief. A pneumonia jacket may be applied. When the cyanosis becomes marked, venesection may be necessary, but we have obtained good results in these cases by dry cupping over the bases of the lungs. Inhalations of oxygen are of the greatest service, and should not be deferred too long.

Delirium Tremens is a form of mania occurring in alcoholic subjects. There are two distinct forms: (1) *The sthenic form*, where the patient is a robust, healthy individual, often plethoric, who has been accustomed to partake freely of alcohol without, perhaps, becoming very intoxicated. (2) *The asthenic form*, which occurs in broken-down alcoholics whose tissues are unhealthy and whose constitution has been undermined. There is little doubt that a patient suddenly deprived of stimulant of which he has usually partaken freely is liable to an attack of delirium tremens, which may be aborted by the judicious administration of alcohol; such cases should be allowed small quantities of their usual stimulant, and it is of great importance to find out from the patient what his habits have been previous to his admission.

The earliest symptoms of delirium tremens are restlessness and inability to sleep. This is an additional reason for the administration of some hypnotic the first night after admission. We are sure that delirium tremens can sometimes be prevented in this way. Soon the restlessness gives place to tremor, twitchings, and hallucinations (a tremor of the tongue and hands is an early and valuable sign); the patient becomes delirious, violent, and maniacal; he throws himself about, moves his fractured limb, apparently without pain, and unless watched may get out of bed. When these symptoms have appeared, there are four special points to be attended to.

1. The patient must be made to sleep. Many hypnotics have been recommended, but chloral 10 to 15 gr., with a similar quantity of bromide of potassium, appears to us the best. Chloral, it is quite true, is a cardiac depressant, but we have not been favourably impressed by trional and sulphonal in these cases. Morphia should be avoided.

2. The patient must be fed. In the sthenic type this is not important—there is violent delirium, the temperature is high, and the pulse full and bounding; but in the asthenic variety the patient will

require careful feeding with a stomach or nasal tube if he refuses to swallow; stimulants should be given if he is much exhausted.

3. A brisk purge should be given.

4. The fracture must receive attention. The best way of controlling the fracture is to put it up in plaster. If this cannot be done owing to the violence of the patient, he must be anæsthetized until the casing has been made. If this treatment is not possible, the limb should be slung, and any damage done to the fracture should be rectified afterwards. An attendant will be necessary, and the patient may have to be strapped down in bed.

Before leaving this subject, we would point out that mental disturbances of various forms, apart from delirium tremens, are by no means uncommon during the treatment of fractures and other surgical cases. When the peculiar conduct of a patient arouses the slightest suspicion in the mind of a house surgeon, he should *at once* notify the authorities and take every precaution for keeping the patient under observation. In this way such accidents as patients throwing themselves out of windows, or making murderous assaults on other inmates of the ward, can be prevented.

Thrombosis is a fairly common complication. It may result from damage inflicted on the vein at the time of the original injury, or from inflammatory changes occurring later. It is recognized by swelling of the limb below the thrombus, and by pain and tenderness; sometimes a definite thickening over the course of the vein. Thrombosis must be regarded seriously: gangrene may be caused by it; while other accidents, such as embolism, may arise from this condition.

Gangrene is recognized by discoloration of the limb below the fracture, and by loss of sensation and warmth. It is usually of the moist variety, and demands amputation.

Involvement of Nerves in Callus must be borne in mind, and any case which shows symptoms of this complication should be at once reported to the visiting surgeon.

Bedsores are to be avoided by careful attention to the points mentioned in chapter XXVI.

Mal-union and Non-union may occur in spite of the most careful treatment. As soon as they are noticed, and unless the house surgeon can remedy the condition, the visiting surgeon should be informed, since an operation may be advisable.

Ischæmic Paralysis, or Volkmann's contracture, usually found in the upper extremity, is probably due to two factors: damage to the muscles and tight splinting; sometimes nerves are also damaged. If care is exercised in the treatment of fractures, it is unlikely to occur. It is recognized by a peculiar claw-like contraction of the hand and forearm after an injury to the bones.

Other rarer complications are not here considered.

Chapter XVI.

SPECIAL FRACTURES.

FRACTURES OF THE BONES OF THE FACE.

Fractures of the Nasal Bones are common enough in surgical practice, and a lifelong disfigurement is the result of neglecting to remedy the displacement. In these injuries either the nasal bones themselves, or their cartilages, or the septum narium, or all of these structures, are displaced or broken. The first point to bear in mind is, that the sooner the parts displaced are put into position, the better and easier that restoration will be. The swelling may be very troublesome; to reduce it hot fomentations will be found most useful. Leeches have been recommended, but for obvious reasons they can be used only very sparingly to the outside of the nose.

The line of treatment is in most cases a simple one. The displaced or depressed bones must be lifted into place again by manipulation with such an instrument as a stiff steel director or a pair of bone forceps inserted into the nostril; once replaced, they will generally remain in position; if not, they must be kept there by plugs of lint or gauze, soaked in carbolized oil.

Displacement of the Cartilages is more obstinate than that of the bones, and generally requires careful plugging with pledgets of lint, frequently changed, to cure the deformity. This is especially true of displacement of the septum, causing obstruction to the respiration through one nostril and catarrh of the mucous membrane. In these cases the septum must first be straightened with an ordinary pair of dressing forceps, or, if they are at hand, with the flat-bladed forceps invented by Adams, and should then be kept in its place by appropriate plugs.

All attempts at moulding by pads, lint, etc., placed outside the nose, appear to be useless, but a carefully moulded gutta-percha "cap" is often very serviceable.

Other fractures of the bones of the face, e.g., of the zygoma or the malar bone, occur so rarely in practice, and differ so widely in every case, that it would be but lost labour to lay down any general rules of treatment.

THE JAW.

Fracture of the Lower Jaw is very common, and occurs with very varying degrees of severity. We will consider first those cases which may be satisfactorily treated by the general surgeon, who does not

claim to possess the special manipulative skill which belongs more properly to those who have given particular attention to the surgery of the teeth and of the parts connected with them.

An ordinary fracture of the jaw occurs from direct violence, and is *frequently compound.* Provided that necrosis does not take place, this fact does not materially alter the process of union, or the treatment, and the fragments as a rule unite firmly enough.

In most cases it will be sufficient to carefully mould a *gutta-percha or plastic felt splint* to the outside of the jaw, as shown in *Fig.* 82, and to fix it with a firm four-tailed bandage (*see also Fig.* 40), so that the upper teeth may fit to the lower ones, and thus serve as a natural splint.

The moulded splint should be fashioned out of an oblong piece of gutta-percha or felt, about 10 in. by 5 in. for an adult man (the size will of course, vary), and must be cut down the middle of its length, except for about three inches in the centre, so that it is of the shape of the centre of the four-tailed bandage which has been before described. To mould and apply it the four ends thus made must be folded up while it is warm, exactly as the bandage is. It will be wise to cut out a paper shape first, to secure an exact fit. If it be necessary, as for the dressing of a wound on the chin, a trap-door may be cut in the splint.

Fig. 82.—Moulded Splint for Lower Jaw.

In more severe cases, additional firmness may be attained by *fastening together the unloosened teeth* on either side of the fracture *with a stout silver wire*; this with care is often of great service. Again, a rough interdental splint may be made by warming and moulding a mass of gutta-percha of about the size of one's thumb, and pressing up the teeth on the side of the fracture into it, and when the fragments are in good position, pressing the whole mass upwards against the upper teeth.

Loosened teeth should always be left alone unless they are obviously shattered. For the first week or ten days all food must of course be liquid, and for the first day or two it will generally be found possible to get nourishment enough taken through a tube, or poured in at the corner of the mouth. But the patient will soon manage to suck in and swallow fluids, and later on soft semi-solid food, without disturbance of the fragments.

Fractures of the jaw of ordinary severity, and which do not present unusual complications of displacement, may be successfully treated on the foregoing lines. Cases, however, will present themselves which

require special apparatus and special mechanical knowledge to keep the fragments in good position. During treatment the mouth must be repeatedly washed out, as food readily collects in the buccal recesses.

SEVERE FRACTURES OF THE JAW REQUIRING SPECIAL APPARATUS.

Fracture of the Lower Jaw.—Until 1816 no advance was made upon handaging as a means of keeping steady the broken ends of the lower jaw. About that time Malgaigne, Lonsdale, and others suggested the plan of tying together the teeth near the fracture with silk or wire, or of boring holes in the alveolus on either side of the fracture, and then tightly twisting up wires passed through them.

The next distinct advance in this direction was due to Lonsdale, who employed an apparatus with a concave semicircular ivory groove as a cup for the teeth ; this was fixed to a curved screw-bar, so attached to a lower padded chin-piece, that by the screwing up of a nut, the front teeth (if any were present) were tightly pressed on their cutting edges, and the jaws pressed up to the teeth. The chief objection to Lonsdale's splint has been its liability to catch in the bedclothes, and to be dragged out of position during sleep, and in any case a splint made on this principle would not be comfortable or trustworthy for mouths which were edentulous, or where molar teeth only existed.

Nevertheless, for cases of great displacement, especially if the fractures are compound, metal cap splints *can* be made (generally vulcanite is used) which are able to fit the teeth and gums and keep the fractured ends of the bones and teeth (if any) in absolute apposition, and the jaws in normal coaptation ; but for this treatment to be successful the attainment of an accurate model is a *sine qua non*.

Methods of Modelling.—There are two ways in which an exact model may be procured.

If the fractured bone can be held in accurate position while the model is taken in wax, carried in a well-selected dentist's impression-tray such as is used for modelling for artificial teeth, an impression may be easily and quickly made which will do quite well ; but if there is much displacement or comminution, or if the jaw presents much swelling or tenderness, the forcible retention of the displaced parts long enough in position to secure a good mould is not possible, and the second plan must be resorted to.

This consists of taking a model of the displaced bone, *as it is*, and then altering the cast from it by sawing it in pieces and again uniting these in their proper position. When the teeth are fairly numerous in both jaws, this task will be rendered much easier from the guides which the faceting of their worn surfaces will afford.

The fragments thus coapted may be retained in place with melted beeswax, and then a solid plaster-of-Paris mould may be made, upon which dies and matrices may be cast, on which vulcanite plates can be moulded.

To fit all the teeth and the gums for about one-third or to half an inch below the teeth on the tongue and lip side, this cap should extend back so far as to fit over at least the farthest back tooth which is embedded in a misplaced piece of jaw. If the fracture be compound, several holes should be drilled in the plate in those situations where the discharge takes place.

It is often sufficient to place this cap or plate in the mouth, and steadily press up the teeth into their proper receptacles, and then to bandage outside with the usual "four-tailed" bandage over a well-fitted gutta-percha socket, made to the horizontal ramus of the jaw after it has been set. The chief advantage of a metal plate is the comparatively small space it occupies in the mouth —the salivary glands soon cease to be stimulated by it.

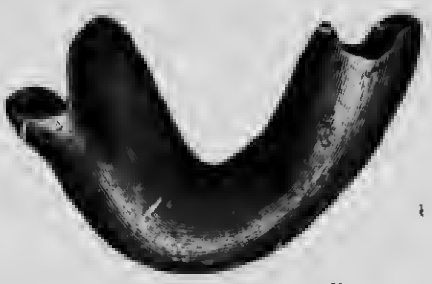


Fig. 83.—Metal Cap Splint for Fractured Lower Jaw, seen from above.

In order to dispense with the four-tailed bandage which keeps the jaws closed, metal arms of stout wire may be affixed to such a plate as is described above. These are brought out at the angles of the mouth and directed horizontally backwards. Turns of a bandage passed from one arm to the other beneath the mandible complete a splint which allows the patient to open the mouth. Hammond's wire splint allows of the same comfort, and can he used where a sufficient number of teeth are standing. A stout piece of iron wire is so bent as to follow the indentations of the necks of the teeth on both inner and outer surfaces. The two ends are soldered together and the splint placed over the crowns of the teeth. Small pieces of fine iron binding wire are then passed between and around several teeth, being directed under and over the inner and outer portions of the splint. The ends of the binding wire are twisted up, tightened, and tucked out of the way. This splint is a very serviceable one, but it should always be applied by a dental surgeon.

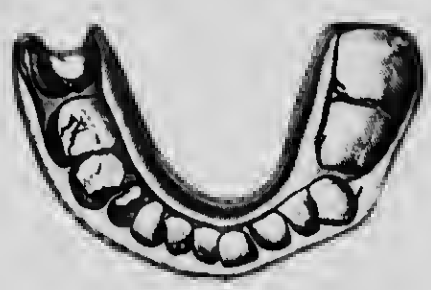


Fig. 84.—Metal Cap Splint for Lower Jaw, seen from below.

In some cases splints have to be made and fitted to each jaw, and when the correct coaptation has been secured, the two pieces can be joined together by vulcanite, leaving spaces for tubes for feeding and for the use of antiseptics. Gutta-percha, or gum resins, may be used

as temporary interdental splints very conveniently, particularly in young persons.

Fractures of the Upper Jaw, with or without broken or displaced teeth, are of much more frequent occurrence in civil practice than formerly, due chiefly to the development of football, cricket, and cycling.

The treatment of such cases is similar to and simpler than that of fractures of the lower jaw, as there is a fixed basis for an interdental splint, or one fitting only to the teeth, gums, and hard palate. The greater vascularity of the bones and soft tissues is an immense advantage, and for this reason any portions of bone having the smallest attachment to soft parts should be replaced in their normal situations, also teeth whose fangs are broken from their sockets, or those entirely detached should be replaced after being thoroughly cleansed in warm water and the coagula removed from their sockets. The recuperative power of the vascular tissues is so great that the most determined effort should be made to avoid the sacrifice of any part of the jaw, alveolar process, or tooth, which has any soft tissue connection. It is therefore especially important to replace the disturbed bones and teeth as soon as possible. Care must be taken if there is much comminution not to pinch any soft parts between the broken fragments in replacing them, otherwise much pain, swelling, and delayed union will result.

When the fragments have been satisfactorily replaced, a vulcanite, gutta-percha, or gum resin splint, or a metal splint lined with gutta-percha or vulcanite, modelled as already described for fractured lower jaw, may be fitted.

THE UPPER EXTREMITY.

Fracture of the Clavicle.—This fracture is stated by statisticians to stand fifth in the order of relative frequency, but it is probable that its real place is higher ; the error (if error it be) having perhaps arisen from the tables being largely drawn from in-patient records, while the majority of these fractures are treated in the casualty rooms of hospitals, and may never come upon their books. Moreover, it is certain that in infants the fracture is often not recognized or treated at all.

At any rate the injury is exceedingly common, and every student may count upon seeing a sufficient number of cases. Yet there is no fracture about the setting of which text-books give more bewildering and contradictory directions.

The great points of difference are, first, as to the position of the arm, and especially of the elbow ; second, as to the use of an axillary pad ; third, whether some set form of apparatus, or strapping, or bandaging is best.

Leaving unconsidered the various questions as to the treatment of complex clavicular fractures which may arise in particular cases,

the methods commonly employed for setting the ordinary examples of the fracture are here described.

In the first place, there is probably only one way in which the fracture can be so treated that there shall be no permanent deformity, and that is by compelling the patient to *lie absolutely flat and still*, with a small cushion between the shoulders, until there is sufficient cohesion of the fragments to prevent any displacement. For this at least a fortnight will be required, and no bandage or apparatus of any kind is called for so long as the position is maintained, for the fragments come naturally into their places.

This treatment may be supplemented by an axillary brace or by a padded splint and bandage. The axillary brace consists of two loops of soft bandage material or skeins of wool, which are passed round the axilla on each side; they are secured at the back by a broad strap with a buckle (care being taken that the buckle does not press against the skin). By means of the strap the two skeins are drawn tight and the shoulders brought well back.

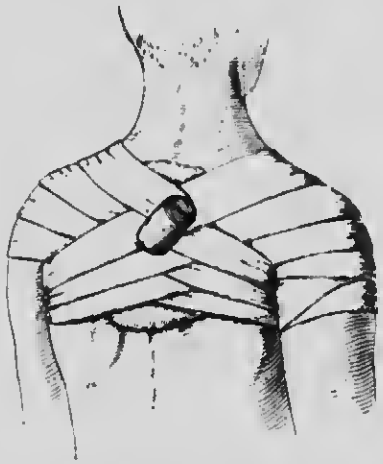


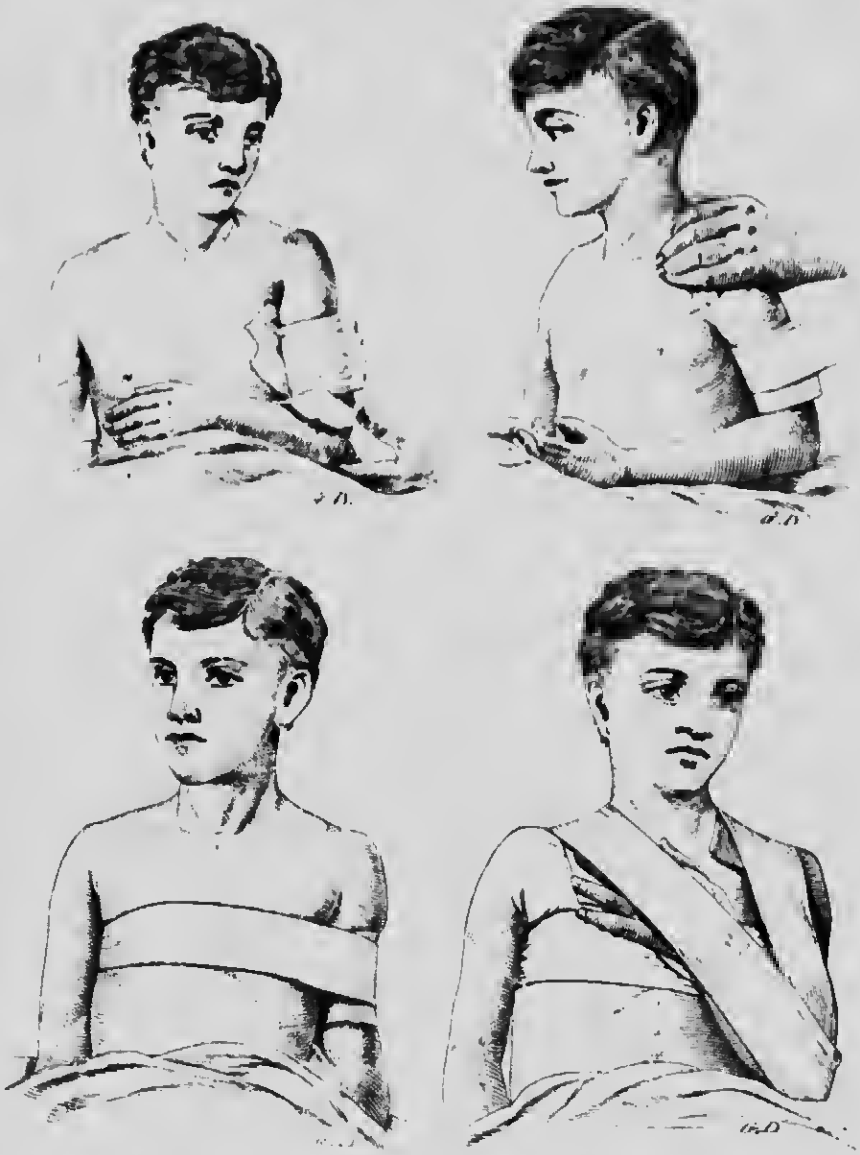
Fig. 85.—The Padded Splint applied for a Fractured Clavicle.

The second method consists of placing a well-padded splint (*Fig.* 85) in the middle of the back, reaching from the seventh cervical vertebra to the mid or lower dorsal region, and applying a double spica.

The Deformity to be rectified in the case of the common *Fracture in the Middle Third* is, when the patient is erect, a downward, inward, and forward displacement of the outer fragment; the shoulder therefore requires to be elevated and to be pressed towards and backwards; and to fix the parts in this position the arm must be fastened to the side.

In Infants and very young Children, incomplete fractures of the clavicle are very common, and are easily overlooked. It is almost hopeless to try to follow any fixed rules as to the setting of these fractures, but they generally unite with little deformity if the arm be brought to the side, the forearm and hand crossed over the chest, and the limb fixed in that position by strips of adhesive plaster (a baby will wriggle out of any ordinary bandage in ten minutes); all precautions being taken to avoid chafing of the skin.

For the more infrequent fractures which involve the *inner* or the *outer extremities* of the clavicle, it is difficult to lay down any general rules of treatment. It may first be said, that in all cases where there



Figs. 86, 87, 88, 89.—Sayre's Method for Fractured Clavicle. (Front.)

is much displacement, the fracture should be put up on the same lines as if it were one in the middle third. If, however, the fracture be quite close to the sternum, any bandage which will confine the arm to the side and the hand and forearm across the chest, for a fortnight, will suffice.

If again the fracture be near the acromion, and there is not much displacement, a shoulder cap of gutta-percha or felt, as in fractures of the neck of the humerus (*q.v.*), will be an efficient mode of treatment. Axillary pads in these last cases are not generally required.

Treatment by broad Strips of Adhesive Plaster is a plan introduced by Sayre, which is now in very general use in this country.

The principle and practice of this method will be understood from *Figs.* 86 to 90. The limbs should be washed and shaved, the axillary hairs be cut short, and the whole area well powdered with boric acid and starch. Two strips of adhesive strapping are cut, three to four inches wide, and of sufficient length. The arm being held in position, one piece is first fastened round it, just above the centre, and secured by a few stitches; the strip is then carried backwards round the body, and fixed to it. The second piece is carried downwards from just behind the uninjured shoulder, and obliquely across the back, the point of the elbow is received in a slit, and the strapping is then carried up over the forearm and hand, which are flexed on the chest, and fastened at the place it started from. Sayre does not use an axillary pad, but if it improves the position it should be employed.

Fig. 90.
SAYRE'S METHOD FOR FRACTURED CLAVICLE.
(Back.)

The principle of Sayre's method is as follows: By means of the first turn of strapping the arm is fixed, and the strapping forms a fulcrum on which the arm may be moved. The first piece of strapping is applied with the point of the elbow directed backwards. Before the second piece of strapping is adjusted the point of the elbow is brought forward, and the first strapping acting as a fulcrum, the shoulder is carried well back and the deformity is rectified.

After-treatment.—This appliance is kept on for three weeks, but it may require changing several times, as it is apt to get loose. Massage should be begun at once. (Ellis's splint (*Fig.* 91) is a satisfactory apparatus which can be substituted for Sayre's method.) If an axillary pad is used, care must be taken that it does not press on the axillary vessels. After three weeks the strapping may be removed, but the arm must be kept in a sling or protected by a bandage for

two to three weeks longer. As a general rule five to six weeks must elapse before the patient is ready for ordinary work.

Fractures of the acromial and sternal ends of the clavicle are treated on the same lines. When the fracture lies between the conoid and trapezoid ligaments there is no displacement; a bandage and sling are usually sufficient.

If the line of fracture lies external to these ligaments, Sayre's method *without backward* traction should be employed.

Fracture of the Sternum is rare, but may occur in consequence of direct or of indirect violence. Care must be taken, in examining the thorax after injury, not to mistake some congenital or acquired incurvation of this bone for a fracture. The displacement, if there be any, can often be reduced by making the patient take an inspiration, or by bending the shoulder-blades back, or by laying the patient down over a sand-bag or a wooden block placed under the middle of the back. The deformity, however, is apt to recur in an obstinate manner, and is then hardly amenable to treatment. In the course of time the parts will often come of themselves into fair position, so that they may be left alone, unless, as sometimes happens, an embarrassment of breathing calls for special operative treatment. In ordinary cases, the ends being brought into as good position as may be, all that is required is a broad calico or flannel roller, applied as for broken ribs, or the double spica of the shoulders may be applied. (*See page* 68.)

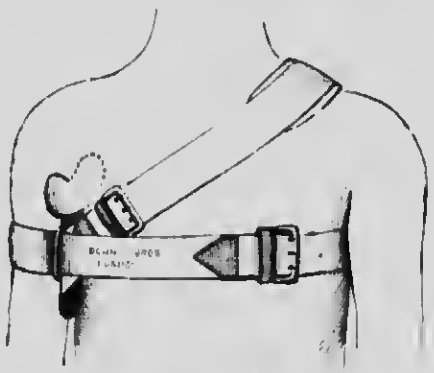


Fig. 91.—Ellis's Bandage.

Fractures of the Ribs require widely different treatment according to the nature and the extent of the injury.

Taking the ordinary cases first, it will be found that the patient has been badly squeezed in a crowd, or has been run over by a light cart, or has suffered some similar injury. He complains of a catching stitch or stab on inspiration; he leans forward, and holds his breath as much as possible, and quickly learns that by pressing his hands to his sides the pain and difficulty in breathing are lessened. On examination of the seat of pain (probably about the seventh or eighth rib), by firm pressure, obvious crepitus and mobility may often be detected, but this is by no means invariably the case, especially in fat people. The stethoscope will frequently detect the crepitus when the sense of touch fails to do so, but in any case, a sufficient injury, followed by symptoms such as the foregoing, gives presumptive

evidence of one or more ribs being cracked or broken, and it will always be safe to treat the patient accordingly.*

In such a case, one, two, or three ribs may be broken, but they are still retaining tolerably firm relations with their fellows; the pleura is but slightly injured, and there is practically no displacement. Firm pressure on the thorax restrains the play of the ribs, and thus the source of pain is avoided.

For these reasons it is advisable to confine the play of the ribs by the application of strips of adhesive strapping somewhat obliquely round the chest (*Figs.* 93, 94). Linen strapping is commonly used; it should be cut into strips 1½ inches wide, and long enough to he within three inches or so of meeting in front. The strips should be

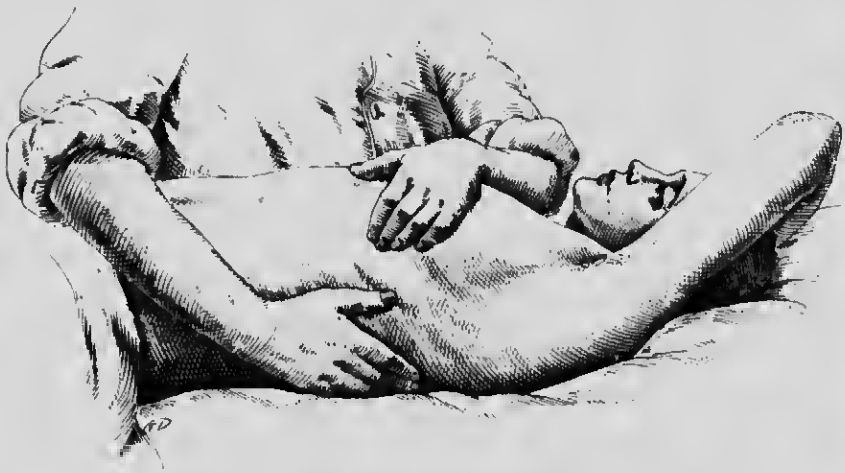


Fig. 92.—Examination for Fracture of the Ribs.
(Patient should always be lying down.)

applied successively from below upwards, starting at the floating ribs. The surgeon, standing in front of the patient and applying the centre of the strip to the middle line behind, should bring the two ends, evenly and firmly, forwards and somewhat upwards, so as to compress the chest walls from behind forwards *during expiration*. The strips should overlap about half an inch, and should be continued, as a rule, up to the third or fourth rib. Over the strapping a flannel or any ordinary bandage should then be firmly rolled, as shown in *Fig.* 95; this may be prevented from slipping down hy the brace shown in the figure, which is simply made by tearing a hole in a piece of broad bandage and putting the head through it, so

* The post-mortem table teaches us how often, in cases of accident, fractures of the ribs are overlooked in the presence of other and more obvious injuries.

that it hangs down in front and behind. The bandage is put on outside this brace, the ends of which are then turned up and fixed.

When the injury is less severe, it may be unnecessary to apply the strapping, a firm bandage being all that is required. In any case the patient will probably be unable to lie flat down in bed for some days. But the foregoing rules of treatment will have to be greatly modified or abandoned in the more serious cases where there is *severe injury to the lungs*, or great crushing of the thoracic walls; such an injury, for example, as that which the direct kick of a horse may inflict, where the rib, instead of being bent outwards until it

Figs. 93, 94.—Application of Strapping to Fractured Ribs.

breaks, is forcibly driven into the chest cavity; or where the whole chest wall may be crushed out of shape, and its bellows action almost or quite abolished. In such a case the dyspnœa will be extreme; the symptoms of hæmo- or pneumo-thorax may quickly develop, with surgical emphysema, and hæmoptysis will almost certainly be present.

Under these circumstances it is clearly unsafe to put any further restrictions on the processes of oxygenation; indeed, no tight bandage or strapping would be borne by the patient for one minute; all that can be done locally is to give a gentle support to the chest walls with a broad flannel roller. If one of the broken ends remains permanently depressed, efforts may be made by manipulation to elevate it; it has

been suggested that the end of the portion which has retained its position should be depressed to the level of the other, in order that the two fragments may interlock, when the spring of the undisplaced end may raise the other with it. The employment of any instrument to forcibly raise up the fragment cannot he recommended, for it is well known that this displacement tends to rectify itself by degrees, as with recovery freedom of respiration advances.

The *Hæmoptysis* is not generally dangerous in itself, but should be watched anxiously in consequence of the pneumonia which is likely to develop in the area of injury. If this occurs there is a very serious increase in the embarrassment to the breathing, and great engorgement of the right side of the heart, evidenced by a quick hard pulse, and partial asphyxia. In such conditions, recourse must be made to drugs, and considerahle relief may be experienced by bleeding the patient, which will temporarily, if not permanently, relieve the engorged right side of the heart. The good effect of taking away seven or eight ounces of blood is often most striking, and might be with advantage more frequently employed. The method of performing the operation of hleeding is described later.

Fig. 95.—Chest Bandage.

With regard to the *Surgical Emphysema*, it is rare for it to be a serious embarrassment, althougli it has sometimes, by spreading beneath the deep cervical fascia, caused difficulty in breathing or swallowing. It is best left alone, or controlled by bandaging only; but if it must be diminished—and cases are on record in which the features of the face were obliterated, and the whole body was blown out—small punctures may be made, or, still better, "Southey's trocars" may be introduced into the cellular tissue, the ensheathing cannulæ, which must be previously boiled, being allowed to remain *in situ*.

All cases of fractured ribs complicated by hæmoptysis and surgical emphysema are to be admitted into the wards.

INJURIES IN THE NEIGHBOURHOOD OF THE SHOULDER JOINT.

Injuries in the region of the shoulder joint are often very difficult to diagnose on account of the swelling of the parts and owing to the manner in which the various injuries mimic one another. In the following account an attempt will be made to explain how a routine

examination of the shoulder region should be made, and a list will be given of the more common forms of injury likely to be met with.

The student is strongly advised to take every opportunity of examining the bony landmarks round the shoulder and other regions described later (*Fig.* 96). By this means alone can he appreciate the departures from the normal which are met with as the result of injury.

We will suppose that a stout, elderly man has fallen onto the region of his shoulder; there is a considerable amount of swelling. The first region to be examined is the clavicle—the bone is subcutaneous, and can be felt along its whole length: any deformity, irregularity, or painful spot is to be noticed. Fracture between the conoid and trapezoid ligaments shows no deformity, gives no crepitus as a rule, and is diagnosed by a point of acute tenderness above and to the outer side of the coracoid process. Excluding injury to the clavicle, both shoulders are to be carefully inspected, with the patient in a good light facing the surgeon. Note the presence or absence of flattening of the shoulder.

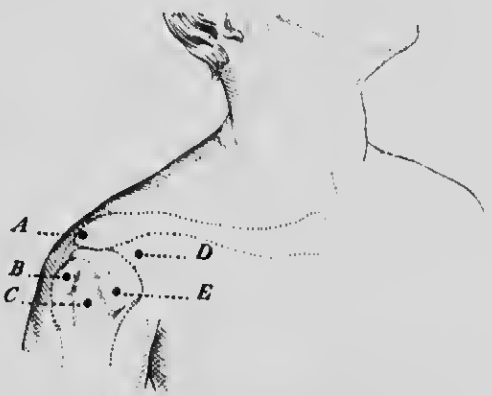


Fig. 96.—Bony Points to be noted in the region of the Shoulder Joint:—
A. Tip of Acromion Process. *B.* Great Tuberosity. *C.* Bicipital Groove. *D.* Coracoid Process. *E.* Lesser Tuberosity.

Flattening of the shoulder is present in dislocation, in fracture of the surgical neck of the scapula, and, to a less extent, in fracture of the upper end of the humerus.

The presence of flattening after receipt of an injury is of value, but its absence must not mislead the observer, since when much swelling is present it may not be marked.

Next look for any abnormal protrusion or swelling apart from the general effusion. Careful inspection in cases of dislocation will nearly always show an abnormal fullness below the coracoid process. Notice the position of the arm. In dislocation it is held away from the side and is fairly rigid, and if the previous swelling caused by the head of the bone has been noticed, the long axis of the arm will be found to be directed towards it. In fracture of the surgical neck the arm may be held away from the side, but there is no swelling beneath the coracoid process.

Now proceed to palpation and manipulation. Feel for the outer extremity of the acromion process, and press the fingers inwards beneath it in the direction of the great tuberosity, *B*. Compare carefully with the opposite side. If the fingers dip in more deeply on the injured

than on the sound side, *the head of the bone has been displaced.* This displacement is caused by dislocation, and to a less extent by fracture, of the surgical neck of the scapula, and sometimes by fracture of the anatomical neck of the humerus.

Place the hand in the axilla and feel for any abnormal bony prominences, again comparing with the sound side. Such abnormal prominences are met with in fracture of the surgical neck of the humerus, when the upper end of the lower fragment is drawn into the axilla, and in fracture of the anatomical neck of the humerus, when the displaced head can sometimes be felt.

Grasp the elbow with one hand and the shoulder with the other, and rotate the arm gently. If the great tuberosity can be felt to rotate, either a fracture of the neck is absent or, if present, it is impacted. If this rotation is accompanied by crepitus (the great tuberosity moving with the shaft) there is probably a fracture of the anatomical neck of the humerus.

Next see whether slight manipulation—pushing up of the elbow, and drawing back the shoulder—will obliterate the deformity: if this manœuvre does so with crepitus there is a fracture of the neck of the scapula.

Lastly, measure the arm from the acromion process to the olecranon or external condyle. In a case of severe injury to the shoulder with much bruising and no apparent displacement, definite shortening is a sign of an impacted fracture.

It may not be possible, even after the most careful examination, to come to a definite conclusion, and more than one injury may be present. Under these circumstances the patient must be put to bed, an *x*-ray photo taken, and some form of temporary apparatus (sling and bandage) should be applied.

General Points in Treatment.—Before any strapping or bandages are applied, it is always advisable to wash the parts, remove the hair if it can be done without causing much pain, and powder the axilla and shoulder with boric acid and starch. The condition of the radial pulse must be noted, since the artery may have been injured. Numbness and tingling denote damage to the brachial plexus. An axillary pad will often cause pain and swelling; if this is so it must be removed at once.

Severe injuries to the shoulder, especially dislocations, often cause damage to the circumflex and suprascapular nerves; this should be remembered, and if marked wasting of the deltoid is noticed during the after-treatment no time should be lost in testing the electrical reaction of the muscles, and if the nerves are injured, adding galvanism to the necessary massage and movement. "Sayre's method" is applicable to fractures of the clavicle and scapula, and gives good results. In all fractures in the region of the shoulder joint a shoulder cap of poroplastic felt should be fitted.

Fractures of the Scapula.—Only three varieties of fracture of the

scapula will be considered: (1) Fracture of the body, usually produced by crushes or severe blows; (2) Fracture of the neck of the scapula; (3) Fracture of the acromion process.

The diagnosis of these injuries may be very difficult, and no definite opinion can be given in many cases until an *x*-ray photograph has been taken. (*Vide supra.*)

1. *Fracture of the Body* is the most readily recognized. It is treated by packing the scapular region and the axilla with wool, after the skin has been powdered with boracic acid and starch. A broad bandage is wound round the shoulder and axilla of the affected side, and the arm is bandaged to the side. The patient should be kept in bed for three weeks. Injuries to the ribs are usually present.

2. *Fracture of the Neck* of the scapula may be treated by a pad in the axilla and a broad bandage round the arm, with the object of supporting the elbow and preventing the scapular fragment dropping down, as it has a tendency to do. *Sayre's method* (*vide ante*) is as good as any.

Massage must be begun at once, and passive movement at the end of a week, the fractured region being steadied by a hand in the axilla. Bandage or strapping should be retained for six weeks, and complete recovery of function expected at the end of seven or eight weeks.

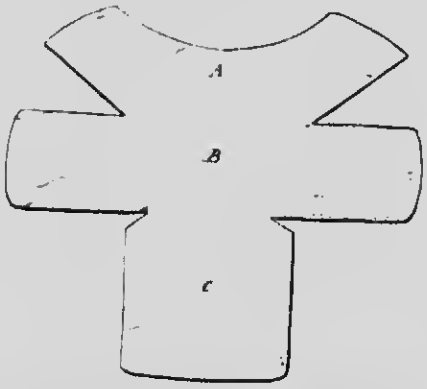


FIG. 97.—OUTLINE OF PORoplastic CAP FOR SHOULDER, which should be moulded into position: *A*, COLLAR; *B*, CHEST-PIECE; *C*, ARMLET. In cases where the shaft of the humerus is broken, the armlet should be made much larger, so as to include the whole arm and elbow.

3. *Fractures of the Acromion Process* are difficult to deal with: the action of the deltoid drags the fragment down. The best treatment is "Sayre's method" without an axillary pad, the humerus being used to push up the detached fragment. The retentive apparatus should be applied for one month.

Fractures of the Humerus.—The following fractures will be considered: (1) Of the anatomical neck; (2) Of the surgical neck; (3) Of the shaft; (4) Of the lower extremity.

1. *Fracture of the Anatomical Neck* occurs in elderly patients, as a rule from direct violence. Considerable bruising and shock are present, so that the patient should be kept in bed for a few days.

TREATMENT.—The fragments should be manipulated into the best possible position, usually under anæsthesia, and a small, soft wool pad should be placed in the axilla. The pad should be very loose, and serves more to keep the skin surfaces apart than to control the fragments.

A shoulder cap should be applied, and the arm supported by a sling. Massage and passive movement should be commenced as soon as possible. Recovery of function cannot be expected even in favourable cases for seven to eight weeks. If the *x*-rays show marked displacement, the visiting surgeon will consider the advisability of removing the loose fragment.

2. *Fracture of the Surgical Neck* occurs in several varieties :

(*a*) Where there is little displacement, and no difficulty is experienced in obtaining and maintaining a good position ; (*b*) The lower fragment is displaced inwards and the upper is abducted, and the displacement is apt to recur ; (*c*) Marked displacement is present : the upper fragment may be displaced outwards, the lower inwards, and dislocation of the head may accompany the fracture.

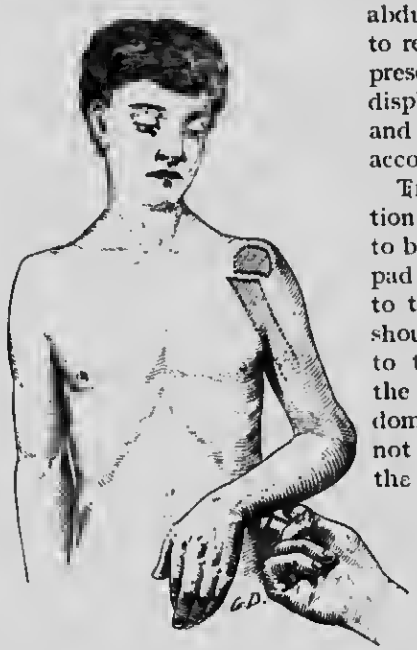


Fig. 98.—Fracture of the Surgical Neck of the Humerus.

Treatment.—(*a*) When manipulation and *x*-rays show the fragments to be in good position, a snug, conical pad of wool running from the axilla to the elbow should be applied and a shoulder cap fitted. The arm is fixed to the side and the forearm across the front of the chest by a broad domette bandage. The elbow should not be supported, as the weight of the arm acts as an extension and prevents shortening.

Massage can be undertaken at once, the cap being readily removed. Passive movement should be started at the end of a week, the upper end of the humerus being grasped by one hand, so as to steady the fragments. The hand should grasp the shoulder from the back, so that the fingers lie in the axilla, pressing against the lower fragment, the thumb being placed on the great tuberosity. On the left side the right hand of the operator will steady the fracture, while the left will hold the elbow and perform the movement.

Retentive apparatus should be kept applied for four weeks, a sling should be used for two weeks, and free use of the arm permitted at the end of six or seven weeks.

(*b*) In fractures of the second type we recommend the following treatment, which is also applicable to uncomplicated fractures of the shaft of the humerus. A long, well-padded tin splint is taken. This is bent into the form of a V, the padding lying on the outside. The apex

of the V is packed into the axilla, and a soft bandage passing in a figure of 8 round the shoulder and opposite side of the neck slings it in position and prevents it slipping. The inner portion of the splint is bandaged or strapped to the chest, and the outer is secured to the arm by a bandage or a strap, and when this has been effected the arm is fixed to the side, and the forearm to the chest, by a bandage as described above. A shoulder cap is applied. We have found this method simple and very satisfactory. The lower fragment is easily controlled, and the whole arm can be readily uncovered for

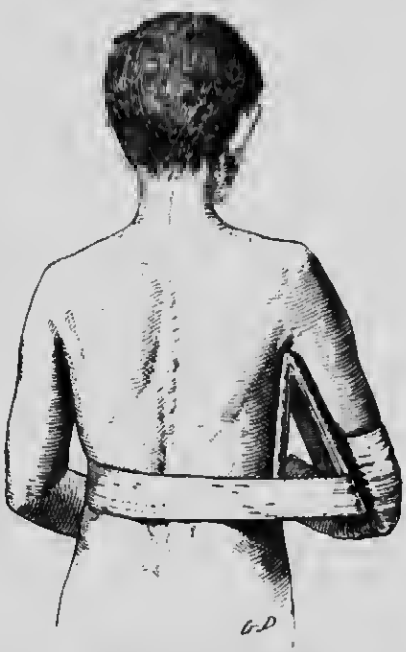


Fig. 99.—Showing Padded Wooden Triangle in Axilla.

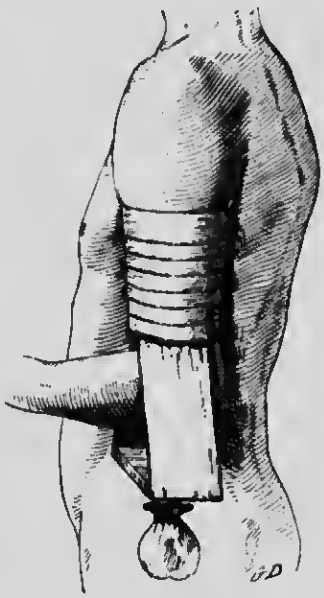


Fig. 100—Fracture Treated by Extension Weight.

massage and inspection. The after-treatment is the same as for the preceding variety. Instead of a tin splint, a large pad, a modification of Stromeyer's cushion, is sometimes of service, or a padded wooden triangle secured round the waist (*Fig.* 99). Such a splint keeps the lower fragment abducted.

(*c*) The third variety of fracture is unsatisfactory. If manipulation fails to reduce the deformity, or if the deformity readily recurs, an extension apparatus with weight and pulley should be employed (*Fig.* 100). As a rule it is advisable to attempt reduction by operation, especially if a dislocation is present, and for consideration of these details the reader is referred to the standard text-books on surgery.

3. *Fractures of the Shaft of the Humerus.*—When the fracture lies above the insertion of the deltoid the upper fragment is usually drawn inwards and the lower outwards, but the displacement is sometimes similar to that which occurs in fracture of the surgical neck, and the same forms of treatment recommended in the first two varieties of this accident will be found to answer admirably; indeed, we strongly advise them in preference to the more cumbersome treatment described below. It is said that non-union is common as a result of this fracture, if the elbow has been allowed to hang free and too much movement has been permitted.

4. *When the shaft is broken below the deltoid insertion*, the upper fragment is drawn outwards, the lower fragment inwards. If the method described above is found to be unsatisfactory, the following apparatus can be applied.

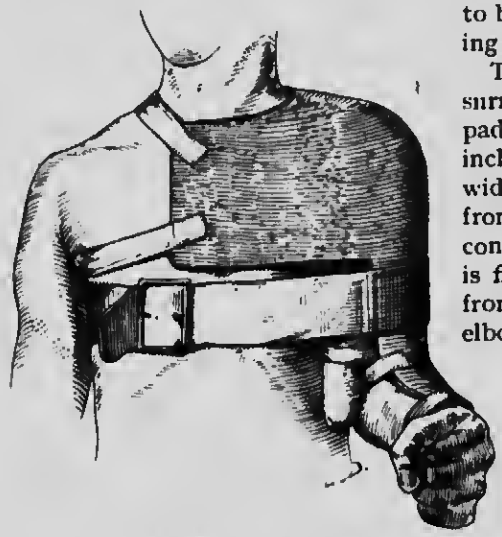


Fig. 101.—Treatment of Fracture of Lower Half of the Humerus.

The fractured bone should be surrounded by three short, well-padded, narrow splints about an inch and a half or two inches in width. One of these extends from the axilla to the internal condyle on the inner side, one is fixed to the front of the arm from the great tuberosity to the elbow, and the third on the back from just below the acromion process to a point an inch or so above the olecranon. These splints are fixed by broad straps or strips of strapping, while the deformity is reduced by extension and counter-extension. A large cap of poroplastic or leather is fitted over the shoulder, the outer side of the arm, and along the elbow and forearm. The cap, therefore, is a shoulder cap and external angular splint combined. The elbow is fixed at right angles, and the forearm is kept midway between supination and pronation. The forearm projects at right angles to the body, and is not brought across the chest (*Fig.* 101). This method is recommended by Cheyne and Burghard. After-treatment will be as for "Surgical Neck."

The special complication of this fracture is injury to the musculo-spiral nerve, which may become involved in the callus from the fracture. Signs of paralysis are to be looked for in the appearance of wrist-drop and radial anæsthesia. If wrist-drop alone is present the nerve is probably only bruised and will recover (*see* "Sprains with Nerve

Injury," Chapter XIX), but if the anæsthesia is marked the prognosis is more serious. Unless improvement takes place, it may be advisable to cut down and free the nerve from the surrounding sheath of callus.

INJURIES IN THE NEIGHBOURHOOD OF THE ELBOW JOINT.

Following falls or blows upon the elbow a number of different lesions may be met with. As in the case of the shoulder, a careful systematic examination must be made in order that an accurate diagnosis may be arrived at. Both arms should be exposed. First

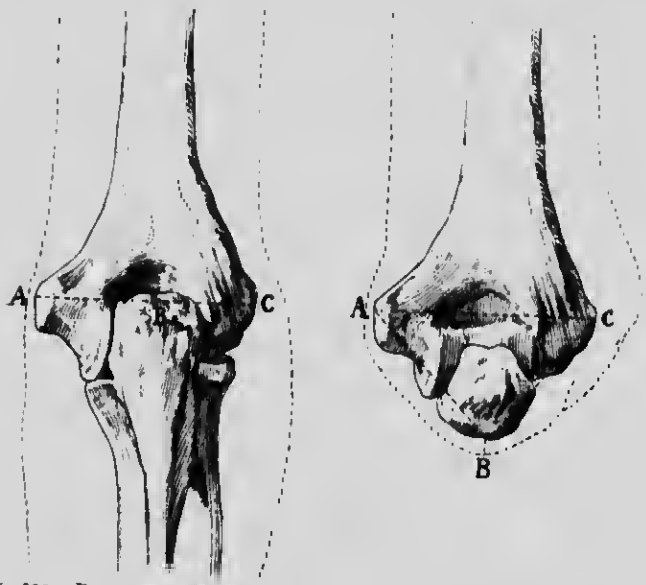


Fig. 102.—Diagram showing Position of Bony Points round Elbow. *A*, Internal Condyle. *B*, Olecranon. *C*, External Condyle.

examine the bony points, the olecranon, the external and internal condyles. When the forearm is extended, these three points lie in the same line; on flexion, however, a triangle is formed which has its apex formed by the olecranon, its base by a line joining the two condyles. Owing to the natural oblique axis of the ulna the olecranon lies nearer the internal than the external condyle, and the internal is the more prominent of the two.

If these points bear their normal relationship to one another, there is no dislocation of the ulna. Dislocation is a common accident, and must first be excluded.

The olecranon is superficial, and examination will always reveal the irregularity of a fracture. If there is separation of the condyles a T-shaped fracture into the joint is present.

Next grasp the condyles with one hand and the shaft of the humerus

with the other. Preternatural mobility with crepitus suggests a fracture of the lower end of the shaft. With such a fracture the lower smaller fragment is usually displaced backwards, the olecranon becomes abnormally prominent, and the condition may easily be mistaken for a dislocation. This is a common error, but a careful examination of the bony points should settle the diagnosis.

If there appears to be no solution of continuity of the shaft of the bone, run the fingers down along the supracondyloid ridges to make sure that the condyles are intact. A fracture of the internal condyle is easily overlooked. Then examine the head of the radius. This lies close beneath the skin immediately below the external condyle. If in its normal situation, it can be felt to rotate when the movements of supination and pronation are performed. An assistant should perform these movements, in order that the mobility of the radius may be better appreciated. If this movement is absent and crepitus attends the attempt to produce it, a fracture of the neck of the radius has occurred. If the head of the bone is abnormally prominent, there is a backward dislocation; if there is a hollow in the place which should be occupied by the head of the bone, there is a forward dislocation.

Fig. 103.
MR. ROBERT JONES' TROUGH SPLINT, WITH INTERRUPTION.

In fractures of the humerus there is usually shortening, when measurements are made from the acromion process to the external condyle.

Dislocations often accompany fractures near the elbow joint. There is frequently so much swelling that an accurate examination cannot be made; all cases therefore should be submitted to the *x*-rays as soon as possible.

The Transverse Supracondyloid Fracture.—The line of fracture runs just above the condyles, and is sometimes oblique. The lower fragment is displaced backwards.

The displacement should be reduced under anæsthesia. The elbow is flexed, and extension is applied to the lower fragments by grasping the condyles, counter-extension being maintained by an assistant, who holds and steadies the arm. Manipulation of the lower fragment, i.e., pressing it forwards while the shaft is pushed backwards, should be employed. As soon as this reduction has been effected, the elbow should be flexed as much as possible, and the bones secured in this position by a tin splint or a trough of poroplastic material (*Fig.* 103).

It may be laid down as a general rule that for all fractures of the humerus in the neighbourhood of the elbow joint, the acutely flexed position is the best.

There are, however, some cases in which the swelling after the injury

is so great that the elbow cannot be flexed even to a right angle. Under these circumstances the patient should be kept in bed, and evaporating lotions or an ice-bag applied to the arm, which should rest in a comfortable trough of poroplastic well padded with wool. As soon as the swelling subsides, which it will do in two or three days, efforts should be made to get the elbow into the required position of acute flexion. If it is impossible or inconvenient to obtain this position, the limb should be put up at right angles on an anterior or a posterior angular splint. In children, and even in adults, the use of a splint may be dispensed with, the elbow being maintained in a position of acute flexion by means of strapping and bandages.

A very careful watch must be kept over the circulation, for one of the dangers of the position, admirable though it is for the fracture, is that considerable pressure may be exerted on the blood-vessels.

If the fracture has been satisfactorily reduced, there will be no risk of the fragments moving, so that the splints can be removed at any time, and the elbow be thoroughly inspected and massaged.

At the end of a week passive movements should be commenced. The movements of gradual extension and flexion should be carefully undertaken, the region of the fracture being steadied with one hand to prevent any displacement taking place.

The splints should be replaced with the elbow less acutely flexed than before, the process being repeated daily. By this means the elbow will be gradually brought down to a right angle, and each day the range of movement will increase.

The splints should be worn for at least four weeks, after which the arm may be carried in a sling for a fortnight, during which period the patient should exercise his arm gently. By that time union should be complete, and more vigorous movements may be allowed. There is often a great deal of callus thrown out around these fractures, but patient massage and movement will assist its absorption. An excellent exercise for patients in a hospital is to get them to use one of the floor polishers with a long handle.

T-shaped fractures into the joint are treated on the same principles, but early massage and passive movements (third day) are necessary. Adhesions are liable to form, and these must be broken down under an anæsthetic.

Bad comminuted fractures are difficult to treat, as it is often impossible to manipulate the fragments into position. Such cases may require operative measures.

Fracture of the Condyles.—Fracture of the external condyle usually involves the elbow joint, fracture of the internal condyle need not do so. Both fractures can be satisfactorily treated by acute flexion; or, if preferred, an internal angular splint may be fitted for fractures of the external, an external angular for fractures of the internal condyle. Union takes place by fibrous tissue, but the functional result is good. A pad should be applied over the fractured condyle to keep it in position.

Fracture of the Olecranon Process.—This is a fairly common fracture, and one that is best treated in many cases by an operation. Much will depend upon the general condition and occupation of the patient and the amount of separation of the fragments. If there is but slight separation, excellent results may be obtained by splints.

The arm should be put up in a position of almost complete extension, and a splint—a padded tin splint is the best—should be applied along the flexor surface, reaching from the anterior axillary fold to the palm of the hand. A moulded poroplastic covering which fixes the arm in the above position gives excellent results. Full extension should not be employed, as it is very irksome to the patient, and tends to produce dislocation if there be wide separation of the fragments.

In addition to the splint, strapping should be applied in a figure-of-8 manner around the point of the elbow to exert traction on the upper fragment, which is pulled up by the triceps. This position is maintained for a week, during which the arm should be gently massaged. At the end of this time the splint should be taken off and the elbow moved very gently. Only a small range of movement should be attempted, and the loose fragment should be steadied with one hand and pressed down towards the ulna.

At the end of the second week the position of the arm should be changed, the degree of flexion should be slightly more acute, and by a gradual process the elbow should be brought to the position of a right angle at the end of the fourth week. Union, generally fibrous, will take place towards the end of the sixth week, after which the splints may be discarded. No severe exertion should be permitted for another month.

Fractures of the Coronoid Process usually complicate backward dislocations of the radius and ulna. The dislocation should be reduced and the arm put up in a position of acute flexion, the after-treatment being the same as for fractures of the lower end of the humerus.

It is sometimes necessary to remove the loose fragment.

FRACTURES OF THE FOREARM.

The Bones of the Forearm.—If one bone be broken, treatment is very simple and satisfactory, since the sound bone acts as a splint. On the other hand, when both are fractured, there may be considerable difficulty in obtaining accurate adjustment and firm union.

General Principles of Treatment.—If the radius is broken, either alone or together with the ulna, it is of the utmost importance to determine the position of the radial fracture with regard to the insertion of the pronator radii teres.

When the fracture lies above the level of this muscular insertion, the upper fragment is supinated by the biceps and supinator brevis, and flexed by the biceps, the lower fragment being fully pronated. In order that the fragments may be got into good apposition, the arm must be put up in full supination.

When the fracture lies below the insertion of this muscle, a position midway between supination and pronation is the best, for the following reasons: (1) The actions of the pronator and supinator muscles are about equally balanced; (2) It is a position of comfort to the patient; (3) The widest degree of separation between the bones is obtained in this position.

The greatest care must be taken to see that the ends of the fractured bones are not pressed in towards one another, as in this position vicious union will occur. Wide splints are therefore selected which will not compress the bones unduly.

When both bones are broken there is a tendency for the radius to sag down and produce an angular deformity. This may be counteracted by a thin splint running along the ulnar border of the forearm.

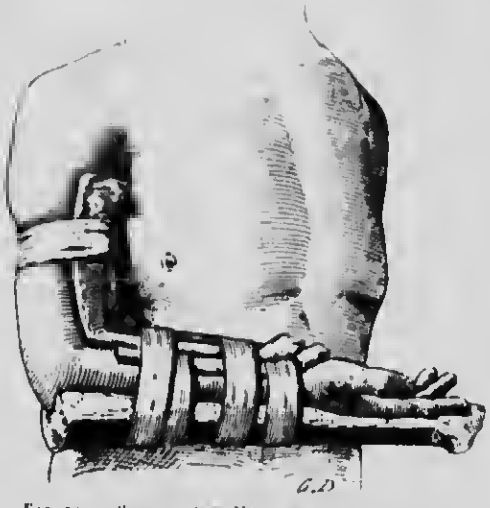


Fig. 104.—Splints for Fractures when above Insertion of the Radial Pronator.

It follows from the above that the treatment is the same whether one or both bones be broken, and detailed consideration will only be given to the double injury. If above the insertion of the pronator radii teres, the arm must be flexed and supinated; it is sometimes necessary to flex the arm to an acute angle before the deformity can be accurately reduced.

The limb should be put up on a posterior or anterior angular splint, and a short splint should be applied along the front or back of the arm according to the method selected. An excellent splint for the purpose has been made by Montague, New Bond Street. It is a posterior angular splint of aluminium, interrupted at the elbow by a hinge fixed by a screw. This enables the surgeon to fix the arm in any position of flexion, and further, to move the elbow joint without interfering with the fracture. An anterior splint is applied from the bend of the elbow to the centre of the palm.

When the fracture is below the insertion of the pronator radii teres, an internal angular splint with a short external straight splint may be employed if both bones are fractured. It is not always necessary to include the elbow joint in the splinting, but it is safer to do so. When only one of the bones is broken, or if satisfactory control can be obtained, the forearm should be fixed by broad well-padded external and internal splints, reaching from the elbow to below the wrist joint.

These fractures must be very carefully watched, and the splints should be removed at frequent intervals so that the position of the fragments can be ascertained, and the following precautions are to be observed:—(1) The splints must not include the fingers: they should reach only to the middle of the palm; (2) They should not be applied too tightly, as there is a danger of ischæmic paralysis developing; (3) Any tendency to angulation of the ulna must be treated at once; if necessary an anæsthetic is to be given and the bones are to be straightened.

Splints should be kept on for a month when a single bone is fractured, six weeks when both are damaged.

Massage and passive movement should be started during the first week.

Colles's Fracture.—This common injury is a fracture of the lower end of the radius just above the wrist joint. It results from falls on the outstretched hand, the violence being chiefly directed to the radial side of the palm. As the result the radius breaks across through the cancellous tissue, and the lower fragment is displaced backwards. This backward displacement is accompanied by a rotation of the fragment on two axes: (1) A rotation on a vertical axis so that the outer part of the fragment is more displaced than the inner, which still maintains its attachment to the ulna by means of the triangular fibro-cartilage; (2) A rotation on a transverse axis, so that the articular surface for the bones of the first row of the carpus is directed towards the dorsum of the hand.

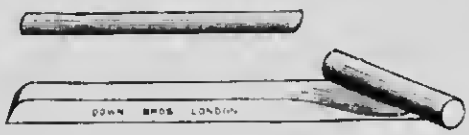


Fig. 105—Carr's Radius Splint.

This triple displacement, as it is called, causes the hand and wrist to appear shaped like a fork, radial abduction being present, while the styloid process of the radius, which should lie half an inch below that of the ulna, is found on the same level, or even higher.

Treatment.—The deformity must be corrected, an anæsthetic being usually required. The patient's hand is grasped by the surgeon, who uses the right hand for a right-, the left hand for a left-sided fracture. Bearing in mind the direction of the displacement, extension is made, counter-extension being applied by an assistant, who grasps the elbow. The surgeon fixes the region of the fracture with his unoccupied hand, and by exerting pressure with his thumb, presses the displaced lower fragment into position; the final movement being one which wrenches the hand into a position of ulnar adduction, so overcoming the radial displacement.

The hand is then placed upon a Carr's splint (*Fig.* 105), which maintains it in the adducted position. Carr's splint is very useful in the treatment of these cases, but certain modifications may be adopted

with advantage: (1) The posterior splint is usually made too narrow: a broader one should be obtained; (2) Hospital patients occasionally are extremely careless, and by injudicious movement may cause the recurrence of the displacement; in order to prevent this, two small pads, placed one over the lower fragment and the other over the lower end of the upper fragment, will be found of service; (3) If these splints are applied too tightly there will be a great deal of troublesome swelling of the fingers, especially in gouty people.

If a Colles's fracture is impacted, the treatment must depend upon the degree of deformity; if slight, no attempt need be made to disimpact the fragments, since the most important detail in treating these cases is to obtain freedom of movement, which is often lost through neglect of massage and passive movement, or through too long confinement to splints.

If on the other hand there is marked deformity, the bones should be disimpacted under anæsthesia and the case treated as previously mentioned.

Of all the fractures which the surgeon is called upon to treat, Colles's fracture requires the most careful and persistent massage and passive movement if a good result is to be obtained.

Massage may be applied before reduction is attempted, and is valuable in overcoming any muscular spasm. In any case it should be applied the next day, and on the occasion of each daily visit. The fingers should be moved on the third day, and the wrist on the fifth or sixth according to the degree of pain which it causes.

Great swelling and œdema attend this fracture in elderly and gouty subjects, and a frequent result, in spite of careful treatment, is stiffness of the fingers and wrist.

In such cases, if there is little deformity, the hand and wrist should be strapped as in the treatment of sprains, and massage and passive movements should be patiently carried out.

Whether a splint or strapping be applied, the hand should be carried in a sling, which may be retained for four or five weeks. The splints should be left off at the end of three weeks.

Fractures of the Metacarpal Bones are recognized since the introduction of *x*-rays as being of common occurrence.

The principles of treatment are very simple. In all cases of blows on, or injuries of, the hand, an *x*-ray photo should be taken. If much displacement is present, attempts must be made to rectify it under anæsthesia, and a splint should be applied until the danger of recurrence of the deformity is passed, usually about ten days. For the carpus a short palmar splint reaching from the middle of the forearm to the palm of the hand will be found suitable. For the metacarpal bone of the thumb, a small strip of zinc padded and moulded to the thumb. For the other metacarpal bones a palmar splint as for the carpus, with a round padded end to fit into the palmar arch. It is often quite sufficient to bandage the hand over a golf ball covered with a pad of cotton wool.

In all these cases active treatment to prevent adhesions must be undertaken as in Colles's fracture, and the splints should be left off as soon as possible. The patient must be encouraged to move the hand in spite of the pain.

In some cases, where there is marked displacement of a fragment of bone, it is necessary to cut down and remove it.

FRACTURES OF THE PELVIS.

Fractures of the pelvis result from such injuries as crushes, blows upon the trunk, and buffer accidents. Almost any part of the pelvis may be damaged. In the more severe cases the fractures are often bilateral, and sometimes the head of the femur is driven through the acetabulum into the pelvic cavity. The diagnosis is made, first, by the history of the injury; secondly, by the detection of crepitus when the bones are carefully palpated, by pain localized in one particular spot when the bones are compressed, by pain induced by coughing, and in most instances by an inability of the patient to flex the thigh on to the abdomen. These fractures are not in themselves serious, and they unite readily, but the complications which accompany them may be fatal. These complications are rupture of the urethra, rupture of the bladder, injuries to the rectum, and laceration of the nerves and blood-vessels.

A case of fractured pelvis, or one in which a fracture is suspected, must be treated with the greatest possible care until these complications have been excluded. The routine treatment of such a case is as follows:—

The patient is stripped, and is carefully examined, attention being paid to the special points referred to above. The urethra is examined for signs of bruising or for evidence of recent hæmorrhage. The patient is asked whether he has passed his water since the accident; if so, whether any special difficulty accompanied the act. If a negative reply is received, the first step is to ascertain whether the urethra and bladder are intact. This is done in the following way:—

The Urethra.—As a rule in injuries of the urethra the canal is torn or damaged by separation of the bones of the pubic arch, the triangular ligament which supports the urethra at this situation being stretched and torn. Occasionally the injury results from spicules of bone which are driven directly into the wall of the urethra. In most instances there are obvious signs of such damage, in the form either of blood escaping from the meatus or of a perineal swelling. *Under no circumstances should a patient in whom an injury of the urethra is suspected be allowed to pass his urine naturally.* Attempts must be made at once to locate the situation of the injury and to estimate its gravity by the passing of a catheter. For this purpose a gum-elastic instrument should be employed first, and if this fails it is necessary to make an attempt with a silver instrument pending further operative procedures. Should the catheter enter the bladder without much difficulty it is

probable there is only a bruising or slight laceration of the urethral wall; in which case it will not be necessary to do more than pass the catheter at regular intervals, say every four hours, a careful watch being kept on the perineum for signs of extravasation. This is a most important observation, because, although there may be a comparatively free passage to the catheter, a small amount of urine may leak through a bruised urethra, into the perineal pouch, and set up extensive suppuration. Supposing, however, that the catheter is introduced with difficulty, accompanied perhaps by fresh hæmorrhage, then it would be wiser to tie in the catheter, and, as before, while the bladder is draining, the perineum must be carefully inspected, and any signs of extravasation treated immediately. If the catheter cannot be passed, no time must be lost in sending for the visiting surgeon and in preparing for perineal section. It cannot be too clearly laid down that the majority of gross injuries to the urethra are best treated by operation.

Injuries to the Bladder.—The question of urethral injuries having been satisfactorily settled, the next duty of the house surgeon is to ascertain whether there is any evidence of injury to the bladder. Such injuries may occur either on the peritoneal or non-peritoneal surface of the organ. In the former case the urine escapes into the peritoneal cavity, and if the condition is not promptly relieved septic peritonitis will be the result. In the latter class the rent is on the anterior surface of the viscus, and the urine escapes into the space of Retzius, from which it will mount up behind the muscles of the abdominal wall. Many cases of bladder injury are readily diagnosed, but there are some in which the detection of this visceral damage is exceedingly difficult. The special points on which stress is to be laid are the following: First, the patient usually expresses an intense desire to pass water, but is completely unable to perform the act. This is one of the most important diagnostic symptoms, and it arises only after injuries, either from rupture of the organ or from the retention of clot within the cavity. Should this symptom be present, the next step is to pass a catheter into the bladder. In most cases, if the bladder is injured, nothing but a little blood-stained urine will be withdrawn. This in itself is sufficiently suggestive, but the diagnosis must be further confirmed by the following procedure. A measured quantity of boracic acid solution—6 to 8 oz. in a child, and 12 to 16 oz. in the adult—should be slowly injected, and remain *in situ* for half a minute, and then be allowed to return into some receptable. This manœuvre should be repeated three times, after which any gross discrepancy between the amount injected and the amount returned will give definite evidence of a rent in the bladder wall. Certain precautions should be observed in performing this test, and certain fallacies avoided. If the rupture is intraperitoneal, the injection of the fluid may give rise to a considerable amount of shock. If this be so, the experiment must not be repeated: there will be sufficient evidence at hand to warrant

an exploratory operation, and the surgeon should be notified. When the rupture is extraperitoneal, the fluid often collects in the areolar tissue behind the pubes, and a species of false bladder is formed, into which fluid may be injected, and from which it may be withdrawn without any noticeable diminution in quantity. Under such circumstances, however, it will be noticed that the abdominal muscles become increasingly rigid with the injection of the fluid, and a considerable amount of pain will be caused, added to which an irregular dullness will be found on percussing above the pubes. Such dullness will not conform to the outline of the bladder, nor will there be the feeling of a distended organ conveyed to the hand. Sometimes, too, the opening in the bladder is small and becomes plugged with swollen mucous membrane or the perivesical fat. In such cases, unless care is taken to actually *distend* the organ, there may be no discrepancy noticed when the fluid is returned, and the rupture may be overlooked. In any case where such symptoms are present, the presumption is that the bladder is injured, and steps must be immediately taken to deal with the damage.

Injuries to the Rectum.—These are fortunately rare, and are most usually caused by a fracture of the coccyx, which is displaced forwards against the rectal wall. In most cases nothing more than a slight laceration exists, which can be dealt with by rectifying the position of the displaced bone, but in more severe injuries extensive operations may be required later on.

Injuries to the Blood-vessels and Nerves.—Apart from serious immediate hæmorrhage which would attract attention by the usual signs of such an accident, injuries to blood-vessels cannot be considered as requiring immediate treatment, but thrombosis of the pelvic veins may be a complication leading later to a fatal issue. Injuries to the nerves will be best considered under the head of "Injuries of the Spine."

Any of the above complications having been satisfactorily remedied or excluded, the fractured pelvis is treated by surrounding the pelvis with a firm wide binder. The patient should be placed upon a fracture-bed, which is better at first than a water-bed, owing to the immobility of the latter. Attempts may be made to manipulate the fragments into the best possible position, although in most instances such treatment is unavailing, and fortunately no bad results occur from their malposition. The knees should be fastened together. Special care must be taken to prevent bed-sores developing. If the skin becomes red and tender an air-bed or a water-bed must be substituted for the fracture-bed. The patient should be confined to bed for six to eight weeks at least, at the end of which time, if union appears firm and if no complications have developed, he may be got up into a wheel-chair, the pelvis being supported with a poroplastic or leather splint. He must not, however, be allowed to walk for three months from the time of the injury.

Fractures of the pelvis are often associated with thoracic and abdominal injuries, and the house surgeon must be very careful not to overlook these, which may be more serious than the actual fracture. The great shock which attends this accident must also be treated.

FRACTURES OF THE FEMUR.

As a result of direct or indirect violence a number of different injuries may be sustained in the region of the upper end of the femur, from which the following are examples: (1) Extracapsular fracture of the neck of the femur: (2) Intracapsular; (3) Separation of the upper femoral epiphysis; (4) Dislocation of the head of the femur, with or without fracture of the acetabular rim.

Fig. 106.—Measurement to Detect Shortening of the Femur.

A routine examination of this region is therefore necessary in order to ascertain the exact nature of the damage. Note (1) The absence or presence of shortening of the limb; (2) The presence or absence of abnormal or normal bony prominences; (3) The position of the limb: whether everted, abducted, or flexed. Measurements should be taken from the anterior superior spine to the internal malleolus (*Fig.* 105), for in most of the injuries in this region a certain amount of shortening can be detected. The shortening is least in an intracapsular fracture, in which it rarely amounts to more than ½ in. In the extracapsular variety it may be as much as 1½ in., while in dislocation it may even exceed 3 in. Next, Bryant's triangle and Nélaton's line are to be defined, and the position of the trochanter with regard to them is to be examined. The trochanter rises above Nélaton's line to an extent corresponding to the shortening of the limb in the three conditions previously mentioned, the upward displacement being most marked in the dorsal dislocation.

Nélaton's Line is an oblique line drawn from the anterior superior iliac spine to the tuberosity of the ischium. The line crosses the middle of the acetabulum and the top of the great trochanter when this bony prominence occupies its normal position (*Fig.* 107).

Bryant's Triangle is obtained in the following manner: A perpendicular line is allowed to fall from the anterior superior spine of the ilium, when the patient is lying supine, both sides of the body being as far as possible symmetrical. Another line is drawn upwards to meet this from the top of the great trochanter, and finally an oblique line joins the anterior superior spine to the trochanter (*Fig.* 108). If the position of the trochanter has been altered as the result of injury, the measurements obtained on the two sides of the body will not correspond, since if the trochanter has been drawn upwards the interval between

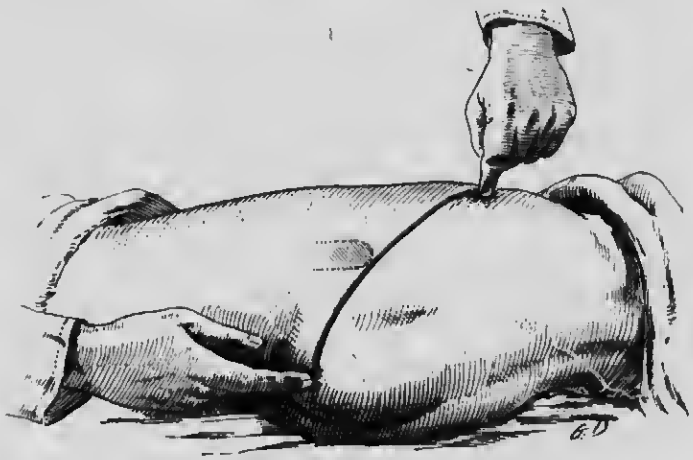


Fig. 107.—Method of defining Nélaton's Line.

the trochanter and the perpendicular line will be diminished; if it has been displaced backwards the interval between it and the anterior superior spine will be increased. The advantage of this method is that it is not necessary to roll the patient over, as in defining Nélaton's line.

Next, the limb is to be palpated, and then rotated. In an intracapsular fracture, the trochanter will be found to rotate through an arc of a circle slightly smaller than the normal. In the case of the extracapsular fracture, on the other hand, the arc of rotation is markedly diminished unless the fracture is impacted; while [in dislocation rotation would be almost impossible owing to the preternatural immobility. The palpation may enable the examiner to detect the presence of crepitus in the case of a fracture, but such a sign is not to be sought for, the other evidence being sufficient to establish the diagnosis. Next, if a dislocation is suspected, the hand or the fingers of the examining hand must be thrust into Scarpa's triangle.

when, if a dorsal dislocation—the common form—is present, a loss of resistance will be noticed in this region as compared with the opposite side. On turning the patient over, the trochanter will appear more prominent in all these injuries, but its greater prominence in the case of dislocation and the marked widening of the gluteal region are very characteristic. The head of the bone in dislocation may be felt on the dorsum ilii, but it is not a sign to be absolutely relied upon, since in the sciatic variety it lies so deeply that it may not be recognized. The preliminary inspection and examination being over, the special signs denoting the particular kind of injury which has to be treated will now be dealt with.

Intracapsular Fracture.—This is a form of injury which occurs in elderly people, produced by relatively slight violence and not accompanied by the signs of gross damage, such as bruising or swelling. The

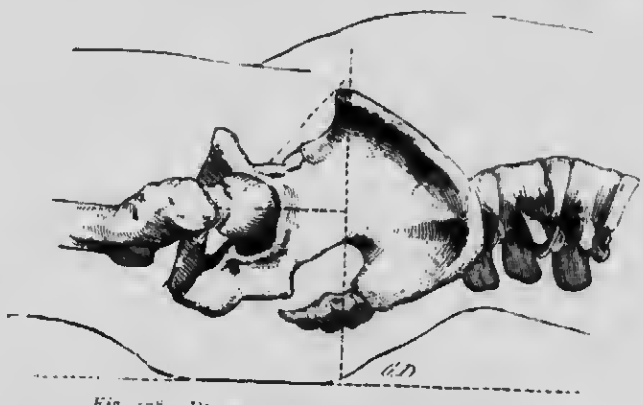


Fig. 108.—Diagram showing Bryant's Triangle.

neck of the bone, having atrophied and softened with advancing age, snaps readily as the result of a slight fall or blow. The signs and symptoms are as follows:—

The patient lies with the leg motionless and everted. He is usually unable to move it himself. Inspection over the region of the hip shows perhaps some slight amount of swelling, and careful measurement will prove the presence of about ½ in. shortening. No attempt should be made to obtain crepitus, since this is likely to damage any bands of the capsule which still remain intact.

Treatment.—This accident, occurring as it does in the later periods of life, is usually treated without the definite object of obtaining firm bony union. In those cases where the fracture is impacted no attempt should be made to alter the condition of affairs. The patient should be propped up in bed with the limb placed between sand-bags, and a careful watch should be kept for signs of congestion of the lungs, since this complication is more serious to the patient than the fracture itself. As soon as the tenderness and swelling permit, gentle massage of the

part must be undertaken. At the end of about a month the patient should be allowed to get up, the fractured limb being supported by a pelvic splint (*Fig.* 109), or a Thomas's hip splint. As soon as this period is reached—and the duration of the bed treatment must be shorter when there is any risk of pneumonia—the patient should be allowed to get about on crutches, and encouraged to use the limb as much as possible. Since union is not aimed at, a species of false joint forms, which allows of a certain amount of activity, and the results are in the main satisfactory. Should such an accident occur in a healthy subject, whether old or young, in whom it is advisable to attempt to obtain bony union, a Liston's splint with an extension apparatus should be applied, or Hodgen's splint should be fitted up, and the case should be treated as one of extracapsular fracture.

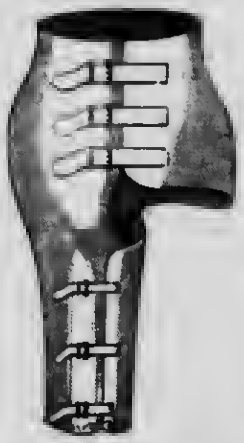


Fig. 109.—Pelvic Splint.

Extracapsular Fracture.—This accident occurs at all ages, but is most usual in young robust patients, when a considerable amount of direct violence has been applied to the region of the great trochanter. This process of bone is driven inwards against the neck, which splits the trochanteric portion of the bone into two parts, the neck itself becoming wedged between the fragments. The signs and symptoms are as follows: The limb is usually in a position of eversion—but if an impacted fracture is sustained when the limb is inverted, the inversion will persist. There are extensive bruising and swelling round the region of the hip joint, and it may be very difficult to locate the position of the bony processes. If this can be done it will be found that the trochanter is broadened and is raised an inch to an inch and a half above Nélaton's line; crepitus may be obtained by the ordinary examination. If the fracture is impacted, nothing but swelling, shortening of the limb (elevation of trochanter), and eversion may be found.

Treatment.—In uncomplicated cases, that is to say where impaction is not present, attempts may be made not only to bring the fractured surfaces into accurate apposition with one another, but also to obtain firm bony union. These results would be obtained by putting the patient under an anæsthetic, and applying forcible extension of the limb while the pelvis is steadied, so as to drag down the trochanter to its proper level. The extension apparatus is then to be fitted (see description), and a Liston's splint is to be applied, the limb being abducted.* A heavy weight—10 to 20 lb.—is to be attached to

* The great fault of a Liston is that it does not allow for abduction. A special hinged splint should be used; or, better still, a Thomas's hip splint, modified for abduction.

the extension, in order to tire out the muscles, which would otherwise drag the femur in an upward direction. Special care must be taken to see that the foot is not too much inverted or everted. If preferred, a Hodgen's splint may be applied, care being taken to see that sufficient extension is exerted in order to keep the trochanter in its proper position. This treatment must be maintained for eight weeks, during which period the limb must be massaged regularly three times a week, the knee moved, and after a fortnight the hip joint also. At the end of eight weeks the patient may be permitted to get up on crutches, and during this time every effort must be made to

Fig. 110.—Liston's Wood Splint.

improve the movements of the hip joint, which will probably be exceedingly stiff. One of the common results of the accident is ankylosis of the hip joint. At the end of ten weeks he will begin to walk, and at the end of twelve he may be discharged.

In the case of the impacted variety, which is diagnosed by the history of the injury, the broadening of the great trochanter, and the swelling and bruising of the tissues over it, together with a definite amount of shortening of the limb, treatment must depend upon the age and condition of the patient and the degree of deformity produced by the impaction. In most cases where the patient is young and robust, it will be good practice to attempt a disimpaction of the fragments, and

Fig. 111.—Hamilton's Splint.

subsequent treatment similar to the above should be adopted. But when a patient is somewhat elderly and the deformity slight, even though there should be an inch of shortening, it is better to attempt nothing active in the way of treatment, but to apply an extension with a lighter weight, 5 to 10 lb., and follow out the general principles as advised above.

Separated epiphyses will be considered under another head.

Fracture of the Lip of Acetabulum.—The signs of this injury are those of the dorsal dislocation of the hip, and the true condition is recognized only when an attempt is made to reduce the deformity. Reduction is effected with comparative ease, but the deformity returns

as soon as the extension is removed. Such cases are to be treated as fractures of the neck by the application of a Liston's splint and an extension with a powerful weight—10 to 20 lb. for a strong adult—after the head of the bone has been manipulated into its proper position.

Fractures of the Shaft.—The three common situations of the fracture of the shaft are: (1) Just below the lesser trochanter—the fracture being an oblique one; (2) In the middle of the shaft—the fracture being transverse; (3) At the lower end—the injury being often complicated by damage to the knee joint. The chief difficulty in dealing with fractures of the shaft of the femur occurs in the first variety, owing to the obliquity of the fragments. In this injury the upper fragment is tilted forwards and outwards by the psoas and the gluteal

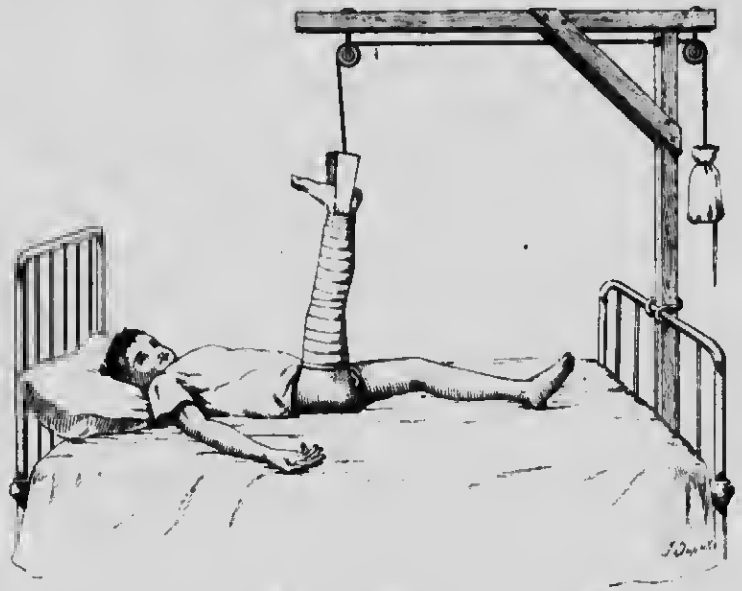


Fig. 112.—Gallows Splint, showing Method of Extension.

muscles, and often forms a sharp angle immediately beneath the skin, the lower fragment being drawn up behind it. No apparatus will enable us to control the upper fragment, and in cases where displacement is marked the fracture must be treated by a double-inclined plane or by a Hodgen's splint, the principle of such treatment being to bring the lower fragment into accurate apposition with the uncontrollable upper fragment. Those cases of fractured femur in which displacement is not marked—and this especially applies to fracture of the middle of the shaft—are very satisfactorily treated by a Liston's splint (*Fig.* 110), short splints or Gooch's splinting being placed round the limb at the seat of the fracture. In very young children a double Liston's splint, fixed by a cross-bar between their lower extremities,

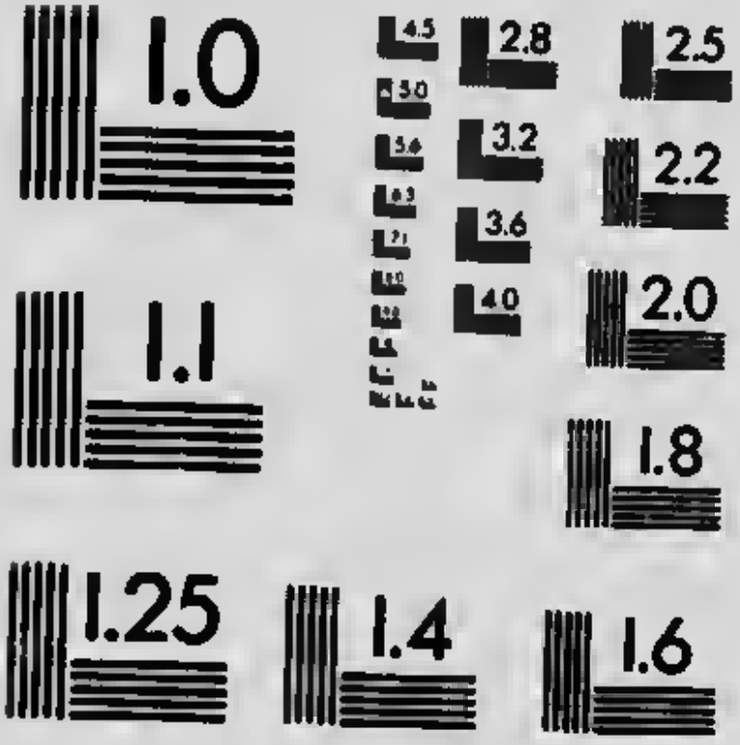
and known as Hamilton's splint (*Fig.* 111), is a most excellent apparatus, as it enables the child to be lifted from the bed, cleaned, and dressed without any trouble. Or again, the gallows splint (*Fig.* 112) may be employed, or some modification of it, by which the limb is slung at right angles to the trunk, and in this way any deformity arising from the obliquity of the fracture is overcome. Whichever method is employed, extension is to be applied. The procedure is as follows :—

The limb is carefully washed and, if hairy, shaved. Two long strips of strapping, 3 in. wide, fixed below to a square piece of board ¼ to ½ in. thick (slightly wider than the ankle opposite the two malleoli) which is known as the stirrup, are heated and pressed against the lower third of the fractured limb. They are here secured by short, thin pieces of strapping 1 to 1½ in. in width, passed in a figure of 8 around the limb above the malleoli and ending just below the fracture; the knee may be left uncovered. It is necessary to see that the pull of the extension is exerted on the femur and not on the knee, and this rule applies to extensions in both fractures and diseases of the hip joint. Large pads of wool should be introduced between the malleoli and the sides of the strapping, to prevent the skin over these processes becoming chafed. A cord is fixed to the stirrup which passes over the pulley at the end of the bed, and is there secured to a tin can which is filled with shot up to the required weight. If now the foot of the bed is raised on blocks, extension and counter-extension are obtained, the patient's body acting as a counter-extending weight. When the fracture has been manipulated into a good position under an anæsthetic (it is always necessary to control the fracture with some splints before the anæsthetic is given), the extension apparatus is applied, and Liston's splint is bandaged to the limb. A proper splint of this kind should extend from the axilla to below the foot, and it is secured to the patient in three places; (1) round the thorax, (2) round the limb at the seat

Fig. 113.
GALLOWS SPLINT FOR FRACTURED FEMUR IN CHILD.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

of fracture, and (3) to the leg and ankle. In securing to the thorax it is necessary to take the first turn of the bandage round the splint from within outwards, and then round the back of the patient's thorax, the direction of the bandage in this way preventing the natural tendency of the splint to rotate forwards. Several turns should be taken round the thorax in order to retain it in position. The remaining bandages should be secured from without inwards, in order to check the tendency of the foot and leg to roll outwards.

In order to prevent the rotation of the limb, a method advised by Cheyne and Burghard may be adopted (*Fig.* 114). This consists in securing the limb at the level of the popliteal space to a short splint, 8 by 4 in., by means of a plaster-of-Paris bandage. The presence of this splint effectually prevents any rotation, either inwards or outwards.

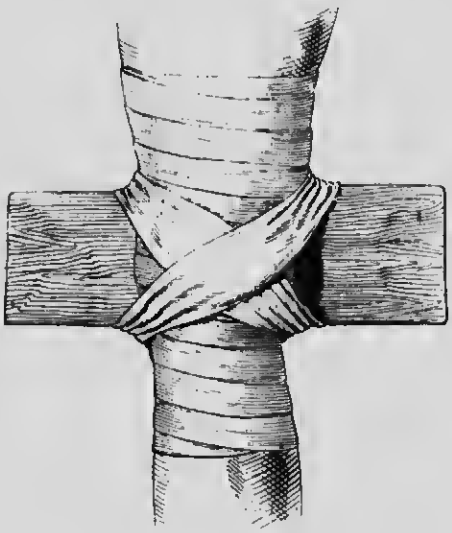


Fig. 114.—Cheyne and Burghard's Method for preventing Rotation of Limb.

Special care must be taken to see that the malleoli and the skin over the heel are not subjected to any great pressure. If the fracture is put up in this way it must be kept up for six to eight weeks, and the amount of weight applied to the limb must be varied according to the age of the patient and the tendency to deformity. Roughly, half a pound a year will be found to answer most purposes, but if there is much spasm the amount can be increased up to 20 lb. for an adult. At the end of six weeks, during which period the limb should have been regularly massaged—this can usually be done without disturbing the extension—the patient should be got up, and some form of retentive apparatus applied.

In the case of children, a well-fitted poroplastic splint is all that is required, or, if preferred, a plaster case may be made.

In the case of adults a Thomas's hip splint is a very valuable form of apparatus, since it enables the patient to get about, and allows of active movements being undertaken, while he himself can hobble about on crutches. If such treatment is not considered advisable, he should be kept in splints for eight weeks, and then allowed to lie in bed without any apparatus on at all, while the limb is regularly massaged, and he should be encouraged to get up for a short time on crutches, gradually exercising the limb, until at the end of about ten weeks he is walking on it as before.

Lower End of the Femur.—These fractures usually run through the condyles in the manner of the T-shaped fracture which is met with in the elbow, the result being: (1) the knee joint is filled with blood, and adhesions are likely to form; (2) the condyles are separated from one another, so that the relation of their articular surfaces to the articular surfaces of the tibia is altered.

TREATMENT.—If the fracture is a transverse one just above the condyles, an attempt should be made under deep anæsthesia to manipulate the fragments into accurate apposition. This is best done with the knee flexed, and owing to the tendency of the gastrocnemius to pull the lower fragment backwards, it may be necessary to divide the tendo Achillis or to put the limb up flexed nearly at a right angle, in order to obtain satisfactory union. In all cases an *x*-ray photograph should be taken in order to ascertain the approximate position of the fragments. Fractures which involve the condyles must be treated on the same principles. Extension may be applied, but the chief object which the surgeon has in mind is to promote absorption of the blood, and to prevent the organization of the adhesions, by early massage and passive movements. In some cases it may be advisable to perform an open operation, but that will not be considered here. The duration of the treatment should be the same as for fractures of the shaft.

HODGEN'S SPLINT.

Hodgen's splint (*Fig.* 115) is an apparatus devised particularly for cases of fractured femur in which it is desired to apply extension in the flexed position of the limb. It is thus peculiarly adapted for fractures in the neighbourhood of the lesser trochanter and in the lower third of the bone. In the former the upper fragment is flexed at the hip by the iliopsoas, and in the latter the lower is flexed at the knee by the gastrocnemius; in neither case can the smaller fragment be controlled, so that the larger one must be brought into its line. This splint is preferable to an inclined plane because it does not impede nursing manipulations, and the patient can to a certain extent move about and even assume a semi-recumbent position without the risk of displacing the fragments.

The splint consists essentially of a stout wire frame shaped to fit the limb, and bent at the knee to an angle of 130°. There is a crossbar at the upper end which corresponds to the fold of the groin, and a transverse one at the lower end. The frame should be long enough to extend from the anterior superior iliac spine to a point six inches below the sole of the foot. At four points on its upper surface hooks are fixed, one at the middle of the thigh-piece and one at the middle of the lower half on either side. From these hooks stout cords are taken to a central pulley, from which in turn a single cord is led over a second pulley attached to a foot-piece at the end of the bed. The limb is suspended from the frame by broad strips of house-flannel, which are

fixed with strong safety-pins to its two sides. The method of application is as follows:—When it has been decided that the case is a suitable one for treatment with a Hodgen's splint, the house surgeon's first care should be to see that everything which may be necessary is at hand; if this is not done, inconvenience will ensue and time will be lost. Thus an ordinary stirrup for extension must be prepared, with side-pieces of strapping which are just long enough to reach from the stirrup to the site of the fracture, and a sufficient number of transverse pieces must be ready. A wire frame of the correct size must be procured, and it is well to see that the pulley and all the cords are in working order. Ten or twelve pieces of house-flannel should be cut about four or five inches broad and one foot in length: and lastly, an iron standard with a pulley must be attached to the foot of the bed.

It is advisable in all cases to give an anæsthetic, for two reasons: (1) the application of an extension stirrup is in itself a painful business; and (2) it is easier to obtain good position of the fragments when the muscles are relaxed.

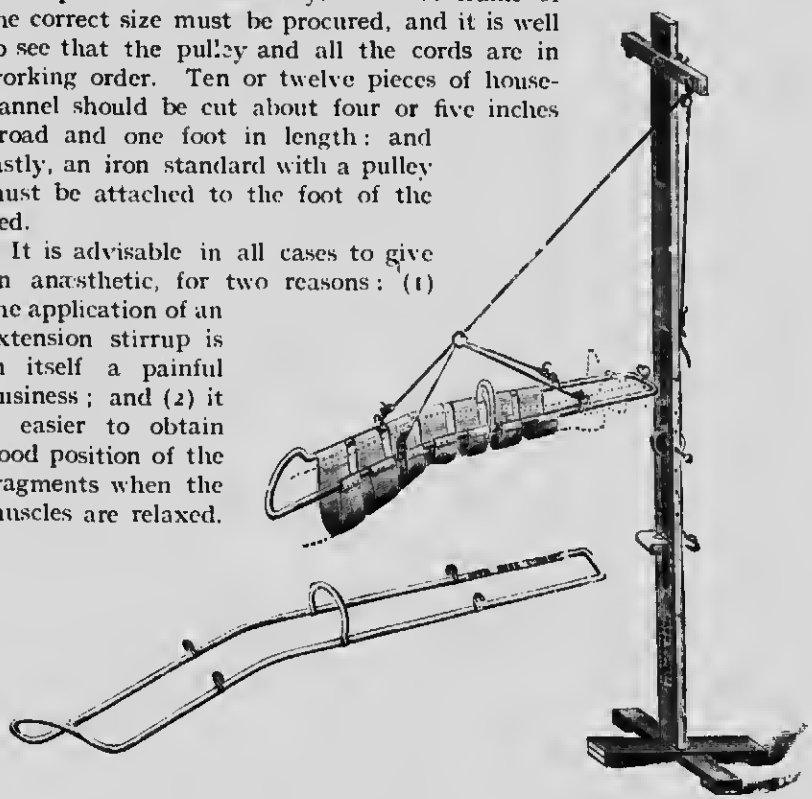


Fig. 115.—Hodgen's Wire Splint and Apparatus Complete.

When the patient is anæsthetized, the extension stirrup is applied. The method of application is similar to that employed when a Liston's long splint is used. It must be remembered that the upper end of the side-pieces of strapping should reach just up to the site of the fracture. The transverse pieces of strapping should be applied round the leg so as to overlap from below upwards, extending from a point three inches above the malleoli to the level of the fracture, leaving out the knee joint. A flannel bandage should be applied over all. The stirrup when held taut should be three inches from the sole of the

foot. A short cord is passed through a hole in the centre of the stirrup, and is knotted on its proximal side.

The wire frame is now held over the limb, and the portions of house-flannel are passed underneath and pinned to the splint on either side, so as to form, as it were, a trough for the limb. They should extend from the heel to the gluteal fold, and their edges should be in apposition but should not overlap. The cord which has been passed through the stirrup is tied to the lower crossbar of the splint. The four cords on the upper surface of the splint are adjusted to the pulley. Those leading from the thigh-pieces should be half as long again as the other two. The single cord which leads away from this is pulled over the pulley on the standard until the leg is raised about one foot from the bed, and the limb is retained in this position by tying the cord to the foot of the standard.

So far everything is comparatively simple, but it is the subsequent adjustment of the apparatus which is all-important to the patient's comfort and alone can ensure a good result. These details can only be learnt by practical experience.

It is often found, for instance, that when the limb is raised the upper crossbar is pressing upon the groin, instead of swinging quite free, as it should do. This can be remedied by tightening the house-flannel under the thigh. As soon as the limb is raised, all the pieces of flannel should be examined, and tightened to the same degree so that the weight of the limb is uniformly distributed. Another point to be observed is that the direction of the short cords leading from the thigh-pieces to the central pulley should be in the line of that leading from the central pulley to the standard. This is simply a matter of arranging the height of the pulley on the standard. They need not, however, be in line with the femur, since the splint acts by producing extension upon the thigh in the semiflexed position, the extending force being the weight of the limb. Eversion is easily corrected by placing the limb upright, the friction between the house-flannel and the bandage being sufficient to retain it in position.

One last word of warning. Hodgen's splint is an excellent apparatus if the treatment is properly carried out; but it is not sufficient to apply it once and never look at it again. The entire apparatus must be overhauled daily, the interdependence of its several parts adjusted, and the position of the limb attended to. If this is conscientiously done, excellent results will be obtained.

It will generally be found that the strapping begins to loosen at the end of three or four weeks, but by that time the extension will have done its work, and the limb can then be taken down and put up in a silicate bandage.

FRACTURES OF THE PATELLA.

This fracture, which usually results from muscular action, is in most cases treated nowadays by open operation, and the various methods

of securing the broken fragments will not be here considered. Splint treatment should be applied to those cases which are not suitable for operative interference. Cases which fall under this category are the following: (1) Most cases of stellate fracture or of fracture produced by direct violence; (2) Fractures in alcoholic subjects or in those whose constitution is unsound, as the result of renal or cardiac disease. It must be clearly understood that an operation on the knee joint is a

Fig. 116.—Fracture of the Patella treated by a simple Back Splint and Strapping.

severe test upon the recuperative powers of the patient's tissues, and they should not be subjected to such an ordeal unless there is a very reasonable chance of success. The non-operative treatment consists in first placing the limb on a well-padded posterior splint extending from the hip to the heel (*Fig.* 116). The splint should be raised so that the hip joint is flexed, in order to relax the rectus femoris. As the joint will in all probability be full of blood, it is advisable to

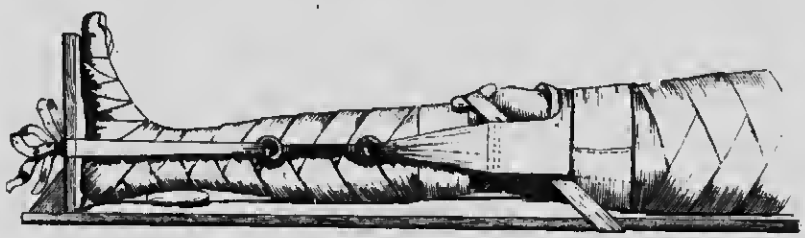


Fig. 117.—Middlesex Hospital Method of treating a Fractured Patella.

accelerate its removal, either by aspirations, which must be conducted with every aseptic precaution, or by massage, or by both massage and elastic compression. The massage should be employed for fifteen minutes twice a day.

As soon as the swelling has subsided and the surgeon is able to locate and approximate the fragments, they should be drawn together by means of a piece of strapping, which is fixed above the upper fragment in the form of a loop. The lower fragment is similarly pushed up by another strip. Either this method, which consists practically in bringing the fragments into apposition by strapping in the form of

figure of 8, or the Middlesex Hospital method should be employed. In this latter form of treatment the limb is placed on a long posterior splint with a firm footpiece (*Fig.* 117), and a broad band of strapping is fixed across the limb just above the upper fragment. From the lower lateral borders of this band two long strips descend parallel with the leg, and then are connected to the footpiece of the splint upon which the limb is resting by means of elastic bands, which exercise continuous elastic traction on the upper fragment. The whole limb is raised so as to relax the rectus femoris. The special object to aim at is accurate coaptation of the two bony surfaces without tilting, and as far as possible without the intervention of the torn aponeurosis. The chief objection to such treatment is the fact that it interferes with massage and passive movement, for under these circumstances the limb must be kept at rest for a period of six weeks, and only the muscles of the thigh can be subjected to daily massage. Lucas-Championnière does away with most retentive apparatus, allowing the patient to walk with the aid of a stick in from six to twelve days. From the onset of the injury until firm bony union is obtained, massage and passive movement are energetically performed. Under ordinary circumstances the house surgeon will find that a sufficiently good result will be obtained if the fragments are merely approximated by strapping, the limb being massaged daily, and gentle flexion of the joint started about the tenth to the fourteenth day. The upper fragment should be steadied by the surgeon's hand while these movements are being carried out, and at first it is advisable to flex the limb only to a very limited extent. The patient may be allowed to walk on his leg within a month, but it should be supported by a poroplastic, leather, or plaster case. As the limb gains strength, greater freedom of movement may be permitted, but as a rule some form of retentive splint is required permanently.

FRACTURES OF THE BONES OF THE LEG.

These are the commonest fractures met with in the surgical wards. Either one or both bones may be broken, and the general treatment is similar in each instance. Fractures may be considered in the middle and upper third, and in the lower third, and Pott's fracture of the fibula will be described among those occurring in the latter group. The fracture is often oblique, and there is some difficulty in manipulating the fragments into good position and in keeping them there. There is a tendency for the lower fragment to be drawn up by the contraction of the gastrocnemius and soleus, and the house surgeon will find that considerable success will attend his efforts if he flexes the knee in order to relax these structures. He must also bear in mind that it is the lower fragment which is the mobile and displaced bone, and no amount of padding applied to the projecting upper fragment can have any effect in rectifying the malposition. The lower fragment is to be manipulated into apposition with the upper fragment,

and it may sometimes be necessary to invert the foot, to flex the knee, or even to divide the tendo Achillis in order to obtain this end.

In cases uncomplicated by much swelling or deformity, the fracture may with advantage be put up in a plaster case, which can be taken down for massage and passive movements at the end of a few days. This is a form of treatment applicable to hospital patients, who can then hobble about on crutches and attend the hospital for the massage as arranged. If, however, the swelling is excessive and the tendency to displacement great, the patient should be admitted and the limb put up under an anæsthetic in a box or Neville's splint and slung so that the posterior leg muscles are relaxed (*Fig.* 118). In some cases a M'Intyre's splint may be substituted. (*See Fig.* 66.)

Extension apparatus can also be applied if there is much spasm of the muscles, but it is exceedingly difficult to apply strapping round

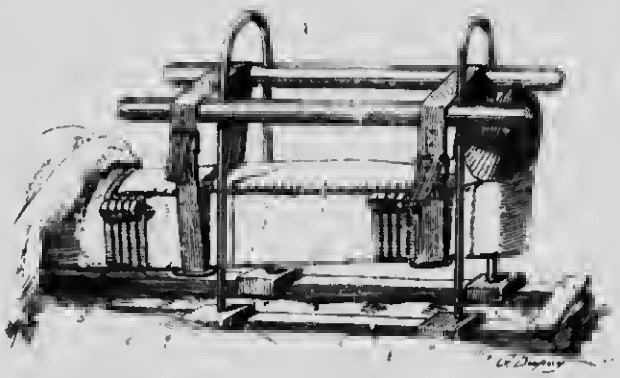


Fig. 118.—Fractured Leg slung in a Box Splint.

the ankle for a weight extension without the production of œdema. The best way of obtaining the extension is to fit an old tennis shoe or slipper on to the patient's foot and fix the extension apparatus to this.

In favourable cases, the patient may leave off the splint in about six weeks, and after another fortnight, during which he accustoms himself gradually to bear the weight of his body on the limb, he can walk about.

The method of *immediate splinting* described by Croft, or some modification of it, has come into very general use, as it has all the advantages of the Bavarian splint in the way of being able to be opened for inspection of the limb, and is yet much simpler. Each splint (for the leg two will be required) consists of two layers of house-flannel. The inner layer, which is generally moistened with warm water, is applied to the limb, while the outer one is thoroughly soaked in plaster-of-Paris cream and put on over it. Both layers are then moulded to the limb while the surgeon holds it in position. *Muslin* bandages are then rolled on so as to thoroughly shape the splints and to bind them together. The turns of the bandage adhere to the plaster; but as

the interval between the various splint pieces is spanned by the muslin only, this can be cut up for examination of the limb along the upper interval, while it serves as a hinge at the lower. In the case of fractures of the leg, the pattern for the pieces of flannel, as in the case of the Bavarian splint (*see Plates I and II*), can be got from the flattened-out stocking of the patient. Inside and outside splints will here be required, and they must be cut of such a size that they will not meet in front or behind for about half-an-inch. This plan of splinting can be adopted in many different forms of injury, and to various parts of the body.

While the case is being applied, the limb must be most *carefully held in position* (preferably by the responsible surgeon) (*Fig.* 119), for upon this the whole success of the treatment will depend. After the case has set, it will generally be advisable for the patient to remain in bed with the limb raised, for at least the first week; but in any event

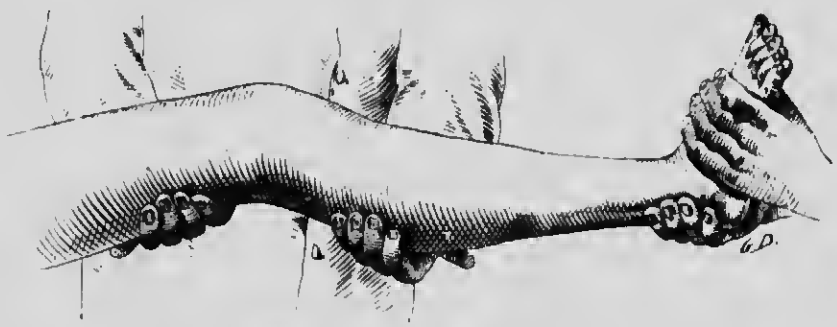


Fig. 119.—Supporting the Limb for Immediate Splinting.

the period of confinement to bed will be much shorter than upon the old plan. Other fractures in this class are sometimes best treated by the back splint and swing cradle, to be presently described.

Treatment by means of the Box Splint.—This plan consists in putting the limb up upon a back splint and with side splints, and swinging the box thus formed from a cradle. *Fig.* 120 represents Neville's splint, and although its application really is simple enough, still there are many small points which must be attended to.

1. *The Splint.*—This is the kind known as "*Neville's Back Splint*," and consists of a plain piece of iron, with cross-pieces for the leather bands by which it is swung; it should be perforated along the sides to allow of the pad being sewn on, and bent up below to form a foot-piece; it has, as well, lesser curves for the swell of the calf and the bend of the knee.

In choosing the splint for a given case, the important points to look to are:—

(*a*). It should be fully broad enough, lest the bandage or side splints should compress the leg too tightly.

(*b*). The foot-piece should be bent up quite at right angles to the leg-piece.

(*c*). The length from the foot to the bend for the knee should correspond to that of the *sound* leg.

(*d*). The thigh-piece should be long enough to enable the bandage to take a firm hold of it.

(*e*). The bend at the knee must not be less than 160°.

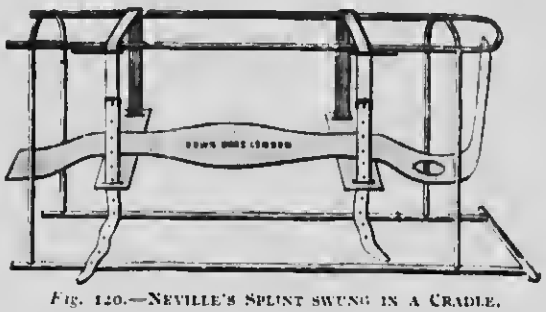


Fig. 120.—Neville's Splint swung in a Cradle.

2. *The Padding* of the back splint must be firm and even, and especially smooth about the heel, where the possibility of a sore being formed must be kept in mind.

3. *The Side Splints* must be well padded, and should be simple, straight, wooden ones, reaching from just above the knee to the edge of the foot-piece. At the foot there should be a short broad strap and buckle, which serves to fasten the two together, the strap passing just below and round the foot-piece (this strap is often omitted).

4. *The Swing Cradle.*—All fractures bad enough to require careful back splinting are bad enough to be swung. Neglect of this is a frequent cause of bad position. The simplest plan is to pass leather straps through the slits in the cross-piece of the splint, and sling it to the cradle, as shown in *Fig.* 120. There are a great many other forms of cradles, and one in great favour is that called after Salter (*Fig.* 121).

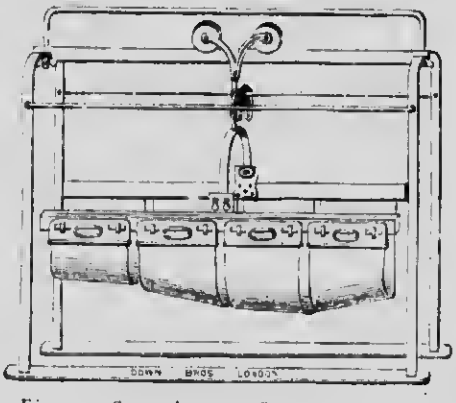


Fig. 121.—Salter's Fixed Cradle with Swing.

In this, as is seen in the figure, the leg is supported in a canvas trough, and the back splint is not fixed to the straps.

The apparatus being ready, the limb must be fastened to the back splint; the whole difficulty of obtaining a good position lies in the necessity for keeping up extension and a slight amount of inward rotation while this fixation is effected. In difficult cases, or where there is much spasm or pain, an anæsthetic should be given, and its action pushed to complete flaccidity of the muscles.

One assistant should now grasp the limb in front the knee, and rolling it slightly inwards, must be prepared to make counter-extension when required. The surgeon, then taking hold on the foot and ankle, will generally be able, by making extension, to get the limb into its proper position.

While the limb is thus extended, it must be settled on the splint and fastened to it, and great care must be taken to keep the plantar surface of the heel well against the foot-piece, with the foot turned slightly inwards, and the hollow above the insertion of the tendo Achillis into the os calcis properly supported. No point in the setting of the fracture is more important than this, as will be understood from what has been said before about the disaster of a sore heel. The readiest road to security in this respect is to have a store of small pads at hand, from which those can be chosen which will best support the hollow beneath the tendon, so that the point of the heel is free of, or only just touches, the splint.

This "fitting" of the foot and ankle finished, and a final look given to see that the upper bend of the splint corresponds to the knee, the limb, still held extended in position, is settled upon the rest of the splint. If a second assistant be at hand, the task of fastening the limb to the splint may be entrusted to him, while the surgeon and the first one keep up the extension. But if, as often happens, one person only is available, the foot must be held by him with one hand while the first few turns of bandage or strapping are made with the other.

In any case the limb must be fastened to the splint very carefully: the heel must be kept down and the foot straight, while very possibly the skin has been bruised, and certainly all the parts are tender. In many cases one or two strips of adhesive strapping may be applied with great advantage round the foot and ankle, great care being taken that they do not strangulate the part, the risk of which is lessened if they are applied with a piece of lint between their surfaces and the skin. In the same way it is advisable to pass a piece of broad strapping round the thigh and the splint upon which it lies.

But whether strapping be used or not, the foot and ankle must in every case be firmly bandaged to the splint, and then the upper part of the leg, the knee, and the lower third of the thigh must be fixed in the same way. No rule can be given as to the extent in which the bandage from the foot should be carried up the limb, but it is generally brought up to the vicinity of the fracture: never over it. This done, in ordinary cases the limb will now be fixed in its proper position, and needs only to have the side splints adjusted and to be swung.

But very often some additional support is required, and further measures have to be adopted to maintain position. Thus one of the fragments may persistently rise, and project dangerously near the skin, or the foot may rotate outwards, defying the action of bandage or strapping; or the heel may constantly come away from the foot-piece; or, as very commonly happens, there may be a bowing

outwards or inwards of the fragments, which simple extension does not overcome.

Directions for such conditions obviously cannot be given in any very precise form. One particular complication is so common, however, that it deserves special mention. The weight of the foot is apt to depress the heel, so that the upper end of the lower fragment is tilted forwards and may even damage the overlying skin. This is best overcome by fitting a sock on to the foot and elevating the heel by fixing the apex of the sock to the top of the foot-piece of the splint.

Pott's Fracture.—This is a fracture combined with a dislocation, there being a dislocation of the foot outwards at the ankle joint and a fracture of the fibula about 3 in. above the external malleolus. In the more complicated cases the tibia may be broken as well, or the

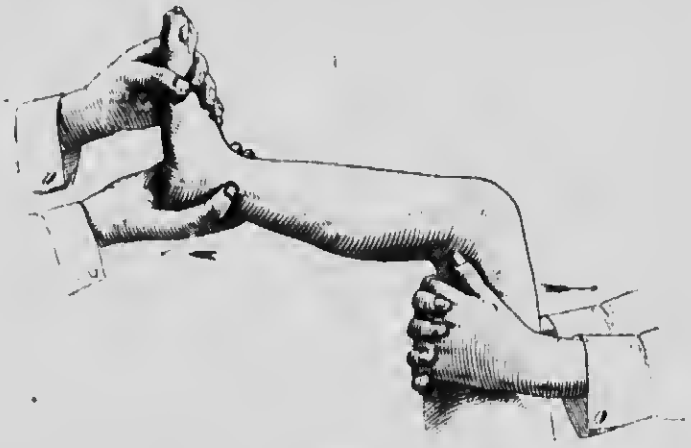


Fig. 122.—Method of Reducing a Pott's Fracture.

astragalus driven up between the two malleoli, so that they are widely separated. Complicated cases of Pott's fracture require the immediate supervision of the surgeon. Simple cases should be treated as follows:

The displacement must be reduced, preferably under an anæsthetic, and a certain amount of time may be well spent as a preliminary in massaging the muscles which are in a state of spasm. In reducing the displacement, it is well to bear in mind the structures which assist in maintaining the deformity; these are the tendo Achillis and the muscles which form it, and the peroneal muscles, which drag the heel backwards and the foot outwards. The first step, therefore, is to flex the limb at the knee, for by this means the tendo Achillis is relaxed: an assistant should steady the flexed knee while the surgeon grasps the foot and heel, the left hand taking the anterior part of the foot, the right hand the heel. The foot is now forcibly twisted inwards, by which manœuvre the displaced surface of the astragalus is brought into its normal position beneath the tibia, and at the same time the

heel should be pulled forward and the foot flexed at the ankle-joint to a right angle or even beyond it. The inner side of the great toe, the inner border of the internal malleolus, and the inner side of the patella should lie in the same line (*Fig.* 122).

If the displacement can be corrected readily and the amount of swelling present is slight, the limb may be put up in a plaster-of-Paris splint extending from above the knee to the middle of the foot, but this must not be applied if it is found that the extended position tends to reproduce the deformity. If the splint has been fitted, the limb must be massaged daily, and each day a careful observation must be made as to the position of the limb. From the fourth day onwards, passive movements to prevent adhesion in the joint and tendon sheaths should be undertaken, and during this time the patient is able to hobble about on crutches without injury. Active movements should be permitted at the end of three weeks, and the patient may put his weight on the injured foot during the sixth week, but a careful watch must be kept for any sign of displacement outwards, in which case the splint must be reapplied and the walking prohibited.

Fig. 123.—Dupuytren's Splint Applied.

When the displacement is more marked, the swelling greater, and the reduction is attended with greater difficulty, the limb should be fixed on a Dupuytren's splint (*Fig.* 123), or a box-splint may be applied after the limb has been manipulated into a satisfactory position. If there is great resistance to the reduction of the deformity, the tendo Achillis may be divided. During the daily inspection of such a case attention must be specially paid to the position of the heel, since it is exceedingly liable to be drawn upwards, and bad results ensue unless special means are taken to prevent it. At the slightest sign of upward displacement, the malposition must be rectified and the knee flexed to a more acute angle.

The other deformity which is likely to recur is the displacement outwards. This must be attended to in the same way, the slightest tendency to malposition being immediately rectified. Massage and passive movements are to be undertaken as in the former variety, and the patient must be encouraged to voluntarily invert and dorsiflex his foot so as to prevent any further displacement.

In bad fractures it is necessary to keep the patient from walking for a somewhat longer period—eight to ten weeks—but from the third

week onwards active movements of flexion and extension should be encouraged, as before.

Fractures of the Bones of the Foot.—These fractures do not call for any special attention. They are diagnosed by means of the *x*-rays, and the broken bones must be manipulated to the best position under the circumstances, with due attention to the normal position of the foot in relation to the leg. A plaster case should be applied, and massage and passive movement undertaken as in the preceding variety In six to eight weeks union is satisfactory.

SEPARATED EPIPHYSES.

The injuries which are considered under this special head are due to damage to the bone in the region of the epiphyseal or growing line; in most cases the actual injury is a fracture on the shaft side of the epiphysis, or as it has been called, juxta-epiphyseal separation. They are therefore confined to the earlier periods of life before union between the two parts of the bone has been effected. The special importance of these injuries arises from the facts, first, that they lie in intimate relationship to the joints of the extremities, which are frequently involved; secondly, owing to the smallness of the epiphyseal fragment, reduction of the deformity is effected with difficulty; and thirdly, they may affect the growth of the bone and lead to distortion of the limb. The injuries are recognized by the following signs and symptoms: (1) The maximum signs of injury are in the neighbourhood of the epiphyseal line; (2) The age of the patient is such that the epiphysis has not yet joined with the rest of the bone; (3) The character of the crepitus is softer and less distinct than that in ordinary fractures. In most cases an *x*-ray examination is very necessary, since the injury is attended by so much swelling that it is not always possible to correctly define the bony prominences.

Reduction of the deformity is effected in the ordinary manner by the application of extension and counter-extension, but here difficulties may be encountered, since there are certain obstacles which oppose the satisfactory reduction in this particular type of injury. They are (1) The interposition of muscle or tendon between the fractured surfaces; (2) The rotation of the fractured epiphysis on an axis (especially is this the case in separation of the lower epiphysis of the femur); (3) The end of the shaft may be pushed through a hole in the periosteum, through which it cannot be withdrawn without an operation. Imperfect apposition nearly always leads to permanent deformity, and every attempt must be made to obtain a satisfactory position. It is not sufficient to rely upon nature in these cases. The general rules with regard to the displacement of epiphyses are as follows:—

There are four epiphyses which are especially liable to injury: the upper and lower end of the humerus and the upper and lower end of the femur; more rarely the epiphyses of the radius and tibia are

injured. Although it is true that according to the direction of the violence which produces the injury, the epiphysis may be displaced into almost any position, the tendency in the majority is for the shaft of the bone to be displaced towards the main vessel of the limb, so that in the case of the upper end of the humerus the resulting deformity is the same as that in fracture of the surgical neck, while at the lower end of the humerus the epiphysis is usually displaced backwards and the shaft forwards. In the case of the femur, separation of the upper epiphysis leads to much the same results as fracture of the neck of the bone, viz., that there is a tendency for the great trochanter to be pulled upwards by the action of the muscles attached to it, a condition which leads to progressive shortening and to the production of coxa vara. In fracture of the lower end of the femur, the epiphysis is displaced forwards and may be rotated, the shaft tending to impinge upon the popliteal vessels, which may be seriously damaged.

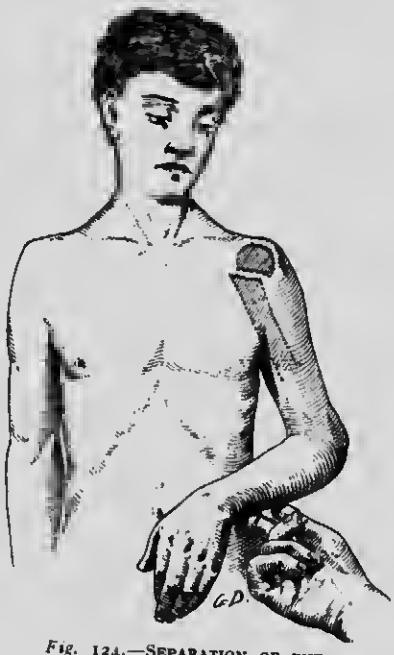


Fig. 124.—Separation of the Upper Epiphysis of the Humerus.

General Principles of Treatment.—An anæsthetic must always be given, and by extension and counter-extension the fragments must be manipulated as far as possible into their normal position. In the case of the upper epiphysis of the humerus (*Fig.* 124) the injury should be treated as a fracture of the surgical neck. A pad of wool of sufficient size is placed in the axilla, and the arm is bandaged to the side. Massage must he undertaken from the first, but passive movements in children need not be started quite so soon as in adults. They should be begun from the seventh to the tenth day, and of necessity in the majority of cases must be performed under anæsthesia. Union is usually firm at the end of six weeks.

Separation of the Lower Epiphysis of the Humerus.—In this injury either the entire epiphysis may be displaced, with or without diastasis of the various centres which enter into its formation, or the outer or the inner condylic portions only may be affected. The usual displacement is that the epiphyseal fragment is displaced backwards and inwards, the inward displacement being due to the falling over or pronation of the forearm, which carries the lower end of the humerus in with the twist. Uncomplicated cases,

that is to say, cases not attended by a large amount of effusion, can be satisfactorily treated as follows:—Under anæsthesia the condyles and the elbow are grasped with the right hand and the shaft of the bone with the left, while the whole of the upper extremity should he steadied by an assistant. The condyles are pulled down and manipulated outwards. Keeping up the extension, the thumb of the left hand is pressed deeply into the antecubital fossa, so as to push the lower end of the shaft in a backward direction. The limb should now be put up in a position of acute flexion and supination, the hand resting on the shoulder of the injured

Fig. 125.—Separation of the Lower Epiphysis of the Humerus.

side. By keeping the forearm in supination, the tendency to inward displacement of the separated fragment is overcome. The limb can be secured in this position by simple means, such as bands of strapping, bandages, or poroplastic splints, and it may be taken as a general rule that if the arm can be got into a position of acute flexion all serious deformity has been rectified.

Massage should be begun from the first, that is to say the next day, but passive movements had better be deferred for a week or ten days and then undertaken with the greatest possible care, since if they are performed too energetically the deformity may be reproduced. As

a rule, it is well to begin by rotating the radio-ulnar joint, and slightly extending the arm through a few degrees, the limb being put up with each sitting in a position of slightly reduced flexion. The cases, however, which give trouble are those which are associated with so much swelling and bruising of the parts that not only is correct manipulation of the fragments an impossibility, but flexion of the arm even to a right angle is attended by so much pressure on the tissues around the elbow as to render it dangerous.

Anything in the shape of excessive pressure must be scrupulously avoided, since such pressure even for a few hours may lead to such very serious complications as *ischæmic paralysis* and *gangrene*. These cases must be treated as follows: The child must be admitted into the hospital, and a gutter or trough of poroplastic material moulded to receive the injured limb. It should lie easily in this receptacle, protected by cotton-wool, in a position flexed to as near a right angle as is possible without undue tension. Lint soaked in evaporating spirit lotion should be left in contact with the swollen parts, and gentle stroking massage should be undertaken from the first for ten or fifteen minutes twice a day. A radiograph should be taken to ascertain the exact state of affairs (*Fig.* 125), and as the swelling diminishes, the arm should be gradually flexed at the elbow until a position of acute flexion is obtained. A period of four to five days may elapse before the swelling diminishes sufficiently to allow the deformity to be completely rectified, and it is always advisable to bring such a case under the notice of the surgeon, since operative interference is often imperative.

When once the limb has been got into a position of flexion and the fragments are in a satisfactory position, the after-treatment should be conducted as in the previous variety, though passive movement may be undertaken on the third or fourth day after the position of acute flexion has been obtained. The fingers must be carefully watched during the first fortnight for signs of swelling, and above all the house surgeon must be on the look-out for any signs of ischæmic paralysis, which usually shows itself by an inability on the part of the child to extend the fingers, which remain flexed in a claw-like manner. In bad cases which are not operated upon, unsatisfactory results are bound to be obtained, but it is worth remembering that interference with full extension is usually less serious and less detrimental to a patient than interference with full flexion.

Separations of the lower epiphysis of the radius are treated on the same lines as Colles's fracture, the deformity of which is closely simulated by this injury.

Separation of the Upper Epiphysis of the Femur.—This can only be diagnosed with certainty by a good radiograph; but when great bruising attends a severe injury to the hip, together with loss of function of the limb and eversion, this injury must be suspected. An extension apparatus should be applied, and the case treated as one of fracture

of the neck of the bone, massage being undertaken as before from the first, and gentle passive movements at the end of fourteen days.

Separation of the Lower Epiphysis of the Femur.—There is great difficulty sometimes in reducing this deformity owing to the swelling, and to the rotation of the separated epiphysis, but an attempt should be made in the following way: The knee should be flexed to a right angle or beyond, and one broad band of webbing is placed round the upper end of the leg and another round the lower end of the femur. The foot should be held firmly by a special assistant, since the principle of the manœuvre depends upon using the foot as a fulcrum. Traction should be exerted at right angles to the long axis of the thigh and leg respectively; the pull should be directed, in the case of the tibia directly forwards, in the case of the femur directly upwards (*Fig.* 126).

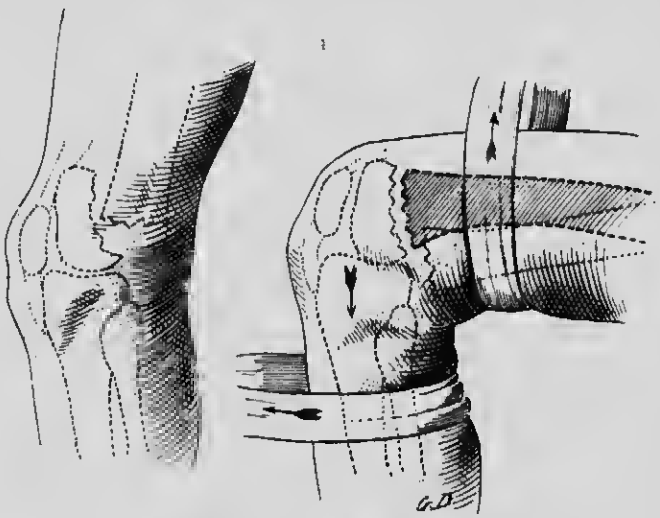


Fig. 126.—Separation of the Lower Epiphysis of the Femur.

The forward traction allows the displaced epiphysis to be drawn away from the femur, while the upward traction draws the shaft of the bone which has been displaced backwards into contact with the loose fragment. If the manipulation is successful, the limb should be flexed at an acute angle, as was the case with the lower end of the humerus, and fixed in this position.

Massage should be undertaken from the first, and gentle passive movements may be begun during the second week, the same precautions being adopted as in the case of a similar injury of the upper extremity. Anything in the nature of tight bandaging or tight compression is shown at once in children by swelling of the hands or feet, and on no account must it be allowed to persist, or irretrievable damage may be wrought to the vessels and the nerves of the limb.

Chapter XVII.

INJURIES TO THE SPINE.

INJURIES to the spine may result from direct or indirect violence. In the less severe cases there is a mere bruising of the muscles or stretching or tearing of the ligaments, both of which may be accompanied by a moderate degree of shock, swelling, and pain. So long as no actual signs of nervous injury are present, the case should be treated by rest, systematic massage for some weeks or months, and general tonics; but it must be remembered that pain will follow movement of the damaged part for a very considerable period after all the active signs of the injury have subsided. Fracture, the more serious injury, is to be specially considered in connection with the associated damage to the spinal cord. If the spinal column is subjected to violence, a condition may result which is sometimes called concussion of the spine. The symptoms of this lesion are somewhat variable and difficult to describe. Possibly pure concussion without gross lesion may exist, but more generally the term concussion is to be applied to a preliminary state of diminished activity of the central nervous system following a severe injury to the spinal column, from which the patient gradually recovers. These cases are most likely instances of hæmorrhage, either into the cord or into the spinal membranes. When the spinal column has been fractured, there is usually associated with the fracture a dislocation or displacement of the bones of the column, which displacement may be temporary or permanent, for the column by virtue of its elasticity may be so displaced that the spinal cord becomes irretrievably damaged, but the bones may spring back into practically their normal position. In other instances the deformity or displacement persists, and a sharp angle is formed by the body of the vertebra immediately below the fracture, against which the cord is compressed or torn to a variable extent. In some cases damage to the cord results from direct injury to the posterior part of the spinal canal, the laminæ being displaced forward, and such cases can of course be treated successfully by operation, since the immediate cause of the compression can be at once removed. In the former cases, where the compressing agent is formed by the posterior surfaces of the bodies of the vertebræ, operative treatment is less successful, since all the operator can do is to remove the posterior wall of the spinal canal, and in very few instances is he able to rectify the deformed state of the vertebral body.

Fractured spine is to be considered under two headings: first, those cases in which operative treatment of the injury is advisable; and, secondly, those in which, owing to the presence of adverse symptoms, nothing operative must be attempted. Experience shows that a greater number of cases are now successfully submitted to operation than in former years, and since we know that in most instances paraplegia resulting from spinal injury is permanent unless treated, any treatment that holds out the smallest prospect of improvement should be employed. Following the injury the nervous manifestations can be classified as follows:—

If the lesion is a total transverse one there will be complete paralysis of the muscles below the lesion, which will be of a flaccid type with loss of reflexes, and it may be said at once that the more completely the reflexes are abolished, and the longer the period which elapses before their return, the worse the prognosis and the more hopeless any attempt at operative treatment. Sensation below the lesion is abolished.

In partial lesions there is a distinct difference according to whether the lesion is above or below the level of the second lumbar vertebra. Above that point the cord itself is damaged, and except for the particular nerve root which may be affected at the seat of the injury, the paralysis tends to be of the upper segment type; that is to say, there is a paralysis of the muscles which later becomes spastic, there is no reaction of degeneration, and the reflexes become exaggerated. On the other hand, if the lesion lies below this level the nerves which enter into the formation of the cauda equina become involved, and the paralysis is of the lower segment type. The muscles remain flaccid, the reactions of degeneration become established, and the reflexes are permanently abolished.

Of course many cases are met with which do not fall strictly into either category, owing to the extent and irregularity of the lesion. Injuries which involve the cauda equina should be distinguished from those which affect the spinal cord itself, because the cauda equina being composed of mixed nerves is capable of regeneration after injury and division, as are the nerves of the limb plexuses, though the results are not quite so satisfactory.

Effects on the Bladder.—It will be found that, following most severe injuries to the spine, whether the lesion lie below or above the level of the second lumbar vertebra, for the first period at any rate the house surgeon will have to deal with retention of urine. In some cases, when the lesion lies above the bladder centre, which is situated in the lumbo-sacral region of the cord, there may be a certain return of reflex control, though it is exceedingly variable in its onset and in its extent. On the other hand, when the lesion lies below this level and affects the cauda equina, the tendency is for dribbling incontinence to set in as the case progresses, but this will not occur until some days or weeks have elapsed, during which the use of the catheter will

be imperative, and it is one of the first details to be learned in the treatment of fracture of the spine.

When a catheter is required at regular intervals the most scrupulous cleanliness is necessary to prevent cystitis, and this cleanliness is to be obtained in the following way: The penis and the meatus are to be thoroughly cleansed, and the former is to be enveloped in an antiseptic dressing. The catheter (preferably of rubber) is boiled before use on each occasion, and a non-irritating lubricant such as sterilized vaseline or olive oil is employed. The bladder is thoroughly emptied, and if this is not possible owing to the atonic state of the musculature, the interior should be washed out with weak boracic acid solution once a day. In spite of all these precautions cystitis may ensue. It must be treated by drugs, by lavage of the bladder, and in severe cases by drainage of that viscus. Ascending septic changes from the bladder to the kidneys are responsible for many fatal issues.

Effects on the Rectum.—In many cases the sphincters are paralyzed, together with the levator ani, the result being a loss of control over the contents of the bowel when they reach this region; but as a matter of fact, owing to the co-existent paralysis of the abdominal muscles and the damage to the sympathetic nerves, the house surgeon will experience more difficulty in getting the bowels to act in the early stages of treatment than in controlling their action during the weeks which follow. Under no circumstances must he allow the tympanites to persist; it must be treated by turpentine injections, fomentations to the abdomen, and suitable purges.

Bed-sores.—Cases which are not subjected to operation are exceedingly liable to develop this complication, which is responsible for a fatal issue in a large number. Only the most scrupulous care and patience will prevent this development, and cases of fractured spine may be looked upon as forming an excellent test of the character of the nursing in a given ward. For details of treatment, see "Bed-sores," Chapter XXVI.

General Treatment of Cases not Submitted to Operation. — The patient should be put on a water- or air-bed, with the shoulders propped up so as to relieve the lungs, which are embarrassed in cases of injury to the cord high up owing to paralysis of the intercostal muscles. The patient is unable to expectorate, and death from some form of pneumonia is exceedingly common. Any actual deformity of the spine which is present must be protected from pressure by a ring pad or suitable appliance, and the patient must be turned regularly so that the same parts of his body are not subjected continually to a tiresome pressure. The bladder and rectum are to be attended to as before mentioned, and the greatest care must be exercised to see that there is scrupulous cleanliness, since when incontinence is present, the patient is very apt to be soiled by the discharges, which trickle away involuntarily. Pain is mitigated by opiates, and spasm

of the muscles may be assisted by massage, but beyond this nothing can be done to remedy a condition which sooner or later must end in death. As a rule it may be said that the higher the injury the sooner the patient succumbs. In some cases death supervenes within a comparatively short time of the accident, probably from an ascending inflammation of the spinal cord. In other cases life may be prolonged for months and years if the process of degeneration is arrested and scrupulous care is taken.

Following injuries to the spine, paraplegia may come on at two distinct periods apart from that which immediately follows injury. A paraplegia occurring immediately after the injury is generally due to compression of the cord by bone, and may or may not require operative treatment. A paraplegia occurring within twenty-four hours of the accident is usually due to progressive hæmorrhage within the spinal canal, and is rarely treated by operation; while a paraplegia supervening at a later date (five or six weeks) is due to the formation of callus in the process of repair, and has been treated by operation with the most brilliant results. Such cases have, therefore, to be specially watched, for the development of a paraplegia in the later stages of an injury to the spine may require active surgical measures.

Chapter XVIII.

OF DISLOCATIONS.

IT seems advisable to give a short account of how to treat the more frequently observed forms of dislocations, though, following the rule already laid down, little will be said on the diagnosis, as it is supposed that the readers of this book have already acquired that knowledge.

Classification.—A dislocation is the partial or complete separation of one or more of the bony structures of a joint from the other.

Six varieties are recognized :—

1. *Complete*, when the bones are entirely separated from one another, e.g., at the shoulder or hip,

2. *Incomplete*, when the bones are still in apposition, but in faulty position, e.g., at the temporomaxillary joint.

3. *Compound*, when there is a wound of the skin.

4. *Spontaneous*, when the dislocation does not arise from violence.

5. *Congenital*, when from malformation the bones cannot remain in position.

6. *Pathological*, when arising from disease of one or both bones.

The first three of these are the classes that will be described, the latter three being of rarer occurrence or associated with diseases, the treatment of which does not come within the scope of this work.

A dislocation is recognized by the alteration in the shape of the joint, by one bone being felt in an unusual position, by an alteration in the length of the limb, and by impaired mobility of the joint. It must, however, be remembered that a fracture may co-exist with a dislocation, in which case care must be taken in handling the limb not to increase the damage to the soft tissues by the sharp ends of the bones. In doubtful cases the advantage of being able to take a skiagram is very great, and this should always be done where possible.

Very considerable damage to the soft tissues is always produced by a dislocation. The cartilages may be injured, the ligament and muscles much stretched if not entirely lacerated, and serious complications may arise from the displaced bone pressing on an artery, a vein, or nerves.

In reducing a dislocation the object aimed at is to replace the bones in their natural position. The performance of this is, however, rendered more or less difficult by the tonic contraction of the muscles. It may be necessary to put the patient under an anæsthetic in order to overcome this contraction, especially in the case of strong muscular persons. The sooner, too, a dislocation is reduced the better, on account of this contraction of the muscles, for it has often been observed that the

difficulty of reduction increases as time goes on. In certain cases the reduction is impeded by the anatomical structure of the joint and by the ligaments.

Methods of Reduction.—The reduction of dislocated bones may be effected by several means:—

1. *By Mechanical Means.*—Since the introduction of anæsthetics, by which relaxation of the muscles is obtained and the great obstacle to reduction removed, this method has fallen into disuse, except occasionally in the case of old dislocations. The force employed by the use of pulleys was very great, and it was not an unknown occurrence for a bone to break under their use.

2. *By Manipulation.*—During the last few years our knowledge of the anatomical relation of the parts concerned in a dislocation has been very much improved, and it has been found that by manipulating the limbs in certain directions—abducting and rotating in, adducting and rotating out, with extension as the case requires—most dislocations can be reduced without the force and risk of damage to the soft parts involved in the use of mechanical means.

It should here be noted that when a dislocation is complicated by a fracture, it is usually advisable to perform an operation. Such injuries are likely to be followed by great impairment of function, and the attention of the surgeon should always be called to them.

SPECIAL DISLOCATIONS.

Dislocation of the Lower Jaw is generally bilateral, both condyles having slipped forward on the articular eminence into the zygomatic fossa, where they may be felt. To reduce it, the patient should be made to sit down on a chair or low stool; the operator stands in front, and with his thumbs passed into the mouth presses the bone downwards and backwards, at the same time raising the chin (*Fig.* 127). As a rule the condyles slip back with a sharp snap, and, unless the surgeon has protected his thumbs by wrapping them in lint or some such substance, he may get them severely crushed between the teeth. The jaw should then be tied up with a four-tailed bandage, similar to that used in fracture of the jaw, and kept in that position for several days, the patient meanwhile being fed on slops.

Fig. 127.
REDUCTION OF DISLOCATION OF JAW.

The Clavicle may be dislocated at either end, but the bone is far

more frequently broken, owing to the very strong attachments to the sternum and scapula. The reduction is easily made, but considerable difficulty is experienced in retaining the bone in its proper position in the case of sternal dislocation. Having replaced the bone, a pad should be firmly fastened on by a figure-of-8 bandage over the shoulders, and the arm fixed to the side. For an acromial dislocation the arm must be supported in a sling and drawn backwards, ve much as a fractured clavicle is put up.

The displacement is very likely to recur, and in order to prevent this the shoulder should be well covered with a plaster-of-Paris case, or plaster bandages, while the bones are held in good position. The plaster case must include and support the elbow, since the weight of the arm is the important factor in causing the recurrence of the dislocation. The casing must be kept on for three or four weeks, at the end of which time union should be firm and the dislocation should not recur. Many patients will be unwilling to submit to this prolonged immobilization, which is not without risk of causing stiffness in the shoulder, but where a permanent cure is desired, and operative treatment refused, it may be undertaken.

Dislocation at the Shoulder Joint is indicated by flattening of the shoulder with a hollow under the acromion; the head of the humerus can be felt in an abnormal position, and the patient supports the arm while the elbow is held away from the side. There is rigidity instead of mobility, and the hand cannot be placed on the opposite shoulder when the elbow is held to the chest.

Several varieties of this dislocation are known, but the most common are those in which the head of the bone has been forced out of the glenoid cavity, and below it into the axilla (subglenoid) or under the coracoid process (subcoracoid).

Except in muscular persons reduction can be made without an anæsthetic. The treatment for these two is the same. The reduction may be effected by extension; in the case of young people by raising the arm above the head, when, with a good pull, the bone will slip back into position. In older and more muscular persons greater force is required than can usually be exerted in this way; hence the following method is often employed: The patient lies down flat on a sofa, and the surgeon places his foot, from which he has removed his boot, in the axilla; the arm is then seized, forcible extension is made at the wrist, and the hand finally brought across the body. In this way the foot acts as a fulcrum, and the force levering the bone out of its false position allows it to slip back into the glenoid cavity, which, as a rule, it does with a distinct snap.

The method known as Kocher's is a very useful one, and is practised as follows: The patient lies on a couch; the surgeon stands by his side, and places the elbow at right angles, pressing it into the side (*Fig.* 128). Taking the elbow in one hand and the wrist in the other, the arm is rotated gently outwards (*Fig.* 129), and the elbow brought forward in

front of the chest (*Fig.* 130) and the hand brought rapidly over to the opposite shoulder (*Fig.* 131). In other words the humerus is raised, rotated out and circumducted, the dislocation being then reduced.

Fig. 128.—First Position Kocher's Method for Reduction of Dislocated Humerus.

Fig. 129.—Second Position.

Fig. 130.—Third Position.

The after-treatment should be: Bandage the arm to the side, and support it in a sling from ten to fourteen days; passive movement should be begun during the first week with great care.

Fig. 131.—Fourth Position.

Dislocations at the Elbow Joint, both bones, or one or the other, may be displaced backwards, forwards, or laterally, the most commonly seen being that in which both bones are displaced backwards. This injury is readily recognized by the projection of the olecranon backwards, with the triceps inserted into it, and of the articular surface of the humerus in front.

Fig. 132.—Reduction of Dislocation of the Elbow Joint.

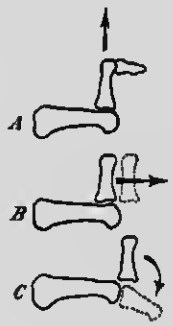
When the ulna alone is dislocated, the direction is always backwards, but the radius, when alone displaced, more frequently forwards. When both bones are dislocated, or the ulna alone, reduction is effected by flexing the arm round the knee of the surgeon. The patient is seated in a chair, and the surgeon places his foot on the seat and bends the elbow round his knee (*Fig.* 132), thus levering the coronoid process of the ulna, which is the obstacle to reduction, over the end of the articular surface of the humerus.

When the radius alone is displaced the arm should be held above and below the elbow and straightened, and then bent at a right angle, at the same time pressing the head of the bone into place.

After reduction, the arm should be bandaged up at right angles, the hand being kept midway between pronation and supination. If the radius has been displaced, a pad should be placed over its head to retain it in position. In about a week passive movement should be commenced.

Dislocations at the Wrist seldom happen, the bones of the forearm generally breaking before the ligaments will give way. They are readily recognized by the great displacement they cause, and are reducible by forcible extension in a line with the forearm. Front and back splints, extending beyond the hand, should be bandaged on.

The **Thumb and Phalanges** may be dislocated, and the injury presents no difficulty in recognition. Reduction is sometimes a matter of some difficulty, however, and considerable force has to be exerted to draw the ends of the bones into place again. In the case of the thumb, extension is made in the direction of the axis of the displaced portion of the bone, and the bone, being thus dislodged from its false position, is brought well forward and bent down into the palm (*Fig.* 133). Extension in a straight direction will often succeed in reducing the displacement. For a displaced phalanx simple extension will suffice, but the chief difficulty lies in getting a good grip of the finger.



A.—Traction exercised in the direction of the dislocated first phalanx.

B.—The base of the phalanx drawn forward until it is level with the head of the metacarpal bone.

C.—Reduction completed by flexing the thumb into the palm.

Fig. 133.—Method of Reducing Dislocation of Thumb (Maynard Smith).

Rest at first, followed by passive movements, is the subsequent treatment.

Dislocation of the Femur may occur in several ways, the femur passing upwards and backwards, downwards and forwards, or upwards and forwards, distinctive names being given to indicate the position the head of the bone takes.

The three commonest varieties are: (1) The *Dorsal*, in which the head passes upwards and backwards, being sometimes above and at others below the obturator internus; (2) The *Thyroid*, the bone passing downwards on to the thyroid foramen; (3) The *Pubic*, in which the head of the bone rests on the pubic bone or below the anterior superior spine of the pubes.

There are several other forms of dislocation, but these are rarely seen and need not detain us here.

Each of the three varieties is recognized by the abnormal position the leg assumes, and as each requires a different manipulative method for reduction, both the symptoms and mode of reduction are briefly given.

In *dorsal* dislocations, the variety most often met with, the thigh, when the head of the bone has passed above the obturator internus, is rotated inwards, and bent on the abdomen, resting the leg on the other thigh. The only movements of the joint possible in this dislocation are inversion, adduction, and some flexion, abduction and eversion being impossible.

Should the head of the bone pass below the obturator internus into the sciatic notch, there are flexion and adduction, but if the muscle is much torn by the accident or subsequent manipulation, the dislocation becomes more like that just described.

Diagnosis must be carefully made from fracture of the neck of the femur.

Reduction should be effected by manipulation in the following

Fig. 134.—Bigelow's Method for Reduction of Dislocated Femur by Manipulation. (The pelvis is fixed by an assistant.)

manner: The patient having been anæsthetized and laid flat on the floor, the surgeon stands on the injured side. Flexing the thigh on the abdomen with the knee bent at a right angle (*Fig.* 134), he slightly adducts and rotates inwards. By this means he disengages the head from behind the socket, and with traction in the line of the femur the reduction will be effected. During these and other manipulations the pelvis must be held steady by an assistant.

The same result may be obtained in a slightly different manner. The surgeon, holding the knee and ankle, flexes the thigh on the body and slightly adducts it, then abducting the leg slowly he at the same time brings the foot over the sound leg, and finally brings the leg down straight. In the words of Bigelow, the procedure is: "Lift up, bend out, roll out."

When the head of the bone is below the obturator internus the same method of reduction may be employed.

A very excellent method which can be used as an alternative to

Bigelow's method, and which often succeeds when the latter fails, is performed as follows :—

The patient lies flat on a mattress, an anæsthetic is administered, and an assistant grasps the iliac crests firmly in the position of the anterior superior spines, and steadies the whole pelvis. The surgeon bends over the patient, folds his arms beneath the popliteal space of the affected limb, which is flexed to a right angle at the hip joint, the leg lying between the surgeon's thighs (*Fig.* 135). Strong upward traction is now made, and the head of the bone is pulled into the acetabulum.

In *thyroid* dislocations the prominence of the trochanter is lost and the thigh abducted, the knee bent and the foot pointed forwards. To reduce it, the thigh is flexed, slightly abducted, and then strongly rotated inwards, adducted and extended.

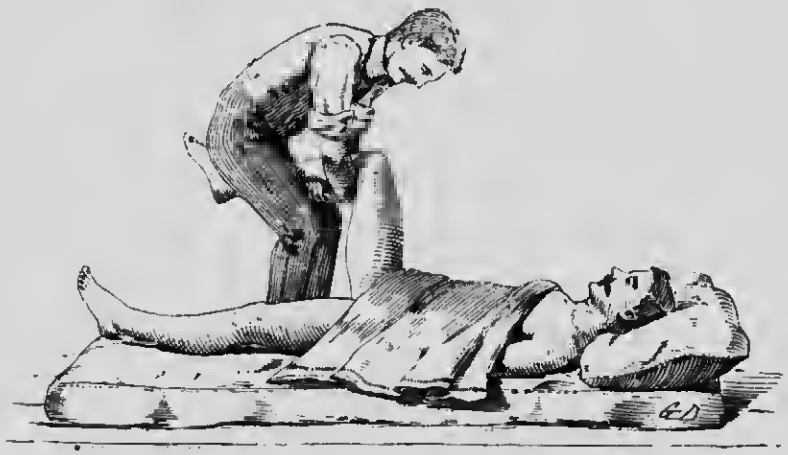


Fig. 135.—Alternative Method for Reduction of Dislocated Femur.

Pubic dislocations are reduced by semiflexing the thigh, abducting and rotating inwards, and drawing the knee inwards and downwards, so that the legs are parallel.

The after-treatment consists of rest in the recumbent position for some time, beginning passive movements in ten or fourteen days. For congenital dislocations and their treatment the reader is referred to larger works.

Dislocations of the Patella are not common, but when they do occur the bone is generally displaced outwards. This is readily recognized, and is reduced by flexion of the thigh at the hip joint to relax the extensor muscles, and by pressure on the edge of the dislocated bone.

Dislocations of the Knee are rare owing to the strength of the ligaments of that joint, and when they do occur are often compound. They are treated by extension with the thigh semiflexed, and the bone is manipulated into place.

Firm bandaging with lateral splints is required for some time afterwards, but passive movements must be commenced after two weeks.

A compound injury is a very severe one, and must be treated with the strictest aseptic precautions, but should the wounds suppurate the question of amputation will have to be considered.

Dislocations of the Ankle are generally associated with fracture of the fibula or inner malleolus, according as the dislocation is outwards or inwards (*vide* " Pott's Fracture ").

Traction of the foot in the proper direction easily reduces the displacement, and the treatment to be followed subsequently is firm bandaging or plaster bandages.

Compound Dislocations are those in which there is a wound of the skin, either arising from the dislocated bone being forced through, or from the accident which causes the condition. They require very careful treatment. All wounds opening joints must be thoroughly washed with saline or weak antiseptic fluids, and the dirt removed with the most scrupulous care. To do this effectually an anæsthetic is advisable, and having satisfied oneself that the wound is quite clean, it should be dressed, and the dislocation reduced and carefully put up. The temperature of the patient must be watched ; any rise demands an inspection of the wound. Suppuration may mean at the worst amputation, and at the best a stiff and perhaps useless joint.

Chapter XIX.

OF SPRAINS.

SPRAINS may be defined as injuries to the soft parts, ligaments, muscles, tendons, or nerves, caused by a twist or wrench of a joint, or by an abnormal forcible movement of a joint. The term sprain will, therefore, be employed to cover a large number of common injuries, and all grades of severity may be encountered, from a slight

Fig. 136.—Fractured Sesamoid.

stretching of some ligamentous structure unaccompanied by swelling, up to the most severe forms where extensive rupture of muscle and ligaments has occurred.

The following classification of sprains and their treatment has been largely taken from Sir William Bennett's article in the *British Medical Journal*, December, 1906.

1. **Sprains with Fractures.**—The introduction of the *x*-rays has shown us that many conditions which were formerly treated as uncomplicated sprains, really are a combination of sprain and fracture. This is especially so in cases of injury to the hand and foot. The skiagram on the preceding page shows the result of a sprain of the thumb sustained by a medical student during a football match, and it will be noticed that the sesamoid bone is fractured; the thumb was forcibly hyperextended, with this result. As far as we know this is the only instance of fractured sesamoid recorded. In some cases a sprain causes the tearing away of a tendon from its bony attachment, a layer of bone accompanying the tendon; in other cases the bone is fractured transversely or obliquely, this accident often occurring in the phalanges. It must therefore be clearly understood that, when possible, all cases of severe sprain should be examined with the *x*-rays to ascertain the exact extent of damage done to the bones.

2. **Sprains with Effusion into Joints.**—As a result of damage to the ligaments of a joint, or from tearing and bruising of a synovial membrane, a sharp attack of traumatic synovitis may follow an injury. These cases are very important, since if not treated with great care stiffness is very likely to occur, and it must be borne in mind that, when a sprain is complicated by a synovitis, adhesions which subsequently may limit the movements of the joint will be both extra- and intra-articular.

3. **Sprains with Marked Swelling.**—These injuries are associated with rupture of muscular fibres, and of blood-vessels. There are great swelling and discoloration of the skin if the sprain is superficial; in some cases very large hæmatomata form.

4. **Sprains with Displacement of Tendons** occur usually in the neighbourhood of the ankle, shoulder, or wrist, when the fibrous sheath which maintains the tendon in position is ruptured, and the tendon itself slips out of place. These injuries are difficult to diagnose correctly until the swelling has subsided.

5. **Sprains with Injury to Nerves.**—All grades of injury may be met with, from simple bruising to complete rupture. In some cases the nerve is stretched, becomes slightly inflamed, and exquisitely tender. This is likely to occur when a nerve trunk passes over the region of a damaged joint, and as examples we may take the brachial plexus in relation to the shoulder, the external popliteal in relation to the knee, and the sciatic in relation to the hip. In mild cases the symptoms soon pass off, but in the more severe type, there may be very great trouble.

In a few instances the nerves are actually ruptured. Fortunately, this accident is rare, since the nerves are sufficiently elastic to yield to a considerable amount of stretching, and it usually occurs where they are more or less fixed, as, for example, rupture of the upper roots (5, 6) of the brachial plexus in injuries and sprains of the neck, or of the circumflex nerve in some injuries to the shoulder.

In all cases of severe sprain examine the patient for signs of injury to nerves. If numbness of the limb persists for twelve hours after an injury, the nerves have probably been damaged (Bennett).

TREATMENT OF SPRAINS.—In cases where fracture complicates a sprain, the treatment adopted should allow the fracture to consolidate, and at the same time prevent the formation of adhesions.

In most instances it is advisable to place the limb on a splint, in the best position obtainable, and to start massage the next day. How far it is justifiable to omit the splint must depend on the nature of the fracture and the opinion of the surgeon, but we are of opinion that in most cases the use of a splint for ten to fourteen days at least is desirable.

Passive movement may be begun with the massage if there appears to be no risk of producing displacement.

Sprains without swelling are best treated by *immediate* massage, followed by the application of strapping or a crêpe Velpeau bandage. Indeed, many cases of slight sprain can be easily *walked off*.

Fig. 137.—ANKLE STRAPPED. A GAP IS LEFT IN FRONT, SO THAT THE STRAPPING SHALL NOT CONSTRICT THE LIMB.

Sprains with Swelling should be treated by rest during the acute stage, a suitable splint being provided, and hot or cold application employed. Cold is apt to produce sloughing in patients whose vitality is poor, and on the whole hot compresses are more satisfactory. If preferred, evaporating lotions, spirit lotion, lead lotion, or a solution of chloride of ammonium, may be employed. As soon as the swelling has begun to subside, the part should be firmly strapped.

Some authorities recommend immediate strapping as tending to prevent the swelling from taking place (*Fig.* 137). It must be employed with great care, since pressure round a swollen limb may lead to sloughing and gangrene. The local application of iodine, vasogen ointment, or mercury in the form of Scott's dressing, is recommended in the more chronic cases.

How soon should massage and passive movements be undertaken? In the most severe cases twenty-four hours should elapse between the injury and the beginning of the massage, but we do not insist on this, for we have seen massage applied with great success a few hours after a very severe sprain.

Hæmatomata should be strapped and not opened. The blood in

most cases will be absorbed, the absorption being aided by the massage. In a few cases where large collections remain, they may be opened with all aseptic precautions, the contents evacuated, and the incision closed.

The guiding principles of treatment of these cases are *pressure*, *massage*, and *movement*: passive movement at the start, and active or voluntary movement as soon as the acute symptoms have subsided. The range and extent of the movements must be limited by the results they produce; and in no case should they excite a return of the swelling and pain. Within a few days (five to seven), the patient should be encouraged to use the limb for ordinary movements—walking, or grasping—until the normal condition is obtained.

Sprains with Effusion into joints are treated in the same way. For an acute effusion a splint is necessary, followed by strapping, massage, and passive movements. It is very necessary in these cases to massage the muscles around the joint. If the joint is very tense and the pain severe, the joint should be aspirated, and the excess of synovial fluid withdrawn.

Sprains with Nerve Injury are the most difficult to treat. Massage often causes the most intense pain; but it must be employed as soon as the patient can bear it. Blisters over the course of the nerve are often of great value, as are also the use of an electric current, and douching.

Gross injury, such as rupture, will require operative treatment.

This will be a convenient place to mention a form of **Internal Sprain of the Knee,** which appears to be due to some displacement of one of the semilunar cartilages, generally the inner one. The usual history of the injury is that the patient, during some sudden rotatory movement of the body, feels an acute pain in the knee, while the joint becomes incapable of full extension, though it can be flexed, and will allow of no weight being borne on it. Often the patient falls to the ground as if he had been shot. Soon, *tenderness and signs of effusion* into the joint come on, and these are generally out of all proportion to the very slight twist which has been the cause. Sometimes these symptoms disappear as quickly as they arose, after some slight movement; sometimes they obstinately remain as a chronic synovitis. This constitutes what is known among football players, to whom the accident most frequently occurs, as "water on the knee."

If the joint be examined, it will be found that where the internal cartilage comes nearest to the surface (where, indeed, it is almost subcutaneous), there will be a spot of acute tenderness, and probably a little swelling. If this be found, the remedy is easy, and striking in its effect. Taking hold of the limb above the ankle with one hand (the patient lying or sitting) the knee should be strongly flexed, while the thumb of the other hand presses the cartilage inwards. Then, *without warning*, the limb should be *jerked into extension*, the pressure being kept up the while. In most cases, even at the first attempt, the cartilage will slip back into its place, and the patient will be able to

extend the knee with great relief, but sometimes the manœuvre will have to be repeated two or three times.

The cause removed, the pain and effusion quickly disappear. It is wise, however, to rest the joint for a few days, and to wear a woven or elastic felt bandage, or a laced kneecap. Unfortunately, when once this derangement has happened, it is *very apt to recur*, and there are many who do not feel themselves safe to undertake such forms of exercise as running, jumping, or dancing, lest they should be suddenly disabled. Many also learn how to put their joints right again for themselves.

Much may be done by massage, the douche, and judicious support, to brace up the relaxed ligaments, and lessen the liability to recurrence; but repeated dislocation is apt to lead to a *chronic synovitis*, and to distortion of the cartilage. This condition may call for an intra-articular operation for removing the cartilage.

The symptoms which arise when a true *loose body* (usually originating as a pedunculated growth from a fringe of the synovial membrane) gets nipped between the joint surfaces, are almost identical with those we have described, except that there is not usually any limitation of extension. Such cases demand operative treatment.

SECTION IV.

OF WOUNDS, ULCERS, AND BURNS.

CHAPTER XX.

OF THE DRESSING OF ACCIDENTAL INCISED WOUNDS.

IN the present chapter we propose to consider the general principles of **Dressing Wounds,** and the ways in which they are dressed in practice.

We shall first take those which may be properly called *Cuts* or *Incised Wounds*, large or small, in which a quick healing is to be desired, and should generally be attainable, and we shall consider the rules as to their washing, closing, and draining, which are founded on the laws of antiseptic surgery.

Some of the general ways of **Dressing,** that is, of covering or protecting these wounds, will now therefore be described, while in the following chapter the methods will be considered in detail of a more scientific treatment of wounds.

In the succeeding chapters of the section the management of bruised wounds, of special forms of wounds (as gunshot wounds), and later still, burns and ulcers, will be discussed.

For any wound *to heal well*, the following conditions must be fulfilled :—

1. The wound must be cleansed, and kept clean.
2. The divided tissues must be accurately readjusted and retained in position.
3. The parts must be kept at rest.
4. All effused fluids must be able to escape. The primary blood effusion *must be arrested completely*, and the wound must be covered and protected by some dressing material.

THE CLEANSING OF THE WOUND.

This will be necessary, even when it has been inflicted with a perfectly clean instrument, lest blood-clots remain in it. For ordinary cases, the thoroughness with which the washing is performed is more important than the fluid which is employed. Unless the wound be contaminated, sterile normal saline is the best for this purpose.

If there be any suspicion that septic or poisonous matter has been introduced into the incision (e.g., in a dissection wound), it should be thoroughly swabbed or syringed out with a 1–40 carbolic lotion, or

of perchloride of mercury of the strength of about 1–2000, or hot peroxide of hydrogen. The process of cleansing tends of itself greatly to check the capillary oozing, and hæmorrhage from other sources must be thoroughly arrested before any attempt is made to close the wound.

It must be understood that the foregoing applies especially to the cases of incised wounds which are seen in the casualty-room practice of a hospital, or under similar conditions elsewhere. When wounds are inflicted, as in operations, by a surgeon, with deliberate intention, they may and should be aseptic from the first, and not merely either fairly clean, or of various degrees of foulness. In such no efforts should be spared to maintain this aseptic condition throughout the healing, after one of the plans described in the following chapter. Even in casualty-room practice this should also be aimed at, unless the dirt, which is more or less always found in wounds on the patients presenting themselves, cannot be removed.

It goes without saying that all foreign bodies must be removed from accidental wounds, and in view of the discovery that ordinary mud and earth are especially dangerous on account of the occasional presence in them of the bacillus of tetanus, special care must be taken to remove every particle from the wound. If the earth has literally been ground into the wound, the best plan is to place the patient under an anæsthetic, and having washed away the more loosely adherent dirt, to scrub the wound with an ordinary nail-brush and 1–40 carbolic lotion, or irrigate it with hot peroxide of hydrogen. Further, since tetanus is likely to follow the infliction of wounds which have been contaminated with soil and earth, it is advisable to give a prophylactic injection of 10 cc. of tetanus antitoxin into the subcutaneous tissues of the abdominal wall.

There is no question but that one of the greatest causes of failure of repair is the continuance of bleeding within a closed wound. The actual bringing together of its sides does, no doubt, often effectually check further capillary bleeding, but it should not be trusted to do so. Should there be much oozing from the cut surface, a strand of catgut or a small tube should be left in a wound for a day or two, and the edges brought together over it. This, combined with firm pressure with some elastic material, such as the prepared wools now in use, will have the desired result.

THE ADJUSTMENT AND CLOSURE OF THE WOUND.

(*a*) **Closure of its Deeper Parts.**—With the exception of the parts which are necessarily separated by the presence of drainage tubes, the adjustment and replacement of the divided tissues must be carried out throughout the whole extent of the wound, and if possible, as perfectly in its deeper parts as on the skin surface; for upon this the manner of healing, as well as the appearance when whole, will greatly depend. But the means at our disposal for keeping the deeper parts together

after replacing them, are somewhat imperfect. In most cases the support and pressure afforded by pads and bandages put on outside the wound are trusted to keep the sides together, and if these will suffice, so much the better. But in many instances it is necessary to fix the parts more securely, either by sutures, passed far below the surface (deep sutures), or by what are known as "buried sutures," by means of which periosteum may be joined to periosteum, fascia to fascia, and finally, if necessary, skin to skin by an external stitch. These buried sutures are used especially in aseptic surgery, and are designed to obviate the use of deep sutures or of drainage tubes. They must be made of catgut or fine silk, and absolutely sterile, or they will be a source of trouble.

Deep Sutures.—If the depths of the wound have to be kept together in this way, it must be because there is a tendency for the parts to separate. There will, therefore, be *tension* on the sutures, and unless some precautions are taken they will speedily cut out. All the contrivances which have been devised to prevent this have for their object that the sutures shall pull upon an area of skin at the margin of the wound, which is shielded in some way from the direct pressure of the wire or thread. For this purpose, the suture, which is passed through the wound at the depth desired, enters and emerges from the skin at a little distance from its edge, and is then fastened to a piece of quill or catheter, or passed through a perforated ivory cylinder, or piece of sheet lead or zinc cut to the requisite size, or shaped as a stud or button.

The suture employed is very often made of stout silver wire, but thick silkworm gut may be used. The suture may be passed with a common needle, or with one of the numerous patterns of handled ones.

For most of the cases where deep sutures are required, the best shield for practical use is a piece of sheet lead. It is sold in strips, ready perforated, but is best cut out with scissors to the shape required in each instance. A piece may be laid along each side of the wound, from ¼ in. to ½ in. away from its edges; holes may then be bored in it to correspond to the number and distance apart of the sutures. The suture having been passed through the strips, the two ends are simply twisted together or tied so as to close the depths of the wound. The twists should be to one side, and lying upon the metal strip.

Instead of using one long piece of shielding metal for each side of the wound, a rounded piece like a trouser button is very commonly cut out for each suture, or pieces of lead of this form are to be had ready made with two studs on them, round which the suture may be twisted or tied. These are convenient enough, but are in no way better than, and in some respects not so good as, the plan first described.

The *removal* of deep sutures is easier than the insertion, for a pair of scissors placed between the skin and the shield on one side will be able to cut the suture short off there, and then it can be drawn out from the other side. No rules can here be given as to the time of their

removal; this must be settled in each case at the surgeon's discretion, but in the great majority of cases their tenure is possible only for a day or two, much less, that is, than in the case of superficial stitches. Deep sutures are very rarely employed, since buried sutures, if aseptic, have all the advantages of the deep variety. In cases of amputation of the breast, when there is great difficulty in bringing the edges of the wound together, some surgeons still employ deep sutures with leaden plates.

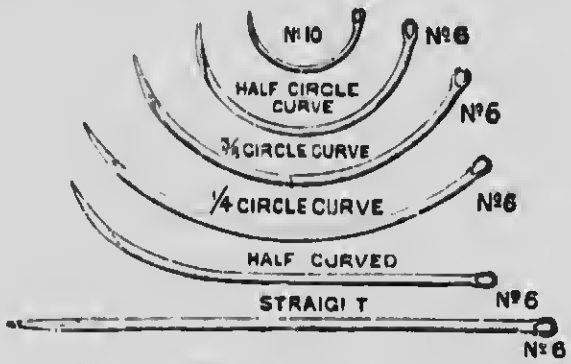


Fig. 138.—Needles for Hagedorn's Needle-holder.

Fig. 139.—Hagedorn's Needle-holder.

Fig. 140.—Cushing's Needle-holder for Round Needles.

Needles.—What is known as Hagedorn's needle (*Fig.* 138) is now largely used, the principle of it being that the cut in the skin is made in the same direction as the pull occurs, and not at right angles as is the case with other flat needles. The wound made by the needle is not then pulled open.

Some surgeons employ tubular needles, but they are falling out of use on account of the difficulty—supposed or otherwise—of keeping the tube clean. Another objection is that they are not convenient when catgut is used.

If short needles be used it will be convenient, and sometimes necessary, to use some kind of holder. For needles of the ordinary kinds a pair of Spencer Wells' forceps (see *Fig.* 8, p. 14) does very well, but several forms of needle-holders are now obtainable.

(*b*) **Closure of the Lips of the Wound.**—Superficial sutures are for the accurate adjustment of the divided skin surface, and of the tissues near it; in most wounds they are the only ones required. No strict rule can be laid down as to the depth at which they should be passed, but it is often convenient to put them deep enough to arrest bleeding from vessels in the cut edges of the wound.

Suture Materials.—Wire, silvered or of silver, silk, catgut, silkworm gut, and occasionally horsehair, are the materials chiefly used for

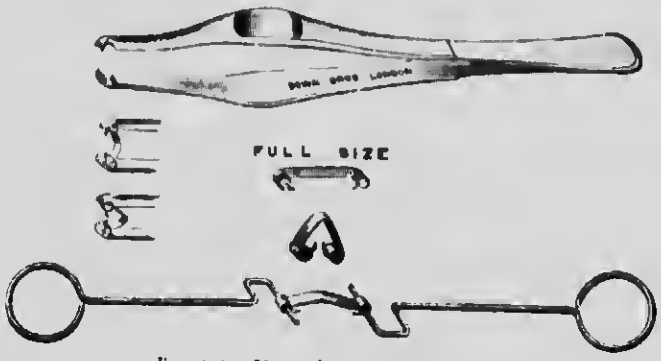


Fig. 141.—Michel's Suture Clips.

sutures. Catgut sutures are not quite trustworthy; they stretch, and may be absorbed too soon; silkworm gut is now largely used instead, and is not open to these objections. It must be well boiled in water before use, and kept in 1–20 carbolic acid solution.

Interrupted Sutures are still very largely used, but the continuous one may often be employed, especially in intestinal surgery. In the interrupted, each point is secured separately by tying in reef knots, and the twist or knot should be at one side, and not over the line of the wound. The actual skin surfaces should, if possible, be brought together exactly, but it is better that the edges should be a little everted rather than inverted. A little inversion is often overlooked at the time of adjustment, the result being an unsightly depression.

Another way of bringing the skin edges together is by means of Michel's clips (*Fig.* 141), small bridges of pliable metal armed at each end with a minute point. They are held over the wound and at right angles to it by means of a special pair of forceps, and are then pressed down on to its edges, while at the same time the blades of the forceps

are forced together, causing the pliable bridge to bend in the middle. These clips bring the edges into accurate apposition with slight eversion, and if removed on the fourth or fifth day leave very little scarring. They have the further advantage that as they do not penetrate through the skin, all risk of infection spreading from the surface of the body into the wound is abolished. They are easily removed by special hooks.

The Number of Sutures must be just as many as will close the wound throughout; fewer will not do, and more are needless. So long as stitches are not doing harm, there is no limit to the time they may be kept in, but as soon as there is any tension, or area of inflammation around them, they are better away.

As catgut sutures should become absorbed they require no removal, and will come away by gentle traction on the loose end. Silk or silkworm gut sutures require only to be snipped and removed with forceps, but wire ones should always have the little hook which will be found at the end which is to be pulled through the wound, carefully straightened out or cut off. No more needless pain can well be inflicted than that caused by neglect of this small precaution.

Adhesive Strapping may be used to relieve tension which would otherwise be borne by the sutures alone, or may be the sole means employed to close a wound. In either case, care must be taken to avoid puckering, and the best way to do this is by cutting the strips as shown in *Fig.* 55, p. 85. If the adjustment be carefully made, it is a good way of closing a wound. The widely diffused support of the plaster is extremely useful, but no wound, not even very small and clean cuts, should ever be completely closed over with strapping; a drop of pus thus shut in may work very great mischief. The strapping should always be applied over a layer of antiseptic gauze.

There only remains to be mentioned a mode of closing small wounds, especially about the face, by *collodion*; the ordinary or the flexible kind may be painted over the wound or applied upon a piece of lint, and by its contraction a close apposition may frequently be attained.

ARRANGEMENTS FOR REST.

It is not necessary to enlarge on the importance of arrangements for rest, i.e., for retaining the wound surfaces in apposition. It will be understood that a wound can hardly heal unless it be kept at rest, and also that the means of securing this rest must vary with every case.

In the case of wounds of the extremities, the end desired can generally be attained by splints, interrupted if necessary, and slings and other contrivances may be brought into use, the limb being placed in the position which causes least tension on the edges of the wound. Moulded splints are especially useful in fixing the parts about a wound.

This necessity for rest must always be kept in mind in considering the firmness with which a wounded part should be bandaged.

THE DRAINAGE, COVERING, AND PROTECTION OF THE WOUND.

The means to be adopted to secure the fulfilment of these conditions, include the different ways in which wounds may be drained, and the several "dressings" that may be put on them.

There will be in all cases some fluid exudation, whether a wound has been closed before the bleeding has stopped or no, and provision must be made for its escape, except in wounds which are at once small and perfectly healthy.

The materials for drainage are, *Indiarubber Tubing*, of different sizes, *Strips of Gauze*, *Wisps of Horsehair*, or *Catgut*; but almost anything of the nature of a tube or thread, if it be in itself unirritating and aseptic, may be placed in a wound to facilitate the escape of the discharges.

As the whole object of a drain is to prevent fluid remaining within a wound, no exception can be made to the rule that all surgical cavities are to be drained *from the bottom*. The place of exit for the drain should therefore be the most dependent part of the wound, unless, as is often advisable, a separate aperture is made for the tube alone. Often, too, it is necessary to pass the drain right across the cavity, either by making it enter the wound at one end and leave it at the other—as may be done in amputations of the limbs or of the breast—or by making apertures, and counter-apertures.

If horsehair be used as a drain (and for wounds with but little discharge it is very useful, especially in sinuses, where it can be laid right along), some 20 or 30 hairs must be cut of equal length and tied together at each end. Catgut, silk, thread, or a short piece of gauze may also be used.

Coming to *Drainage tubes* proper, glass ones have been almost entirely abandoned, except for draining the pelvis, and as fluid cannot flow upwards unless drawn by the capillary attraction, a wisp of gauze should be placed inside.

But the drainage material which will probably be for long in most general use, is *indiarubber tubing*, of which special kinds are made, of various sizes, and perforated at frequent intervals.

The points to be kept in mind as to the drainage of a wound by indiarubber tubing are: (1) The size of the tube; (2) The mode of introducing it; (3) The keeping it in its place; (4) The occasions of its withdrawal for cleansing or shortening; and, finally, the time when it may be permanently discarded.

All drains are foreign bodies, and, *ipso facto*, hurtful. The tube, therefore, must be as small as will freely carry off the discharges. No general rule can be laid down as to the mode of its insertion. It may be put in before or after the wound is sutured, and a probe or director, or the special instrument devised by Lister, may be used. Forceps of the ordinary kind are objectionable, as they disturb the tissues.

The tube is apt to *slip out accidentally*, though this (which should not happen if the dressings are properly applied) may be prevented by passing a stitch through the tube wall, from ¼ to ½ an inch from its end, and fixing it to the skin. A safety pin may be put across the aperture of the tube, or some form of shield employed, which will effectually prevent its slipping in.

For the same reason that the tube should be as small as will be efficient, it should be *removed as soon as it is safe to do so*; and if it cannot be withdrawn altogether, it should be shortened up from day to day. But it is impossible to lay down any strict rules; in such a case as an amputation of a limb or breast, healing by first intention, the tube may be removed on the second or third day, while in some abscesses it may have to be left in for some weeks; but in any case it is a safe rule to follow, that every time the dressing of the wound is changed, the tube must be taken out and syringed through with carbolic lotion.

When a tube has been used to drain the pelvis or some other situation where the position of the tube is unfavourable for free drainage, the exudate should be mopped out with long strips of gauze, or if very copious it should be sucked up through a catheter attached to a glass syringe.

Most *abdominal drains should be removed in twenty-four or forty-eight hours*. After that period the tube drains only its own track, being surrounded by matted omentum and coils of intestine. Cases of strictly localized abscess may require longer drainage, but as the peritoneal cavity is capable of dealing with its exudations in a very satisfactory manner, tubes may often be dispensed with earlier in abdominal than in other wounds.

All abdominal tubes should have very small lateral openings, as there is a distinct risk of omentum or intestine prolapsing through large apertures and becoming strangulated.

In cases of accidental wounds a drainage tube is usually required, but in many operations it is possible to do without one, in those, for example, where the incisions have passed through healthy structures. Here, if all bleeding be stopped before the wound be closed, and firm, equable pressure applied, not only by the dressings but also during the time that they are being put on, it will be found that healing will take place perfectly. There are many advantages in being able to dispense with a drainage tube, and amongst them by no means the least, both as regards disturbance of the wound and the comfort of the patient, is the greatly lessened need for changing the dressings. A tube is in itself irritating, and affords a space into which leakage of serum must, and will, take place. Its presence may also lead to the formation of a troublesome sinus which materially delays the healing.

In cases where it is not thought desirable to close the wound entirely, one angle may be left open, so that any discharge may find a ready means of escape.

SURGICAL DRESSINGS.

Although we are using the term "the dressing of wounds" in its larger meaning, to include all the details of its management, "surgical dressing" is a phrase generally used in a more contracted sense, to express the materials and medicaments which are put over a wound to cover and protect it, and to forward its healing. These may be conveniently divided into *dry*, *watery*, and *oily* dressings.

The medications used may have for their purpose the prevention of decomposition, or the maintenance of simple cleanliness, or some stimulation of the wound; or a cool, a warm, or a moist atmosphere may be desired, or simple greasiness of the surface. But whatever be the nature of the dressing it must before all fulfil the indications of cleanliness, and absorption of the discharges.

Just as in former times it was believed that a simple fracture could not unite unless healing salves of various kinds were applied to the skin, so, even to the present day, many seem to find it difficult to remember that the nature of wounds is to heal, and that nothing applied to a wound can of itself heal it, though many things can be done to retard or prevent the healing process. In fact the results now desired are almost absolutely negative ones, such as the avoidance of movement, of irritation, or of tension, the removal of discharges, and the like.

But, while it is every day more recognized that the best way to dress a wound is to let it "severely alone," in general some kind of application will be required, and the nature of the dressing does in many cases affect the course of repair. Thus granulations will often become large and flabby under fomentations, and again small and prone to bleed under the use of chloride of zinc. A choice, therefore, has to be exercised, but experience alone will give the power of judicious selection.

Classification.—For the purposes of description, some classification of wound dressings must be adopted, and the following may probably be found convenient. We shall first divide them into dry, watery, and oily dressings, and then arrange the drugs and materials used under each head, according as to whether they are chosen because they are non-irritant, anodyne, antiseptic, or stimulating.

The **Dressing by Dry Absorbent Pads** is a plan now universally adopted by surgeons. The principles of this method are dry and infrequent dressings, with immobility and pressure.

A great many different materials have been used for pads in this form of dressing, and sometimes one, sometimes another, will answer best, each individual operator having his own likes and dislikes in this as in most matters connected with surgical procedures. What is wanted is a proper firmness, combined with elasticity, so that a moderate restraining pressure is kept on the wound. At the same time the material must be *absorbent*, to provide for the infrequency of

dressing. Pads of lint, of salicylic wool, boracic lint, wood-wool, and carbolic or other prepared gauze, and many more have been used. It would be impossible to say that one preparation is better than another, for all the materials now obtainable are so carefully prepared that the choice depends more on the individual surgeon than on their relative value. A wound dressed with any of these absorbent materials must have its edges, and if necessary, its deeper parts, adjusted with the appropriate sutures, and provision must be made for its drainage; secondly, the mechanical fixation of the neighbouring parts should, if necessary, be secured by moulded splints, or plaster-of-Paris bandages or similar contrivances for the fulfilment of the indication of immobility; and thirdly, the parts immediately concerned in the wound must be covered, and lightly but firmly pressed upon by the absorbent pads, secured by bandages or strapping.

If the discharges from a wound thus treated are only moderate in amount, there will be no necessity to change the dressings for some days, and no method gives better results in the case of large healthy wounds.

Wet Dressings.—This class of application is a very large one, and comprehends all lotions, tinctures, and hot or cold compresses; every dressing, in short, by means of which the surfaces of wounds may be kept moist. In the great majority of cases, the moistening fluid is applied by soaking gauze or strips of lint in it.

Antiseptic lotions are generally used at the immediate dressing of an incision. A few layers of gauze, generally that prepared with the double cyanide, or with perchloride of mercury, or lint saturated with boric acid, are soaked in some antiseptic solution and laid over the wound.

The number of *lotions* now used has been considerably reduced, the experience of the last few years having taught surgeons that carbolic acid 1–40 or 1–100, perchloride of mercury 1–2000 or 1–5000, biniodide of mercury 1–2000 or 1–5000, peroxide of hydrogen 5 to 10 vols. are the most suitable, but for operations on the eye, or for delicate structures, a saturated solution of boric acid or normal saline must be used.

Irrigation is a form of wet dressing which is sometimes, though rarely, used for clean wounds, especially when they are near joints, but it is much more often adopted for foul or sloughing ulcers, under which head it is again mentioned. Its great drawback is the risk to the patient of catching cold from the exposure, which can hardly be avoided.

To set up an irrigation apparatus, all that is required is an arrangement by which a constant drip of water, or of some lotion, can be made to fall upon the wound, as shown in *Fig.* 142. This may be done by suspending a vessel over the wound, properly fitted with a tap and indiarubber tubing, or the tube may be allowed to act as a siphon. In either case the difficulty is to get the drip to be sufficiently slow,

and quite as good a plan is the simpler one of hanging one or two strips of lint from a vessel supported above the wound. The fluid is evenly distributed, drop by drop, by the strips, which act as siphons by the capillary attraction of their fibres (*see Fig.* 142). It will be necessary to put some pan or basin beneath the wounded part, and the bed must be kept dry with waterproofing; but there is always some slopping, and the patient had better lie in blankets.

Plain boiled water, a solution of permanganate of potassium, carbolic, or boric acid, are the fluids most frequently used for irrigation, and although, if this treatment be continued for many days, the granulations are apt to become sodden, no dressing will more efficiently clean a wound; immersion of the wounded part in a bath of warm carbolic, a solution of permanganate of potassium, iodine, or boric acid, for many hours, is often also extremely beneficial.

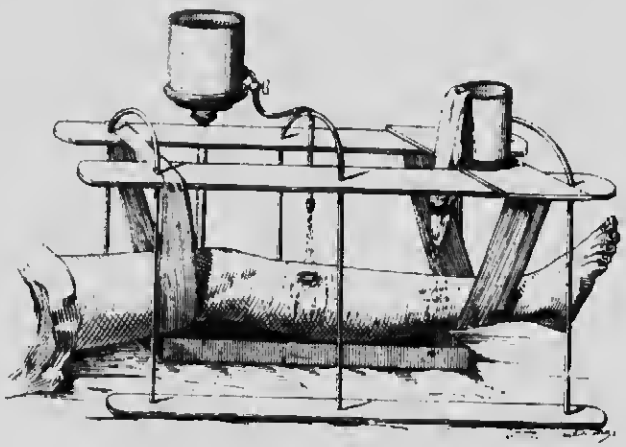


Fig. 142.—METHODS OF IRRIGATION.

Fomentations.—A fomentation is made by soaking a piece of lint in boiling water, and wringing it as dry as possible in a warmed towel. Some few people, laundresses especially, are able to perform this wringing with their unaided wrists, but for most it will be necessary to use a set of wringing sticks. These consist of two pieces of stick like rulers, about 2 ft. 6 in. in length, passed through the ends of a round towel, about 2 ft. 6 in. by 10 in. When the soaked lint is picked out of the boiling water, it should be allowed to drip for a few seconds, and then it must be placed in the centre of the towelling, and the whole twisted up by the leverage of the sticks until no more water comes away. This should take but a few moments. Another good way is to sew the ends of a piece of flannel together and to pass the sticks through before the boiling water is poured on to it. It can then be lifted and wrung without loss of time, and put into a dry, warm towel.

For a simple fomentation the lint should just be applied to the skin

as an application of warmth and moisture, and covered with a piece of oiled-silk slightly larger than the fomentation; over this again a layer of cotton-wool should be laid, and the whole fixed with a triangular bandage or a few turns of a roller.

The best material for fomentations is boric lint, or if a stronger antiseptic is required, carbolic acid 1–40 should be added to the boiling water so that an antiseptic dressing is made.

Carbolic fomentations should not be applied to the fingers, especially in young women, as there is a risk of gangrene being produced.

But these fomentations are often used with some counter-irritant or anodyne; thus laudanum, or the tincture of belladonna, may be sprinkled over the flannel, which may be substituted for lint if it is not to be placed on a wound, or turpentine is used more frequently still. This last forms the common turpentine stupe, so often used for lumbago. In all cases, if the fomentation is to produce its proper action, the flannel must be wrung dry out of boiling water, and if the wringing be not effectually performed it is quite likely that some scalding of the skin will take place.

Certain alcoholic *Tinctures*, generally freely diluted, were once, and are still by some, used as wet dressings. Of these, friar's balsam (tinctura benzoini co.) should be mentioned as an admirable stimulant for wounds which are slow to heal. It is applied by soaking pads, or strips of lint, in the tincture, and is probably the best of the preparations of aromatic gum resins.

Tincture of iodine, freely diluted, is often used as an antiseptic and stimulant application; it makes an admirable irrigating fluid, especially for foul wounds.

Oily Dressings are rarely employed except for burns and ulcers.

Ointments of various kinds are largely employed as dressings for wounds, especially in the later stages of their healing. Some are chosen for this purpose because they are non-irritant, as the ung. simplex or ung. acidi borici, or because they have more or less stimulant properties, as the ung. zinci oxidi, or the ung. hydrarg. ammoniati, diluted with an equal quantity of vaseline or lard. For others the reader is referred to the text-books on therapeutics.

Vaseline is a clean and bland dressing, and serves also as a basis to which various drugs may be added, so that they can be applied as ointments. Some of these will be mentioned under the headings of the dressing of ulcers, bedsores, syphilitic sores, etc.

Lanolin (*adeps lanæ*), the purified cholesterin fat of sheep's wool, is largely used as a basis for ointments on account of the power it has of penetrating the skin, and from the fact that it does not become rancid.

Speaking generally, ointments are most conveniently applied by spreading them on lint or on butter-cloth.

Chapter XXI.

OF THE ANTISEPTIC DRESSING OF WOUNDS, AND THE ASEPTIC PRECAUTIONS OF OPERATIVE SURGERY.

IN the third edition of this work it was necessary to re-write this chapter, on account of recent developments in the practice of treating wounds by aseptic or antiseptic methods, though the alterations which had taken place were more in details than in principles. Very much the same remarks apply now.

The broad principles enunciated by Lister are still followed, though we have long ago given up many of the details that even the founder of antiseptic surgery at one time considered essential. When Lister brought out this method of treating wounds, the idea that germs—to use the term in a general and perhaps popular sense—might be conveyed by the air as well as by the instruments, was firmly rooted; and consequently elaborate precautions were taken to disinfect the air as far as could be done, and to prevent the access of air to the wound by numerous layers of antiseptic wool or gauze and impervious material such as "jaconette."

Experience has taught surgeons—or perhaps bacteriologists have—that many of these precautions were unnecessary, and that the destruction of bacteria, and the prevention of their access after an operation, are better effected by other means than those at first employed. This has resulted in a great simplification of methods, with considerable advantage both to the patient and surgeon.

This is not the place to enter into any detail of the wonderful effects that have followed the universal adoption of Lister's principles. Nor is it advisable to recount the methods that were employed in the early days of antiseptic or aseptic surgery. These have been so improved on that they are now quite out of date.

As some confusion may arise in the minds of beginners between the words aseptic and antiseptic, we may explain that aseptic is "applied to substances which are free from putrefaction and which cannot convey the causes of putrefaction to others": while antiseptic is employed to designate "substances which prevent or check putrefaction, these acting by destroying the germs upon the presence of which putrefaction depends."

A wound must be considered to have run a *perfectly aseptic course*, when there is, throughout its healing no fever, *and no suppuration.*

The object aimed at is to secure this, and however well the patient may recover, all cases must be regarded as failures in which, after antiseptic and aseptic precautions have been taken, traumatic fever, or profuse suppuration, or both, develop. It is hardly necessary to say that both aseptic and antiseptic precautions should always be taken in every case in which there is a wound of the surface.

It is obvious that the Listerian method, when it is applied to operation wounds, starts under far more favourable conditions than in the case of accidental injuries; but in both instances the same end is desired, and much the same means are taken to attain it.

These means are, all of them, intended to ensure absolute purity and the absence of germ elements, and they may be considered under the following heads: (1) Purity of the air; (2) Of the instruments; (3) Of the persons of all concerned in the operations and dressing of the wound; (4) Of the wound itself and the parts adjoining.

Moreover, this method is concerned not only with the dressing of the wound in an absolutely cleanly fashion, but with the maintenance of it in this condition.

1. **Purity of the Air surrounding the Wound.**—Till a few years ago all operations and even many dressings were done in a cloud of vapour produced by a "steam spray." This has been shown to be quite unnecessary. Attempts to keep the air pure are now directed more towards filtering the air which is admitted into an operating theatre, though much air must be admitted by other means, and in private operations no such precautions can be taken.

It is generally recognized that the air is not so laden with pathogenic organisms as was once supposed. And it has been found that spraying the air—which was even at best insufficiently done—was unnecessary, inconvenient, and often harmed the patient by the damping, and has consequently been dropped.

2. **Purity of Instruments.**—*Everything that is likely to come into contact with the wound during an operation should be boiled or sterilized by steam under pressure.* This is the keynote of successful asepsis, and any preparation of ligatures, swabs, and instruments in which such a method of sterilization is not employed, must be regarded as unsatisfactory. Although certain methods for preparing sponges have been and will be described in this book, we are strongly of the opinion that other materials, in the preparation of which steam or boiling water has been used, are in all respects preferable.

In the case of instruments, care must be taken to see that they have been thoroughly cleaned after an operation before further use, since blood and septic matter are liable to collect between the teeth of artery forceps and other appliances, in which case mere boiling may not be sufficient to ensure absolute asepsis. After every operation the instruments should be well scrubbed with a nail-brush in running warm water, and then boiled in a solution of carbonate of soda before a final cleaning and drying.

Distilled water is much less injurious to instruments, especially knives, than ordinary tap water.

Before any operation the instruments should be boiled for fifteen to twenty minutes, and all swabs, trays, drainage tubes, gauze plugging, and towels, that may be used by the operator or his assistants, should have been thoroughly sterilized in an autoclave or other apparatus.

Nothing, therefore, that has not been boiled, will come into contact with the tissues, and many sources of sepsis will be eliminated. This principle should be carried further in the matter of the use of boiled rubber gloves. Some surgeons do not advocate their use, holding that they tend to interfere with accuracy and touch, and no doubt in abdominal work this is true to a large extent. But whatever view the surgeon may hold with regard to his own use of gloves, there can be no question that all assistants and nurses should wear them, since each pair of hands that is introduced into a wound or comes into contact with instruments or swabs which are to be employed is an additional source of avoidable danger.

All instruments, especially forceps, should be counted before and after an operation, to avoid the accident of leaving them behind in the wound, and the same rule applies to gauze pads or rolls which are used in packing off the abdominal cavity during operations in this region.

Pads of Wool twisted up in gauze, or large pads of gauze, are used now in place of sponges for absorbing blood or discharges from a wound. They are very convenient, and can be sterilized with certainty. They are burnt after being once used.

Sponge Cloths, that is open woven cotton towels, are also extensively used in the place of sponges and for placing over the mackintosh sheets, or for covering extruded viscera in abdominal operations. They can be boiled before an operation to render them aseptic.

If *Sponges* are employed they must be carefully cleaned before any use is made of them. There are many ways recommended, but perhaps the best is the following: First as regards the selection of sponges, only those of the best quality should be used, and, as far as possible, they should be of an equal quality throughout. Having washed out the sand and small shells, which are always embedded in commercial sponges, with repeated washings of water, they should be soaked in a dilute solution of hydrochloric acid for several days, and rinsed in clean water, then in a dilute solution of carbonate of soda to neutralize any acid which may be retained. After washing with water to remove the soda, they should be soaked in carbolic acid lotion 1–20 for some hours, squeezed as dry as possible, and gently heated to complete the drying process. The sponges should then be kept in a closed vessel ready for use.

After an operation they must be washed well with water, and afterwards with a solution of carbonate of soda, to remove the blood and fibrin, then in water again, and lastly in carbolic acid solution, and dried as before.

Another plan for cleaning sponges is to wash in a solution of hyposulphite of soda (half a pound to the gallon), to which is added ¼ oz. of oxalic acid. The SO_2 generated dissolves the fibrin, bleaches the sponge, and disinfects it at the same time. The sponges are then well washed in water to remove the precipitated sulphur, and soaked in 1–20 carbolic.

3. **Purity of Person of Dressers and Surgeons.**—Very great importance is laid on the *cleanliness of the operator's and assistant's hands*, for it is believed that septic matter is far more frequently conveyed to a wound by them than from the air or elsewhere. Many operators now make use of india-rubber gloves, which can be sterilized by boiling, and we are of the opinion that by their use one possible source of infection is eliminated.

These gloves cost 2s. to 2s. 6d. per pair, and may be put on wet or dry, but in each case the hands must be scrupulously cleaned beforehand, since if this is not done, and the glove is punctured during the operation, the wound will be contaminated.

To Purify the Hands.—They should be scrubbed for ten minutes in running hot water with a nail-brush and ether soap. They should then be carefully dried, and soaked for two minutes in a solution of biniodide of mercury in spirit 1–[illegible]; afterwards they are rinsed in an aqueous solution of the same salt 1–2000. By these means the fat and epidermal scales are removed and the skin is rendered as far as possible innocuous to the patient upon whom the operation is to be performed.

4. **Purity of the Wound and Adjacent Parts.**—The preparation of the patient's skin is considered in detail under "Preparation for Operation"; but, before the operation is begun, the preparatory dressing should be removed, the whole region washed with ether soap and water, and finally wiped over with a solution of biniodide of mercury in spirit, 1–2000. Except for the part immediately concerned at the operation, the patient's body should be carefully covered with sterilized towels.

The details of the *Arrest of Bleeding, the Drainage, and the Application of Sutures*, are those which have been already described. Forcipressure or torsion may be freely employed, and a silk ligature may be used if the occasion calls for it, though catgut is sometimes employed. The general rule as to the desirability of arresting all hæmorrhage before the wound is closed, applies with equal force to aseptic wounds as to others, for though a blood-clot, lying in the cavity of such a wound, may become organized, or at least be replaced by organized tissue, its presence is to be avoided if possible.

The wound having been made absolutely aseptic, or as near it as possible, the next point to consider is, how it is to be *dressed*, that is *covered up*, so that the changes which it will go through from this time, until it is completely healed, may be performed in an absolutely healthy fashion, without fever, suppuration, or pain. To effect this, some form of antiseptic dressing is usually employed.

Dressings have in the last few years become very much simplified, as it has been found from experience that many of the precautions formerly recommended by Lister were unnecessary.

The wound having been sutured up, the surrounding skin is wiped clean, a cloth being pressed fairly firmly near it and swept away from the wound, while another is held on it to prevent any dragging on the sutures or accidental removal of the drainage tube, if one has been inserted.

Immediately over the wound is usually placed some gauze—either that prepared with perchloride of mercury, known as sal alembroth, or with the double cyanide—which has been soaked for a few minutes in carbolic lotion. Some surgeons use boric lint. Over this are placed several layers of thin lint or gauze, and above all a large pad of some prepared wool, either Smyth's absorbent wool, iodoform wool, sal alembroth wool, or wood wool, according to the fancy of the surgeon. The whole mass is then bandaged firmly on, or held in place by broad pieces of strapping.

The steps to be taken at the future dressings are precisely the same as for the original one, and all the precautions for cleanliness of hands, instruments, etc., must be as rigidly carried out.

It is impossible to lay down rules as to the time of re-dressing. Some cases may be left for a week, indeed, until the wound is completely healed, while but few require to be dressed daily, unless there is much discharge, as in septic cases.

Any circumstance which arouses a suspicion that things are going wrong, such as undue pain, or a high temperature, will call for prompt re-dressing. The wound will be known to be aseptic by the absence of smell, by its edges presenting a quiet, inactive appearance, and the almost total absence of tenderness anywhere. The discharge should be serous, or, in recent cases, blood-stained, moderate in amount, and freely discharged through the tubes.

In re-dressing, the skin surface around the wound should be lightly sponged with 1–40 carbolic solution, and gentle pressure made to ascertain that there is no bagging of discharge. The drainage tube should be taken out, boiled, and replaced if necessary. The wound should not be syringed through, as this will only separate parts which are adhering. If at any time the wound becomes in the least offensive, or freely suppurates, antiseptic precautions may be said to have failed, and means must be taken to attempt to bring it to an aseptic condition. It may be necessary to take out the suture and thoroughly cleanse the raw surface, and after taking means for the escape of any discharge of pus, the wound is dressed with absorbent wool. It is in these cases that the use of iodoform is of such value, some of the foulest surfaces becoming rapidly sweet when the powder is freely sprinkled on.

The two antiseptics which are now most used in the preparation of dressings, are (1) *Sal alembroth* (a double salt of perchloride of mercury and ammonium chloride); and (2) The *double cyanide of mercury and*

zinc. Sal alembroth gauze contains 1 per cent, the wool 2 per cent, and the mercuric zinc dressings about 3 per cent of the salt; the former are coloured blue and the latter violet; the colouring matter not only renders the material easily recognizable, but also serves, in the case of the mercuric zinc, to fix the salt in the dressings. The disadvantage of the alembroth preparations is that the discharges from the wound readily dissolve the salt, and soaking in the dressings, take up an increasing amount, until the solution may become strong enough to cause vesication of the skin. In using either dressing a layer of the gauze, which has been wrung out of 1–2000 mercuric chloride or weak carbolic solution, is first applied; over this several layers of dry gauze, and finally, a plentiful covering of wool.

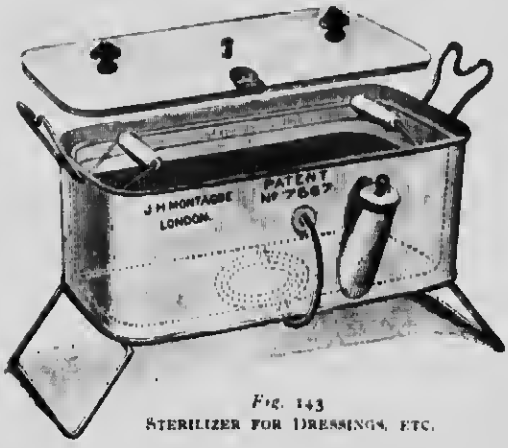


Fig. 143
STERILIZER FOR DRESSINGS, ETC.

In most hospitals the dressings are sterilized by heat the day before an operation. Special apparatus for doing this has been invented, the principle being that by the heat employed any micro-organism which may have been conveyed to the dressing is destroyed. The need of this precaution will be seen when it is mentioned that many, or even most, antiseptic dressings do not become active until they are moistened, with the result that unless the germicidal power of the antiseptic held in suspension is strong enough to destroy any germ that may be present, the discharge from the wound, with the warmth of the patient, by washing away the antiseptic, creates an ideal cultivating ground.

While all these precautions are taken by the majority of surgeons, there are some who hold that the use of antiseptic solutions is not only unnecessary, but harmful. They sterilize their instruments by heat and use no lotion but pure boiled water or sterilized saline, the theory being that by removal of all blood-clots, etc., by such an unirritating medium as water, the tissues are not damaged in any way, and the natural activity of the cells—the *vis medicatrix naturæ*—is sufficient to destroy any organisms that may have strayed into the wound. This is especially so in abdominal surgery. At the same time, for general work we recommend the moderate use of antiseptics.

Chapter XXII.

OF THE DRESSING OF BRUISED AND PUNCTURED WOUNDS, AND OF CERTAIN SPECIAL KINDS OF WOUNDS.

I.—OF THE DRESSING OF BRUISED AND PUNCTURED WOUNDS.

Bruised Wounds.—All wounds *may*, but bruised wounds *must*, go through certain phases of inflammation ending in suppurative granulations. The accepted pathology of this process is to be found in all recent text-books, but no modern word expresses it so well as the old-fashioned phrase of the *digestion of the wound*. As soon as this is accomplished, and not till then, the wound "cleans" and begins to heal; and if this old word were more often in our thoughts and mouths, we should more rarely see wounds with bruised and inflamed edges coerced into contact, but never into union.

The extent of this "digestion" varies from that condition when the edges of the wound just fail to unite by first intention, but quiet down, clean, and take on a healing action within a couple of days, to that which occurs when for a considerable area round the wound the tissues have been bruised to death, and must separate as sloughs before any healing can take place.

As soon as this process is finished, whether the merest pellicle of lymph, or a large slough, has been thrown off, the wound presents few difficulties in the way of its dressing, and any of the plans or materials before mentioned may be used. All the precautions of drainage and cleanliness must be rigidly carried out, for though the protective power of granulation tissue against septic poisoning is very great, blood poisons may yet be absorbed through it.

It is, therefore, in their earliest stages that bruised wounds present special points in their dressing: in these injuries the *internal tension* which is sure to develop in the tissues in the immediate neighbourhood of the wound must be diminished in every possible way; moreover, as the whole process is an inflammatory one, and may be septic as well, the cleansing of the wound, and the removal of all discharges by drainage, must be carefully attended to.

A bruised or torn wound should never be tightly closed up, and this not only because the edges will not unite, but because the dragging together of tissues of doubtful vitality must still further reduce their chance of recovery. The wounded parts should be replaced and supported in a gentle fashion, by strapping or bandaging. If sutures

are put in they must serve for support rather than for readjustment, while in small wounds where there has been no tearing off of flaps of tissue, it is often best to bring the edges together as well as possible, in the hope that they may have sufficient vitality to recover.

In all cases it must be drained even more carefully than a clean cut, and whatever be the dressing which is applied, it must be of a kind that will keep down the swelling and tension, prevent fœtor, and hasten the separation of the sloughs, if any have formed. For these ends fomentations, frequently changed, are very useful.

When a foul wound has to be cleaned, a fomentation made of boric lint folded in several layers and put on as hot as the patient can bear it, is the best treatment. The surface may be sprinkled with iodoform —though many surgeons express their disapproval of the substance, it is undoubtedly useful—or with boric acid before the application of the fomentation, and the whole covered with a large pad of wool extending at least an inch round the lint on all sides. This will require changing in three or four hours.

All the arrangements for the support and approximation of the edges of the wound must be carefully watched lest they should become a cause of tension, and therefore of destruction of vitality. Stitches must be promptly cut, and strapping removed, almost *before* there are any indications for such relief.

Sometimes, but rarely, the congested area around a bruised wound requires incisions to be made in it, as is so frequently the case in cellulitis (*q.v.*), for the effectual relief of tension.

Punctured Wounds require very careful attention, as they are sometimes followed by disastrous results. This is especially the case if a large artery has been wounded or if septic matter has been carried into the tissues along the track of the puncture.

In the former case there may not be very serious bleeding at the time of the injury, and the seriousness of the case may be overlooked. Recurrent hæmorrhage follows, and the patient may lose so much blood that his life is in danger.

In the latter instance, if septic matter is carried into the tissues and the external wound closes, deep-seated suppuration may take place, burrowing along the fascial planes and causing extensive destruction of the parts.

The rules that should be applied to the treatment of punctured wounds are as follows:—

1. If the wound is clean, and no important anatomical structure lies in its neighbourhood, it should be gently probed to make certain that no foreign body is present, and should then be washed out with a weak antiseptic lotion and covered with an antiseptic dressing.

2. If it is probable that a large vessel has been damaged, owing to the position of the wound, it should be carefully enlarged, with due regard to surrounding structures, and carefully explored to its depths until the damaged vessel is exposed. If the vessel is an artery it will

be necessary to ligature it above and below the puncture, and to divide it. If a vein has been injured it may be possible to close the opening with sutures or a ligature, a procedure which is scarcely applicable in the case of an artery, owing to the risk of traumatic aneurysm.

Attempts have lately been made to suture arteries, but at present it cannot be regarded generally as the safe line of treatment.

If the wound has been inflicted with a septic instrument, and septic matter has been carried into it, a free incision must be made, so that the whole track can be cleaned out and drained. It is necessary in these cases, when the wound is in such parts as the thigh and buttock, to ascertain the position of the patient at the time of the infliction of the injury. The importance of this precaution will be understood when it is remembered that a stab through the thigh with the limb flexed will take a different course when the limb is extended, and the result is that careful probing in the wrong position may result in a large portion of the wound being overlooked.

A case of this kind has been noted, where the patient was stabbed in the thigh with a penknife by a boy sitting next to him in school. The wound was carefully explored, cleaned, and drained. Serious sepsis supervened, and the child died of tetanus. It was subsequently discovered that a portion of the trousers had been carried into the track and had become buried in the tissues on the opposite side of the limb. The alteration in the direction of the track owing to the change in the position of the muscles when the wound was examined in extension, was unfortunately overlooked.

All punctured wounds of this character, i.e., of septic nature, should be thoroughly cleaned, drained, and allowed to granulate from the bottom, and if necessary, owing to the position of the wound, counter-drainage should be provided.

II.—OF CERTAIN SPECIAL WOUNDS.

The particular wounds we are now about to consider have, some of them, been mentioned before from the view-point of the arrest of bleeding, so that this complication must, for our present purpose, be excluded; nor, again, shall we consider those wounds which are inflicted in the course of major surgical operations.

Scalp Wounds.—These are very generally bruised wounds, although in consequence of the way in which the tissues of the scalp are stretched over the calvarium, they almost always look like incised ones, even if they be produced by the bluntest of instruments or missiles.

It used to be laid down as an inflexible rule that sutures should never be put into scalp wounds, partly because their edges so very generally fail to unite, but principally from the risks of the bagging of pent-up discharges inside the wound thus closed. It is now recognized that these risks can be avoided by the thorough use of antiseptic lotions and such powders as iodoform and boric acid, and that the tissues of the scalp are so well nourished that not only in clean cuts, but also

when the parts have been split upon the skull by a blunt instrument, the edges may yet unite by first intention if they be accurately brought together, and tension be carefully guarded against.

It is seldom necessary to have to allow for drainage, even in very serious scalp wounds, if the flaps of skin and the edges are carefuly cleaned of all dirt with some antiseptic lotion. The surfaces may even be scrubbed with some such solution to remove dirt when it has been ground into the wound.

Wounds of the scalp have, by the use of antiseptic washes and dressings, been robbed of the greater part of their terrors ; nevertheless, they must always be watched carefully, and the whole head should be daily examined for that kind of œdema which is known as " bogginess." The sutures must be taken out, and the adhesions broken down if there be any collection of pus. Generally the thermometer will give an early warning of collecting matter.

With regard to the dressings, no wounds are better fitted for the antiseptic method, either with cyanide gauze, salicylic wool or any of the other preparations in use. If the plan is to succeed thoroughly, the head must be shaved for some distance round the wound. If sloughing takes place (which is rare), boracic fomentations will generally be the best dressing.

A superficial necrosis of the skull may occur in connection with scalp wounds. The bone may separate as a scale of sequestrum, but more commonly the dead white patch of bare bone which is at first exposed, becomes more and more encroached upon by granulations, and is eaten up by them, so to speak, almost insensibly.

Cuts of the Ear.—The special point about these wounds is that the vitality of these parts is very good, so that torn pieces, however nearly detached, should almost always be replaced. Every care should be taken to prevent future deformity. If the cartilage be torn, sutures should not be passed through it and the skin together, but cartilage must he sewn to cartilage, and skin to skin. The whole organ must be kept warm by cotton wool.

Cut Throat.—This may be among the most serious of all wounds, even to being immediately fatal, or may he absolutely trivial. It is almost always suicidal or homicidal.

Apart from the question of hæmorrhage, the especial dangers of these wounds are, primarily, the possible injury to the air- or food-passage, or to both ; and, secondly, the danger of pus tracking down within the compartments of the cervical fascia, involving the pericardium or pleura, or leading to septic poisoning.

In self-inflicted wounds, fortunately, owing to an apparently innate tendency of the suicide to attack his " pomum Adami " in preference to any more vital part, the respiratory tract escapes more often than might have been expected. When it is injured, the knife or razor almost always divides the thyro-hyoid membrane, so that the rima glottidis is exposed, while the epiglottis is frequently cut away from

its attachments. The cartilages of the larynx themselves may resist cutting, and from anatomical reasons it follows that any division of the tracheal tube, or of the crico-thyroid membrane, is accompanied by such injury to the great vessels that the bleeding quickly causes death. In most cases, therefore, the larynx is more often exposed than entered, but sometimes a downward direction of the cut exposes the top of the larynx alone, while in others the œsophagus may be laid open behind the opened larynx. In all these cases the proper performance of breathing and swallowing will be greatly interfered with.

If, on examination of the wound, there seems to be general laying open of the pharynx and larynx, and the chink of the glottis be freely exposed, *œdema* of the latter is practically certain to come on, and its effects had better be anticipated and combated by inserting a full-sized laryngotomy tube through the crico-thyroid space, carrying out all the precautions which will be described under the head of the operation of tracheotomy. Some patients might be able to keep in an intubation tube. If, however, the exposure of the glottis be slight, the membrane being rather "nicked" than divided, the patient should be anxiously watched, the steam inhalation and the instruments for tracheotomy being ready at hand, so that they can be used at once if sudden dyspnœa occur. (*See* "Tracheotomy.")

When the **Pharynx** is wounded, food, when swallowed, may escape by the wound, and may also set up irritation of the larynx. Both these complications are very hurtful, so that it becomes necessary to get the food past the wound in the œsophagus. For this purpose a very soft *stomach pump tube* may be sometimes successfully introduced by the mouth, and the pump, or a length of tubing fitted with a funnel, employed. (*See* "Use of Stomach Pump.")

But a better plan is to pass a *large soft catheter* into the pharynx through the nose. Introduced in this way, the tube will lie at the back of the food passage, and little or no spasm will be set up by its insertion. The catheter should then be connected with a tube and funnel, and in this way liquid food may safely, and indeed easily, be given.

The *Prognosis*, in the cases of bad cut throat which we have been considering, is always unfavourable, for, apart from the injury itself, there is, very generally, a complete absence of any desire to get well. Nevertheless cases apparently hopeless do sometimes recover.

Whether the air- or food-passages be wounded or no, the *position of the head* is important—it should always be kept bent downwards, so that the edges of the wound may come together. Two or three patterns of bandages have been devised for this purpose.

If the patient is restless and uncontrollable, a poroplastic splint may be moulded to the head, neck, and shoulders, so as to keep the head still, and prevent him from tearing open the wound. A watcher should be provided for these cases, as they are very apt to attempt to inflict fresh damage upon themselves.

Sutures may be employed in cases of clean cut wounds not implicating the air-passages, but care must be taken to provide free drainage, and watch must he kept for the formation of pus, on account of the tendency of the latter to burrow amongst the planes of the cervical fascia. Sutures should not be used when the edges of the wound are jagged and bruised, and the same rule is to be enforced after wounds involving the trachea or œsophagus. It may be absolutely necessary, however, to apply sutures to trachea or œsophagus should there be much separation of the parts after deep wounds inflicted in them. Strict antiseptic precautions should be observed in dressing all wounds.

Whether septic absorption occurs or no, a low form of *pneumonia* is very apt to develop, and is very often fatal. A stimulating treatment generally, with alcohol, will be, as a rule, required.

Wounds of the Buttocks.—A very awkward wound is sometimes inflicted upon the buttocks by the breaking of a chamber utensil whilst it is sat upon. This usually happens to heavy women. Such an injury, or indeed any wound of that part, is very apt to take on unhealthy action, as wounds in loose fat will do anywhere in the body; an attempt should be made to get healing by first intention, but care must be taken that the discharges are allowed to have a very free exit if this is not obtained.

Wounds into Joint Cavities.—Any wound by which the interior of a joint is exposed is a very serious occurrence, and even when the injury at the outset may seem to be only the most trivial cut, it may well happen that in the end there will result a destruction of the joint, or a loss of the limb, or it may be of the life.

As a matter of fact it is often the trivial cuts which are the most dangerous, from the fact that they are considered trivial.

Wounds into joints may be divided practically into two classes. Under the first heading fall those cases in which the wound is a small one, or the injury in itself unimportant, being serious only because a joint is entered. In the second class come all the cases of wounds with disorganization of the joint structures, laceration of the capsule, free exposure of the cavity, rupture of the ligaments, etc.

Simple Wounds of Joints, i.e., where the joint is just opened, and no more, by an incised wound. The first and very important point to bear in mind with regard to these injuries is that in cases where there is any doubt as to whether the joint has really been opened, under no circumstances should any attempt be made to decide the question by probing, or in any other way. More mischief has often been done by an unnecessary use of a probe than by the instrument which inflicted the wound in the first place, and the only safe rule to follow is that in cases of doubt the joint must be supposed to have been opened, and be treated accordingly.

If the wound be just a *simple puncture*, in which the fact of the joint being opened has been proved by the escape of a few drops of synovia, the skin should be cleansed and an antiseptic dressing applied, the

limb should be put on a splint, and if the knee or ankle, it should be swung from a cradle. An ice-bag may be applied.

If, however, the wound has distinctly *opened the joint*, a decision will have to be arrived at as to whether it will be best to further open the joint and wash it out, or simply to dress it with some antiseptic dressing. The procedure must depend very much on the nature and extent of the damage. For instance, if a small wound is made with a dirty knife, or road dirt has been ground into the joint, there is no doubt that a free opening and thorough washing out of the joint is the only method that will prevent extensive injury and possibly danger to life. On the other hand, if the injury is made with a clean instrument, it would be bad surgery to further open the joint or subject the patient to the risk of a stiff joint.

The safe rule to follow is this. Unless there is good reason to believe that the wound has been inflicted by a septic instrument, adopt expectant treatment. Clean, and shave if necessary, the skin around the wound, and apply an antiseptic dressing. Watch carefully for signs of infection, such as a considerable rise of temperature, effusion and pain; if these appear, it will probably be necessary to take some active surgical measures. It is, however, not uncommon for a smart attack of synovitis to follow such an injury, without suppuration taking place, and the greatest care and discrimination must be exercised as to whether the joint should or should not be opened.

There is no question but that all wounds in which *the joint can in any sense be said to be exposed* or to have its investing or lining structures seriously injured, should be treated with strict antiseptic precautions. The joint must be thoroughly syringed out with saline; provision must be made for the thorough drainage of the joint cavity, if necessary, by counter-puncture or incision. In fact, all the details of the dressing described in Chapter XX. must be observed, while, of course, splinting and swinging are as necessary now as ever.

If the antiseptic precautions fail of their object, or if they have not been adopted, *acute synovitis* will surely follow. This is almost certain to run on to suppuration, and this practically means, at the best, ankylosis; while very possibly a subsequent excision or amputation may become necessary.

We must not here discuss the surgery of traumatic arthritis; but we hope that enough has been said to impress upon the reader the extreme seriousness of *all* wounds which even by the smallest aperture communicate with a joint.

Wounds of Tendons.—Tendons, especially those of the muscles of the hand or foot, are frequently divided in wounds of the extremities, and the manner in which they will re-unite will depend greatly upon their immediate treatment.

The cut ends of the tendons should be drawn out of their sheaths and stitched together by three or four catgut or silk sutures passed through the tendinous substance, the ends being then cut short. The

tendon having been joined, the sheath should then, if possible, be closed with a few points of the finest catgut suture, and the rest of the wound adjusted and drained in the usual fashion. The limb, after dressing must be placed on a splint in the position which causes least strain on the divided tendons. A flexible tin splint, which can easily be bent to the proper shape, will be found most useful.

Inasmuch as the great risk attending these wounds is the diffuse inflammation which is apt to attack the sheaths of tendons, and which is of a septic nature, it will be seen at once that the strictest antiseptic methods must be followed. With attention to drainage, and perfect rest on a proper splint, these cases will often do very well with dry absorbent dressings. Even if it is not possible to get the ends of the tendons quite together, they will probably join eventually by the formation of an intervening band of firm fibrous tissue, if no acute inflammation disturbs the healing process.

Wounds of Nerves.—This injury is often overlooked, because care is not taken to test for anæsthesia or loss of motor power before an anæsthetic is given. In all wounds where there is any probability of a nerve having been damaged, careful examination of the various nerves must be made.

If a nerve has been merely contused or partially divided, no immediate treatment is necessary, beyond that required for the wound generally. Afterwards return of function must be encouraged by massage and electricity, and if this fails it may be advisable to cut down and free the nerve from a surrounding belt of inflammatory tissue.

When the nerve has been completely divided, the cut ends are to be sought for, carefully trimmed, if lacerated, with a sharp knife, and sutured in accurate apposition with fine catgut sutures. The sheath may be sutured separately.

If this be done soon after the injury, repair of structure and function will very probably take place, for nervous tissue resists the effects of injury almost better than any other. Even if an interval of half an inch were to exist between the divided ends, they might eventually come together if no barrier lay between; and it is well known how nerve trunks will recover their functional activity when re-united, even when the ends have been lying apart for weeks or months. The great enemy to repair is, of course, suppuration.

The most important details in the after-treatment are careful splinting so as to correct the deformity which is likely to ensue, and constant use of electricity.

In injuries of the musculospiral nerve, for example, the hand should be supported on a palmar splint, so as to prevent the "wrist drop." Similarly in other cases, the tendency to contraction must be counteracted, and the paralyzed muscles should be regularly exercised with the battery, so as to prevent their becoming useless.

Chapter XXIII.

OF GUNSHOT WOUNDS AND BRUISES; AND OF FROSTBITE.

GUNSHOT WOUNDS.

THESE were, at one time, supposed to form a class of injuries differing in their pathology from all other wounds, and requiring different treatment. They were taken to be essentially poisoned wounds, and the main idea in their dressing was to encourage local inflammatory action and to delay union, until by profuse suppuration

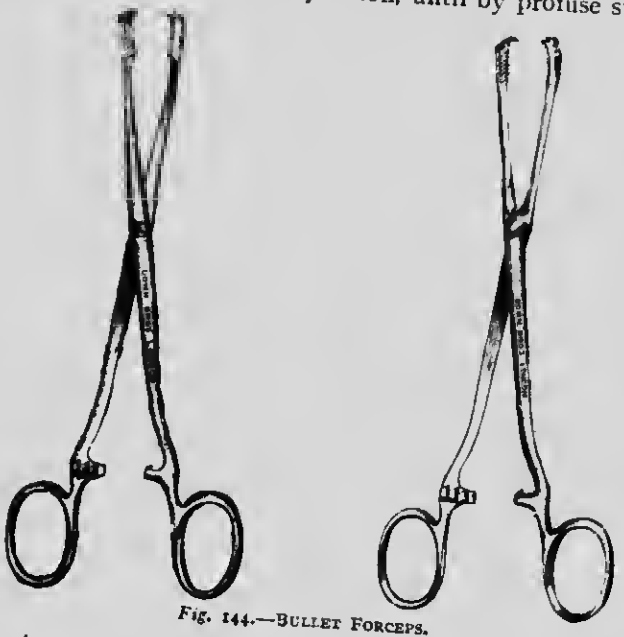


Fig. 144.—Bullet Forceps.

the poison (generally supposed to be due to the gunpowder) had been completely eliminated.

This notion naturally led to a very barbarous system of dressing, and it was not until it was recognized that these were essentially and typically *bruised wounds*, that more rational plans were adopted.

Only the more simple cases of this class of injury, or those in which some immediate treatment is called for, can here be considered as belonging to minor surgery; and with this limitation it will be found that their surgical dressing will not differ much from that of all other contused wounds.

The hæmorrhage is generally slight, but whether slight or severe, must be arrested on general principles.

The next point to consider is whether *the bullet*, or whatever may be the missile employed, be *still in the wound*; and if so, whether an attempt should at once be made to extract it. To decide this point an exploration should be made, and, if possible, with the finger: speaking generally, if by this means a foreign body be felt, it can without difficulty be extracted with a pair of ordinary dressing forceps, or with forceps especially made for the purpose, as shown *Figs.* 144, 145, 146, or with a bullet extractor (*Fig.* 147). Search should also be made for any piece of wadding, cloth, etc., which may have been carried in

Fig. 145.—Bullet-Extracting Forceps (Egyptian Army Model).

Fig. 146.—Forceps with Vulsellum ends.

Fig. 147.—Bullet Extractor.

Fig. 148.—Nélaton's Probe.

with the missile. If nothing can be felt with the finger, then a further examination must be made with a silver probe, or one tipped with porcelain (Nélaton's), *Fig.* 148, by which a bullet may be detected, as in the case of Garibaldi, by the mark of the lead on the porcelain. In making this examination the patient must always be placed accurately in the same position as when the wound was received, a precaution which is often overlooked.

Unless the probe detects the bullet in a place whence it can easily be extracted, the responsibility of attempting to recover it, or of deciding to leave it alone, should not be left to the dresser, or junior

surgeon, nor indeed should the patient be subjected by them to a prolonged or deep probing.

The Röntgen rays have proved of great use in the correct location of bullets, and a description will be found, in a later part of this book, of how to take skiagrams and determine the exact position.

Sometimes a bullet will travel a considerable distance from the original wound and be found still lying immediately beneath the skin. Thus a pistol bullet may run almost all round the skull beneath the scalp, or round the thorax in the course of the ribs. In such a case a small incision will allow of its escape; the track of the ball, however, will almost certainly form a suppurating sinus.

Whether the bullet has passed out of the body, or has been removed, or left, it is vain to hope that the wound it has caused will ever unite by first intention. After a period of inaction, inflammation, with suppuration and more or less sloughing, will take place, as in all bruised wounds, and this will be succeeded by repair by granulation.

The *dressing* should therefore be light, and great care must be taken to keep the wound clean in every possible way. Antiseptic fomentations will be found to hasten the separation of the sloughs.

BRUISES.

Whenever capillaries or veins are ruptured in or beneath the skin, some variety of *bruise* is produced. Under this head fall two chief kinds of injuries. In the first there is a general infiltration of the tissues, in the second there is a bag of blood, and speaking generally, in the one the capillaries, and in the other a vein of some size, have been ruptured. In either case the great point to keep in mind is that the effused blood should be *left alone*, except under one or two quite exceptional conditions.

For the common bruise, or infiltration of blood, in the vast majority of cases no special treatment is required. It is very doubtful if any external application can appreciably affect the re-absorption of the effusion, or the course of the discoloration, but it is probable that local cold and astringent dressings may be useful, if applied early, in limiting the extent of the primary escape of blood.

The astringent action of strong liq. plumbi subacet. is also very effective, and the actions of cold and astringents may be combined.

A still better line of treatment is that by firm, even compression, but only when it can be applied in time to prevent the infiltration of the tissues taking place. A wet bandage, smoothly applied, or a Martin's india-rubber roller, may in such cases absolutely prevent the development of an ecchymosis.

This moderate pressure can never be hurtful, but it must be remembered that the vitality is greatly lowered in bruised tissues, so that all tight constriction, or unyielding compression, as that of a circular piece of strapping or the corner of a splint, must be avoided lest an ulcer, which would certainly be slow to heal, should be caused.

Severe bruises will often be associated with great swelling and tension of the parts. These must be met by position and bandaging; only in the *most extreme cases*, when the vitality of the surrounding area of skin is seriously threatened, should the surgeon be tempted to relieve this tension by operative measures. The conditions are just the reverse of those present in inflammation, and an extraordinary degree of stretching will be now borne by the tissues without their giving way or sloughing. If it becomes absolutely necessary to incise an ecchymosed area, small and numerous punctures should be made, and antiseptic precautions adopted. But it is, we repeat, generally bad surgery thus to interfere with the natural process of re-absorption.

When a fairly large vein is ruptured beneath the skin, a *Hæmatoma*, or bag of blood, is the result, and much of what has just been said will apply accurately to its management. The fluctuating swellings thus caused are sometimes very large. Thus the rupture of the saphena vein may cause an effusion which will give a wave of fluctuation from the knee to the crest of the ilium, and, generally speaking, the blood thus poured out does not coagulate in the same way as if it had escaped from the body. Nothing but tension so extreme that the vitality of the parts is seriously threatened, or the occurrence of suppurative inflammation within the cavity (which is rare), should induce the surgeon to open these bags of blood. Rest, position, local cold, and especially, carefully regulated pressure, as with india-rubber or other bandages, will in almost all cases effect their re-absorption. They do, however, sometimes suppurate, and sometimes they remain with the blood unabsorbed for an indefinite time. In the first case the tumour must be opened and drained like any other abscess; in the second, when patience has fairly been exhausted, and it is plain that absorption is not going to take place, the fluid must be removed. Sometimes aspiration, or the use of a small trocar and cannula, will be sufficient to empty the sac, but in most cases it will have to be laid more freely open, and the contents turned out; the operation should be performed aseptically, and the cavity thoroughly washed out, while there should always be pressure put upon its walls to prevent a fresh filling up. In most cases it will not be necessary to drain, and the incision may be sutured up completely.

Lastly, as in the case of a diffuse ecchymosis, sometimes, but very rarely, the tension on the tissues bounding a hæmatoma may be so great that it must be relieved by incision. This procedure should be delayed as long as possible, but if it must be done it should be with the strictest antiseptic precautions.

Special Bruises.—First among these may be mentioned *Hæmatoma of the Scalp*, generally occurring in newly-born infants, as one of the accidents of labour, but also as a complication of fractures and other injuries to the head. Unless actual death of the skull bone takes place, which is very rare, the blood is invariably re-absorbed, and incision is never required. The peculiarly deceptive feeling simulating

depressed fracture is described under "Injuries of the Scalp," Chapter XLVI.

Subconjunctival Ecchymosis is sometimes of importance as a diagnostic sign in suspected fracture of the anterior fossa of the base of the skull, but it commonly occurs almost spontaneously, as during a paroxysm of whooping-cough. It should always be left alone, as it is never in itself a matter of importance, and is generally soon absorbed.

So, too, with the ordinary *Black Eye*, when the extravasation has once taken place, no application will affect the rainbow-like hues of the discoloration, or make them disappear quicker than in their own good time. But the early application of cold, as by an ice-bag or an evaporating lotion, or of astringents, and especially of the acetate of lead, may do a good deal to limit the actual escape of blood and serum.

Hæmatocele should also be mentioned as being an extravasation of blood into a natural cavity, usually the cavity of the tunica vaginalis testis. Whether it occurs spontaneously or in consequence of a blow, its treatment does not differ from that of other hæmatomata. Elevation of the scrotum, cold, and carefully managed compression (*see* strapping the testicle, p. 87), will powerfully aid the absorption of the effused blood, and if these measures fail, the cavity of the tunica vaginalis must be opened. If there be reason to believe that its contents are chiefly fluid, a hydrocele trocar may be used (*see* treatment of "Hydrocele"), but if the clotted blood cannot thus be removed, the cavity must be laid open and allowed to granulate up.

FROSTBITE.

A few cases of this injury occur in this country whenever it is visited by severe weather, generally in ill-fed, ill-clad people, whose circulation is enfeebled by privation or organic disease, and although it is in no sense a bruise, it may here be shortly considered. The main point to recollect about this form of gangrene is, that the tissue dies, not when it is frozen, but when it thaws, in consequence of the intense capillary congestion then set up. In countries where the accident is common this is well known, and when any part, as the nose or tip of the ear, becomes dead-white and loses its sensibility, the custom is to rub it for a long time, but not too vigorously, with handfuls of snow. Following the same principle, great care must be taken not to thaw the frozen part too quickly. The patient should be kept in a cold room, and bathed first with cold water, and then gently rubbed with the hand till circulation begins to be restored, when there will be much throbbing and feeling of heat, and the extent of the mischief will be disclosed. At no time must heat be applied, but the part should be wrapped up in cotton wool.

Sometimes a frostbite is produced by the prolonged application of the ether spray, especially if the parts frozen are already in a state of inflammation, and even an ice-bag, if left on for too long, may produce sloughing. Thus we have known such a bag, left on a hernia for a night, produce extensive destruction by the morning.

Chapter XXIV.

ULCERS.

ULCERS are wounds which are slow in healing, as the result of either constitutional disorders—diabetes, albuminuria, anæmia, etc.—or of imperfect local treatment. The first essential in the treatment is to deal with the constitutional disease as far as possible, so that the tissues may the better respond to local surgical measures. When grave constitutional disturbance is present, no active operative treatment should be undertaken.

Local Treatment will consist in encouraging a healthy reaction, so that fresh, active granulations may form, which can be covered either by the natural growth of the epithelium at the periphery, or by skin grafts transplanted on to the surface. When once an ulcer has become healthy, and shows signs of active healing, all that is necessary is to protect the part from undue pressure or irritation, and to facilitate the growth of epithelium. For this purpose nothing is better than strips of green protective, perforated to allow the discharge from the granulating surface to escape, the whole area being subsequently covered by an antiseptic gauze dressing. The gentle pressure of the protective keeps the granulations flat and allows the epithelium to grow unchecked and uninjured over the surface of the ulcer. The limb should, when possible, be kept at rest until healing has taken place. In any case of ulcer, the venous return from the parts should be assisted as much as possible, either by an elevated position of the limb, or by firmly bandaging from its extremity to a point well above the situation of the lesions. Certain kinds of ulcers, however, will require special treatment.

The Inflamed Ulcer is one in which an active infective process is at work, causing increasing destruction of the tissue and acute inflammatory phenomena. It arises in old neglected ulcers which have been contaminated by dirty dressings. The patient should go to bed, and the leg should be elevated and dressed with moist antiseptic gauze or carbolic acid fomentations. If the surface is not a large one, it should be painted with a solution of strong carbolic acid. A careful watch must be kept for a spreading cellulitis.

The Callous Ulcer is one the edges of which are everted and indurated, and the base is covered with small, unhealthy granulations. There is usually a considerable amount of matting together of the surrounding tissues, and sometimes in long-standing cases the ulcer is adherent to the bone. In order to procure healing, it will be necessary to stimulate

the callous surface, either by applying blisters to the edges and margins of the ulcer, or by scraping away the everted, indurated margin. In addition, it is often advisable to incise the tissues deeply, about one inch from the margin of the sore, so that contraction may take place. If such ulcers are thoroughly scraped and carefully dressed, or if the limb be kept at rest and elevated, they will soon become healthy. Skin grafting may be required in the later stages. Calcium iodide in 3-gr. doses thrice daily has been stated to give marvellous results in cases of chronic ulcer. It may be used in conjunction with any of the above methods of treatment.

The Anæmic Ulcer is a weak, avascular condition which occurs in anæmic women. There is no thickening as in the callous variety, but there is no attempt at healing. The administration of iron by the mouth, and the application of stimulating dressings—lotio rubra, Unna's plaster, or friar's balsam—will give satisfactory results.

The Irritable Ulcer is a painful condition due to the exposure of an inflamed nerve filament in the base of the ulcer. The point of tenderness should be accurately localized, and the nerve fibres divided a little distance above the ulcer or the tender point. Subsequently the ordinary treatment should be undertaken.

The Varicose Ulcer is the common variety seen in the out-patient department. It is very difficult to treat unless the patient will consent to remain in bed. If the so-called ambulatory treatment be adopted, a certain number will heal slowly: this consists in "strapping" the ulcer with Unna's gelatin bandage, which supports the limb and prevents it swelling. The objection to this treatment is that the dressing has to be frequently renewed when the discharge is copious. Another method is to encourage a healthy reaction by stimulating lotions or ointments—the cyanide of mercury ointment is an excellent application—and to bandage the limb firmly from below upwards with a crêpe Velpeau bandage: this should be put on in the morning before the foot begins to swell, and the patient should walk or stand as little as possible. In some cases benefit will result from excision of the dilated veins. Unna's "gelatin" plaster is made up as follows: Gelatin, 5 parts; oxide of zinc, 5 parts; boric acid, 1 part; glycerin, 8 parts; water, 6 parts.

Unna's plaster, which must not be confused with the above, is a powerful antiseptic preparation with very stimulating properties; it should be cut out the exact size of the ulcer and applied to the surface.

Wright's gelatin-formalin treatment has given good results in some cases of chronic ulcer.

Varicose ulcers are liable to bleed when the destructive process has attacked one of the dilated veins. Properly treated this is not a serious matter, but neglect or carelessness may lead to fatal results. A firm antiseptic dressing should be applied over the bleeding ulcer, and the limb should be carefully bandaged from below upwards. The patient

should be confined to bed until the ulcer shows signs of healing, and the limb should be elevated above the level of the trunk.

The Perforating Ulcer is a destructive condition of the tissues arising from suppuration in a bursa beneath a callosity or corn. The suppuration tracks into the joints, and may burrow for a considerable distance into the sole of the foot. It is usually associated with tabes dorsalis, but occurs in other conditions. The ulcer should first be cleaned by moist antiseptic dressings, fomentations, or baths, and all the thickened epidermis should be cut away. If the sinus is unhealthy it should be scraped. The cavity should be plugged with gauze soaked in lotio rubra or friar's balsam, and the track should be allowed to close from the bottom. During treatment the patient should not walk on the affected foot.

The Phagedænic Ulcer is an acute destructive process, occurring in alcoholics or diabetic patients. It may or may not be associated with syphilis. In appearance the ulcer resembles the inflamed variety, but the process is more acute, the tissue destruction and sloughing are more extensive, and the constitutional symptoms are more severe (*see* " Syphilis ").

The method of exposing ulcers to a current of oxygen has given very satisfactory results, and is to be recommended. The gas is allowed to play on the surface of the ulcer for periods varying from ten to twenty minutes, after which a dressing is applied in the ordinary way.

As a stimulating dressing for ulcers which are *clean* but slow to heal, nothing is better than the so-called " red ointment." This is an ointment made up of *scarlet red* 10 per cent, with vaseline or lanolin. Scarlet red has the peculiar power of stimulating epithelial growth.

Chapter XXV.

THE GENERAL TREATMENT OF SYPHILIS AND GONORRHŒA.

SYPHILIS.

As a house surgeon is often called upon to treat cases of venereal disease, a short account of the various methods at his disposal will be given.

Constitutional Treatment.—Mercury is the only drug which has a specific action upon early syphilis. It may be administered in many ways; three only will be considered here: (1) By the mouth; (2) By inunction; (3) By hypodermic injection.

By the Mouth.—In the form of pills:—Pil. Hydrarg. c. Creta; Pil. Hydrarg. Tannatis, gr. j–ij t.d.s.

These are the usual modes of administering the drug, and the compounds have the advantage as a rule of not causing diarrhœa. Should this complication arise, the addition of a grain of Dover's powder to each pill will succeed in checking it.

The pill of the green iodide of mercury, gr. $\frac{1}{3}$ t.d.s., is an excellent remedy, but the pills must be freshly prepared, and are likely to cause diarrhœa.

In the later stages of the disease it is usual to combine mercury with iodide of potassium, as in the following mixture, according to the requirements of the case:—

℞ Liq. Hydrarg. Perchlor.	℥ss–℥j	Syr. Aurantii	℥j
Pot. Iod.	gr. v—xv	Aq. Chlor.	ad ℥j
Sp. Ammon. Aromat.	℥j		

℥j t.d.s.

In cases of syphilitic ulceration of the mouth and throat, the aromatic spirit of ammonia should be omitted.

The combination of mercury and arsenic in the form of Donovan's solution, ♏x t.d.s. c. aqua, is very serviceable in some severe cases of the disease, especially if there is intolerance to mercury alone.

Treatment by Inunction.—A piece of unguentum hydrarg. the size of a large filbert, equal to about a drachm, is rubbed into the groin or abdominal wall, the part being subsequently covered by a flannel bandage. It is well to vary the site of the inunction, as the friction may produce a pustular eruption, and to alternate between the two sides of the body: if the part is hairy it should be shaved. The

method is a very satisfactory one, especially in children, but it takes ten to twenty minutes to thoroughly rub in the ointment.

Treatment by Injection.—This is the most reliable way of administering mercury, and it does not cause the digestive disturbances which are often excited when the drug is given by the mouth. The chief objection to it is the pain which it sometimes causes, for although in most cases there is nothing more than a feeling of soreness around the region of the puncture, occasionally great pain is complained of. Cases of syphilis which progress rapidly in spite of other treatment, are usually benefited by injections.

Both the soluble and insoluble salts of mercury are used for injections; the soluble cause less pain, hut are less certain in their action, and must be given more frequently—every other day.

Soluble injection:—

℞ Hydrarg. Sozoiodolatis, gr. ½ | Sodii Iodidi gr. ⅔
In 10 min. of distilled water.

Insoluble injections:—

℞ Calomel suspended in sterilized Olive Oil gr. ½–⅔ in ℥x

or ℞ Grey Oil (Hydrarg. Pur., ʒj; Adeps Lanæ Anhyd., ʒiv; Paraffin. Liq.—Carbolisat. ad 2%—ad ʒx).
℥x weekly. (J. E. Lane.)

Lambkin has introduced a form of mercury for injection made up with creosote, which he says is practically painless.

The injection should be made into the gluteal region in the middle of a line from the anterior superior spine to the upper end of the natal cleft, a point well away from the large vessels and nerves (Lane). Injections of iodipin 10–25 % are very useful in some resistant tertiary lesions.

A long 2-in. needle of fair calibre should be used, and it should be plunged deeply into the muscles, and not merely into the subcutaneous tissue, the injection being slowly forced into the muscular tissue. All antiseptic precautions must he observed, otherwise troublesome abscesses will result.

Duration of Treatment.—At least two years, with short periods of intermission, when the mercury is given by the mouth; if injections are used, a three months' course each year for two years is probably sufficient.

In whatever form the mercury is given, great care must be taken to impress upon the patient the need for oral cleanliness, as a preventive in a large measure of mercurial stomatitis. The teeth must be brushed twice a day with an antiseptic wash, and the mouth rinsed with a solution of alum 10 per cent (Lane). If in spite of this the gums become painful, the mercury should be stopped for a time.

The nature of the disease should always be explained to the patient, so that he may realize the value of and necessity for regular treatment, and in order that he may take such steps as may be necessary to isolate himself as much as possible.

RECENT ADVANCES IN DIAGNOSIS AND TREATMENT.

By ALEXANDER FLEMING, M.B., B.S., F.R.C.S.

Of recent years laboratory work has come to the aid of the surgeon in the diagnosis and the treatment of syphilis. Modern research in syphilis can be divided into several stages: (1) Schaudinn's discovery of the *Spirochæta pallida*; (2) Roux and Metchnikoff's discovery that the disease is transmissible to some of the lower animals; (3) Wassermann's application of the Bordet-Gengou reaction to the diagnosis of syphilis (Wassermann reaction); (4) Ehrlich's discovery of Salvarsan.

The discovery of the organism and the recent easy methods of its demonstration have rendered the diagnosis of syphilis comparatively simple in the early stages. The elucidation of the fact that some of the lower animals may be infected has possibly done more for research on syphilis than anything else, as it rendered easy experimental work on this disease and so paved the way for the other more practical advances.

The Demonstration of the Spirochæta Pallida.—The spirochæte is a slender organism 4 μ to 14 μ long, showing a series of from six to fourteen regular corkscrew-like curves. The ends are pointed. It is actively motile, having three motions: (1) A rotatory movement around a longitudinal axis: this movement may be seen sometimes to be suddenly reversed; (2) An undulating movement caused by the spirochæte bending on itself; (3) A slow progression backwards or forwards: this motion is a very slow one, so the organism can be kept under observation in one field of the microscope for a considerable time. The spirals persist in rest, thus differing from some other spirochætæ.

Staining is difficult with any of the ordinary stains. Two methods are now used in its demonstration, to the exclusion of all others.

1. *Burris' Method.*—A small drop of Chinese ink is placed on a slide. Some serum from a chancre is mixed with it, and the whole is spread out on a slide after the manner of making a blood film, dried, and examined. The spirochætæ are seen as clear spirals on a dark ground. The film must not be too thick, else the spirochætæ are overlaid by the ink and obscured, while too thin a film does not furnish a sufficiently dark background. The proper thickness of film appears a dark brown colour to the naked eye.

2. *Dark-ground Illumination Method.*—By means of a special microscope condenser all the direct rays of light are cut off, so that only very oblique rays reach the object on the slide. Some of these are reflected from the sides of the object and travel up to the eye. Where there is nothing on the slide to reflect the light, the field appears dark. Thus the spirochæte appears as a bright spiral on a black ground. This method has the advantage that the characteristic motion of the spirochæte is preserved. Serum from a chancre is diluted with a little salt solution, placed on a slide, and covered with a *clean* coverslip

in such a way that no air-bubbles are present. Connection is made between the under surface of the slide and the special condenser by means of a drop of cedar oil. The specimen is then examined with a $\frac{1}{6}$ in. objective and a high-power eye-piece (× 8). A strong illumination is essential. When the condenser has been properly centred and focussed, the spirochætæ can easily be seen and their characteristic movement observed.

The Wassermann Reaction.—The Wassermann reaction is the application to syphilis of the general principle laid down by Bordet and Gengou in 1900 for all organisms, that if any antigen is incubated with its corresponding "immune body" (amboceptor) and alexin (complement), this last is firmly bound up so that it is not able to act with any other antigen-amboceptor combination.

It will be necessary to define some of the terms used in order to explain the mechanisms clearly. An *antigen* is a substance which when injected into the animal body will give rise to antibodies. These antibodies are specific; that is, they will only act towards the particular antigen which has been used in their production. Thus, if typhoid bacilli be injected, there are produced antibodies which will act upon typhoid bacilli but not on other bacteria. These antibodies are of various kinds, but for the purposes of this test the one we are concerned with is the "*immune body*" or "*amboceptor.*" This amboceptor has in itself no destructive action on the antigen, but when it is mixed with some fresh serum the destructive action is very manifest. This fresh serum contains a substance, "*complement,*" which is not specific, but is capable of acting on any antigen in the presence of the amboceptor corresponding to this antigen. Complement is present in all fresh serum; it is destroyed by heating the serum to 56° C. or by keeping the serum for some days. The amboceptor, on the other hand, is not destroyed by this temperature, and it still retains its power after many months. It is thus easy to obtain sera containing either complement or amboceptor alone. Fresh serum of any animal which has not been immunized will contain complement only, while serum of the immunized animal heated to 56° C. for half an hour, contains amboceptor specific for the antigen used in immunization, but no complement.

In the Wassermann reaction for syphilis two antigen-amboceptor combinations are used. In the first stage syphilitic serum (containing syphilitic amboceptor), syphilitic antigen, and complement are incubated together, during which incubation the complement is fixed to the syphilitic antigen. There is, however, no visible change to denote this, so that for the purpose of demonstrating that the complement is fixed, another antigen-amboceptor is introduced. This consists of sheep's corpuscles (which have been washed free from serum) and the corresponding amboceptor (derived from a rabbit which has been immunized with sheep's corpuscles). If any complement had been left free in the original mixture, this, with the aid of

the hæmolytic amboceptor, would completely dissolve the sheep's corpuscles, which change is easily observed by the hæmoglobin becoming diffused throughout the fluid.

In the original Wassermann reaction the antigen is an extract of the liver of a syphilitic fœtus, the amboceptor is serum from a syphilitic patient, heated to 56° C. for half an hour, and the complement is fresh guinea-pig's serum. The antigen must be carefully standardized before use, as if too strong an antigen is used there may be some non-specific fixation of the complement, and so a positive reaction may be obtained with a normal serum. The complement also must be tested, and the quantity that is used is twice the minimum amount which will completely dissolve the amount of sheeps' corpuscles (fully sensitized with hæmolytic amboceptor) which would be subsequently added in the test.

The test is done by mixing in small test tubes the various substances as shown in the diagram (*Fig.* 149).

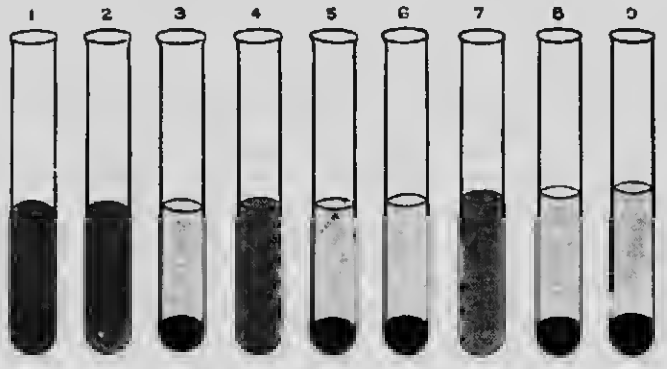


Fig. 149.—Original Wassermann Reaction.

Tube								
1.	Normal serum (heated)	+	salt sol.	+	complement	+	sheep's corpuscles (sensitized)	= Hæmolysis
2.	,, ,, ,,	+	antigen	+	,,	+	,,	= ,, ,,
3.	,, ,, ,,	+	salt solution	..	..	+	,,	= No hæmolysis
4.	Syphilitic ,,	,,	+ ,,	+	complement	+	,,	= Hæmolysis
5.	,, ,,	,,	+ antigen	+	,,	+	,,	= No hæmolysis
6.	,, ,,	,,	+ salt solution	..	..	+	,,	= ,, ,,
7	Complement	+	,,	..	..	+	,,	= Hæmolysis
8.	Antigen	+	,,	..	..	+	,,	= No hæmolysis
9.	Salt solution	..	..	..	..	+	,,	= ,, ,,

Before the sheep's corpuscles are added, the mixtures are incubated for one hour at 37° C. to allow fixation of the complement to take place. The sheep's corpuscles are washed free from serum by repeated centrifugalization, and are made up to a strength of 5 per cent with normal salt solution. They are "sensitized" by the addition of a small quantity of serum from a rabbit which has been immunized against sheep's corpuscles. After the sheep's corpuscles are added, all the tubes are incubated for another hour, and if after the first period of incubation the complement was not "fixed," then during the second incubation this will act on the sensitized sheep's corpuscles

and dissolve them. Thus there will be hæmolysis in tubes, 1, 2, 4, and 7, and no hæmolysis in 3, 5, 6, and 8 and 9. In tubes 1 and 4 there will be hæmolysis, as there was nothing to fix the complement during the first incubation. In tube 2 there will be hæmolysis, as the antigen is incapable of fixing the complement when only normal serum is present, whereas in tube 5 the complement will be fixed through the agency of the syphilitic serum and so no hæmolysis will take place. The other tubes are controls of the various substances used in the test.

Many modifications of the test have been devised, but the simplest is that of Hecht, which, modified as regards the technique of its performance, has been very largely used by the author. In this, advantage is taken of the fact that fresh human serum contains complement and also hæmolytic amboceptor for sheep's corpuscles, thus rendering the guinea-pig and the immunized rabbit unnecessary. In this method very small test tubes (*Fig.* 150) are used (5 mm. in diameter and 1½ cm. long), and mixtures are made as follows:—

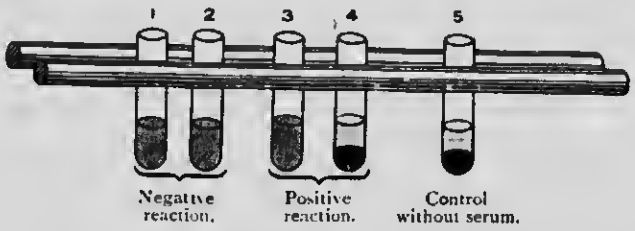


Fig. 150.—Modified Wassermann Reaction.

Tubes arranged between two glass rods held together with plasticine for incubation in a water bath. The projecting ends of the rods rest on the sides of the bath.

Tube 1.	Salt solution,	40 c.mm.	Normal serum,	10 c.mm.	Sheep's corpuscles,	10 c.mm.
,, 2.	*Antigen	,,	,,	,,	,,	,,
,, 3.	Salt solution	,,	Syphilitic serum	,,	,,	,,
,, 4.	*Antigen	,,	,,	,,	,,	,,
,, 5.	,,	,,	Salt solution	,,	,,	,,

These are incubated for three-quarters of an hour in the air at 37° C., or in a water bath at the same temperature, for a quarter of an hour, and then to each is added 10 c.mm. of washed sheep's corpuscles (10 per cent suspension in normal salt solution). Hæmolysis occurs in tubes 1, 2, and 3, but not in 4 and 5.

In a few cases there is no natural amboceptor for sheep's corpuscle in the blood to be tested, but when this is observed, 10 c.mm. of one's own serum which has been heated to 56° C. (to destroy complement) is added to supply the deficiency.

The Wassermann reaction has two very important practical uses in connection with syphilis: (1) In the diagnosis of the disease; (2) In indicating whether or not the disease has been eradicated as the result of treatment.

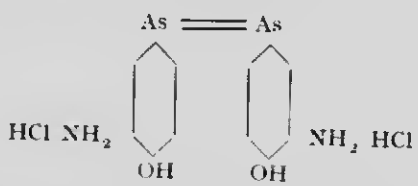
* The antigen here is made by extracting one gramme of heart muscle with 5 c.c. alcohol for twenty-four hours at 37° C.

In secondary and tertiary syphilis where there are lesions, the reaction is present in almost every case (95 to 98 per cent), so that in those conditions a negative reaction has almost as much diagnostic value as a positive. In primary syphilis the reaction is not present in so large a number of cases (75 per cent), so that a negative result in such a case is not of much value. In primary syphilis, however, the diagnosis can easily be made by the demonstration of the spirochæte. In parasyphilis there is a remarkable difference between tabes dorsalis and general paralysis. In the former the reaction is as a rule weak, and is only present in about 70 per cent of cases, while in the latter it is very strong and is present in every case. Using the cerebrospinal fluid the reaction can be obtained in almost all cases of general paralysis and in rather more than half the number of cases of tabes; but it is very rare in any other condition, so that a positive Wassermann reaction in the cerebrospinal fluid is almost pathognomonic of parasyphilis. In congenital syphilis, the reaction is strong and is present in almost every case.

As a result of treatment, the reaction becomes weaker and ultimately, when the case is cured, disappears. In some cases, however, the disappearance of the reaction is only temporary, and when treatment is stopped it returns after a short period. Thus, before a case can be said to be cured, the reaction must have remained negative for a period of one year after treatment has been discontinued.

The best method of procedure is to test the blood about one month after treatment has stopped. If it be positive, treatment is resumed, but if it be negative, nothing should be done for six months, when the blood should be tested again. If the reaction is still negative, another test should be done after a further period of six months, when a negative reaction can be taken to indicate that the patient is cured. As regards the effect of different forms of treatment on the Wassermann reaction, the most potent is salvarsan; then comes mercury, either in the form of injections or inunctions, while the least powerful is mercury taken orally as pills or mixture.

Treatment by Salvarsan.—In 1910 Ehrlich introduced a new drug for the treatment of syphilis and other diseases caused by spirochætæ. This drug was a complex organic combination of arsenic containing 28 per cent of its weight of this element. Chemically the drug is dioxydiamido arsenobenzol, and its formula is:—



but it is more generally known as "606," as it was spoken of in Ehrlich's laboratory, or "Salvarsan," the name under which it is sold.

Salvarsan is the result of a long series of experiments into what Ehrlich terms "chemotherapy," i.e., the exhibition of a drug which in the body is highly toxic to the infecting agent, while it is but little harmful to the tissues of the body. In other words, his object was to obtain a drug which was very highly bacteriotropic but only slightly organotropic.

During his researches he discovered that, dealing with trypanosomes, he could kill off almost all the organisms by means of continued treatment by one substance, but that those which persisted produced a race which was quite unaffected by that particular drug. This fresh race was, however, susceptible to other drugs, so he tried by combinations of these drugs to establish a "cribra therapeutica" through which none of the parasites could escape.

When he introduced salvarsan he attempted by means of one or two large doses (therapia magna sterilisans) to destroy completely all spirochætæ in the body, and so effect a cure at once and prevent the production of a "salvarsan-immune" race of spirochætæ. There is, however, no absolute evidence that such an immune race of organisms is developed even after several doses of the drug, although certain recurrences have been noted which were more resistant to treatment than were the original lesions.

The drug is obtained as a yellow crystalline powder in hermetically sealed glass capsules, filled with a neutral gas. It decomposes rapidly in solution or when exposed to the air, so that it has to be made up and used immediately. The powder is soluble in water, forming a strongly acid solution which is quite unfit to inject owing to its intensely irritant effect. When this solution is neutralized with alkali, the drug comes down as a thick yellow precipitate which redissolves in excess of alkali.

Methods of Administration of the Drug.—It may be given subcutaneously, intramuscularly, or intravenously. The first two methods were used exclusively in the early stages of the employment of the drug, but they have been replaced almost entirely by the last.

The advantages of the intravenous method are: (1) The clinical results are better, more rapid, and more certain; (2) Relapses are much less frequent; (3) The injection is practically painless; (4) There is no risk of the slough at the site of inoculation, provided the operation is done skilfully.

The only advantage of the intramuscular or subcutaneous method is that less technical skill is required for the injection. The disadvantages are: (1) That great pain may follow the injection; (2) That necrosis of the tissues may occur at the site of inoculation, resulting in the formation of a sterile abscess; (3) The drug is not absorbed with the same rapidity as when inoculated into the vein, so that the action is less rapid and certain.

Intramuscular Injection.—0·5 gram of the solid substance is triturated in a sterile mortar with 1·1 c.c. of 15 per cent sodium hydrate solution, and then the volume is made up to 5 c.c. with distilled water.

The injection is made deep into the gluteal muscles, and must be made slowly to avoid tearing the muscle. Great care must be taken not to inject close to the sciatic nerve.

Intravenous Injection.—0·5 gram of the solid substance is dropped on to the surface of 50 c.c. of sterile distilled water in a flask. This is gently shaken for a few minutes till solution is complete. (It is well to agitate the water gently while adding the powder, so that a thin layer forms on the surface of the fluid, and solution is more rapid than it is when the powder becomes caked together in one mass). When solution is complete, 200 c.c. of sterile salt solution (0·9 per cent) is added, making a total volume of 250 c.c. (or 50 c.c. per 0·1 gram of salvarsan). Then 20 per cent NaOH solution is added with a pipette or syringe until the precipitate which forms just redissolves. The quantity required is about 0·6 c.c., and it is best to run in ½ c.c., and then, after shaking, add the alkali drop by drop, shaking all the time, until a clear solution is obtained. The fluid is then ready for injection.

Several points are very important in this preparation: (1) All solutions and flasks must be absolutely sterile. (2) Neutralization must not be commenced before solution is quite complete; (3) Too much alkali must not be added, as in certain fatal cases pulmonary thrombosis has apparently followed a too alkaline solution; (4) The salt solution must be made from freshly distilled water, or distilled water which has been sterilized immediately after distillation and kept free from contamination. It has been shown that distilled water on being left exposed for some days contains large numbers of bacteria. If such water be used for making up the salt solution, although this solution be sterilized before use, yet it contains large quantities of dead bacteria, which are apparently responsible in large part for unpleasant symptoms following intravenous injection, such as rigors, fever, and vomiting. Tap water must not be used, as the salvarsan is partially precipitated by some of the salts contained in it.

The vein selected is in almost all cases either the median basilic or the median cephalic. These are large, easy to find even when most of the other veins are obscured by fat, and are more fixed than the other veins of the arm, which, although they may be more prominent, are much less easy to puncture with a needle.

The veins may be rendered prominent by tying a bandage round the upper arm, but a better method is by means of an appliance similar to that used in blood-pressure apparatus. This consists of a rubber bag (a section of a bicycle tyre 8 inches long does very well) inside a washable white linen cover, which cover is prolonged into a long tail. The bag is connected with a small rubber bellows, and in the connecting tube there is a tap which connects the bag with either the bellows or the outer air. This armlet is wound loosely round the upper arm and the end is tucked in. The bag is now blown up with the bellows until a pressure is obtained sufficient to compress the veins without interfering with the arteries. After the needle is in the vein the tap is

turned, letting the air out of the armlet. This is of great advantage, as there is no movement of the arm such as is usual when the removal of a compressing bandage is attempted—a movement which occasionally results in the needle being jerked out of the vein. *The needle used must be sharp*, else it pushes the vein on one side, and the point ought not to be too long, otherwise there is a likelihood of transfixing the vein. The calibre of the needle varies with the method employed, for whereas a comparatively wide needle must be used if gravity alone is the compelling force (unless the injection is to take an inordinately long time), a calibre only a little wider than that of an ordinary hypodermic needle suffices if one uses a syringe to force the fluid into the vein. The advantage of a small needle is that it is easier to get into the vein, especially when the latter is small, as in some women and young children. Only under very exceptional circumstances should it be necessary to cut down on the vein, and except in young children, and in a few cases of adults where the veins are obscured by fat, cutting down on a vein is merely a confession of the surgeon's want of skill.

In all cases great care must be taken that no salvarsan solution is injected into the subcutaneous tissue around the vein, otherwise considerable pain may follow. This is obviated by allowing some blood to run back into the tube, where it is seen at a small glass window close to the needle, or by injecting some salt solution first, when pain and swelling at the site of injection shows that there is a leakage around the vein.

Two methods are in use for administering the injection. In the first, gravity forces the fluid into the vein, and it is to be recommended on account of its simplicity: in the other, which is to be recommended for its efficiency and general applicability, a syringe is the compelling force.

Gravity Method.—The apparatus consists of a funnel or some such receptacle leading by a tube to a needle, which is inserted into a vein. Salt solution is now run in to make sure there is no leakage. This is followed by the salvarsan solution, and the remains of this are washed out by some more salt solution.

Modifications have been devised where two funnels are attached to the needle by tubing and a Y-junction, both tubes having a clip which can be opened or shut at will.

Syringe Method.—The most convenient apparatus consists of a 20 c.c. "record" syringe, fitted with a three-way tap, one limb connected with the needle and the other with the flasks of salvarsan and salt solution. The limb with the needle has a piece of wide glass tubing let into it near the syringe, and near the needle a piece of narrow glass tubing. The former serves, when held vertically with the end distal to the needle upwards, to catch any air bubbles which would otherwise pass into the vein.

The side limb of the tap has let into it a bulbar glass tube fitted with

glass wool to serve as a filter, and is bifurcated by means of a second three-way tap, so that it communicates with either salvarsan or salt solution. The flasks are covered with double metal caps, with small holes for the delivery tubes, so that any contamination from the air is avoided.

The tubes are placed in the flasks, and by manipulating the taps the whole apparatus is easily filled with salt solution from the flask. The needle is inserted into the vein, and slight suction applied by the syringe till blood appears at the "window" near the needle. This is

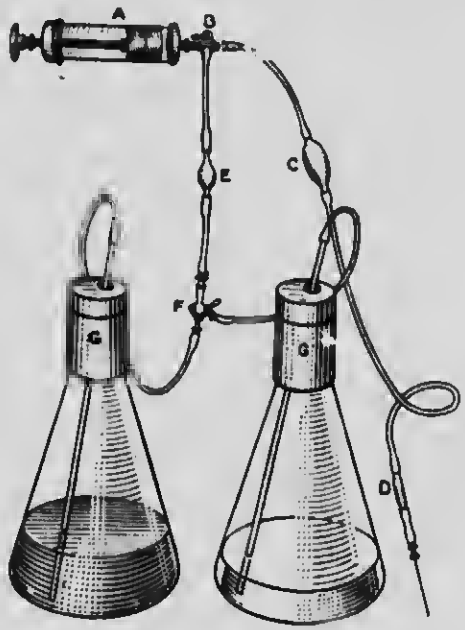


Fig. 151.

A. Record syringe.
B. Three-way tap connecting syringe with flasks or needle.
C. Air-bubble trap.
D. Glass window close to needle.
E. Glass-wool filter.
F. Three-way tap connecting syringe to either of flasks.
O. Metal caps to prevent contamination of solutions.

pushed back into the vein, and then the salvarsan is injected by filling the syringe from the flask of that solution and expelling it into the vein. When the injection of salvarsan is complete, 20 c.c. of salt solution should be injected to wash the salvarsan out of the tubes and to avoid any leakage of the drug around the vein when the needle is withdrawn.

For some hours before the injection the patient should not have had a heavy meal. The injection should be made in bed, and the patient should be kept in bed for twenty-four or forty-eight hours afterwards. The immediate results following injection—rigors, high fever (up to 104°), and vomiting—are now much less since freshly distilled water

has been used; but they occur especially in cases of secondary syphilis. The temperature may persist for two or three days, and for some days there may be symptoms of gastro-intestinal irritation. Many patients have practically no symptoms except slight headache and malaise.

Contraindications.—These become fewer as the drug becomes more commonly used. Any serious affection of the heart or vascular system increases the danger of a serious result. Phthisis, diabetes, or albuminuria are not a bar to its use. It is well not to use it where there is a retinal affection, bearing in mind the optic atrophy induced by other arsenical preparations.

Dangers of the Treatment.—In a certain number of cases death has followed the administration of salvarsan in patients whose organs were apparently healthy. The cause of death was generally coma or pulmonary thrombosis. In some cases where the organs have been examined after death, the distribution of arsenic in the tissues is the same as it is in arsenical poisoning. In some the fatal result may have been due to faulty preparation of the drug, but in others it seems to be due to the patient having an idiosyncrasy for arsenic. Optic neuritis following salvarsan has not been authenticated; deafness due to paralysis of the auditory nerve has been reported, but it is rare. In a large series of cases which I have observed, none of these serious sequelæ have been seen.

Dosage.—For adult men the dose is 0·5 or 0·6 gram, and for women 0·4 to 0·6 gram. For a child of ten years 0·2 gram is a suitable dose.

The best way of using the drug, in my opinion, is to give an intravenous dose and repeat this twice at intervals of a week. In primary and early secondary syphilis this will often be found to be sufficient to make the Wassermann reaction negative, but it is wiser to have a six months' course of mercurial treatment. If at the end of this time the Wassermann reaction is negative, treatment may be stopped and the reaction again tested in about six months. If it is negative, then the patient can, I think, be regarded as cured, although it is wise to have another test done about a year after.

If the first Wassermann reaction is still positive, then one can either go on with mercury, or give another dose of salvarsan and repeat the test in two months. If it is impossible for the treatment to be controlled by the Wassermann reaction, the three doses of salvarsan ought to be followed by mercurial treatment for at least one year.

Effect of Salvarsan on Syphilitic Lesions.—Practically all primary, secondary, and tertiary lesions clear up with great rapidity after an intravenous injection. Even large foul ulcers heal very quickly, although they may have resisted mercurial treatment for weeks.

In primary chancres where spirochætæ were numerous before injection, one is unable to find these twenty-four hours afterwards.

If the injections are made in the primary stage before the Wassermann reaction has become positive, this will remain negative in almost all cases, and no fresh lesions develop. In secondary syphilis, two

injections in the majority of cases cause the previously positive reaction to become negative. This change is observed from four to eight weeks after the first injection. In tertiary cases, especially if the infection is of many years' standing, there is greater difficulty in getting the reaction to become negative. In congenital syphilis, only rarely is the Wassermann reaction changed by salvarsan to negative, although the actual lesions are readily amenable to treatment by this substance.

In general paralysis no benefit has been observed from the use of salvarsan.

In tabes, sometimes the patient seems to improve somewhat in his general health, but the signs of the disease remain. Time only will show whether it is possible to arrest this disease by means of salvarsan.

Salvarsan has been used in other diseases in man caused by spirochætæ, such as yaws, with as much success as in syphilis.

In spirochætal diseases of animals also it has been shown to have a very great effect, so it would seem to be not so much a specific poison for the organism of syphilis as for spirochetæ generally. It has also been used in diseases caused by other protozoa, e.g., trypanosomiasis and malaria, with only moderate success.

Ehrlich has recently introduced a new compound having a slightly different chemical constitution from the original Salvarsan. This is very readily soluble in water giving a neutral solution which can with safety be injected intravenously. At the same time it is not so toxic, so that larger doses can be given and the dose repeated more frequently. It is recommended that four doses be given at intervals of one day, and if the Wassermann reaction is not negative one week after, a course of mercury is given. The dose given of this neo-salvarsan is 50 per cent greater than that dose of the original salvarsan.

GONORRHŒA.

Local Treatment.—There is great difference of opinion as to the value of injections in the acute stage of gonorrhœa; on the whole there is evidence that the silver compounds are beneficial in all but the most acute cases.

The best injections are those of protargol and nargol, 1 per cent, but they should not be persisted in if they give rise to much pain, nor if the discharge becomes thin and scanty and fails to clear up: a more stimulating lotion is then required.

The injection should be applied in the following way. The patient empties his bladder and introduces into the meatus the nozzle of a small glass syringe holding about two drachms; the fluid is gently injected into the canal, and the end of the penis held, so as to retain the antiseptic for a period of one to three minutes. The fluid is then allowed to escape, and the process is repeated twice more: in all, three injections are given on each occasion. Injections should be given three times a day.

When the discharge persists, although thinner and less copious in the later stages, stimulating injections—zinci permang., gr. ¼ or ½ ad ℥j—should be employed.

Janet's method of pressure irrigation may be tried in cases which are very obstinate; it consists in distending the urethra and bladder with a weak solution of permanganate of potash, which is introduced by means of an irrigator suspended six or seven feet above the level of the bladder. The force of such a stream distends the urethra and its follicles and makes the compressor urethræ yield so that the fluid enters the bladder and is subsequently voided.

General Treatment.—Whether local treatment is or is not adopted, general treatment will be required, many surgeons regarding it of more importance than the local measures. The bowels must be well opened; the diet should be light; all highly seasoned foods, coffee, and alcohol should be prohibited.

A large quantity of fluid should be taken to dilute the urine and make it less irritating to the inflamed mucous membrane; barley-water, soda-water, soda and milk, or lemonade being the best for the purpose. At least three pints should be taken in the twenty-four hours.

Drugs.—Urotropin or helmitol in 10-gr. doses, with 10–20 gr. of citrate of potash and ½ dr. tinct. of hyoscyamus, forms an excellent sedative mixture.

Capsules of sandal-wood oil or cubebs are sometimes of service, but they cause rashes and digestive troubles. Gonosan appears to be more satisfactory; it can be given in capsules three times a day.

For Chordee.—Small doses of chloral hydrate gr. 5–7, combined with bromide of potassium gr. 20–30, will be found satisfactory. Camphor pills gr. 1–3 are said to be useful, but the action is uncertain.

As in the case of syphilis, the nature of the disease should be carefully explained to the patient, and the danger of the disease being communicated to others and to other parts of himself, such as the eye, by means of the discharge, made clear, so that he can take the necessary precautions.

A patient is not "free" from infection until repeated microscopical examination fails to show the presence of the gonococci.

THE DRESSING OF VENEREAL SORES, ETC.

We here consider the chief ways of dressing the initial lesion of syphilis, i.e., the true syphilitic or infecting sore, as it most commonly presents itself, the later syphilitic ulcerations, and the common soft, non-infecting, or suppurative sore, often called chancroid.

The question of early excision or cauterization of the initial sore can hardly be more than alluded to. We believe no one now recommends it. It may, at any rate, be said that if an abrasion be detected within a few hours of an impure connection, it will be quite justifiable to cauterize with fuming nitric acid, or with Ricord's paste (acid. sulph.

fort. and charcoal, q.s.), or with Paquelin's or the actual cautery. Its value is doubtful and its practice excessively painful.

Excision, unless a large wound he made, can do no more than the acid or the cautery, and is in other ways very objectionahle, while from the milder caustics, such as the nitrate of silver, no efficient protection can be expected.

But in the vast majority of cases, the time for any attempt to confine the sore to its local action has long since passed by when attention is seriously attracted to it.

The local dressing of the **Ordinary Infecting Sore** which runs its course without complications is generally simple enough. The sore itself, and the surrounding parts, must be kept scrupulously clean, bathed several times a day, and unless the foreskin be very short it will be wise in all cases to keep a piece of lint between it and the balanus. For the sore itself, black-wash, iodoform, and yellow-wash stand before all other preparations, and any one of the three is suitable for most cases.

The *Black-wash* (lotio nigra, lot. hydrarg. suboxid.), prepared by adding 15 gr. of calomel to 5 oz. of lime-water, may be used to wash the sore; also the dressing may consist of a piece of lint soaked in the lotion, and covered if necessary with gutta-percha tissue. The mercurial suboxide is very heavy, and it is better to add some mucilage to the lotion so as to suspend the powder as much as possible.

Iodoform.—This is one of the most useful of all local dressings, and the way in which specific sores take on a healing action under it is very striking. Unfortunately its strong and unmistakable odour is very difficult to hide, and one practical drawback to its employment is that the significance of its smell is now getting to be recognized by the public, so that patients naturally object to the risk of detection. Unfortunately no efficient substitute has yet been found, or perhaps we should say, that though numbers of such have been recommended, none of them seem to have been able to oust iodoform from the position which, in spite of its disadvantageous smell, it has attained.

Iodoform may be used in the form of a very fine powder simply dusted upon the sore. This is a very good way if the ulcer be a small one, and especially if it be well covered hy the foreskin. The smallest possible quantity should be taken up with a quill and applied, great care being taken not to scatter even a grain about. The powder is not so apt to scatter if the neighbouring parts have been smeared with vaseline or zinc ointment.

Another good way of using the drug is as an ointment, mixed with vaseline in various proportions, from 20 to 60 gr. to the ounce, or as a paste* (Gerrard), which can be moulded into a wafer form with the

* Gerrard recommends the following formula for iodoform paste:—

Iodoform	ʒj	Glycerin	ʒi
Wood Charcoal	ʒij	Oil of Lavender	♏xx
Glycerin of Starch	ʒi		

Mix

fingers or with a piece of wood. It may also be used in the form of a liniment, made by adding 1 oz. of the oil of eucalyptus and 5 oz. of olive oil to 1½ dr. of the iodoform powder.

Lastly, it is soluble in ether, and thus will dry as a thin pellicle over the surface of the sore, if an ethereal solution be painted on it.

The *Yellow-wash* (lotio flava, lot. hydrarg. peroxidi), is used precisely as the black wash, but is more actively stimulant.

As soon as the surface of the sore has lost its specific character, and is beginning to granulate, a weak stimulating lotion, as that of the sulphate of zinc, or of the subacetate of lead, zinc ointment, or some other simple dressing, will be all that is required. The induration must not be expected to disappear for some time after the surface is healed.

In feeble constitutions, or through neglect of cleanliness, infecting or true syphilitic sores may become freely suppurating ulcers with more or less loss of tissue. The requisite dressings for the sore in this state do not differ from those of the non-infecting chancre, which is usually a simple suppurating sore, but which may become an ulcer with well-marked loss of substance, or, in extreme cases, may run on into sloughing phagedæna.

The best treatment at first for any suppurating sore, whether infective or not, in the absence of deep ulceration, is some simple antiseptic dressing, changed every few hours. Under this dressing the sore, if it be a simple one, will soon subside and take on a healing action, or, if infecting, will soon manifest the characteristic Hunterian induration.

If the *ulceration be deep*, the patient should be kept in bed, and (in the case of male patients) the penis should be supported. Frequent warm fomentations are often found to be better than water dressings. Iodoform is useful also in this condition: it may be dusted on the ulcer, and a fomentation placed over all.

The destructive course of **True Sloughing Phagedæna** is seen nowhere more strikingly than in the genital organs, both male and female. In broken-down constitutions, or in patients profoundly unhealthy, any venereal sore may take on a sloughing action, which, once set up, seems to run riot in the loose tissues of these parts.

It is essential to arrest this destructive inflammation as soon as possible, and if absolute rest, fomentations, and poultices fail to do so, it is best to lose no time, but at once to apply the *Fuming Nitric Acid* or the thermo-cautery to the edges and base of the ulcer. A boric fomentation should then be applied and the parts bathed constantly with carbolic or chlorinated soda lotion. In very severe cases—and sometimes the destruction is very widespread—*the Continuous Bath* produces very striking effects. (Lane recommends the occasional application of tartrate of iron, 20 gr. to the ounce.)

In all these cases a generous diet and stimulant treatment will be required. Preparations of quinine, or the liquid extract of bark,

carbonate of ammonia, and chlorate of potash, are the chief drugs employed; alcohol will probably have to be given in full quantities.

As soon as the excavated ulcer begins to clean, and the sloughs to separate, *Iodoform* and boric acid are often very useful applications; but, speaking generally, any weak stimulating lotion will do for the dressing. At this time the *possibility of hæmorrhage* from eroded vessels must be kept in view. This may occur anywhere if the destruction has been deep, but is more frequent when the phagedænic action has extended to, or has occurred in, the glands of the groin or their neighbourhood (virulent bubo).

All that has been said as to the dressing of these specific sores applies equally whether they occur in men or women, save that in the latter the dressing is generally more difficult to manage, and that indolent infective sores, when they occur high up in the vagina, are very apt to be overlooked.

The ulcers which result from the *Breaking down of Syphilitic Deposits in the Skin* or the tissues beneath, or as the result of other specific inflammatory processes, differ from ordinary ulcers in their dressing in only one or two points, and it is only with their dressing that we have here to do.

The surgeon's efforts are in all cases directed towards the disappearance of those peculiar characteristics which cause these ulcers to be called *specific*. When once these are lost, and the sore assumes an ordinary appearance, it rapidly heals.

The fœtor, the sharp-cut edges, the dirty base, and the sanious discharge, must be replaced by healthy granulations, bevelled-off edges, and the secretion of "laudable" pus; and to effect this, in all cases constitutional as well as local treatment is called for. It is this that makes it so necessary to recognize these ulcers. Nothing is more common than to see some obstinate ulceration baffle for months or years all efforts to heal it over, and then to find it disappearing from day to day, almost from hour to hour, as soon as full doses of iodide of potassium are administered.

On the other hand, although attention must be given to the condition of the circulation in the part, this is not so urgently demanded as in the case of simple ulcers.

The first importance of constitutional treatment being understood, by proper local dressing the rate of healing may be greatly increased. So long as the sore has any specific character, so long must the *dressings* be antisyphilitic. The preparations of iodoform, black wash, various mercurial ointments, especially the ung. hydrarg. oxid. rub., calomel and vaseline, or the ung. hydrarg. subchlor., may all be used with advantage, with many more. The acid nitrate, or the bicyanide of mercury, may be used as a caustic for warts, fissures, or mucous tubercles, as in the mouth; as may also the mercuric perchloride in a strong solution (say 24 gr. to the ounce).

Chapter XXVI.

OF CERTAIN SPECIAL INFLAMMATIONS.

ERYSIPELAS.

THIS is an infective condition of the skin or subcutaneous tissues, due to a peculiar variety of streptococcus. It is customary to consider certain special varieties :—

1. **Erysipelas Proper,** the infection being confined to the lymphatic spaces immediately beneath the epidermis, a form usually unaccompanied by swelling of the tissues except in such situations as the scrotum or the eyelids.

2. **Cellulocutaneous Erysipelas.**—A superficial form of cellulitis, indicated by swelling and redness of the part.

3. **Deep Cellulitis,** which is an infection of the sub-fascial layers. Only as the process tracks towards the surface does the skin become red. There are, however, considerable pain and swelling, and the whole part has a brawny, indurated feeling.

The last two varieties may be associated with a large amount of tissue destruction, owing to the sloughing of the skin stretched over the inflammatory exudate.

Treatment.—As these infections are more liable to occur in patients whose constitution is unsound, either from glycosuria or albuminuria, a careful examination of the urine must be made. As a routine, the bowels should be opened by a brisk purge ; subsequently, stimulants and tonics may be administered, quinine and iron being most useful. A rigor is often the first symptom of the superficial variety, and in many cases—especially in children—the constitutional symptoms are most severe. The temperature may rise to 104° or 105°.

Local Treatment consists in applying lotions or protective dressings, leaving the disease to run its course, a form of treatment suited to mild cases ; but any unhealthy focus from which the infection has arisen should be actively treated with pure carbolic acid. One of the best applications in mild forms of the disease is the lotio plumbi c. opio, or, if preferred, gauze wrung out of 1–60 carbolic may be substituted. Ichthyol has been used in the form of a paint with much success

If the attack is a severe one, and if the part affected is suitable for more active treatment, the tincture of iodine or strong solutions of silver nitrate may be painted ½ to 1 inch away from the red, sharply defined edge. The object of this treatment is to excite a protective leucocytosis which will be able to destroy the organisms of the infection

as they reach this protected zone. Kraske scarifies the area round the erysipelatous rash with a fine knife in order to produce the same effect, and it is said that a more energetic and satisfactory reaction is produced by this method.

Incisions are not required as a rule in this variety, but when the scrotum or the eyelids are attacked, the loose cellular tissues become swollen and œdematous, and the knife may be used with advantage. Minute punctures only should be made. In alcoholics, erysipelas may attack the mouth and pharynx, an exceedingly dangerous situation, since there is considerable risk of œdema of the glottis supervening. Erysipelas of the face and scalp may give rise to serious intra-cranial complications, since the infective process may spread along the numerous channels of communication into the cranial cavity.

Treatment of the other cellulitic varieties must be conducted along more rigorous lines. In a few cases it may be advisable to try the effects of rest and moist antiseptic dressings for twenty-four hours, but with this exception, the sooner incisions are made into the inflamed area the better. If active treatment is delayed, the inflammatory process tends to burrow along the fascial planes, and deep-seated abscesses will form. The incisions should be free and numerous, with a due regard to the position of important structures, and they should extend, in the case of the deep cellulitis, right through the deep fascia. Drainage tubes must be employed in those cases where there is a localization of the pus.

After-treatment will consist in supporting the patient's strength, so that he may be able to neutralize the toxins elaborated in the affected region. Alcohol may be required, and iron, quinine, nux vomica, and arsenic will be of service. The part should be dressed with moist antiseptic dressing. In many cases constant irrigation with weak carbolic (1–200) or boracic acid is indicated, or as an alternative, if a limb is affected, it may be immersed in a bath of the same antiseptic. It is very essential to see that only a very weak solution is used, as the continued application of strong antiseptics is very injurious to the tissues, and may lead to poisoning. As soon as the acute inflammatory phenomena have subsided, massage and passive movements should be cautiously undertaken, so as to prevent undue fixation.

The greatest care must be taken that the infection from these cases is not conveyed to others, especially to surgical or midwifery patients. Cases of erysipelas and cellulitis should be isolated.

BOILS.

A boil is an infective gangrene involving a small area of the cutis, in most instances starting around a hair follicle or in a sebaceous gland; in this respect it is closely allied to acne. When the infective process is more extensive and involves the deeper layers, it becomes a carbuncle. These infective conditions are liable to arise in those who suffer from diabetes or albuminuria, and it is always necessary to examine carefully

for these pathological conditions in any case of extensive infection with boils. Apart from these constitutional diseases, patients who sufler from boils usually show a very low resistance to the staphylococcus, a point to be specially considered in connection with the treatment.

Treatment.—*Local Treatment* consists chiefly in applying an antiseptic dressing after careful purification of the surrounding skin. In many cases the boil aborts or becomes blind; that is to say, the inflammatory process subsides without suppuration. The general method of covering a boil with a poultice or fomentation is to be condemned, since it tends to disseminate the infection and to cause a fresh crop to erupt.

When once a boil has made its appearance as a conical, red, tender swelling, an excellent form of treatment is to cut out and apply a small piece of Unna's plaster rather larger than the boil, with a small opening in the middle, which should be over the centre of the inflamed area. The boil must be carefully protected from pressure or irritation, either by a pad of gauze or lint, or by means of a small celluloid shield.

Another method, applicable to those boils which have come to a head, is to snip off the projecting point and to apply pure carbolic with the end of a match to the centre of the area.

Gallois treats cases as follows: A solution is made up of iodine (1 dr.) and acetone (2½ dr.); a probe surrounded with cotton-wool is dipped into this iodacetone and applied to the boils, giving them the appearance of so many "beauty spots." A piece of absorbent material large enough to cover the whole region is soaked in boric acid glycerin (glycerin 6 oz., boric acid 5 dr.), and this is applied as a dressing over the whole area. The dressing is renewed once or twice a day, according to the amount of discharge. To succeed in this treatment, M. Gallois insists that antiseptic precautions should be observed.

Bier's cupping-glasses may be applied with benefit to the affected parts (*see* Chapter XXXVII).

In cases where there are considerable induration and pain, relief will be afforded by a free incision into the brawny mass.

General Treatment consists in free purgation and the administration of tonics—iron, arsenic, and quinine. The sulphide and the iodide of calcium have been used with much success.

Vaccin Treatment.—The condition of furunculosis, or the general development of boils, being due to a lowered resistance to a staphylococcal infection, Wright has treated patients by means of a staphylococcal "vaccin," the object being to increase the opsonic index, and so the general resistance to this micro-organism. The results of this method fully justify its wide application.

CARBUNCLE.

As in the case of the preceding diseases the association of this condition with diabetes, albuminuria, and other debilitating conditions must

always be borne in mind. Not that these states necessarily preclude the successful treatment of carbuncle by operation; indeed, in many cases there is an improvement in the glycosuria or general condition after the local infective process has been satisfactorily dealt with. At the same time it will be advisable to consider how far the administration of an anæsthetic is likely to be injurious. If the general condition is on the whole good, radical local treatment under anæsthesia should be resorted to; if, on the other hand, constitutional disease is advanced, the minimal amount of local treatment necessary should alone be attempted.

A second detail of practical importance in connection with the pathology of carbuncle is the fact that the vessels in the substance of the inflamed area are in a state of infective thrombosis, and there is danger of the spread of systemic infection or pyæmia. Carbuncles on the face or scalp are especially dangerous, since the free communication between the superficial veins and the cranial venous sinuses renders the latter liable to fatal thrombosis.

The patient must be liberally fed and well supplied with alcohol, the bowels should act freely, and every effort be made with tonics, iron and quinine, to improve the general health. If the pain is excessive, morphia may be given, though the need for this drug must be made subservient to the state of the kidneys.

Local Treatment consists in:—

1. Complete excision of the whole infected area wide of the disease; this can only occasionally be practised, but is very satisfactory, the resulting wound, after thorough disinfection, being lightly packed with gauze and allowed to granulate.

2. Scraping out the gangrenous core and the application of pure carbolic acid. It has been urged against this line of treatment that there is some danger of the clots becoming dislodged and carried into the circulation, with the result that pyæmia is set up. If the operation is carried out thoroughly, so that the deep fascia at the bottom of the wound is well exposed, and all the indurated tissue at the periphery of the necrotic area is radically treated, there is little danger of this accident occurring; it is much more likely to supervene if the operator is over-cautious, and merely stirs up the centre of the process with a timid hand.

3. I have lately treated a number of carbuncles, especially in debilitated subjects to whom I have been disinclined to administer a general anæsthetic, in the following way. The carbuncle is fomented until the central core softens, and then a small piece of lint is cut the exact size of the carbuncle, and soaked in the following: Glycerin of carbolic acid 1 part, glycerin 1 part. The soaked lint is then applied to the carbuncle accurately; a small piece of oiled silk is placed over the lint, and the whole is covered with a gauze dressing. If there is any tendency of the lint to shift, it must be kept in place with strapping. I have found this method very satisfactory, as the glycerin excites a

free flow of lymph. Care must be taken, however, that only a small piece of lint is used, as the solution of carbolic acid is very strong. Good feeding and tonics are essential adjuncts to successful treatment. I am less inclined to operate on carbuncles than formerly.

4. Incisions, usually crucial, may be made into the swelling, and pure carbolic acid may be injected, 5–10 minims, into various points of the swelling. The wound is then fomented and the dead material allowed to slough out.

Under all conditions it is wise to apply fomentations (carbolic) to assist the slough to separate, and a careful eye must be kept on the wound, since the pus occasionally has a tendency to burrow away into the surrounding tissues.

As soon as the sloughs have separated and healthy granulations have made their appearance, the wound should be dressed with protective, and if the epithelium is slow in covering the surface of the wound, skin-grafting may be employed.

NOMA, OR CANCRUM ORIS.

A special kind of phagedænic ulceration is known as *noma*, or when it occurs, as is usual, about the mouth, *cancrum oris*. In its pathology it appears to be almost identical with sloughing phagedæna, as it is in its treatment. It is especially a disease of children, and is characterized by the peculiar dryness of the slough, which looks more like an eschar, and by the rapidity of its destruction. It is often almost painless, and may be accompanied by singularly little constitutional disturbance until quite late in the progress of the case. This, the true "cancrum oris," must not be confounded with that common ulceration of the mucous membrane of the mouth which is often met with in ill-nourished children.

It is frequently a sequel of diphtheria or scarlatina, but it seems as often to attack children to all appearance healthy and well nourished, as those who show signs of malnutrition.

Whenever there appears, in children, in the substance of the cheeks, or on the vulva, *a dusky induration*, with a dry central slough, the case should be looked upon with suspicion, and if it shows any tendency to spread, there is no question but that the right course is to remove the gangrenous tissue at once, and to apply nitric acid, or some other form of cautery, freely; after the acid has been allowed to act for five minutes, a lotion of bicarbonate of soda should be applied to neutralize the excess.

One common cause of death in these cases is the poisonous effect of the putrid discharges when these have been swallowed. It is impossible to prevent this altogether, but very much may be done by extremely frequent washing out with such lotions as the chlorate of potash, chlorinated soda, dilute liq. chlori, or sanitas or sulphurous acid. Chlorate of potash should also be freely given internally in doses of 3–5 gr. t.d.s.

BED-SORES.

Experience alone as to what *bed-sores* may become if neglected will enable the student to realize the extraordinary amount of destruction which this form of ulceration from pressure can cause, or the rapidity with which it spreads, or the insidiousness of its commencement. It is also very necessary for every surgeon and every nurse to understand that, with the exception of certain paralytic cases, bed-sores are *almost always preventable*, and when present are, as a rule, standing evidence of *neglect or mismanagement*. But, though we will not qualify this assertion further, it must be allowed that sometimes it is extremely hard to prevent soreness, as, for example, in the case of hip disease with extreme emaciation, contraction of both legs, and suppuration. Sometimes, again, tissues have such a low vitality that it seems as if the least touch would produce a slough; still, with incessant watchfulness, bed-sores *can* be prevented, although once begun they are very hard indeed to arrest or to heal.

In *warding off* the formation of bed-sores, attention must be specially directed to the following points:—

1. The *bed* must, in all cases, be smoothly made, elastic, and soft; a spring mattress is often a great help, and water cushions may be used for the buttocks. But in cases where there is a well-marked tendency to soreness there is nothing like a *complete water bed*. In filling one of these beds care must be taken to have the water properly warmed, and not to put in more than will just support the patient.

2. In every possible way *continuous pressure must be avoided* upon the parts which are liable to become sore, such as the sacrum, trochanters, ischial tuberosities, heels, occiput, elbows, or the spines of the scapulæ. Taking every precaution (when precaution is needed, as in fractures) against doing local harm by movement, in some way or other it must be managed that the patient shall shift his points of pressure upon the bed, lying now a little low, now a little high; first with the head to one side, next day turned slightly over (for the least shift is as efficient as a great one) to the other; a pillow may be put under the knees one day and omitted the next.

3. Something may be done to improve the *nutrition of the skin* by bathing with stimulant lotions (whisky or brandy and water is a common application). Starch or violet powder should be freely used, and if the tendency to soreness appears imminent, the part, which will be a bony prominence, should be strengthened by washing it with brandy and white-of-egg mixture, or spirits of wine and perchloride of mercury lotion, 1–2000, and the sore or threatening part protected by a circular pad of wool or lint.

4. *Absolute cleanliness*, as regards removal of excretions, is another essential in the prevention of bed-sores, for nothing softens the skin more and makes it more liable to break down than to be constantly

wet with urine or foul with fæcal matter. Incontinence of either or both must make one doubly careful.

Nowadays, in hospitals or where skilled nursing has been employed from the first, such precautions as we have mentioned will be sufficient to prevent soreness altogether, or at the worst to limit it to a superficial excoriation. The cases we meet with where true ulceration is present are those where there has been previous neglect of nursing care, through ignorance or poverty.

Such cases are not infrequent among those who come at last to be hospital in-patients, and whatever the nature of the original illness may be, the bed-sores will count heavily against recovery. These ulcerations are indeed very hard to dress; they present the characters of deep foul sloughing ulcers, not generally painful, but tending to destroy all the soft parts between the skin and the bone, and often complicated by necrosis of the bone itself. The great point then is to remove all pressure, and to get the ulcer to begin to clean.

If a sore has already developed it must be dressed with some antiseptic ointment, such as boric ointment, or with resin ointment if a more stimulating preparation is required.

Very much will depend upon whether there is improvement of the constitutional condition or the reverse. If there be general recovery, local recovery is often extremely rapid when once it is started.

Chapter XXVII.

BURNS AND SCALDS.

WHEN a large area of the body is involved, burns and scalds give rise to many complications, and they are injuries which it is difficult to treat satisfactorily. In the early stages profound shock and great bodily depression must be combated: indeed, the mortality following burns is greatest during the first twenty-four hours which follow the injury. This shock must receive appropriate treatment, saline injections being most valuable, and at the same time every effort must be made to prevent any further loss of vitality through prolonged exposure and manipulation. In any case of extensive burns there is a danger of asphyxia, or of poisoning by carbon monoxide. It is necessary to bear these dangers in mind, for prompt performance of artificial respiration, together with oxygen inhalations, may be most effective in meeting these complications. Subsequently there is considerable risk of septic absorption from the large sloughing surface, and fatal issues are due to the development of low forms of pneumonia, duodenal ulceration, and meningeal inflammation and thrombosis. In the final stages much trouble will be experienced in dealing with large granulating surfaces, and with rapidly contracting scars—scars which if left may cause permanent deformity and disablement.

Treatment.—This will therefore be considered according to three main stages: (1) *Immediately after infliction;* (2) *During separation of the sloughs when repair is taking place;* (3) *When granulations have appeared and the wound is beginning to cicatrize.*

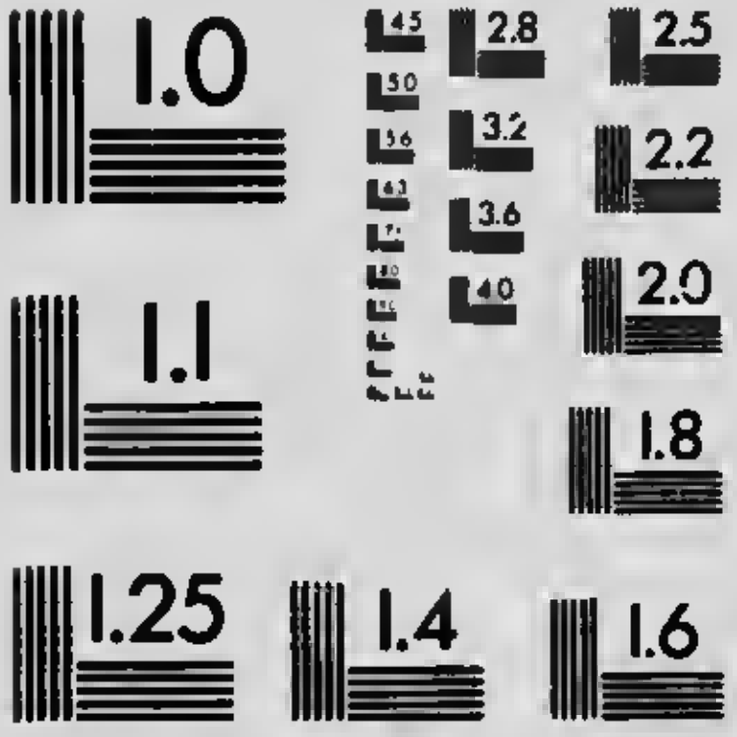
1. **Immediate Treatment.**—The patient must be put to bed as soon as possible, the clothes must be cut off, and without delay or exposure a dressing must be applied over the whole of the damaged area. If the burn is very extensive, it is better to deal gradually with different regions than to completely strip and expose the whole surface at once. Charred skin or dead tissues should be snipped away carefully with scissors, if this step can be accomplished quickly. Blisters should be cut open, so that the serum can drain away. If the clothes adhere, and if there is a large amount of dirt present, it is advisable either to immerse the part in a warm (100° F.) boracic acid bath, or to soak it with warm boracic acid solution.

A number of different applications have been recommended after the above preliminaries:—

(*a*). *Oily dressings*, which have little tendency to adhere to the

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 – 0300 – Phone
(716) 288 – 5989 – Fax

burnt surface — eucalyptus oil and vaseline, or the ointment of Réclus :—

℞	Antipyrin	ʒj	Phenol	gr. xv
	Salol		Hydrarg. Perchlor.	gr. ij
	Acidi Borici	āā ʒss	Vaselin. (pur.)	ʒvij
	Iodoformi	gr. xv		

This can be diluted by the addition of more vaseline if necessary.

(*b*). *Antiseptic dressings*, which may be left unchanged for some time. Lint soaked in a saturated solution of picric acid is applied to the part, and over this layers of cotton-wool secured by a bandage. As an alternative an antiseptic cyanide gauze dressing may be used.

Werner's treatment consists in soaking the burnt part in a 2–5 per cent solution of carbolic acid, which is anæsthetic and antiseptic. The acid is removed by a second bath of normal saline solution, and the surface of the burn is dusted with a powder composed of acetanilide 1 part, zinc stearate 5 parts ; over this narrow strips of Lister's green protective are placed, and the whole region is finally covered with wet sublimate gauze, and bandaged.

Stimulants will be required until the shock has passed off ; later, iron and quinine should be given, digitalis and nux vomica if there is evidence of cardiac weakness. Morphia may be necessary, but must be given with caution.

When the part has been dressed, provided no symptoms of septic poisoning arise, no attempt should be made to interfere with the damaged part. The dressings may be left alone for several days. But if, as is usually the case, the wound does not remain clean, the dressing must be changed repeatedly, as in the case of any large septic wound. It is often necessary to perform this dressing under an anæsthetic, owing to the pain which it inflicts upon the patient.

2. **Treatment during the Separation of the Sloughs.**—If the burn has not remained aseptic—and it is very difficult to ensure this condition—a considerable amount of offensive discharge will accompany the separation of the dead from the living tissues. At this period, as has been said, there is great danger of complications developing from septic absorption. The separation of the sloughs should be assisted with scissors, so that very little dead tissue remains to harbour putrefactive organisms. All purulent blebs or foci should be opened up, and the dressings should be frequently changed. If the position of the part permits, a weak antiseptic bath is most satisfactory ; this failing, large fomentations applied to the sloughing surfaces are satisfactory. In milder cases an oily dressing, as above described, may be continued until granulations have appeared.

If antiseptic baths or lotions are used, they must be made up very dilute, as the large surface exposed to their action readily permits of the absorption of the poisons from which they are made, and it is no unusual thing for carbolic or mercurial poisoning to occur during the treatment of a burn.

During this stage the patient's temperature will rise, and he will exhibit signs of septic poisoning.

3. **Treatment when the Wound has begun to Granulate.**—The main objects now are to accelerate the healing process and to prevent undue contraction. If the granulations are flabby and unhealthy, stimulating lotions—lotio rubra—should be applied, and general tonics—nux vomica and iron—should be administered. As a dressing, nothing is more satisfactory than a piece of green protective, a number of holes being cut in it to prevent the retention of the discharge, or perforated zinc or silver foil. The protective is placed directly over the granulating surface, and it is then covered by sterilized gauze. Under this treatment the granulations become flat and healthy, while the growing epithelium is not damaged each time the dressing is changed. The wound should be well irrigated with normal saline or boracic acid solution once or twice a day.

If large areas of granulation remain, and the epithelium is sluggish in covering them, skin grafting must be employed in order to diminish the risk of subsequent contraction.

During this stage every care must be taken to check this contraction, especially in the neighbourhood of joints. For this purpose splints should be employed which exert a force in the direction opposite to that of the adjoining fibrous tissue, and as soon as possible the scar should be massaged and stretched. Gentle kneading and stretching alone are required, or the scar will be torn open.

Scalds or Burns of the Larynx and Pharynx present such special features that they must be mentioned separately.

They are produced generally by drinking scalding liquids, and are thus far more frequent in children than in more sensible adults. (The habit of allowing children to drink out of the spout of a kettle will account for more scalds of these parts than all other causes put together.) But breathing hot air, as in a fire, may produce the same effects, and practically the action of any chemical caustic is the same in this situation as that of the thermal ones.

Scalds of the *Pharynx* itself are not usually very serious, unless the consequent œdema of the tongue and fauces reaches a very high degree; but when the scald extends farther down, so as to affect the arytenoepiglottidean folds and the œsophagus, there are both an immediate and a remote risk of complications. The remote one is that the scald of the gullet may cause a contracting cicatrix, and thus become itself a simple stricture, or that the cicatrix may be the seat of a new growth, and thus develop into a malignant one.

But it is with the immediate risk of suffocation through œdema of the larynx that we are concerned here. These cases always cause anxiety, and require very prompt treatment. If, shortly after the accident, there be a distinct difficulty of breathing, from obstruction, the safest plan will be not to wait for more urgent symptoms, but at once to perform *laryngotomy*, or, in young children, a high *tracheotomy*,

and then to treat the case with a warm moistened atmosphere, and in all other respects as if it were a case of diphtheria in which the operation has been called for. But often there is a deceitful calm for some hours, and we may be tempted to think that the larynx has escaped altogether, when suddenly the most urgent dyspnœa may be developed. Whenever, therefore, inspection of the mouth and throat shows that a scalding fluid or a corrosive liquid has passed down it, the patient must be carefully watched, made to breathe a steamy atmosphere, and the surgeon should be ready himself, and have his instruments in readiness, to open the windpipe if necessary.

Skin Grafting may be employed to cover large granulating surfaces, or to make good recent deficiencies resulting from operation. The main objects of the procedure are to accelerate healing, since, although the epithelium may ultimately grow over a large granulating area, the process is slow; and also to diminish the amount of contraction which always occurs to a great extent during the period of epithelial growth.

Before considering the various methods which may be employed, it is necessary, for success, to insist upon the most *rigid asepsis*. The greatest enemy to any form of plastic surgery is sepsis. Antiseptic lotions should not be used, since they injure the delicate epithelial cells. Sterile gloves should be worn by the operator, fat and epithelial débris should be removed from the patient's skin with ether soap followed by absolute alcohol, and all instruments should be dry or immersed in normal saline.

Of the various methods employed, three only will be considered: (1) Transplantation of the whole thickness of the skin—devoid of fat; (2) Transplantation of the epithelial layers, together with a thin slice of the corium (Thiersch); and (3) Small particles of epithelium which have been snipped off with scissors are dropped on to a granulating surface, where they grow like seeds in a suitable soil (Reverdin).

The first method is more particularly applicable to recent wounds, such as those caused upon the face by the removal of a large rodent ulcer; but it may be used to cover granulating surfaces, and it has the advantage of providing a thicker and more resistant covering than the succeeding methods.

If a granulating surface is to be treated, it is advisable, a few days previously, to remove with a sharp spoon redundant granulations down to the firm fibrous layer, taking care not to destroy the deeper parts too thoroughly; the surface is then dressed with perforated oiled silk covered with gauze moistened by normal saline. This preliminary treatment ensures that the granulations shall be young and vigorous and that the surface shall be uniform and flat.

If the surface to be covered is that of a recent wound, all bleeding must be checked, and if any antiseptics have been used the surface must be *well irrigated* with normal saline.

"The skin required is removed from a suitable situation—thigh or abdomen—after careful preparation, in the form of a long ellipse. The

incisions are made down to the aponeurotic covering of the muscles. The flap thus includes skin and subcutaneous fat, and is set aside in warm saline solution. The wound is sutured and dressed. The surface to be grafted is now uncovered. The flap is taken from the saline solution, and the fat is removed. This is done by turning it over in the palm and cutting away the fat with scissors curved on the flat. When the surface to be covered is large, the graft may be divided into as many pieces as necessary for distributing it over the surface at suitable intervals. After the application of the grafts the wound is covered with an oiled silk and gauze dressing as before described."

This method is a modification of that of Wolfe Krause as suggested by Young, of Glasgow, who advises that the dressings should be changed each day. If this is done the greatest care must be exercised not to displace these grafts, and it is advisable as a precaution that the grafts be stitched to the margins of the wound with a few points of fine silkworm gut at the time of the grafting.

Grafts may be taken from other patients; the foreskin of a child that has just been circumcised being of great service when there is a very large area to be covered. It should be kept in warm saline until the surface to be grafted is exposed. Frog's skin and mucous membranes have also been used.

Thiersch's method is the one usually employed. The details are as follows: A surface of skin on the thigh, arm, or abdomen is carefully prepared by shaving and cleaning, and the granulating surface is washed over with normal saline preparatory to the placing of the grafts. There is some difference of opinion as to how this granulating surface should be prepared. Thiersch advised the removal of the granulations, but this does not always seem satisfactory. If the surface can be prepared a few days previously as above described, it is in the best condition for the reception of the grafts. If, however, Thiersch's advice is followed, the surface granulations should be removed by gently rubbing with a piece of gauze until the firm deep layers are exposed and the whole surface is smooth and uniform. *Bleeding must be checked with hot saline and gentle pressure.*

Thin slices are now cut from the prepared surface with a sharp razor; these should just include the tops of the papillary layer, and if cut correctly they will be free from fat and will leave a uniform bleeding surface. They are cut with a gentle sawing movement. A little practice will enable the operator to cut long even strips.

Unless the grafts curl up in a troublesome manner, it is better to transfer them direct on the razor to the surface to be treated, where they can be flattened out by means of a probe. The objection to transferring them to saline is that they are apt to curl up in a still more troublesome way, and it is not always easy to tell which is the "cut" surface, and moreover the less exposure and manipulation they are subjected to the better.

When the whole surface has been adequately covered—and as many

as ten strips may be needed—a piece of silver foil or oiled silk, perforated so as to allow the discharge to escape, is placed on the wound, over which moist gauze and wool are bandaged. The dressing should not be changed for four days, at the end of which period the grafts should be found adherent.

The surface from which the grafts were taken should be dressed with some antiseptic ointment, as a gauze dressing is apt to stick to it and cause pain.

Reverdin's method can be easily applied with the above-mentioned preparations and precautions, but is less satisfactory.

Whichever method is selected, success will depend upon absolute asepsis.

The Tagliacozzian method is not considered here.

SECTION V.

OF CASES REQUIRING PROLONGED OR MECHANICAL TREATMENT.

CHAPTER XXVIII.

OF HIP DISEASE.

THERE are certain surgical cases in which deformity is a prominent feature, which are so common, and require such patient and prolonged treatment, that every student of surgery should understand the principles of their mechanical and general management.

The most important of these are the usual forms of *Hip Disease*, of *Lateral* and *Angular Spinal Curvature*, of *Club Foot*, *Contracted Knee*, and *Bandy Leg*.

In describing, as we propose to do in this section, the ordinary proceedings for the treatment of these conditions, we shall confine ourselves to the manual operations, and shall not discuss their pathology or treatment in other respects.

1.—ACUTE HIP DISEASE.

In all the acute forms of hip disease the surgeon's efforts are directed towards subduing the inflammation, so that suppuration shall not occur, and towards preventing deformity. If these ends are to be obtained, the joint must be *kept at rest*, and the limb *kept in extension*.

The muscles about the hip are the chief agents in keeping up irritation and causing the deformity of *flexion* and *abduction*, and it is because muscular spasm can be better controlled by steady traction than by any other means, that the use of the stirrup and weight is so general in these cases; for although the plan was first introduced with the idea that an actual separation of the inflamed joint surfaces was thus obtained, it is now generally held that this does not take place.

The most **Common Plan of Treatment** is to put the patient to bed in the supine position, with the head low; with a stirrup and weight attached to the limb, and passing over a pulley (*Fig.* 152); and with the foot of the bed raised, as described for fractures of the femur, under which heading the method of putting on the stirrup and weight will be found.

The *Bed* should resemble a fracture bed in all respects, particularly in smoothness and absence of sagging.

The Amount of Weight will vary in every case, and may be anything between 3 and 12 lb. It must be the smallest that will keep the limb at rest, but it must be sufficient for this, or it will simply act as a

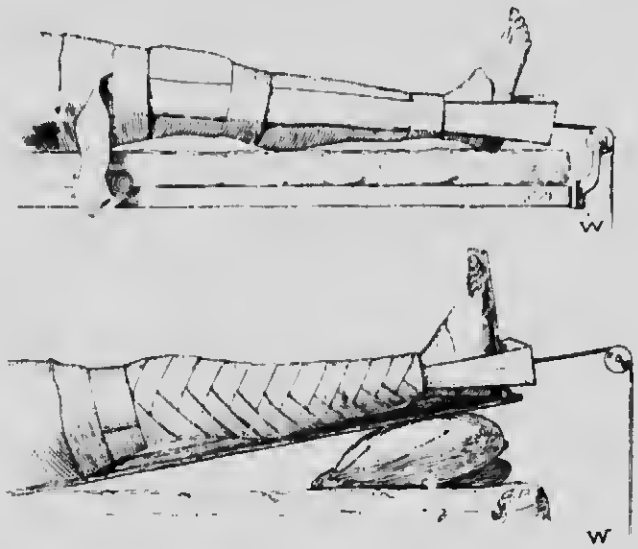


Fig. 152.—Stirrup and Weight in Position.

stimulus to the contracting muscles, and be actively harmful. It often takes some days for the spasm of the muscles to be exhausted.

The Direction of the Pull of the Stirrup.—The pull upon the limb in these cases should be in the direction of the deformity.

Fig. 153.—Method of Fastening down a Child in Bed.

This is essentially a children's disease, and for this reason it is often difficult at first to secure the continuous supine position with the head low. When children have once learnt that rest means ease, they will lie flat and still enough, crying only when they are moved, or when

weight is lifted from the leg. But at first it is often necessary to fasten a child down, and this can easily be done, as shown in the figure (*Fig.* 153), by a sort of harness of webbing by means of which the shoulders and chest are attached to the bedstead, or to a thin piece of wood running across underneath the mattress.

The same result may be obtained, as will be described later, by putting the child in a Thomas's hip splint.

No counter-irritant is considered advisable in these cases, perfect rest being the best treatment that can be followed.

Other Methods of Treatment.

1. By the **Stirrup and Weight,** combined with the *long splint*, adjusted as for fractures of the femur. This is very useful in cases where there is great pain, and where the limb becomes so ill-nourished that it is unable to sustain properly without assistance the requisite pull on the stirrup. If the stirrup and weight are required for a long time, especially if there be much wasting of the limb, some of the pull should be made from above the knee; for that joint may suffer, or the upper epiphysis of the tibia may become separated from the shaft in consequence of the constant traction.

2. By **Thomas's Splint.** This splint will be considered in detail immediately, and, as time has fully justified the inventor's expectations of its use, it may be applied to the patient in any stage of the disease, including the earliest and most acute one, when confinement to bed is imperative, provided that the deformity, flexion, and abduction have been overcome.

3. By **Bryant's Splint** (*Figs.* 154, 155). This is a useful splint for many stages and forms of hip disease, or of fractures about the hip, and may here be conveniently described, though it is more extensively used in chronic suppurative cases, or after excision or osteotomy.

Its appearance and application are sufficiently explained in the figures. In *Fig.* 155 it will be seen that extension is made with a pulley and weight fastened to the foot-piece, and this will be found better than the indiarubber springs in *Fig.* 154.

In the cases we are now considering, i.e., cases of early hip disease, there will generally be no shortening, so that the two foot-pieces should be at the same level. It is always wise to put on flannel bandages round the legs before fastening them with the ordinary roller to the splint. The interrupted part should be opposite the great trochanter, and a broad flannel roller will be found the best for fastening the trunk to the two splints between which it lies.

The great advantage of this apparatus, as in Thomas's hip splint, is that the patient can be readily lifted, or turned right over, or on to one side, the splints which run on either side being so firmly braced together above and below that the trunk and limbs are perfectly rigid, while the parallelism of the legs is well maintained.

The valuable aid which anæsthetics afford in some cases of acute hip disease in their early stages must also be mentioned. It not infrequently happens that the muscular spasm and consequent deformity appear to be out of all proportion to the other signs of inflammation about the joint, and the stirrup and weight fail to produce rest by extension. As soon, however, as the patient is anæsthetized,

Fig. 154. Bryant's Splint.

the limb comes down readily, and it is often wise to fix it then and there in good position on a Bryant's or Thomas's splint—or to a simple long splint,—while the spasm has been thus temporarily abolished. It is not rare for the subjects of hysterical neuromimesis to simulate the contraction of the limb and other symptoms of genuine hip disease. If

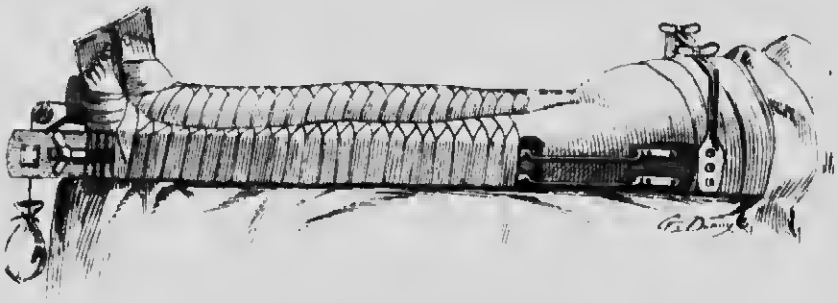


Fig. 155.—Bryant's Splint Applied.

such a patient be put under chloroform, the symptoms due to muscular contraction will of course disappear. But they will disappear also in cases of genuine joint mischief, if this be only commencing. Cases of real joint disease may thus be put down "only hysterical" because the suspected articulation, usually exquisitely tender, has been found to move with freedom when the patient was anæsthetized.

II.—CHRONIC OR OLD-STANDING FORMS OF HIP DISEASE.

The treatment of these cases is to a large extent mechanical, since in nearly all of them some degree of deformity is present. In the cases we are now considering there is *no bony ankylosis*, and suppuration has either terminated or been absent throughout.

In these cases the general plan of treatment is to keep the *patient lying down*, and to try, by means of the stirrup and weight, to pull the limb gradually *straight*, the weight employed being generally

greater than in acute cases. The foot of the bed should also be more raised.

Unless the case be a very simple one, it will be found that the limb apparently lies straight enough directly the weight is put on; but if the hand be now placed below the lumbar spines it will be seen that they form an arch to an extent corresponding to the deformity. In other words *lordosis* of the back has been produced. The appearance of improvement is therefore quite deceptive, and the weight is doing little or no good. It must always be kept in mind that for the apparatus to be of any avail in reducing deformity, no lordosis must be allowed, that is, the *whole back must be in contact with the bed*. The only way to secure this is to make the *pull* of the stirrup almost in *the direction*

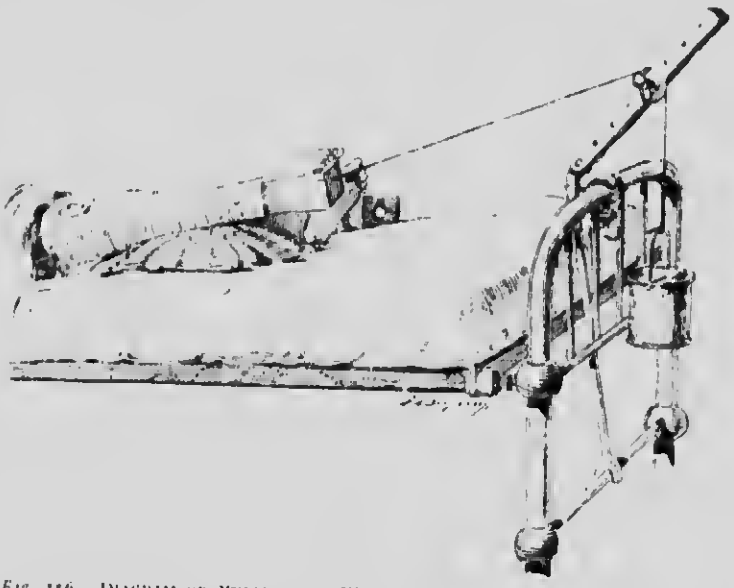


Fig. 156. Diagram of Pulley and Weight making Traction in Direction of Deformity.

of the flexed and abducted femur. This may most readily be done by attaching the pulley-block to a standard placed at the end of the bed, so that it may be raised or lowered (*Fig.* 156). The standard also may be shifted laterally.

It is best to make no attempt at reduction of the deformity during the first week of treatment, but simply to get the parts at rest, and to abolish muscular spasm, by making traction in the direction which the femur assumes when the spine is flat on the bed. Then inch by inch, and very gradually, the limb may be *adducted and extended*. When the extension has done its work, if the parts are quiet and free from pain, Thomas's treatment may be begun, but only if the limb is in a good position. In more advanced cases the limb is more acutely

flexed and *adducted*, under which circumstance the adduction must be overcome, as was the abduction of the earlier stage.

Thomas's Splint.—The mechanical principles on which many cases of hip disease may be successfully treated with little or no confinement to bed, are fully explained and advocated by H. O. Thomas, in his book on this subject,* from which a quotation is made below, in order that the student may read in the inventor's own words the description and use of the splint. The account has been slightly condensed, and it has been thought as well to retain it in this edition for the benefit of those who do not live near to an instrument maker and can only employ a blacksmith to fashion the splint.

The *Objects of Thomas's Splints* are, first, to secure rest and to avoid friction, by means of posterior fixation of the hip joint, together with

Fig. 157.—Single Thomas's Splint.

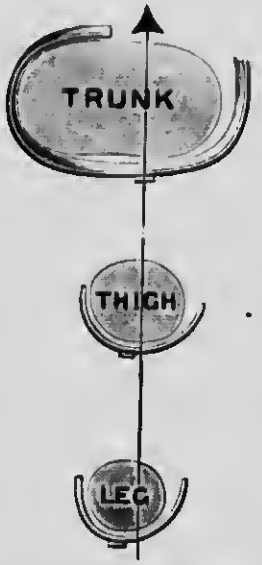


Fig. 158.—Section of Trunk and Limbs at level of the half circles of the Splint.

the trunk, thigh, and leg; and secondly, to allow the weight of the limb gradually to remedy the deformity in the place of a more active form of extension.

"We will suppose the patient, æt. 10, with right hip-joint disease. The surgeon requests him to stand on the left limb, and proceeds to measure him for the instrument. A block, or several if necessary, is placed under the sole of his right foot, until the sound limb is raised sufficiently to allow the spine to resume its natural form.

"Now he takes a long, flat piece of malleable iron, one inch by a

* "Diseases of Hip, Knee, and Ankle Joints." Liverpool, 1876.

quarter for an adult, and three-quarters of an inch by three-sixteenths for children, long enough to extend from the lower angle of the shoulder-blade in a perpendicular line downwards over the lumbar region, across the pelvis slightly external, but close to, the posterior superior spinous process of the ilium, and to the prominence of the buttock, along the course of the sciatic nerve, to a point slightly external to the centre of the extremity of the calf of the leg. The iron must be modelled to this track to avoid excoriations.

"The lumbar portion of the upright must be invariably almost a plane surface, and rotated on its axis in the direction of the arrows (*Figs.* 157, 158) more or less in proportion to the plumpness of the patient. The iron forms this upright portion. It is very necessary that it should come below the knee, to enable the surgeon to fix this joint.

Fig. 159.
DOUBLE THOMAS'S SPLINT.

"Then measure round the chest, a little below the axilla, deducting, in the case of an adult, four inches from the chest circumference. This latter will be the measure for the upper cross piece, which is made from a piece of hoop iron, one and a half inches by one-eighth of an inch. The hoop is firmly joined to the top of the upright with a rivet at one-third of its length from the end next to the diseased side (*Fig.* 157). It is important to give the upper crescent this oval shape, to assist in arresting the machine from rotating from its position behind the body, and thus producing inversion of the limb. Another strip of hoop metal, three-quarters of an inch by one-eighth of an inch, and in length two-thirds of the circumference of the thigh, is fastened to the upright, at a position from one to two inches below the fold of the buttock; and then another piece of metal of like strength equal to half the circumference of the leg at the calf is firmly riveted to the lower extremity of the upright.

"The short portion of the top half circle is next to the diseased side, with a space intervening, while the long portion must be closely fitted to the sound side. If the machine should tend to rotate from the diseased side, then daily contract the long wing of the crescents, and expand the short ones.

"In applying the instruments with two uprights (*Fig.* 150), care should be taken to measure the distance between the tip of right and left posterior spinous processes, and then to set the uprights parallel and apart one inch more than such measurement, or it cannot be tolerated by the patient. The two uprights should be connected by a cross-bar when practicable.

"The instrument is now ready to be padded and covered. The former is conveniently done with boiler felt, the latter with basil leather.

"It will often occur that some slight alteration will be demanded, at some period during the progress of the case, and if it is one attended with much deformity, the surgeon will, for a few weeks, occasionally have to alter the curves of the appliance. This modification he should be prepared to perform himself, with wrenches.

"The patient being placed in the machine, the upper circle round the chest is closed with a strap and buckle, and the limb is bound with flannel from the calf upwards beyond the small crescent.

Fig. 160.—THOMAS'S SPLINT APPLIED—FRONT VIEW.

Fig. 161.—THOMAS'S SPLINT APPLIED—BACK VIEW.

(Reduced from Thomas's book.)

"Should the instrument rotate towards the diseased side, and so become a side splint, the surgeon should contract the longer wing of the upper crescent, and expand the shorter one; or if the instrument does not rotate, yet the stem is not over the prominence of the buttock and well behind the thigh, then the upright requires more twisting.

"It is very desirable that the patient should be confined to bed for

a period at the commencement of the treatment. This preliminary reclination I have never noticed to injure the general health, but invariably improves the patient's condition, and shortens the acute stage.

" The surgeon, being satisfied that suppuration has been avoided during the first stage of the mechanical treatment, permits the patient to proceed on to the second stage. He is then allowed to go about with the assistance of crutches, the frame is continued, and an iron patten at least four inches in depth is placed under the shoe of the sound limb (*Fig.* 160).

" Now we come to the third stage. The patient takes off the frame-work in bed and replaces it during the day, still using the crutch and patten for a certain period.

" We now arrive at the fourth stage. The patient totally discards the frame, and uses the crutch and patten only. These he sets aside after the surgeon is well satisfied with regard to the permanence of the cure. If the case does not progress to the satisfaction of the surgeon, some of these stages must necessarily be prolonged.

" The weight of the lower extremity is equal to reducing any angular deformity of the hip or knee joint, not resulting from true ankylosis, and is capable also in some degree of diminishing any shortening, should absorption of the head of the bone occur, provided a suitable mechanical arrangement be applied and continued during a sufficient period."

The advantages gained by not having to confine the patient to bed are certainly very great, if the splint fit properly and be well looked after, but we are strongly in favour of starting treatment with a weight extension, the splint being applied subsequently when the deformity has disappeared.

The flexibility of the lumbar spine is always very great, and is especially marked in children ; the patten should, therefore, be in them not only relatively but absolutely as high as, or higher than, is necessary for adult patients.

Chapter XXIX.

OF SPINAL DISEASE.

SPINAL disease, whether rachitic or tuberculous, may require a long period of immobilization for its permanent cure ; such cases, since they only occasionally need active surgical treatment, are sometimes neglected. It may be taken as a general rule that tuberculous disease of the spine can be cured, in the majority of cases, by rest and other appropriate treatment.

It was formerly the custom to treat many of these cases by the "spinal jacket," a treatment which should be reserved for special cases in the final stages, when a satisfactory state has been brought about by prolonged rest.

In the early stages, when the disease is active, as shown by the pain and rigidity—even though no deformity be present—the child

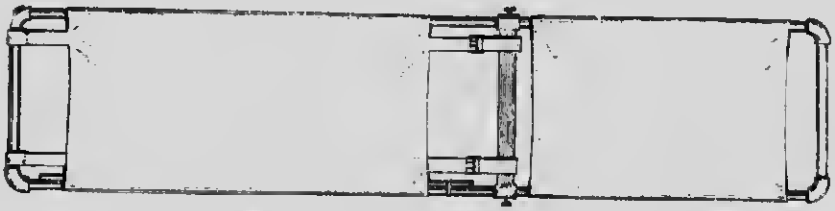


Fig. 162.—Bradford & Lovett's Frame for Cases of Spinal Disease.

must be fixed firmly to some strong support, so that absolute rest is obtained.

In the case of very young children this can be arrived at by nothing more complicated or expensive than a wooden box-lid, or a flat piece of basket work carefully padded, or a frame splint (*Fig.* 162), upon which the child is fixed with straps. If there is any angular deformity, special care must be taken to protect the projecting parts from friction and injury.

In the case of older children, indeed in the vast majority of cases, Phelps' box (*Fig.* 163) should be employed, a form of treatment which gives very good results.

Phelps' Box is a hollow trough of wood lined with padded cushions. At the lower end there are two smaller troughs which receive the legs, and into which they are firmly bandaged. The trunk is fixed to the main part of the box by broad bands of webbing. The lower

extremities being fixed in a position of abduction, the action of the bladder and rectum can be attended to readily, with a minimum of soiling and trouble.

In fitting a Phelps' box the following points should be attended to:—

1. Projecting bony points must be protected by special pads.

2. Allowance must be made for growth: at least six to eight inches when the splint is first fitted.

3. Special covers, which can be washed, should be placed over the lining cushions.

Once a week, or oftener if necessary, the child is to be taken out, placed flat on a bed, and washed. Ordinary clothes can be worn, but some ingenuity will be needed in fitting them so that they can be put on and taken off with the least disturbance.

The child must remain in the box for at least eighteen months for tuberculous disease: often longer if there has been any return of active symptoms: after which a spinal jacket may be fitted and worn until the subsequent course of the case shows the disease to be quiescent.

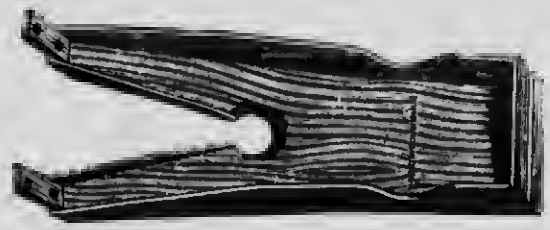


Fig. 163.—PHELPS' BOX SPLINT.

During this treatment the child must be kept in the open air as much as possible: or taken to the seaside, if it can be arranged, for a long period. Cod-liver oil and tonics should be administered. Children bear this confinement very well. At regular periods the child should be brought up for examination, and the surgeon directs his attention to the following details:—

1. Has the child complained of pain, a symptom suggesting that the disease is still active?

2. Is there any swelling or fullness in those positions where abscesses are likely to point? (*a*) Lumbar region; (*b*) Internal to anterior superior iliac spine; (*c*) In Scarpa's triangle. These are the commonest situations in which abscesses are found, but when the disease is situated higher up in the spine, the abscess may appear in other positions, which are described in the surgical text-books.

In cervical caries watch must be kept for retropharyngeal abscess.

3. Has the child any trouble with the urine or fæces? These are often the earliest symptoms of paraplegia, and from time to time examination must be made to see whether this complication has developed.

4. Is the box causing any injurious pressure upon the projecting spine ?

Cases of high cervical caries are not suitable for " box " treatment. The patient should be kept in bed, lying quite flat, with a small pillow under the hollow of the neck and sand-bags placed on either side. If the child is restless and refuses to lie still, an extension collar with weight and pulley may be applied (*Fig.* 164), or a poroplastic splint moulded to the upper part of the thorax, head, and neck.

High caries is especially langerous owing to the involvement of the transverse part of the crucial ligament and consequent risk of dislocation of the odontoid process,

The use of an extension apparatus is especially valuable when

Fig. 164.—Method of treating High Cervical Caries.

symptoms of paraplegia are appearing, and should always be given a thorough trial before operative measures are considered.

When all signs of active mischief have disappeared, a jacket, jury-mast, or other form of support may be fitted, in order that the patient may get about.

No fixed rule can be laid down as to the length of time that should elapse before this apparatus is discarded, but generally speaking it should be in a year to eighteen months.

JACKETS.

These are made of plaster-of-Paris, leather, and poroplastic or resinous felt, all of which can be moulded to the body. Plaster is not so popular as it was, for, although cheap and easily applied, it is apt to crack and become soiled, and it is in addition unnecessarily heavy.

Plaster Jacket.—The end desired is to *immobilize the spine* about the seat of the disease, and to fix the whole spine *in the best position possible*, that is, with as little curvature and rotation of the vertebral sections as the extent and stage of the disease will allow.

To do this by means of any splint or case moulded to the body, it is obvious that it must be fitted (1) While the trunk is as much

extended as it may, or rather as it ought to, be; (2) With the thorax in the position of inspiration; (3) With all bony prominences protected; (4) With a good hold on the pelvis to serve as the basis of support.

It must also be as light as is compatible with strength, and be loose

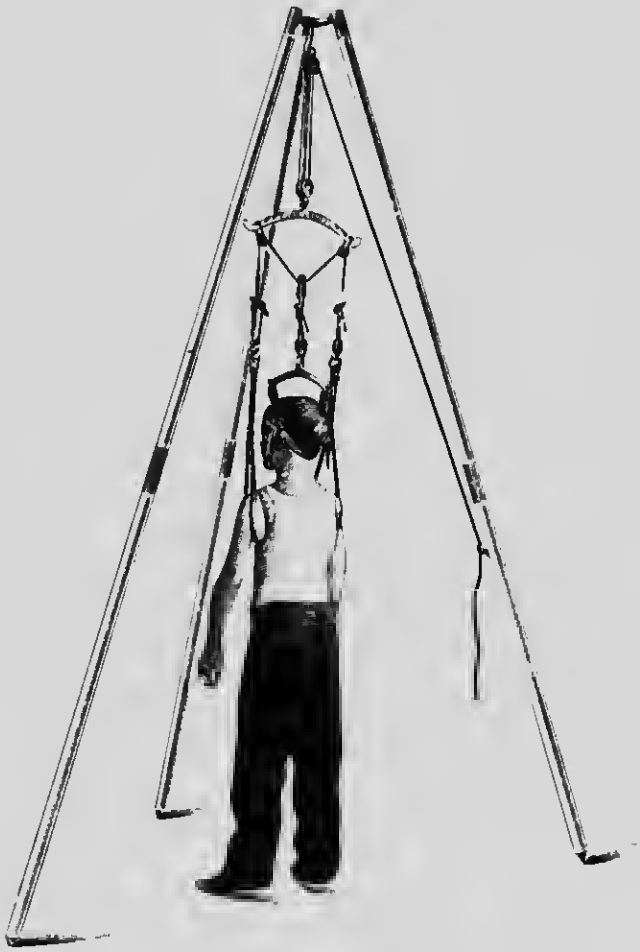


Fig. 165.—Suspension (partial) by Tripod and Pulleys.

enough over the abdomen to allow of moderate distention by food or flatus.

The Extension of the Trunk may be attained by Sayre's method of suspension, or, in the case of children, by simply holding them up with the hands in the armpits, or by the inclined plane; this latter, however, cannot be used for the ordinary plaster case.

Of these three methods, the *suspension* from the tripod requires the most care. As shown in the figure (*Fig.* 165), the patient can be suspended with the feet just *off* or just *on* the ground—in England the general practice, with which we thoroughly agree, is not to swing the patient clear of the ground—by means of straps and padded slings, which pass round the head and beneath the axillæ, and are attached to a crossbar, itself connected with a cord passing over a system of multiplying pulleys. By means of this cord, partial or complete suspension may be attained by the patient himself, or by an assistant, with a very moderate amount of force.

In severe cases, or if there be any loss of power in the legs, the patient may conveniently sit under the crossbar, inside the tripod, and have the slings adjusted.

The Objections to the Suspension Apparatus are, that in children it is alarming and fatiguing, and even for adults it is generally a trying ordeal. For most cases it is no doubt safe enough, but delicate patients must be watched lest faintness come on, and if the consolidation of the vertebræ be only in its early stages it is impossible to be too careful not to inflict damage by forcible extension. Unfortunately, it is difficult to estimate the force which is being employed, owing to the multiplying pulleys.

Speaking generally, however, it may be said that for adults, if the ordinary plaster case is to be applied, *gentle suspension* from the tripod, in the standing or sitting position, will be best; but that for young children, suspension by an assistant with the hands in the armpits is much to be preferred.

The *Simple Inclined Plane*, with the arms thrown over the head and grasping a bar, is even a better and safer way of producing extension in the position of inspiration. This position cannot be maintained while a bandage is being rolled on the trunk, so that it will not do for an ordinary plaster case; but for the poroplastic jacket, or for a modification of the plaster one to be presently described, it has much to recommend it.

The Inspiratory Position of the chest-walls is secured by the raising of the hands, if the inclined plane be used, and this is the case also with the tripod, if the patient be self-suspended; if not, the hands may be raised to grasp the legs of the support, but the management of this is often a difficulty. In holding up children by the hands in the axillæ, it is easy to maintain the desired position of the arms and chest-walls.

The Protection of Prominences is most important. Not only the angle at the curvature of the spine, if one be present, but any other projection which seems in the least likely to be rubbed, must be protected by pads placed on either side, or around, but not over it. The pads are best made of tow, covered with old table-linen, and are placed in position next to the skin. Careful moulding of the case to all irregularities, by pressing and squeezing it into shape before it sets, will also prevent chafing.

The Hold on the Pelvis is very important, and its neglect is the most common cause of failure of the treatment. If the case merely encloses the trunk as in a barrel, there is no relief afforded in the way of support for the weight of the head and upper extremities, nor is the rotation of the spine at all prevented. The requisite grip is easily secured by taking care to bring the bandage, or the felt, at least 1½ inches below the iliac crest, and to mould the case to the prominence of that bone.

We will pass now from the consideration of the general principles of the jacket treatment, to a description of the actual application of the common plaster jacket, of its modifications, and of the poroplastic jacket.

Ordinary Application of the Jacket.—A time should be chosen not less than two hours after a meal, if possible upon a dry day, and there should be a fire in the room in which the operation is to be performed. A firm horse-hair mattress should be laid on the floor near the fire, ready to place the patient upon as soon as the jacket is adapted.

The patient is then stripped, and the singlet or jersey which is to go under the jacket, and which should be of a kind specially made for the purpose, is slipped on, and the tags for the shoulders tied or fastened with safety pins (on no account must an ordinary pin be used anywhere in these cases). The pads must then be adjusted to protect the angular curve. If the abdomen be unusually retracted, it is wise to place a temporary pad to bring up the circumference of the jacket there to its normal size. The permanent pads at the back or elsewhere should be fastened to the jersey with a stitch or two, after they have been carefully adjusted. The bottom of this garment is then fastened, back and front together, between the thighs, with a safety pin.

If the patient is a girl about the age of puberty, care must be taken to leave room for the developing breasts. This is usually done with pads in the same way that allowance is made for any temporary enlargement of the stomach by a meal.

All is ready now for suspension. In the case of a child, as we have said, this is best performed by an assistant placing his hands in the axillæ, so as to grasp the arms at their highest point. The child can thus easily be held with the shoulders well thrown back and with the toes just touching the ground. But if *suspension by straps and pulleys* is to be employed, the patient must have the head and shoulder-slings of the tripod adjusted so as to give an equal pull upon every part, as seen in *Fig.* 105. The straps of all the slings, and of the chin and occiput supports, can be altered to suit different patients, and too much care cannot be taken to get the support exactly right before applying the bandage. As a general rule, the patient stands for the suspension; but if there be great weakness, or any paralysis, or simply if it be found more comfortable, a seat without a back (a rotary music stool does best) may be placed beneath the tripod.

When the slings have once been adjusted, the actual raising should

not be made until everything is ready for the application of the bandage, and in our opinion it is never advisable to swing the patient quite clear of the ground or stool.

The general manipulation of rolling on a plaster-of-Paris bandage has already been described, and this particular form does not differ in any essential point.

Six or eight freshly rubbed muslin bandages will be required, and both they and a small quantity of loose plaster should be put into an oven for about an hour before they are wanted. In moistening the bandages, a large basin of warm water should be used; as soon as one is ready, it is taken out and another is put in the water, while the surgeon rapidly rolls the first on to the trunk of the patient, allowing the bandage to take pretty much its own course, but endeavouring to work generally in figures of 8, the upper loop encircling the chest and the lower one grasping the pelvis. The bandage must on no account be drawn upon, but merely rolled on. When the first is finished the second is taken out of the water and a third one put in, and so on. As a rule, for a child of eight years of age, four bandages will be enough to make a jacket three layers thick everywhere, and four layers in the parts that require most strength. For an adult, six will generally be necessary.

While the bandages are being rolled on, an assistant should rub in additional loose plaster with the hand, moistening it as is required; and when all the bandages are put on, the whole jacket must be worked over with moistened plaster, well rubbed in, until the surface has a uniform smooth feeling. The prominences of the pelvic crest and the spine must now be moulded before the plaster sets.

All this must be done very quickly, for the position is a fatiguing one. In most cases it is wise to have one assistant whose whole care is to watch the patient, and to look after the suspension. If in the process of applying the jacket, any symptoms of embarrassment, either of the breathing or the circulation, appear, the patient must be promptly let down.

When the application is finished, some patients, if there be no great discomfort, may be left partly suspended for about ten minutes while the jacket begins to set, but as a rule it is advisable to remove them from the apparatus as soon as possible, and lay them flat on the mattress placed ready on the floor near a fire. The removal must be made with great care, so as to avoid any cracking of the case. Hot-water bottles, or hot bricks, laid near the case, will hasten its drying, especially in damp weather.

As a rule the patient had better remain still for three or four hours while the case is setting. It will then probably require a little trimming and cutting away in the armpits, etc., which can conveniently be done with a sharp knife.

The safety pin in the perineum, and the stomach pad, when present, can be removed as soon as the patient is laid down.

Fig. 166 is drawn from a case of angular curvature of ordinary severity, in which a plaster case had been applied.

In the poor, particularly when a child is allowed to go home with a jacket on, some means must be taken to prevent vermin getting inside the jacket. Soaking the jersey in boric acid or sprinkling the skin with it is generally sufficient.

One great drawback to this treatment is the impossibility of getting at the skin to wash it, or of cleansing the jersey. If only one jersey be used, it cannot be changed without making a new jacket.

There are two ways in which this difficulty may be partially overcome. The first, recommended by Keetley, consists in laying two clean handkerchiefs or napkins, back and front, between the jersey and the skin (and of course inside the pads) before the jacket is applied. When these have to be changed, it is easily done by pinning a clean napkin to the lower edge of the soiled one, which should project a little below the plaster jacket; then, by pulling the latter out at its upper end, the new follows the old one and lies in its place.

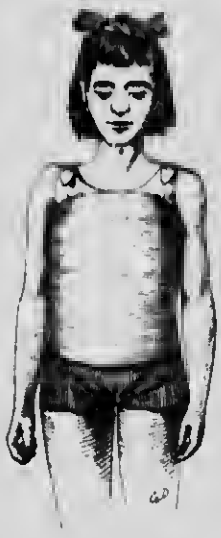


Fig. 166.
PLASTER-OF-PARIS JACKET APPLIED.

The other way is on the same principle, and is Oxley's device. Two jerseys, instead of one, are worn throughout the treatment (the pads being fastened to the outer one only). The outer one adheres to the plaster, and forms part of the case, but the inner one can be removed by pulling it off, over the head and shoulders, after having tacked a clean one to its lower edge all round.

Poroplastic Jackets.—The moulding of *resinous felt* into a spinal jacket does not differ in its main principles from the moulding of that material for other splints, but the large amount of felt employed, together with the great rapidity with which it sets, makes a certain amount of practice necessary in order to be able to fit a case of spinal curvature properly.

Advantages.—A well-fitted poroplastic jacket is often an admirable method of treatment. It is not much more than half the weight of a plaster one, is porous, so that the action of the skin is but little interfered with, and it can be removed altogether, or widely loosened, at frequent intervals, for the purposes of cleanliness, although it will not long stand being taken off every night, as is sometimes advised.

These jackets are sold roughly blocked out (*Fig.* 167) in a sufficient number of sizes, and of three qualities, of which the two most expensive are about equally good, though the dearer one is rather the lighter of the two. The third and coarsest quality is not recommended.

The jackets are fitted with the necessary straps, buckles, and

eyelet holes, and lately an additional improvement has been to leave unstiffened the felt corresponding to the front iliac spines, and (in women) to the breasts, as shown in the figure. Other parts may also be left unstiffened as required, as over tender prominent ribs, or spinous processes.

A jacket of about the right size having been chosen, it must be *accurately fitted* to the body of the patient while the position of extension is maintained.

One way of doing this is to take a plaster cast of the trunk, and block the jacket upon that instead of upon the body. This is a plan very generally followed by instrument makers, and has this advantage, than any number of jackets can be moulded in the future without

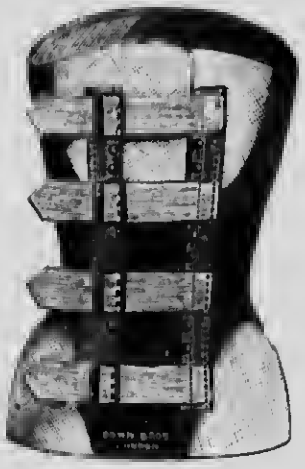


Fig. 167.—Poroplastic Felt Jacket.

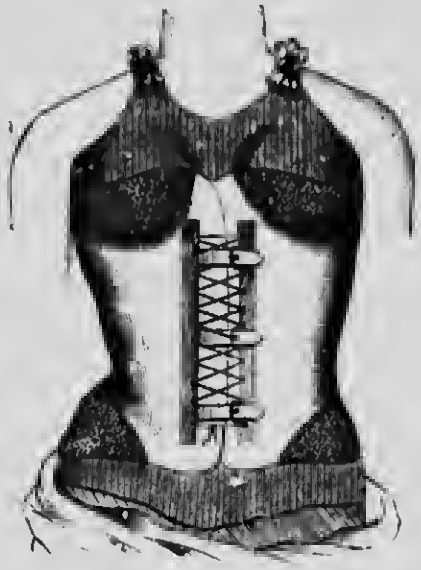


Fig. 168.—Poroplastic Jacket applied.

further trouble to the patient. But the first cast is difficult to make, except by a professional modeller, and generally speaking, the position of extension is not well maintained. A cast, however, would be absolutely necessary if leather were used instead of felt.

But the general practice is either to suspend the patient from the *tripod*, or to procure the extension and the inspiratory position, by means of an *inclined plane*. As we have said before, we consider the latter is, in ordinary cases, to be preferred.

In either case the fitting of the jersey and pads is just the same as if the plaster jacket were about to be made, and if the tripod be used, the head and shoulders are adjusted exactly as has been before described. If the plan of the inclined plane be chosen, the patient lies down on it, and, raising the arms above the head, catches hold of some bar or

support. The best inclined plane is the simplest, namely, a board about two feet wide, and with an inclination of about two feet in six. There must be no foot-piece, nor any pillow for the head.

The same method of *Softening the Jacket* can be employed in either case. This can be done very well in a good-sized oven at the ordinary cooking heat, in which the jacket should be suspended from some support, such as a surgical cradle; it must hang free, and must not touch the sides anywhere, or it will burn; it must also be well moistened, and a pan of water should be placed on the floor of the oven.

A more convenient plan is to use a specially contrived *steam chamber*, sold or let out by instrument makers, and which consists of an iron cylinder with a double bottom, into which an oil stove-lamp, a spirit-lamp, or a gas-jet is put. A pan of water stands within the cylinder, which has a tight-fitting lid.

The lamp quickly generates the steam, and there should be heat enough to soften the jacket thoroughly in three or four minutes. It is then ready for application, and must be *at once* and *as quickly as possible* put on. The patient being suspended from the tripod, an assistant (who is advised to have gloves on) quickly draws, first the waist-strap and buckle together, then the pelvic ones, and lastly those about the breast, the responsible surgeon the while moulding and kneading the felt to the prominences of spine and other parts.

This is a good plan to follow, but a better is to have, ready cut, six or eight lengths of broad, stout bandage stuff; then, whether the patient be suspended or be lying on the inclined plane, the jacket can be quickly slipped on and the sides brought round into position, care being taken that the softened parts of the felt correspond to the hips and breasts, and that the buckles come opposite the straps. The lengths of bandage are then quickly passed round and knotted in front by the assistant, while the surgeon brings the sides accurately forward, and moulds them as he does so. The waist bandage is tied first, then those for the hips; the breast ones next, and then intermediate ones as may be required. In this way all fumbling with hot buckles and straps is avoided, the jacket is easily put on before it can set, and a closer, more accurate fit is attained.

The jacket sets too firmly in a minute or two for any further moulding to be done, but it is not really strong for about half an hour, so the patient must lie still for that time, if on the plane, or may remain semi-suspended if this can be borne, or, as in the case of the plaster, may be carefully released from the tripod and laid flat on a mattress, but in this case *not* close to a fire.

When the felt has set, the bandages may be cast off, and the straps and buckles closed. These will very likely require some adjustment, and for this reason it is often wiser to mould the jacket *before* the straps and buckles are sewn on. The jacket itself will almost certainly have to be cut away somewhere, or slightly altered, and this may be done in one of two ways, as may seem best: namely, with a hot iron, which

will re-softeo parts that do not quite fit, or by dissolving the resin out of the felt with spirits of wine sufficiently to make it much more pliable. This is often a very good plan for such parts os the armpits.

If the jacket be a failure, or if, as ought to happen in the progress of a case, it seems as if a further improvement were possible, the case must be [illegible]ped off and re-softened in the steam chamber, unless it be badly cracked, or be worn out.

In *Fig.* 168 is shown a felt jacket, moulded to an adult ease of bad lateral curvature. In this case a similar jacket had been woro for several years.

Cervical Caries—Jury-masts.—When the seat of the spinal disense is in the cervical regioo, it is obvious that no jacket can, of itself, fix the

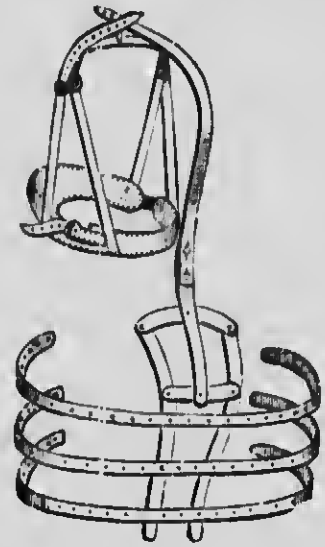


Fig. 169.—Jury-mast Frame.

Fig. 170.—Jury-mast Applied.

vertebræ. Io acute cases it is geoerally oecessary to make the patient lie absolutely flat, with the head fixed with *pillows and sand-bags.*

But there are maoy stages io the disease in which it is both safe aod advisable to allow the patient to get about, provided that in some way or another the weight of the head and oeck can be taken off the diseased vertebræ. This oiay be done by the simple plao knowo as the " jury-mast " system.

Its maio features can be seeo io the accompanyiog figure (*Fig.* 170). It coosists of a light plaster jacket, from which spriogs the mast itself, which is a light bar, with a joint for the adjustmeot of its leogth, arching overhead, and having a cross-yard about five ioches loog from which haog straps to support the head from the chin and occiput.

The mast is forked below, so as oot to press upoo the vertebral

spines, and has attached to it thin strips of tinned iron, with pierced rough holes; these go round the body and are worked into the plaster jacket (*Fig.* 169).

In fitting the mast, the steel bar should first be bent with wrenches to the right shape, and then tempered. The exact height may be afterwards adjusted.

The jacket may be put on with or without suspension, as may seem best, but if the tripod be used, the greatest possible care must be taken not to put too much strain on the vertebræ of the neck. The plaster jacket must be as light as will fix the mast, which, with the

Figs. 171, 172.—Poroplastic Jackets for Cervical Curvature.

cross strips, is imbedded in its substance, having layers of plaster both above and beneath the iron.

As soon as the jacket is set, the straps may be adjusted, and the length so fixed that the bar is just clear of the head, when the latter is supported to the extent which gives greatest relief. This height will have to be altered from time to time.

Leather Jackets are very expensive and rarely ordered. They are, however, very serviceable in cervical caries instead of a jury-mast, and they have the great advantage of fixing the head more firmly than any other form of apparatus.

Chapter XXX.

OF GENU VALGUM, TALIPES, ETC.

GENU VALGUM OR KNOCK-KNEE.

PUTTING aside those cases in which some operation about the femur or the knee joint seems to be advisable, much may be done by a patient use of the simplest forms of splints: in very young children especially, quite as much as, and probably more than, can be effected by the most expensive forms of instruments.

Two Outside Splints of a simple pattern (*Fig.* 173) will be found quite efficient for most cases. These may be fastened on by webbing straps or by broad pieces of strapping. In either case one strap, or strip of plaster, must always go over the knee, as shown in the figure. Long, thick stockings had best be worn beneath the splints, or a flannel bandage may be applied instead; a calico bandage may be put on over all if the webbing or strapping fails to fix the splint firmly enough.

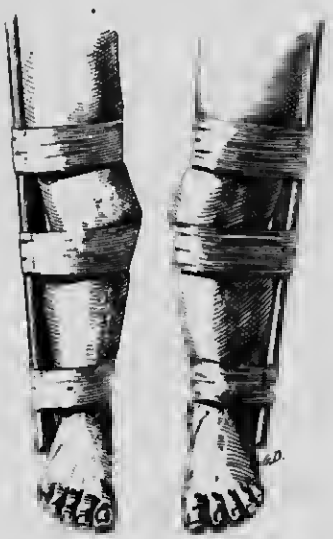


Fig. 173.
SIMPLE SPLINTS FOR GENU VALGUM.

In bad cases, or in those which are quickly getting worse, it is best to wear the splints continuously, only taking them off night and morning for re-adjustment. But in slight cases, or in those on the road to recovery, free movement in bed may be allowed, and the splints put on the first thing every morning.

Another plan is to put up the legs in light *Plaster-of-Paris* cases, stiffened if necessary by a wooden splint on the outside. While the plaster bandages are being put on, the knock-knee must be forcibly straightened as much as it will bear. The new position of the limb will be retained by the splint, and when this has been worn a short time (say three weeks), it may be taken off, and a further forcible straightening effected and retained in the same manner.

Valgus of the knee is often associated with that of the foot. Whether this is cause or effect, is a much disputed point; but in any case both conditions must be attended to.

BANDY (OR BOWED) LEGS, CURVATURE OF THE TIBIA, ETC.

Simple bandy-leg, or general outward curvature of the tibiæ, inasmuch as it is nearly the reverse of knock-knee, may be well treated on just the same lines, the splints being put on the inside instead of the outside of the legs. This condition yields to treatment more readily than valgus of the knee.

The curved tibiæ which occur as a consequence of rickets are now

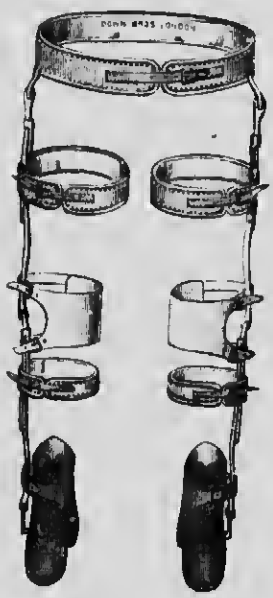


Fig. 174.—Splints for Genu Valgum.

Fig. 175.—Splint for Bandy-leg, attached.

(Diagrams of Apparatus for use in late cases when patient begins to walk.)

far more frequently treated by *Section of the Bones* with a saw or a chisel, than formerly was the case. If properly performed, the operation is practically free from danger, and is followed by excellent results, but it must not be undertaken until all rachitic symptoms have disappeared.

Splinting.—But the number of rickety legs which can be improved or cured by proper splinting will always be very large as compared

with those in which osteotomy is at all called for, and common light wooden splints are infinitely preferable to "irons" of any kind.

The length and method of attachment of these splints will depend a good deal upon the stage of the disease, and upon the age of the patient. In the *Acute stage of Rickets*, and especially if the children are quite young and are only just beginning to "feel their feet," it is best to keep them from bearing any of their weight, often increased by a tumid belly and a heavy head, upon the yielding leg and thigh bones. In this case the splints had better be worn day and night, always being adjusted morning and evening. They must be well padded, and should extend three or four inches below the foot, being attached by handages or webbing straps, and generally to the inside of the limb. If this length does not succeed in keeping the child off its feet, they may be made of different lengths, and if this fails, the legs must be tied together, or some such plan as was described in the chapter on hip disease must be adopted. (See *Fig.* 153.)

As a rule, webbing straps and buckles are here better than strapping or bandaging. A broad strap should always go round the place of greatest curvature.

These splints are best put on the inside of the leg, but there are frequent exceptions, and it is often advisable to change about from one side to the other to avoid sores over the malleoli.

The limbs should be well rubbed morning and evening for ten minutes, so as to improve the nutrition of the muscles. As the improvement continues, and the bones consolidate, the splints may be left off at night, and finally abandoned altogether.

CLUB-FOOT.

The different kinds of club-foot are very numerous, and the cases of each variety of the deformity differ very much among themselves in the extent to which they are amenable to treatment, and as to whether one plan of treatment or another is the more suitable.

Club-foot consists in a twisting or deformity of the foot, with the result that it is displaced inwards (varus), or outwards (valgus). These primary displacements are really associated with some undue shortening or lengthening of the tendo Achillis. In the former there is inability to dorsiflex at the ankle, and the child will later walk on the tips of the toes, the heel failing to reach the ground; in the latter the foot is dorsiflexed to such an extent that the dorsum may be in contact with the anterior tibial region.

These forms of club-foot arise from two main causes:—

1. *Acquired.*—Infantile paralysis or anterior poliomyelitis is responsible for most cases. A few are due to more extensive spinal lesions. Certain groups of muscles become paralyzed, and they are then unable to oppose the action of those which have escaped, with the result that the foot is pulled into a bad position by the active muscles.

Other causes of acquired talipes are peripheral neuritis, faulty splinting after fractures, or contractions caused by burns.

2. *Congenital.*—A form dependent upon some malposition of the fœtus in utero. There is no paralysis, but in severe cases there has been so much interference with the development of the tendons and ligaments, and so much contraction of the tissues of the foot, that the treatment must extend over a long period and a great deal of patience is required.

Paralytic Varieties of Club-foot.—These should be recognized at the earliest possible moment—that is, as soon as the effect of the damage to the anterior horn cells is shown by the loss of power in the limb and the acquirement of some deformity. The commonest form is a talipes equinus owing to damage to the anterior tibial muscles, but the other groups—peroneal and posterior tibial—may be attacked. On examining the limb it will be noticed that the muscles do not contract voluntarily, and that they give the reaction to degeneration. Occasionally one muscle of the group, such as the extensor longus hallucis, may escape.

Fig. 176.—Leg Stem, with stop ankle-joint, for slight cases.

Fig. 177.—Leg Stem, with S-springs to raise front part of foot.

Experience has shown that if the nutrition of the muscles is maintained by massage and *electrical treatment*, and if nerve tonics such as strychnia are administered, there is a fair extent of recovery in a large number of cases. Such treatment should be undertaken at once, and during this time the limb must be kept in a good position by means of splints. When the paralysis persists, such measures as tendon grafting, tendon lengthening, or arthrodesis may be advisable; they will not, however, be discussed here. Failing these, a boot should be ordered which will tend to correct the deformity (*Figs.* 176, 177). In talipes equinus a spring should be placed under the anterior part of the foot to tilt it up, while the flail-like movement of the ankle joint may be controlled by means of special hinged irons.

Other forms of acquired talipes should be treated by tenotomy.

Congenital Talipes—T. Calcaneus.—The foot is strongly dorsiflexed at the ankle, and is longer and narrower than usual. Operative treatment is rarely required; it is usually sufficient to massage and

manipulate the foot so as to stretch the shortened tendons. If this is persisted in from the earliest possible moment (immediately after birth) the deformity will be rectified. In neglected cases it may be necessary to shorten the tendo Achillis.

Talipes Equino-Varus, the commonest form of club-foot, occurs in different degrees. In some cases there is only slight inversion of the foot, with some contraction of the tendo Achillis, so that the foot cannot be flexed beyond a right angle. The most extreme forms show gross deformity, and in neglected cases the child may walk upon the dorsum of the foot. Only those forms which are amenable to simple treatment are considered here; inveterate or relapsing cases must be treated by osteotomy or other operations, and a consideration of them is beyond the scope of this work.

Treatment consists in: (1) Manipulation; (2) Splinting; (3) Tenotomy; (4) Wrenching.

Manipulation should be started soon after birth, and can be entrusted to the mother or nurse, under supervision. It consists in gently massaging the affected limb so as to make the muscles and tendons supple, and then stretching the foot in the direction opposite to the deformity. In this connection the double nature of the deformity must be borne in mind: first, the varus must be dealt with by pressing the foot over to a position of valgus while the malleoli are steadied with one hand; and secondly, the dorsum of the foot must be pressed up towards the tibia, so as to stretch the tendo Achillis. These movements must be repeated several times, and it is advisable that at least ten minutes should be spent over them morning and evening.

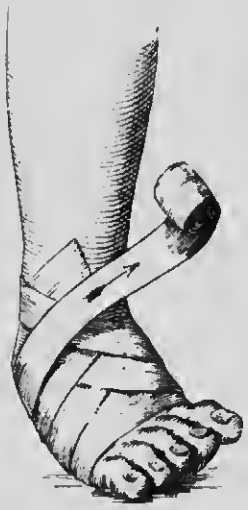


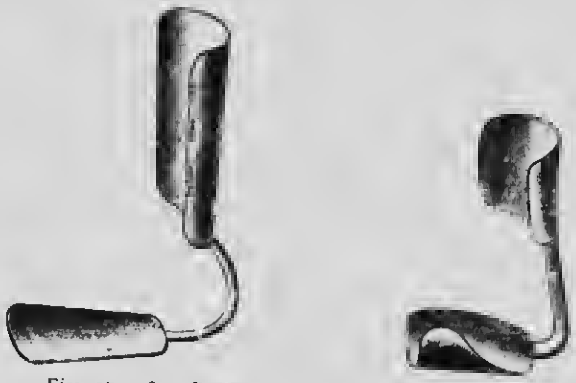
Fig. 178.
PLASTER-OF-PARIS BANDAGE FOR TALIPES EQUINO-VARUS.

Such manipulative treatment is usually combined with *splinting*, which tends to maintain the foot in a corrected position. The three main varieties of splints are: (1) Plaster-of-Paris; (2) Malleable metal; (3) Adams' shoe.

Plaster-of Paris may be used after operations upon the foot when it is desired to keep the part fixed in a definite position, but it is unsuitable as a routine, since it prevents the regular performance of massage and manipulation, which are essential. It is best applied in the form of a plaster bandage, after a flannel or domette bandage has been wound round the foot and leg (*Fig.* 178). *The Malleable Metal Splint* is very convenient. A simple form consists in a strip of metal which can be bandaged to the back of the leg, while the foot fits into a metal trough which can be bent to any angle (*Figs.* 179, 180). The foot is bandaged to this splint in such a way that there is always a certain

amount of pressure exerted so as to correct the deformity. This apparatus can be readily taken off and put on by the mother, and is cheap and efficient.

A Scarpa's Shoe, or some modification of it, is still employed (though not quite so generally as heretofore), more especially in the later stages of the treatment. In *Figs.* 181, 182, a good form of shoe and the mode of its application are shown, and no further description is called for.



Figs. 179, 180.—Robert Jones' Splints for Talipes.

In all the varieties of this instrument, expense is a great drawback, and it is absolutely essential to have the shoe of the right size.

The principle of the shoe treatment is to adjust the angles of the instrument to those of the deformity, and then, after fastening the foot and leg firmly into it by straps, to bring the parts into position gradually by turning day by day, but very slightly, the rack and pinion hinges, or other contrivances for altering the direction of the sole (varus) and

Figs. 181, 182.—Adams' Modification of Scarpa's Shoe.

the angle of the foot (equinus). These shoes will have to be readjusted very frequently, and the flannel bandage, which should always be put on the limb under the shoe, taken off, so that the slightest commencement of a sore may be observed; these are very apt to form, especially over the heel.

The greatest practical difficulty in this method is the keeping the

heel down into its place in the shoe. Unless this be done, every turn of the rack and pinion will only lift it a little more, and no good will be effected. This is a very common oversight, and is of itself a sufficient reason for frequent readjustment.

It will be gathered from the above that the treatment by Scarpa's shoe is a troublesome one, and though success will often repay the daily care required, it will never be a favoured method.

Tenotomy is required in a large number of cases, but it should not be performed until some trial has been given to manipulation and splinting. The structures which may require division are the tibialis anticus and the inner part of the plantar fascia, and the tendo Achillis. It may be necessary to divide the tibialis posticus, the anterior part of the internal lateral ligament, and the abductor hallucis; but this should not be done until a good trial has been given to less drastic methods, as the foot is considerably weakened by it.

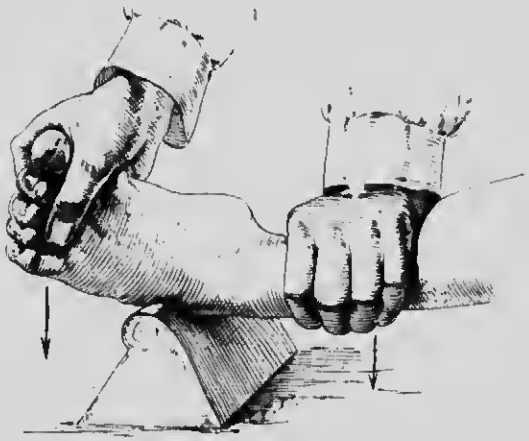


Fig. 183.—Wrenching for Talipes Equino-Varus.

The structures on the inner side—that is to say, those affecting the varus deformity—should always be dealt with first, and the varus should be entirely corrected before any attempt is made to deal with the equinus. If this rule is not observed the results obtained will not be satisfactory.

After tenotomy the foot is put up in the faulty position, if necessary in plaster, and is taken down at the end of four days in order that the position may be changed, the deformity being gradually corrected until it has disappeared; manipulation and massage being regularly undertaken. It is better not to over-correct the deformity immediately after division of the tendon, as such a proceeding causes a big gap to form between the cut ends, and leads occasionally to weakness or non-union of the tendons.

Wrenching consists in forcibly stretching the structures on the inner

side of the foot or the tendo Achillis, under anæsthesia. It is a useful alternative method to tenotomy in cases of slight deformity, or after tenotomy, if there is any relapse. The child is anæsthetized, and the foot is grasped in one hand, the other being used to steady the malleoli (*Fig. 183*). After a little preliminary kneading of the tissues on the inner side of the foot, it is cautiously wrenched until the deformity is over-corrected. Some fibrous bands will be heard to snap, and there is sometimes considerable ecchymosis after the operation. If ordinary care is taken not to apply undue violence, no harm will result, and the position of the foot is markedly improved; but if the operator is too energetic or careless, the malleoli may be fractured or the epiphysis displaced. After wrenching, the limb should be splinted for a few days, and then manipulations should be resumed.

In order to obtain satisfactory results in the treatment of talipes, cases must be kept under observation for several years, and great patience be exercised. There is an unfortunate tendency for the deformity to recur, and the child should be fitted with special boots and varus straps as soon as it begins to walk.

Talipes Valgus is a less common form, and can generally be treated by manipulation, a special boot (see below) with an outside iron, and a valgus strap being ordered when the child begins to walk.

Spurious Valgus.—Flat-foot results from a weakening of the arches of the foot, especially that part supported by the inferior calcaneo-scaphoid or spring ligament. In most cases long hours of standing, faulty fitting boots, and bad health are responsible for the condition, but it must be carefully remembered that as the result of infective processes, such as rheumatism or gonorrhœa, the astragaloscaphoid joint may be attacked, giving rise to what is known as "acute flat-foot."

In the acute cases the foot should be given rest by means of a splint or a plaster-of-Paris case. It should be put up in a position of varus, so as to over-correct the deformity, while appropriate remedies are applied to treat the primary infection.

Chronic cases should be treated by massage of the foot and posterior tibial muscles, and the patient should be advised to walk and stand on the outside of the foot, and to improve the muscular tone by tiptoe exercises morning and evening.

Proper flat-foot boots should be ordered. These are stout, easily fitting boots, with a firm arch, thicker on the inner than the outer side, so that the weight of the body is thrown on to the outer side of the foot. Little advantage is derived from pads inserted to support the arch. In more advanced cases the foot should be wrenched into a position of varus, and put up in plaster for a month to allow the ligaments to shorten up, after which the above treatment is to be undertaken.

SECTION VI.

OF MINOR SURGERY AND KINDRED SUBJECTS.

CHAPTER XXXI.

OF THE TREATMENT OF ABSCESSES.

THE localized collection of pus to which the term abscess has been given is in all cases treated by incision. At the same time it is necessary to recognize certain stages in the formation of the abscess which have some bearing upon treatment, and further the steps that should be taken to provide adequate drainage and healing.

When an infective process, upon which the formation of an abscess depends, occurs in a superficial region, steps may be taken to cut short the development of the suppuration, as for example in cases of cellulitis and diffuse phlegmons. Free incisions, under such circumstances, followed as they are by the exit of the toxins and by the advent of protective and immunizing lymph to the infected area, are beneficial and advisable; but when the source of trouble lies at some distance from the surface, and where perhaps from the anatomical relations of the part it is desirable to give nature a chance either of effecting resolution of the inflammatory exudate or of determining it into a definite abscess, local applications—fomentations or hot irrigations—are to be employed.

Detection of Pus.—When an abscess distinctly *points*, there can be no difficulty in recognizing the condition of affairs, but in deep-seated collections of pus, it often happens that the spot where it comes nearest to the skin is indicated, not by an elevation, but by a peculiar sensation to the finger, a mixture of bogginess and dimpling, which we can compare to nothing better than to the feeling conveyed to the finger when it is passed over the keyhole of a door with three or four folds of some soft stuff (say a handkerchief) intervening.

The recognition by *fluctuation* of deep-seated collections of pus, or of any other fluid, which is not making its way at any point to the surface, is a matter of tactile education, which every student must most earnestly and diligently set himself to acquire by practice on every possible occasion, and which can in no wise be taught by words. One extremely common cause of error is due to the fact that the beginner is apt to "try for fluctuation" with both hands placed trans-

versely to the direction of the muscles, instead of parallel with the direction of their fibres. The most perfect fluctuation may be felt by placing the fingers across the belly of such a muscle as the quadriceps extensor femoris, and a tyro may well be thus deceived into the belief that fluid is present.

As soon as pus has made its presence manifest, either by the phenomenon of fluctuation or by a softening or bogginess in an area of induration, no time should be lost in giving it a ready exit. All abscesses should be opened as soon as they have declared themselves; and they should be opened freely, with due respect to the anatomy of the part concerned, and in such a position that drainage of the contents is favoured.

Methods of Incision. — With regard to the ordinary methods of incision of abscesses, little need be said beyond that which common sense would suggest. The curved scalpel, generally called a "Syme's" knife, is often recommended, but we believe that in most cases a straight blade is better. For large sacs a common dissecting scalpel will be the most convenient form, and for small ones, especially if deeply seated, a narrow-bladed, double-edged, lancet-pointed knife is often used; sometimes the instrument which gives the least pain, from the extreme thinness of its blade, is the old-fashioned bleeding lancet.

Whatever knife is used it should be very sharp, and the dresser should endeavour to open all abscesses, save those which present some anatomical reason for dissection or delay, as quickly as possible, making up his mind beforehand how far, how deep, and in what direction, the cut is to be made, in order that one movement of the hand and wrist may suffice.

Direction of Incision.—The rule is that incisions should be made in the long axis of the trunk or limbs, unless there be any reason to the contrary, but that in any case they must be parallel to, and not across the direction of, structures which it is desired to avoid.

As a rule, abscesses, especially acute ones, must be opened where they point, and this is very often not the spot which would be chosen by the surgeon, who would prefer to make his opening at the most dependent part; this may necessitate the making of a *counter-opening* by passing a director through the sac from the upper pointing aperture to the bottom of the cavity, and cutting down upon the point of the instrument, so held that it can be felt there through the skin.

If important structures are likely to be encountered or injured, Hilton's method should be employed: this consists in incising the tissues down to the deep fascia, and inserting a director into the most prominent part of the swelling, or where fluctuation is most obvious, until the pus flows along the groove. The opening is then enlarged with sinus forceps or Spencer Wells' forceps, until a track of sufficient size has been established. When once the opening has been made, it is usually unnecessary to do more than insert a drainage tube, so that the discharge can find a ready exit. There is no great objection

to the irrigation of the cavity with weak antiseptics, though it does no more than wash away the clot which has collected in the cavity. Strong antiseptics and scraping of the cavity wall are in most cases injurious, since the protective barrier of granulation tissue is damaged, fresh lymphatic spaces are opened up, and young vessels are torn across. The necrotic material which often lies against the granulation tissue wall is soon cast off, and can be gently syringed away at the daily dressing. Scraping and strong antiseptics do not facilitate its separation.

Drainage.—All abscesses require drainage, though the duration and form of this drainage vary in individual cases. The object is two-fold: first, to allow the necrotic tissue, which must separate from the healthy granulations, to come away; secondly, to prevent the superficial opening closing before the deeper parts have become clean and healthy. Two chief agents are in vogue for procuring drainage, viz., strips of gauze, and rubber tubes (occasionally glass); sometimes both are combined. Generally a rubber tube of fair size (for the purpose of draining an abscess of any size no tube smaller than a cigarette should be employed) is the best, but where the bleeding is profuse, or where the position of the abscess is unsuitable for tube drainage, as in ischiorectal abscess, gauze may be substituted. In such cases care should be taken that the gauze is not tightly packed into the cavity; this prevents shrinkage and contraction, which are essential for healing. Light packing, which can readily be removed, is all that is required.

Generally speaking, acute abscesses are fomented, or covered with some moist absorbent dressing, such as large masses of wool; but the choice of the dressing which would be most appropriate in any particular case can hardly be reduced to rules.

During the subsequent progress of the case, irrigations of the cavity through the tube once or twice daily are of value, the tubes being gradually shortened as the cavity closes. With regard to the irrigation, it is worth remarking that peroxide of hydrogen, though a remedy of undoubted value, and frequently employed in these cases, must be used with the utmost caution. When brought into contact with blood or proteid matter the oxygen is given off freely, and if it is injected into a cavity from which there is not a very ready exit, the gas so generated may force its way through the walls of the abscess into the cellular tissue, causing serious complications. Drainage should not be too prolonged, since the presence of a tube or strip of gauze is a source of irritation, and sinuses are often caused by a too zealous adherence to the tube over a long period. When the temperature has been normal for four or five days, when the discharge has become clean, thin, and sweet, it is time to think of withdrawing the drain. No definite rules can be laid down, but provided that the superficial opening is kept patent by a small plug, it is often very advantageous to remove the drainage early.

Rest is an important factor in the healing of abscesses. Neglect of

this detail is another cause of troublesome sinuses. The part should be immobilized as far as possible. Splints, bandages, or whatever apparatus may be most suitable should be applied, and, in cases where the conditions of the part permit, gentle pressure will assist the natural process of contraction and obliteration of the cavity.

Axillary Abscess usually arises from suppuration in the cellular tissue or glands of the axilla. The abscess lies beneath the deep fascia, and should be opened by a vertical incision on the inner axillary wall in order to avoid important structures, and the pus should be reached by Hilton's method.

Submaxillary Abscess arises either from suppuration in the submaxillary lymphatic glands or as the result of a cellulitis. Cellulitis in this region is especially serious, owing to the risk of œdema of the glottis supervening. This œdema, which occurs in the aryteno-epiglottidean folds, causes occlusion of the superior aperture of the larynx, and fatal dyspnœa often follows an attempt to anæsthetize the patient. In no instance is the beneficial effect of incisions into the indurated area of a cellulitis more marked than in Ludwig's angina. The incisions may be made either parallel with and under cover of the border of the lower jaw, or vertically in the median line; and if there is dyspnœa when the patient comes under treatment, local anæsthesia alone should be employed.

Ischiorectal Abscess occurs after infection of the fat in the ischiorectal fossa, the infection passing in from the bowel, either through a gross abrasion, such as may be produced by a foreign body, or ulcer, or by means of lymphatic communication. There are two well-recognized varieties of ischiorectal abscess: the acute form, caused in most instances by the *Bacillus coli* or other pyogenic organisms, and the tuberculous. The acute, the ordinary variety, is treated by free incisions, which should extend widely across the buttock at right angles to the anus, and in most cases it is advisable to make crucial incisions over the centre of the fossa, removing subsequently all undermined skin; the finger should then be introduced and all loculi broken into. The cavity should be lightly packed with gauze and allowed to granulate from the bottom.

Cases of ischiorectal, and for the matter of that, anal abscesses, illustrate the importance of rest in order that perfect healing may be secured. The common result of these abscesses is that after they have discharged their contents, owing to the movement of the part and the bad circulation, a sinus or fistula is formed, which necessitates a subsequent operation to effect its cure. For this reason it has been advocated that in all such cases the external sphincter should be divided, and the abscess cavity made continuous with the lumen of the anus, so that the frequent contractions of this muscle shall not interfere with the healing process.

This treatment is advisable if, at the time of active treatment, a fistulous communication with the bowel is evident, but it is unwise as a

routine. If the patient is kept rigidly in bed, lying for the most part on the face or opposite side, healing may occur perfectly. Under no circumstances should he be allowed to get up until a thorough trial of rest has been made. If this treatment is combined with daily dressing and the application of lotio rubra and stimulating injections, in a fair proportion of cases the formation of a fistula may be avoided.

The treatment of the tuberculous variety is conducted on the same principles, but it is often advisable to scrape out the walls of the cavity after the pus has escaped. As a rule the simpler the operation the better in these cases, and as soon as possible the patient should be sent away to the seaside, while those remedies which are of value in combating tuberculosis elsewhere should be actively employed.

Anal Abscess may be described as a modification of the ischiorectal variety. It is much commoner, and arises from infection of the sebaceous glands and lymphoid tissue which surround the anal orifice.

The treatment should be conducted on precisely similar lines to those used in the former variety, and later, if necessary, any fistula can be dealt with.

Mammary Abscess.—There are three recognized varieties of mammary abscess: the *superficial*, which is no more than a subcutaneous collection of pus of slight extent; the *intramammary*, which results from an infection spreading into the breast, along the lymphatics or ducts, from a cracked nipple which has been neglected; and the *submammary*, usually a chronic variety dependent upon caries of the rib, the exciting organism being either the tubercle bacillus or the bacillus of typhoid fever.

Intramammary Abscess.—During the early weeks of lactation, the breast becomes swollen, painful, and red. The abscess presents in one of the quadrants, and should be opened by incisions which radiate out from the nipple. Mere incision is, however, inadequate in these cases. Owing to the tendency of the pus to burrow into adjacent loculi, the finger should be introduced into the abscess cavity, and all secondary communications freely opened up. If there is pocketing in a downward direction, a counter-opening should be made in the costomammary sulcus. Tubes should be employed for from four days to a week, and the breast should be carefully supported by means of a bandage.

Submammary Abscess.—Every now and then we come across cases where pus is pent up beneath the breast close against the great pectoral muscle, lifting up the whole gland, and coming to the surface at its margin, often at two or more places. The condition results from tuberculous or typhoid infection of a rib, costal cartilage, or sternum. A free opening and thorough drainage of the tissues underlying the breast is the essential treatment of this condition. It will often happen that the natural pointing is at a spot in the upper half of the circle surrounding the breast, and in this place the first opening must be made, but if possible the abscess should be drained from a lower point, and it will generally be the best plan to pass a director downwards

behind the gland until it can be felt protruding below. By cutting down upon its point there will be no difficulty in getting a drainage tube right through, and in emptying the abscess from the bottom.

Peritonsillar Abscess, or Quinsy.—(*See under* "Diseases of the Pharynx.")

Deep Cervical Abscess.—The early recognition of the presence of pus beneath the deeper fasciæ of the neck is of the highest importance, yet sometimes it is extremely difficult: the pus is so confined and so deep, and there is often so much general swelling, that fluctuation is hardly to be made out, while nowhere is there anything like pointing. But pus in this region must be let out as soon as possible, for the consequences of not giving it exit may be very disastrous. Burrowing in the direction of least resistance, the matter may burst into the pleura or pericardium: or the air-passages or blood-vessels in the neck may be involved in the destructive inflammation.

The constitutional disturbance is generally very great, and the temperature chart will itself be evidence of the formation of pus. In cases of doubt an exploring trocar may well be used, but when pus is known to be present, a freer opening than that effected by a needle is desirable. From anatomical considerations free use of the knife is dangerous, therefore the incision should be made carefully. When the cavity is reached the relief is usually immediate and very marked. The opening may be kept patent by a drainage tube, and the cavity syringed out in the usual way.

Superficial Cervical Abscesses.—These abscesses must never be confounded with the foregoing. They are often glandular, or periglandular. If they originate in glandular inflammation, attention should be directed to the head, where the source of irritation will generally be found in the shape of eczema or lice, or to the condition of the teeth, a common cause of cervical glandular trouble.

Alveolar Abscess, or "Gum-boil."—Here again relief should be given as soon as an elastic bulging of the gum indicates the presence of pus. A narrow-bladed scalpel should be used, and the incision should be made close to the alveolus.

Retropharyngeal Abscess is caused by the formation of pus at the back of the pharynx. There are four causes of this condition:—

1. Suppuration at the back of the nasopharynx, possibly from infection of the glands or the cellular tissue which drain that cavity—a complication of adenoids and therefore common in young children: the abscess so formed lies usually in the middle line.

2. Infection of the cellular tissue around the tonsil. Such an abscess being laterally placed, bulges into the pharynx from the side. This is a common variety, and may be called the "parapharyngeal."

3. The breaking down of the deep lateral cervical glands. Such an abscess is not truly retropharyngeal, but lies against the lateral wall of the pharynx, and may simulate the second variety.

4. When tuberculous disease has attacked the bodies of the upper

cervical vertebræ, an abscess is sometimes formed which pushes the pharyngeal wall forward and bulges into the mouth.

The anatomy of this abscess is as different from the first two varieties as its pathology, for it lies behind the prevertebral layer of cervical fascia, and has a greater tendency to track outwards along the line of attachment of this structure. The first two varieties, on the other hand, lie in front of this layer of fascia, and their treatment is different from that appropriate in the last two forms.

The symptoms of a retropharyngeal abscess are difficulty in swallowing—the food tending to regurgitate even through the nose of the child, —difficulty in breathing, and in some cases severe dyspnœa. The child cries in a peculiar manner. The diagnosis is made by passing a finger to the back of the patient's throat, and detecting the soft bulging swelling in front of the vertebral column.

TREATMENT.—In the first two forms, incise the swelling through the mouth and enlarge the opening with sinus or Spencer Wells' forceps. The mouth should be washed or swabbed out regularly, and the general health of the child attended to. The remaining varieties are usually treated by incision of the neck. The third form has already been considered under the head of deep cervical abscess. The form which arises from spinal caries is on no account to be opened through the mouth. A careful dissection must be made behind the sternomastoid in the direction of the transverse processes of the vertebræ, and the pus must be reached by Hilton's method.

Whitlow.—The suppurative condition of the fingers known as whitlow or felon usually results from a punctured wound with a septic instrument, or is due to subsequent infection of a simple cut.

It is usual to speak of four different varieties of whitlow, which depend upon the depth of the infection ; and as the particular variety met with in a given case may require special treatment, all four will be alluded to under their respective headings.

1. *Subcuticular.*—The pus collects beneath the epidermis ; there is often an exudation of blood-stained serum with very little pus, and the epidermis may be stripped up for some distance from the underlying dermis.

2. *Subcutaneous.*—In this form the infection tracks into a deeper level, and the tough tissue of the finger-pulp becomes attacked. It is excessively painful owing to the tension which is produced, and if neglected may lead to the following varieties.

3. *Thecal.*—This is a suppurative tenosynovitis. The synovial membrane which accompanies the tendons along the flexor sheaths becomes infected, and the whole canal may in this way become filled with pus. In the case of the thumb and little finger, the results may be still more serious, owing to the communication which usually exists between the synovial membranes of the flexor sheaths and the great synovial membrane or palmar bursa which envelops the flexor tendons in the palm. Fortunately this accident is rare, but its occurrence is a

very serious matter, often leading to destruction of the hand and permanent crippling.

The flexor sheath cannot be said to extend beyond the distal extremity of the second phalanx, so that whitlows which are confined to the region of the terminal phalanx and carefully treated should not give rise to this complication.

4. *Subperiosteal.*—In this form the infection gives rise to a periostitis, the periosteum of the terminal phalanx being attacked and necrosis of the bone a common result. The intimate connection of the skin and periosteum by the fibrous ligaments which traverse the superficial fascia favours this result.

TREATMENT.—This consists in incising the tense and suppurating area as soon as possible, *providing rest for the affected finger by a suitable splint*, and in the application of antiseptic dressings. But while these directions appear sufficiently simple, it will be necessary to elaborate them according to individual cases.

In the subcuticular variety, which is practically painless owing to the pus lying superficial to the sensitive papillæ, a free opening can be made without any anæsthetic, and all undermined skin can be snipped away with scissors without the least discomfort to the patient.

The subcutaneous form is more difficult to treat, and it may be said at once that the causes of failure are usually an insufficient incision, and the absence of rest to the part. It often happens that an incision has to be made without an anæsthetic, and the timidity of both the operator and his patient results in an insufficient opening being made. Although with thorough cocaine anæsthesia the operation may be quite satisfactory, it is always advisable to give a general anæsthetic when possible.

In making the incisions into the swollen infected area, two precautions must be taken: (1) To see that the opening is adequate, so that the pus can discharge freely. This is not so easily achieved. Owing to the dense fibrous tissue in the part, as soon as the greater part of the exudation has been let out, the edges of the wound tend to close, and there is retention of the pus. To obviate this it is recommended that two elliptical incisions should be made, and a portion of skin and subcutaneous tissue be excised, so that the pulp is freely opened up, and sloughs should be carefully removed with a spoon. (2) Care should be taken in making the incision that the flexor sheaths be not damaged. This precaution is very necessary, for it has often happened that an energetic operator, with the above rule in mind, has carried his incision right down to the synovial membrane of the sheath, and has caused an infection of it.

In the thecal form free incisions will be required opposite the centre of the second and first phalanges; either central or lateral incisions may be made, but there appears to be no special advantage in the latter.

The subperiosteal form is treated in the same manner, but subsequently it will be necessary to remove the necrotic bone.

The *After-treatment* is of much importance. Fomentations and baths of weak antiseptics are of undoubted value, but they are often overdone. It is rarely that a whitlow requires fomentations for more than three or four days, and much harm results from allowing the tissues to become sodden and unhealthy from too much water treatment. In favourable cases dry dressing may be applied in the first week, and as soon as pain has disappeared gentle passive movements of the fingers should be undertaken to break down the adhesions, which have a tendency to form in the thecal variety. Bier's congestion has been of great value in the treatment of whitlows. Cathcart, of Edinburgh, has written very favourably on the subject. In my hands it has been successful only when free incisions have been made, and I combine with it immersion in weak iodine baths for a period of one to two hours twice a day. The routine treatment has been as follows: An appropriate incision has been made, and the pus has been let out. A dry dressing is then applied till the bleeding has been checked. The finger is then soaked in weak iodine, and at the end of an hour a band is tied round the base of the finger so as to cause sufficient congestion, and an antiseptic dressing is applied. The congestion is kept up for one, two, or three hours, according to the patient's comfort. I am here dealing with the bad cases, which in my opinion are not suited to ordinary casualty treatment, and I am convinced that many fingers could be saved if the patient were kept under proper supervision for a week or so in the wards. The milder cases can be dealt with adequately as out-patients, and Bier's congestion and the iodine bath can be employed for the first few days on the occasion of each visit. *A splint should always be applied before the patient leaves.*

Unfortunately, the result is too often a stiff and useless finger which may require amputation; but this must be looked upon as a last resort. It is true that where the process tends to spread, and where there is a risk of infection of the hand and arm, amputation must be seriously considered, and again, where after careful treatment a useless appendage remains; but while it is impossible to lay down absolute rules for these cases, it should be clearly understood that amputation is called for only in the acute stages, to avert a more serious condition; and even where the finger appears totally and irretrievably destroyed it is much better to wait until the suppurative process has subsided before venturing on the amputation. By such a course the free opening up of lymphatic spaces in the presence of an acute infection is prevented, and the surgeon is often able to save some part of the finger in the form of a stump, which will be of service to the patient. It is astonishing how often a bad suppurative condition of the fingers results in an almost complete cure.

The above remarks apply to the whitlows met with on the palmar aspect of the digits, but the allied condition on the dorsum—"peri-onychia"—is to be treated on similar principles, plus the free removal of the nail.

Palmar and Plantar Abscesses are caused by punctured wounds, or are the result of a spreading whitlow. They should be opened by free longitudinal incisions, but the position of the arterial arches should be carefully borne in mind, since hæmorrhage in wounds of this kind is troublesome and often serious. If the pus has tracked back through the interosseous spaces, a counter-opening should be made on the dorsum. After incision the whole limb should be placed on a splint and kept at rest, but as soon as the temperature is normal and the wounds are healthy, careful movement of the fingers should be undertaken to diminish the stiffness, a usual sequela from the adhesions which have formed in the synovial coverings of the tendons.

Suppurating Bursa Patellæ is another very acute form of abscess which calls for early relief. Of the treatment of the common housemaid's knee we will say something presently, but instances are not at all rare of a suppurative inflammation of this bursa, which may, or may not, have been previously enlarged. The results of neglecting to incise this acute abscess as soon as it is recognized are comparable to, and indeed may be even more serious than, the case of a whitlow. The patella may necrose in part, or altogether; or worse still, the knee joint may become involved, if the pus fails to make its way to the surface. On the other hand, an incision made into the acutely inflamed bursa some little time before suppuration has actually occurred, can do no harm, may very possibly prevent matter being formed at all, and will certainly give present relief.

On all accounts, therefore, abscess or commencing abscess of the bursa patellæ requires an incision, which must be free and in the middle line, and which must fairly open up the bursa.

The patient must, of course, be confined to bed, and the leg will be most comfortable when placed on a slightly bent M'Intyre, or on a back splint with a little extra padding beneath the hollow of the knee. An antiseptic fomentation will be the best dressing, and recovery is usually very speedy.

Popliteal Abscess arises from a number of causes, most commonly from an infection of the glands or cellular tissue of the popliteal space via the lymphatics, from a sore on the heel. It is a condition that may easily be overlooked. The patient, usually a child, complains of pain in the knee, and the knee joint is sometimes swollen from an effusion of fluid, and the limb is flexed. Such cases have been diagnosed as various forms of synovitis, the swelling in the popliteal space having been missed. If neglected, the pus will track up the thigh, producing serious damage, and worse still, may infect the knee joint via the various communicating bursæ in this region. In any suspected case of this kind the popliteal space is to be very carefully examined, and if pus is present it will be found full, tender, and not necessarily red—because the pus is formed beneath the deep fascia.

TREATMENT consists in making a free incision on the outer side of the space in front of the tendon of the biceps, evacuating the pus, and

inserting a drainage tube. Care must be taken that the tube does not press on the popliteal artery.

Acute Necrosis or Acute Periostitis.—The next deep-seated collection of pus we have to consider has to be treated very differently, for cases of *suppuration beneath the periosteum*, or indeed of periostitis threatening suppuration, require more urgently perhaps than any other collection of pus, *early* and *very free incision*. In *acute periostitis* (acute diffuse osteitis and periostitis, acute necrosis, or suppurative periostitis) we have a condition in which it is hardly paradoxical to say that the pus should, if possible, be removed before it is formed. No time should be lost in relieving the strangulating tension of the inflamed membrane by free incision right down to the bone. Unfortunately the inflammation is deep, and fluctuation may be hard to detect, so that it only too often happens that the case is called one of "very bad rheumatism," until the pus has stripped off the periosteum, up and down the limb, and the bone is doomed to die, although by taking action a few hours earlier it might have been saved. But although fluctuation may be obscure, this inflammation is really quite unlike any less serious form: the swollen limb, the skin shining from tension, and white from the same cause, the peculiar hard œdema and exquisite tenderness, and the depth at which the fluctuation can be felt, if felt at all, are all signs which should be distinctive enough.

TREATMENT.—There is only one line of treatment, namely, to make a *free incision*, or more than one if requisite, right down to the bone. In many cases the knife will strike against hard dead bone, and in any case the relief afforded by the exit of the pent-up pus will be very great. The cavity must be syringed out, and in all respects treated like an acute abscess, until the time comes for the consideration by the visiting surgeon of operative measures for the removal of the necrosed shaft in its entirety, or of a portion of it.

Though much may be done by free incision to relieve the local trouble in these cases, it must be admitted that some of them appear to obtain little relief from the constitutional disturbance usually present with this disease. This arises from the fact that there are often small collections of pus in situations where they cannot be got at, e.g., the lungs, or walls of the heart; and though we may evacuate the pus on the bone the others will be sufficient to destroy the patient's life.

Buboes.—This term is applied to all glandular or periglandular abscesses which occur in consequence of inflammation set up in, or around, the femoral and inguinal glands. The exciting causes are very various. In scrofulous children, the irritation of eczema intertrigo, or of ascarides, or phimosis, may cause the inguinal glands to break down, while a sore heel or inflamed scratch on the leg may produce the same result in the femoral group.

In adults, similar injuries of the leg but rarely produce a femoral bubo, while (also somewhat rarely) herpetic eruptions about the corona glandis, the irritation of piles, or of condylomata about the anus, may

be the cause of suppuration about or in the inguinal glands. But, in adults, the most frequent causes of buboes are gonorrhœa, soft chancre, or more rarely, hard or the true syphilitic sores; these buboes are almost always abscesses *around* the glands, which run a subacute, burrowing course. They may, however, take on a phagedænic action in patients with broken-down constitutions.

Buboes should always be opened early, from the tendency they have to form long fistulous tracks in the cellular tissues. A vertical incision should be made with a straight scalpel or a Syme's knife, and the abscess cavity kept open, so that it may heal from the bottom. This may conveniently be done by packing it with a strip of antiseptic lint.

The cut is made vertically, in order to avoid wounding the superficial arteries in this region. These are, however, often enough divided, and the bleeding must be averted by ligature. The superficial epigastric is the one most likely to be wounded, and being an artery of moderate size may bleed rather furiously for a short time. If fistulous tracks remain, they will have to be laid open and treated in the manner to be presently described.

Chronic Abscesses.—Chronic or cold abscesses differ from the acute variety in that the three cardinal symptoms and signs of inflammation—heat, redness, and pain—are usually absent. Pathologically they are said to be different, in the absence of pyogenic organisms and leucocytes. This statement is not strictly true, as recent observations have shown that not only are degenerated leucocytes present in the tuberculous variety of abscess—the typical chronic abscess—but that many forms of cold abscess are due to pyogenic organisms of low virulence and activity.

Some of the abscesses considered in the previous chapter, such as the retropharyngeal, cervical, and popliteal, may present themselves in a chronic form.

Chronic abscesses do not call for evacuation in consequence of constitutional irritation or fever due to mechanical retention of pus, but for some less urgent cause, so that the opening is made more deliberately, and is not followed by that marked, almost instantaneous alleviation of symptoms, which is characteristic of the opening of an acute abscess.

The chief ways in which a chronic abscess may be opened are:—

1. By simple incision.
2. By free incision, and, if necessary, counter-incision.
3. By some form of aspirator.

Free Incision with the antiseptic precautions before described is now the common treatment. In all the details of the dressing, and in every other particular, the arrangements are the same as have been previously detailed.

Position of Incision.—This should be made by preference in a dependent place, or a drainage tube may be passed through from an upper

to a lower opening. In fact any of the methods of draining which have been described in the section on wounds may be employed.

Aspirators.—Of these there are several, but they are mostly modifications of Dieulafoy's, shown in *Fig.* 184, except in the case of small instruments which are used chiefly for exploration, in which the fluid enters the barrel of the syringe, and is thence expelled, by a special arrangement of taps. Smaller syringes still may be used, down to the ordinary hypodermic syringe, by means of which the nature of obscure swellings, or the existence of fluid in such situations as the pleura or the liver, may be safely proved or disproved more easily than would otherwise be possible.

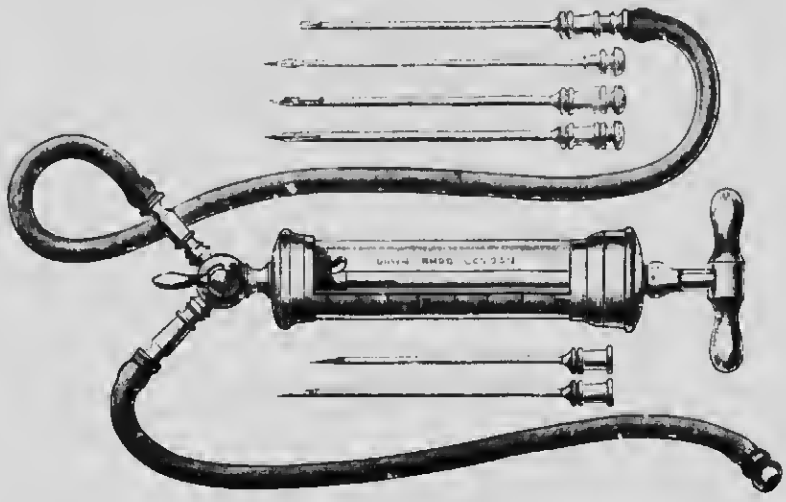


Fig. 184.—DIEULAFOY'S ASPIRATOR.

Before using any aspirator, its connections must be seen to be air-tight, and the powers of the syringe to maintain a good vacuum should always be tested.

The aspirator has been largely used by surgeons for dealing with chronic tuberculous abscesses—even psoas abscess—and certainly in many cases the results have been excellent. There is a growing tendency to avoid extensive operations in these cases, and the aspirator often fulfils the object of our treatment—viz., to remove dead or necrotic material, so that bactericidal serum can take its place—in an admirable manner.

Caution needed in use.—Whether the actual puncture be made with a fine trocar and cannula, or with a pen-pointed hollow tube, it is very important that the needle should be sharp; if not, there will be great risk of its pushing some piece of tissue, false membrane, etc., before it, so that it is blocked at once, and completely. This tendency to blocking of the aspirating needle is the great drawback to the apparatus, and must always be kept in view.

With regard to the actual insertion of the needle, few general directions are called for. The depth to which the operator wishes to go must be decided beforehand, and the finger should be placed upon the needle to serve as a guide. The cavity should be punctured quickly, so as to avoid pushing the sac wall in front of the point of the instrument, and the direction of the needle should always be perpendicular to the surface of the tumour.

Hæmorrhage into an Abscess Cavity.—As soon as the internal pressure of the fluid contents is removed it naturally happens that bleeding from the vessels in the abscess wall may occur. When an abscess is opened, therefore, care should be taken that the parts are not squeezed or

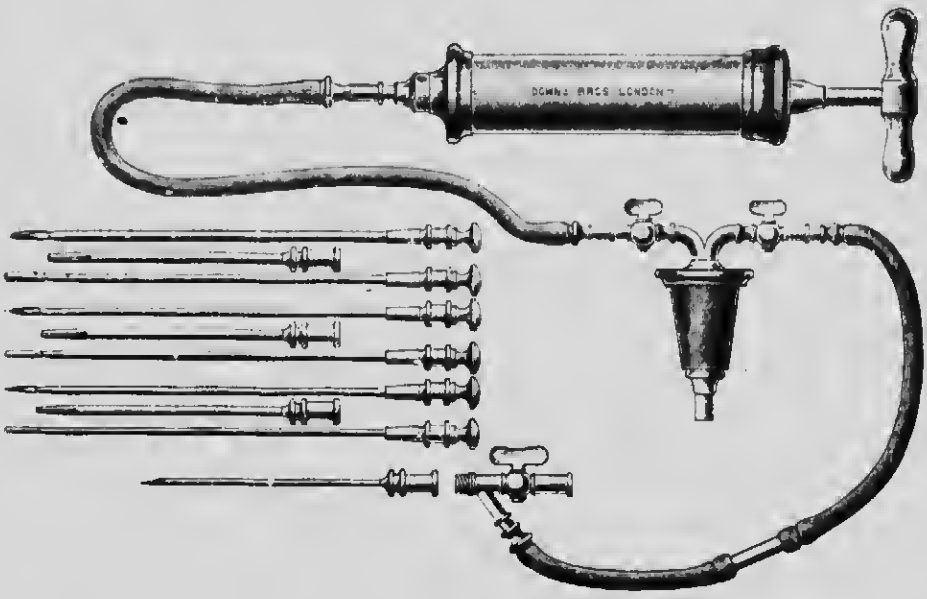


Fig. 185.—Potain's Aspirator.

roughly handled. The sudden relief of pressure, even without manipulation, may often enough result in a bleeding into the abscess, sufficient to cause delay in its complete evacuation. In most cases the blood-clots become disintegrated and broken down, and escape as débris when the sac is syringed out, so that moderate pressure is all that is required; but sometimes the bleeding assumes a more serious form; a blood-vessel of some size may be running through, or in the walls of the abscess, and may be eroded; or a vessel may have been wounded in the opening, or the walls may be in a dangerously sloughy or congested condition. From any of these causes it may happen that the sac of the abscess becomes distended with blood-clot, while from the aperture there is a trickling stream of fluid blood, which serves as an evidence that bleeding is still going on.

We have here *inside* the cavity those conditions of distention and

high temperature which most favour hæmorrhage, and unless the sac can be emptied of the clots through the existing opening, the only course is to enlarge it and to turn them out.

Chronic Psoas Abscess.—This is taken as the type of chronic tuberculous abscess that requires treatment. It is a very common form of the disease which is seen in the surgical wards.

There are three main varieties of psoas abscess:—

1. An early stage, when the abscess has not reached the surface, and is indicated by a tender thickening felt in the line of the psoas on deep palpation of the abdomen.

2. When the pus has tracked out along the fascia iliaca, and presents either as a lumbar abscess in Petit's triangle or as an iliac abscess, internal to the anterior superior spine of the ilium.

3. When the abscess has passed with the psoas tendon underneath Poupart's ligament and presents to the outer side of the femoral vessels in Scarpa's triangle. From this point the pus may track in many directions along the branches of the femoral artery.

The treatment of the first variety is somewhat difficult, because, to reach the pus from the front, the peritoneum must be displaced inwards or opened. As it is necessary to avoid both these manœuvres as far as possible, the general rule is either to wait until the pus approaches the surface, when it can be reached directly by an incision over the most prominent point, or to perform an operation recommended by Treves, making a vertical incision just outside the transverse processes of the vertebræ, traversing the muscles and lumbar aponeurosis until the cavity in the psoas is reached.

In the case of the second and third forms the pus can be evacuated by any of the methods previously mentioned.

There are three points to be specially considered in dealing with these abscesses by incision:—

The question of

1. Scraping out the abscess cavity so as to remove the infected lining membrane.

2. Injecting any germicide or antiseptic into the cavity.

3. Drainage.

Opinions are very divided upon these three subjects, and no doubt successful cases have followed the scraping of a psoas abscess with a sharp spoon, the injection of iodine solution, iodoform emulsion, or even carbolic acid, followed by the introduction of a drainage tube for some time.

Scraping with a sharp spoon, however carefully carried out, is dangerous: the peritoneum may be opened and infected. It is not possible to discriminate between good and bad tissue, and while a certain amount of infected material may be removed, the fibrous wall and healthy granulations may be damaged. Thirdly, the method may cause free bleeding, leading to the abscess cavity becoming distended with clots.

If the walls of the cavity are carefully sponged with pads of gauze, the softened gelatinous membrane will be found to come away quite easily, and its removal may be assisted by flushing out the cavity with normal saline. This method causes little bleeding.

With regard to the injection of antiseptics, we would point out that when a large cavity, such as that of a psoas abscess, is filled with any antiseptic, such as iodoform or carbolic acid, there is some risk of poisoning by the drug.

Weak iodine 5j ad Oj may be used with safety, and in many cases "iodoform emulsion," i.e., iodoform suspended in glycerin, is employed, but its use is best confined to smaller abscess cavities.

If a drainage tube is employed there is always a risk of a secondary infection occurring. Such an occurrence is a serious disaster; and the greatest care must be taken in operating on these cases that every aseptic precaution is observed.

When a tube passes from the region of the groin into a large cavity of this nature, a mixed infection is very likely to take place, and for this reason the tube should be omitted. In certain cases where smart bleeding attends the opening and clearing of a psoas abscess, it is advisable to insert a tube for twenty-four to forty-eight hours, after which it should be removed; in most cases it is better to close the wound completely.

During the course of the disease the abscess cavity will very likely refill, in which case the operation should be repeated.

Needless to say, vaccine treatment should be systematically employed in suitable cases.

While these rules may govern the treatment of a large psoas abscess, it must be admitted that in certain situations small superficial tuberculous abscesses may be treated in a more radical manner. In cases where there is only a small cavity, and where satisfactory pressure can be applied, not only may a thorough scraping be advised, but the whole abscess may be dissected out and removed.

Chapter XXXII.

OF THE EVACUATION OF THE SYNOVIAL SACS OF JOINTS, AND OF BURSAL AND SEROUS CAVITIES.

JOINT CAVITIES may become distended with fluid, either through acute or chronic inflammatory effusion, which may be serous or purulent; or more rarely, from hæmorrhage, as in a case of fractured patella, or from some much slighter injury in patients with a constitutional tendency to hæmorrhage, and in some of these cases it may be advisable or imperative to relieve the tension within the joint.

JOINT EFFUSIONS.

These will come under some one of the following heads:—

Acute inflammatory effusion—non-purulent—(traumatic, or idiopathic); *Acute suppuration within the joint*—(abscess of joint); *Chronic effusion*—(hydrops articuli, or joint dropsy); *Hæmorrhage*—always accompanied by more or less inflammatory effusion: may be traumatic, or a symptom of the hæmorrhagic diathesis.

Acute Inflammatory Effusion, Non-purulent. — It is very rarely indeed that an idiopathic synovitis causes distention to such an extent that the fluid has to be removed. Rest, cold, or massage will almost always sufficiently reduce it. But if this mode of relief be decided upon, it must be effected with a fine aspirating needle, and it is best to remove only sufficient fluid to lower the tension, without endeavouring to empty the sac, in which attempt the joint structures might be further injured. In aspirating joint cavities, the needle must always be extremely sharp, have been sterilized by boiling, and the spot of puncture have been very carefully washed with antiseptics before operation.

But in cases of effusion arising in consequence of *injury*, it somewhat more frequently occurs that the internal tension is so great that it is right to prevent permanent damage through the softening of the ligamentous structures about the joint by removing the fluid. This is always done by aspiration, as above mentioned.

In rare cases of *chronic effusion* into a joint, where the quantity of fluid is large, the signs of inflammation absent, and when the ordinary measures for producing absorption have failed, recourse has been had to aspiration, followed by pressure, or to tapping; but the injection of stimulating fluid is not recommended, as, though in some cases improvement has followed, serious results have been known.

In cases of very severe injury to a joint, as, for example, that which is inflicted on the knee joint in some cases of fracture of the patella, the joint may become greatly *distended with blood* as well as with inflammatory effusion, and the tension here also may be so great as to call for aspiration, as was mentioned when we were considering that fracture. If it be adopted, a somewhat larger cannula or needle will be required than for the removal of simple serum. The same antiseptic precautions must be followed.

Patients who are examples of the hæmorrhagic diathesis, either in the shape of hæmophilia or purpura, or who are attacked with scurvy, may have almost spontaneous effusion of blood into their joint cavities. In these cases no operative interference is ever called for, and the effusion must be left to be absorbed by natural means.

Acute Suppuration within the Joint.—But when in *acute arthritis* the local and constitutional signs point to the presence of *pus* in a joint, the line of treatment differs in almost every particular from those we have been discussing. Now, every hour's delay in affording relief is dangerous, and the only treatment that can be advised is laying the joint open freely and thoroughly irrigating the cavity. It would in our opinion be useless to adopt any other course, such as tapping with a trocar or injecting antiseptic fluids. Before, however, proceeding to such a serious operation it is as well to insert a hypodermic needle of large size and withdraw some of the fluid, to make certain that pus is present. Tapping with an ordinary trocar is attended by more risk of damaging the joint cavity, but in the case of turbid synovia it is sometimes necessary to use this instrument, as the thick fluid may not be able to flow through an aspirating needle.

If a joint is to be freely opened, this must be done by such incisions as will secure drainage and a free passage for lotions, etc. The presence of any symptoms of septicæmia is an additional reason for opening and freely draining the joint, and the injection or syringing out with some antiseptic fluid. In all cases the joint must be kept carefully splinted, and great attention must be given to its position, which should be that of the greatest use to the patient should ankylosis ensue. As a rule, the joint cavity, and the abscesses which are apt to form in its neighbourhood, will have to be washed out very frequently.

Suppuration inside a joint also occurs in the later stages of chronic arthritis, calling for relief by incision; hardly ever by aspiration. The necessity for relief is not in these cases so urgent, but in all other respects their management is similar, although the prognosis is much less hopeful.

We have hitherto considered the question of evacuation of joint cavities as applying to all joints, but it is the knee which is especially apt to become acutely inflamed, or dropsical, or in which there is found blood, or acute suppuration. We must therefore consider particularly the exact methods of aspiration and incision of the knee, although we need not do so in the case of any other articulation.

Aspiration of the Knee Joint.—The spot where the synovial membrane of the knee joint comes nearest to the surface is on the inner side, at the level of the lower border of the patella, and the aspirating needle should there be plunged into the place where the fluctuation seems to be most distinct, entering the cavity of the joint at right angles to the skin surface, which has been carefully washed with soap and water and some antiseptic fluid. Gentle pressure should be made upon the part as long as any fluid escapes, and when the cannula is withdrawn, a very small pad of lint soaked in collodion may be placed on the spot as a precautionary measure. If the needle be one of the fine ones generally used in aspiration, this pad is hardly necessary, but if a larger trocar and cannula be used it should never be omitted. Whatever instrument is used should be well boiled, in order to render it aseptic.

Incision of the Knee Joint.—If one opening only be made, this will almost always be on the inner side; but as a rule a counter-opening is also deemed advisable, to secure thorough drainage, and the readiest way to get into the joint on the outer side is to make the inner incision first, and then to pass a probe or director across the interior of the cavity until it can be felt beneath the skin, and can there be cut down upon.

Enlarged Bursa Patellæ.—It frequently happens that this bursa, as well as others, is the subject of chronic enlargement, from accumulation of fluid within. In some cases this may be absorbed by the action of iodine, blisters, etc., or by steady compression or strapping. But very frequently it will be necessary to evacuate the glairy or gelatinous contents of these sacs. The best method is to open the cavity with a sharp double-edged knife. When the sac is emptied and the contents are thoroughly evacuated, the incision may be stitched up for two-thirds of its length, and a strand of catgut left in for drainage. Firm compression with a pad and bandage must be maintained, and it will generally be wise to restrain the movement of the part by means of a splint. At the end of a week or ten days, provided the antiseptic precautions have been efficient, the wound will be found to have united, and the catgut strand will have been absorbed, except that part outside the wound, which will come away with the dressing. Thus in the case of an enlarged bursa patellæ, or "housemaid's knee," a back splint for the knee joint should be applied.

In cases where the bursal wall is very much thickened, it is usually necessary to dissect out the bursa; this should be done through a vertical incision, and the knife kept close to the bursal wall, in order to avoid wounding the knee joint.

Simple Ganglia are small nodules which vary in size from that of a pea to a walnut. They are usually found on the back of the wrist in connection with the extensor tendons, but they may arise in other situations. They are the products of collagenous connective tissue degeneration—probably the result of trauma—and though they

may communicate with the synovial membranes covering the tendons or lining the neighbouring joint cavities, such communications are secondary.

1. *Counter-irritation with Pressure.* The swelling should be painted with iodine liniment and firmly bandaged or strapped. In a certain number of cases this will be successful.

2. *Puncture.*—A tenotome is inserted beneath the skin, with due regard to the anatomy of the part, and the swelling is freely incised, a valvular opening being made. Pressure is then exerted over the swelling, so that its contents are extruded. A collodion dressing is applied with firm pressure, so that the walls of the cavity are brought into apposition. It is better to allow the gelatinous contents of the ganglion to escape externally than into the cellular tissues, and the whole proceeding must be conducted under the most careful asepsis, or very serious, even disastrous, results may occur.

3. *Excision.*—When a ganglion resists the above methods of treatment, or when the surgeon and patient both desire a speedy cure, the ganglion may be exposed by a free incision and dissected out. The tendon sheath, or sometimes a joint cavity, may be opened, but if absolute asepsis is maintained there is no danger. Subsequently, early movement of the part must be undertaken to prevent the tendon from becoming fixed by adhesions.

As these ganglia are very mobile they should be steadied with the fingers of the left hand while the puncture is made and until the sac is empty, otherwise the operator may have a little trouble in getting into the sac.

Compound Ganglia, such as those which often extend beneath the annular ligament at the wrist, are much more serious, and frequently contain "melon-seed bodies." The best way to treat them is by vertical incisions above and below the annular ligament, whereby the cavity must be thoroughly irrigated. It is usually well to drain for a couple of days, the hand and arm being kept on a splint.

EVACUATION OF SEROUS CAVITIES.

The serous cavities of the pleura, peritoneum, and the tunica vaginalis testis are frequently the seat of fluid accumulations which have to be removed by aspiration, tapping, or incision, and the methods of the evacuation in each case must be considered separately.

Paracentesis Thoracis is a simple enough operation, if the physical signs of the presence of fluid are distinct, but if there be any doubt on that point, or if the pleura has to be punctured in an unusual place, it will be safer first to insert a fine exploring aspirating needle, the most convenient instrument being an ordinary hypodermic syringe.

Aspiration is generally the method chosen when the fluid is believed to be serum, or when the pleural cavity is to be emptied for the first time. The ordinary pattern of the instrument is shown in *Fig. 180*, and its management has been described. The [illegible] selection for the

insertion of the needle, and for all other punctures and incisions into the pleura, is either in the mid-axillary line in the middle of the fifth or sixth interspace, or, if an opening further back be required, in the seventh or eighth interspace, just in front of or behind the posterior axillary line. The needle or fine trocar must be very sharp, and must be inserted with a "stab" so as to avoid pushing forward any false membrane adhering to the parietal pleura. The patient should lie as low as the performance of the operation will allow, and if faintness should ensue the evacuation should be stopped for a time. The fluid should ensue drawn off very slowly.

The aspirator has displaced the old trocar and cannula to a great extent, but the latter instrument is still frequently employed. It is desirable, when a trocar is used, to have some arrangement by means of which air shall be excluded from the chest cavity during the operation.

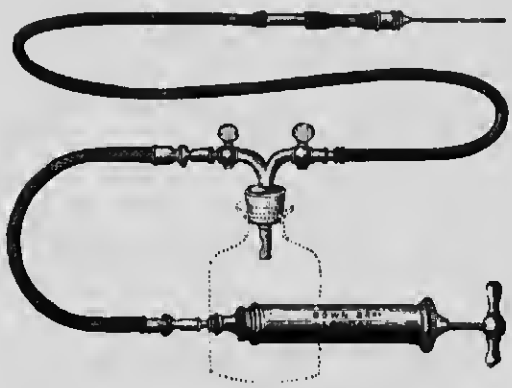


Fig. 186.—Aspirator, with bottle.

The tube having been attached, the trocar is inserted as the aspirating needle was, and the cutting piston is immediately withdrawn into the handle, so that the fluid passes down the side branch and down the tube, which acts as a syphon.

It will often happen that the aspirator or trocar will draw off healthy serum, and that the operation will not need to be repeated, or at least only once or twice, the fluid remaining serous throughout. But if the evacuation has to be often repeated, pus is almost certain to be formed, while in other cases it may be present from the first. Should this be so, we have now to do with an empyema instead of a serous pleurisy; and it will be necessary to evacuate the pus.

Operation for Empyema.—The collection of pus in the pleural cavity, called an empyema, may be treated in three ways, each method being required according to the special needs of the case: (1) Aspiration; (2) Incision through an intercostal space and drainage; (3) Excision of a portion of a rib, and drainage through the larger space thus afforded.

1. *Aspiration* is usually required for the purposes of diagnosis, but can rarely be considered as the adequate treatment, though occasionally empyemata have, it is said, been cured by this simple procedure. On the other hand, as a preliminary to more radical methods it is of undoubted value, since the gradual removal of the pus by means of the aspirator in cases of urgent dyspnœa or great cardiac embarrass-

ment, enables us to perform the further operation with much less risk. It may be taken as a rule that if there are physical signs indicating an empyema of considerable size, half to one pint of the pus should be evacuated by means of the aspirator before the resection of a rib is undertaken.

2. *Incision* is not to be regarded as the ideal method, since the small interval between the ribs usually interferes with the drainage which is required, but it is of service occasionally in empyemata in children, or if the patient's condition prohibits more than local anæsthesia or general anæsthesia of very short duration.

The operation can be performed very quickly by incising the skin over the seventh intercostal space in the posterior axillary line, and completing the operation with the knife or sharp-pointed scissors. If the latter are used, they are thrust into the pleural cavity through the intercostal muscles, and then opened, all danger of injuring the intercostal vessels being avoided if the instrument is kept near the

Fig. 187.—Doyen's Raspatory.

upper border of the rib. If the knife is preferred, it is thrust into the pleural cavity in the same manner, cutting through the muscles anteriorly as it is withdrawn. The opening is then enlarged with sinus or artery forceps, and a stout tube, which will better withstand the compressing influence of the ribs, is inserted into the cavity, and a dressing applied. The position of the patient should be the same as that in the following operation.

Excision of Rib.—This operation may be done under local anæsthesia, but it is better performed under chloroform. If the condition of the patient is such as to render local anæsthesia advisable, incision only is preferable. The patient should lie on the back, with the shoulder and thorax of the affected side drawn well over the edge of the bed or operating-table; the eighth rib is defined, and a point is taken along it just in front of the post-axillary fold formed by the latissimus dorsi—that is, in the posterior axillary line.

Three precautions are to be observed in opening empyemata:—

1. Not to make the incision too far forward, or the empyema will not drain satisfactorily.

2. Not to place the incision so that the inferior angle of the scapula will come into contact with the drainage tube: an accident which may happen if the incision is placed too far back.

3. Not to make a valvular opening through the skin.

As the arm is usually raised to the level of, or above, the patient's head, the skin is stretched and the angle of the scapula is brought forward, and these displacements must be kept in mind when the

incision is made. The skin should be gently drawn down over the eighth rib, and an incision two inches long made straight down to the periosteum. This should be carefully and thoroughly lifted from the bone by suitable raspatories, and the inner surface of the rib should be cleared in a similar manner with Doyen's curved periosteal elevator (*Fig.* 187). The rib is cut through at each extremity of the incision by means of strong forceps, and 1–1½ inches of bone are removed. The periosteum on the deep surface of the rib is now exposed, and a pair of sinus forceps—or if the empyema is of long standing, a pair of sharp-pointed scissors—is thrust through the middle of the periosteum and pleura into the cavity of the empyema. If these precautions are

Fig. 188.—"Hospital" Empyema Tube.

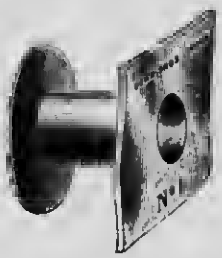


Fig. 189.—Pollard's Empyema Tube.

observed, the intercostal vessels which are here lying in the subcostal grooves will escape injury. Should they be damaged they should be secured by passing a curved needle armed with a silk ligature round them, or even round the proximal end of the rib, and tying in the ligature firmly. As soon as the pleura is opened, the pus rushes out and the air rushes in, and at this point the patient's condition may become serious. The pus should be only allowed to come out slowly, and the affected side of the thorax should be firmly compressed by an assistant, so as to diminish this movement. Severe syncope should be treated at once by the injection of strychnia, 5 min., and by inhalation of oxygen.

A finger should be introduced into the cavity so as to remove the masses of lymph, which retard expansion of the lung, and which often interfere with drainage. A large scoop is of great service for this purpose. Finally, a large-sized drainage tube, provided with a broad flange (*Figs.* 188, 189) to prevent it falling into the pleural cavity, is introduced, and a firm dressing is applied.

The cavity should never be washed out at the time of the operation—later, if a foul sinus forms, it may be advisable to irrigate it with a weak solution of iodine; but there is always a risk of syncope following any injection into the pleural cavity.

The dressings should be frequently changed, and the tube should be removed as soon as possible; this can sometimes be done from the

fourth to the sixth day, since the pleura, like the peritoneum, is capable of more active repair than other tissues.

The long-continued presence of the tube is the cause of sinus formation and chronic irritation, but in some cases it must be retained for a much longer time In this respect each case must be treated on its merits, but it may be removed before all the discharge has ceased, provided the lung has expanded, since any healing or granulating surface continues to discharge, especially in the presence of a drainage tube.

Empyemata must be treated with the most careful antisepsis. The infection is rarely a mixed one. The pneumococcus is present in the majority of cases, and if other micro-organisms are kept away, healing is carried out in a satisfactory and rapid manner. The cause of persistent sinus after operation may be due to the empyema being of long standing—the great thickening of the pleura preventing the lung from expanding ; but in many cases it is surely due to careless after-treatment.

During convalescence the patient should be encouraged to exercise the lung of the affected side. This may be done by turning him on to the sound side of the chest, and making him breathe deeply, thus expanding the affected lung. Toy trumpets and balloons should be given to children for the same purpose.

The above descriptions apply to generalized or extensive empyemata ; when the collection of pus is strictly localized, the rib must be removed which gives best access to the cavity. But the above precautions should be observed.

Pneumo- and Hæmothorax.—As the result of injury or disease the pleural cavity may be filled with air or blood. The natural tendency in both instances is for absorption to take place without any active treatment being required ; but if there is great interference with respiration, owing to the extent of the accumulation—the patient becoming cyanosed and suffering from urgent dyspnœa—or if the heart is greatly displaced, the pleural cavity should be aspirated and the pressure reduced. Of course the greatest possible care must be taken to keep everything aseptic, or serious complications will be the result.

Air can be withdrawn very satisfactorily by means of Potain's aspirator, and in many cases, owing to the wound in the lung healing, it does not reaccumulate.

Paracentesis Abdominis is a more simple operation than that for the evacuation of the pleural cavity The spot chosen is almost always midway between the umbilicus and the pubes, and exactly in the middle line. Before tapping, the bladder should be emptied, if necessary with a catheter. The patient should be placed half sitting-up in bed, and a very broad flannel bandage, or some form of binder, must be so adjusted that it can be tightened up from time to time, to give support to the abdominal walls and contents, as the fluid is removed.

Draining by Trocar and Cannula.—A simple full-sized instrument may be used, but a much more convenient pattern is the "piston trocar," with a side branch for a tube. If the puncture is made exactly in the mid-line there is very little pain connected with it. The direction of the puncture should be backwards, and slightly downwards, for as the abdomen diminishes in size, the trocar will alter its position, tending to point more and more upwards and away from the fluid.

The fluid should be received into a bucket placed on the floor by the side of the bed, and, as we have said, the abdominal walls must be carefully supported throughout the operation. The patient must be watched, lest faintness should come on, and will often require a little stimulant. If necessary the flow of the ascitic fluid may be stopped by raising the tube above the level of the abdomen till the faintness passes off.

By a Southey's Trocar.—Another way of draining ascitic fluid is to employ one of Southey's trocars (*Fig.* 190). These trocars with their ensheathing cannulæ are made as fine as possible, and can be connected with a specially fine kind of drainage tube. The insertion of these small instruments is practically painless, and is performed in the same place and direction as the larger ones. The trocar and cannula may be inserted, and the trocar withdrawn after the usual manner of using this instrument, the tubing being then slipped over the protruding end. But as the end and the tube are both small it is sometimes a little difficult to do this. A side branch has been suggested as an improvement in this respect, but this is not at all necessary, for the difficulty is quite overcome if the tube be attached beforehand to the empty cannula, and the trocar be then thrust into it, piercing the tube first, at a very little distance from its end. When the trocar and cannula have been inserted in the tissues, and the trocar is withdrawn, it will be found that the small puncture which has been made in the indiarubber tube closes of itself. The tube is said to deliver the fluid at a rate of from ten to twenty ounces per hour, so that there is no sudden disturbance of the visceral relations, and no necessity for swathing the abdomen in any form of binder.

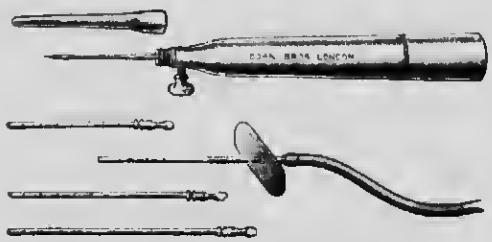


Fig. 190.—Southey's Fine Trocars and Cannulæ.

Anasarca.—These trocars were originally introduced by Southey for a different purpose, namely, for the relief of severe and tense anasarca—a condition which may here be conveniently considered. In the great majority of cases of serous effusion into the cellular tissues, elevation and the removal of all obstruction to the venous circulation will be all that is required, and if the œdema be more obstinate than

usual, it may be diminished by bandaging, and especially by the use of Martin's rubber bandage. But sometimes the distention of the parts is so great that the skin is stretched even to bursting, and a peculiar form of superficial gangrene, combined with a condition of erysipelas, may develop.

Under these circumstances it becomes necessary to relieve the tension by removal of the fluid, and this was commonly done by making numerous stabs or minute incisions with a small scalpel from which the serum could drain away. The objections to this proceeding were that the limbs affected (usually the legs) were forced to remain wrapped up in sloppy clothes, and that the skin, bathed in the exuded serum, soon became sodden. Moreover, it not infrequently happened that the punctures themselves became the starting-points of troublesome sores.

These objections are all met by the use of the fine cannulæ above mentioned. Three or four of these may be introduced into the dropsical parts by means of the trocar, and then the serum which escapes through them may be conducted away from the bedclothes by the indiarubber tubing.

The tubes should be of sufficient length to discharge the fluid into some vessel below the bed.

The cannulæ should be introduced at right angles to the surface; they should fairly enter the cellular tissue, and on withdrawal the puncture should be covered with a pad of wool secured by collodion. Great care must be taken to keep the instruments scrupulously clean, and they should always be well boiled before they are used.

Hydrocele of the Tunica Vaginalis.—The treatment of this condition may either be palliative, remedial, or curative. Thus, it often occurs that a moderate-sized hydrocele may remain stationary for years, giving little or no trouble, provided only that the scrotum is properly supported by a suspensory bandage.

But in most cases the serous effusion will sooner or later accumulate to an extent which produces discomfort or pain, and very frequently the sac takes only a short time (that is, one to be measured by weeks) to fill. The remedy in these cases is to remove the fluid by tapping, whenever and as often as it causes inconvenience by distention. Although it very rarely happens that the fluid does not reaccumulate, still most patients are thus enabled to escape any real disablement.

Tapping a Hydrocele.—In deciding whether the right time has come to tap a hydrocele, attention should be given rather to the tenseness of the sac, than to its size. It is always wise to wait until it is fairly full, not only because the operation is then easier, but because the intervals between the tappings should be as long as possible.

No surgical operation would seem to be easier than this one, and in truth it is as easy as it seems to be. Yet even here there is a right and a wrong way, and the wrong is often chosen.

The points to be looked to are, that the testicle be protected from injury, that the skin of the scrotum and the sac be made tense and

prominent in front, and that the cavity be entered with one stab of the trocar, the veins of the scrotum being avoided, and the depth of the plunge being regulated beforehand by the position of the finger on the trocar.

Most of these points are shown in *Fig.* 191, where the left hand is seen to be making the tissues tense in front, and at the same time receiving and protecting the testis behind, while the forefinger of the right hand steadies the trocar and serves as a shield, so that it cannot be pushed in too far.

In *Fig.* 192, on the contrary, some of the common faults committed in tapping are illustrated, such as the oblique position of the trocar (which may never enter the sac at all), the left hand pushing the testis

Fig. 191.—Tapping a Hydrocele (*right way*).

Fig. 192.—Tapping a Hydrocele (*wrong way*).

downwards and forwards, etc. Before the trocar is introduced an effort should be made to locate the testicle, either by allowing a strong light to shine through the hydrocele, when the testicle can often be seen as a dark crescentic body, or by getting the patient to locate it himself. The mere fact that the anterior part of the sac can be clearly transilluminated is satisfactory evidence that the testicle occupies its normal position at the back of the sac. The skin of the scrotum is to be carefully cleaned (*see* p. 322).

The trocar commonly employed is shown, half size, in *Fig.* 193, but smaller ones, down to a fine exploring trocar, may well be used. During the time that the fluid is escaping the cannula should be steadied with the left hand, or it may slip out of the opening in the sac, with the result that the fluid escapes into the tissues of the scrotum, and produces an œdema which is somewhat alarming in appearance. When all the fluid that will escape has been drawn off, the cannula must be withdrawn, and unless a needlessly large instrument has been used,

there will be no necessity for considering the wound, though it would be safer to fasten on some aseptic wool with collodion. A suspensory bandage should be worn from the first.

So far as the tapping is concerned, the directions given above for the ordinary hydrocele will apply almost equally to any of the various cystic accumulations which are common here (such as hydrocele of the cord, spermatocele, etc.), and we need not consider them further.

The commoner complications which result from tapping are :—

Hæmatocele—usually from an injury to the testicle ; occasionally from a scrotal vein.

Sloughing and suppuration from the use of dirty instruments, though occasionally from the patient's constitutional debility. *Failure to strike the fluid* is nearly always due to bad technique.

Fig. 193.—Hydrocele Trocar.

If a hæmatncele occurs it should be treated by the application of an ice-bag or evaporating lotions, and the patient should rest in hed for a day or two.

The tapping of collections of fluid in the tunica vaginalis is also of use for diagnostic purposes. An old hydrocele is often mistaken for a new growth, and *vice versa*. If an exploratory puncture is made with a small trocar and cannula, valuable information may be obtained.

From the old hydrocele dark blood, loaded with cholesterin crystals, can be obtained, but from a new growth which has ruptured into the cavity of the tunica vaginalis, or which is still confined by a stretched tunica albuginea, bright red blood will flow.

Hydroceles in children rarely require any very drastic treatment. If the hydrocele is of the congenital type, a free communication existing between the sac and the peritoneal cavity, a truss should be applied in the hope that adhesions will form at the region of the internal abdominal ring, thus converting the congenital to the infantile type. The infantile form, which is shut off from the peritoneal cavity, and the ordinary scrotal form, are best treated by multiple punctures with a sharp Hagedorn needle ; the fluid escaping into the cellular tissue is absorbed. A compress soaked in lead lotion should be applied.

Injection for Hydroceles.—This method of treatment is less frequently used, owing to the more certain results obtained by the open operation.

The method aims at exciting sufficient inflammation in the walls of the sac to lead to their adhesion and obliteration of the cavity. Such treatment should not be employed in children, or in any patient who does not seem to be thoroughly robust, as it may lead to sloughing and cellulitis.

The best agent for the purpose is carbolic acid, and the technique is as follows:—

The skin of the scrotum is carefully cleaned with ether soap and biniodide, 1–2000 in spirit. The hydrocele is then tapped in the ordinary manner, and all the fluid is withdrawn. Thirty to sixty minims of pure carbolic, i.e., a saturated solution of phenol in glycerin, obtained by adding the pure phenol crystals to the glycerin until they cease to dissolve, are injected through the cannula into the sac; the opening in the cannula is closed by means of a small spigot of wood, *the cannula remaining in situ*. The scrotum is now gently manipulated so as to diffuse the acid widely over the serous surface, and when this has been done, the spigot is removed, and any remaining fluid is expressed by a gentle "milking" movement. The cannula is withdrawn, and a collodion dressing is applied.

The patient may complain of a sensation of pain during the action of the acid, and he may become faint. The scrotum should be supported by means of a suspensory bandage, and the patient should remain quiet for a couple of days; after which, if there is no marked reaction, he may return to his work.

The Radical, or Open Operation, which is much in favour at present, since it offers the most certain prospect of cure, consists in making an incision through the coverings of the scrotum, opening the tunica vaginalis, and allowing the fluid to escape, and then dissecting away the parietal serous membrane up to the point where it is reflected on to the testicle and epididymis. Although a simple procedure, certain precautions must be observed.

Not only is the tunica vaginalis thickened in old-standing hydroceles, but the other coverings of the scrotum share in the change. The result is that there is often a sac a quarter-of-an-inch thick covering the walls of the hydrocele cavity. As it is the *serous* layer that secretes the fluid, this layer alone requires removal, and an attempt should be made to separate it from the other thickened layers, so that the tissue removed is as thin as possible. If this cannot be done, the thickened tunicæ must be cut away; but every vessel must be carefully tied. Moreover it is advisable to sew round the cut edge with a fine continuous catgut suture, so as to check any bleeding. The vessels in the thickened layers are numerous though small, and they cannot retract owing to the chronic inflammatory thickening.

No adequate pressure can be applied to the scrotum, hence the common complication after operation on hydroceles is to find the whole cavity distended with blood-clot, a complication which often necessitates a late visit to the theatre in order that the clot may be turned out. This accident can be prevented by attention to the above details, and by the employment of a good-sized drainage tube for twenty-four hours. The tube should be the size of a cigarette; smaller sizes get blocked by clot and are useless. Drainage is not required in small hydroceles, nor in those cases where the sac is thin and avascular.

Chapter XXXIII.

OF THE USE OF CATHETERS AND OTHER INSTRUMENTS IN THE BLADDER.

IN this chapter we shall consider, first, the chief practical points which arise in connection with the passage of instruments along the urethra into the bladder; next, the methods of emptying the bladder of its contents by aspiration or by tapping, and of washing out the bladder and urethra; lastly, certain complications, such as retention and suppression of urine.

Uses of Catheters, Bougies, etc.—The passage of a catheter may be required for the relief of *retention*, whether arising from spasm, stricture, or enlarged prostate, or from an atonic or paralytic state of the bladder walls; or from a combination of several of these causes. It may also be necessary, both for the prevention of extravasation, and the relief of retention in cases of injury to the urethra (and sometimes in rupture of the bladder), and later, for the prevention of traumatic stricture.

Catheters or bougies are also employed for the *cure of strictures* by mechanical dilatation, and both the metal instruments, and what are known as *medicated bougies*, are employed in disorders of the urethral mucous membrane, such as gonorrhœa. Again, catheters are used for the systematic emptying of the bladder, and for the introduction of lotions ("washing out" the bladder) to improve the condition of its mucous membrane; and those of a very large size are employed to remove calculous débris after lithotrity, and, more rarely, blood-clots.

Lastly, catheters or bougies are frequently used as guides to the position of the urethra, or of strictures within it, in various operations.

Sounds, on the contrary, are used purely for diagnostic purposes; while *staffs* are directors of various shapes and curves, which possess a deep groove, along which a cutting instrument may be passed for the incision of a urethral stricture, or for entrance to the bladder. There are, moreover, many other instruments, such as internal urethrotomes, urethral dilators, galvanic bougies, etc., the purposes of which may be known from their names. With the majority of urethral instruments we have here nothing to do, and we have therefore only to treat of the actual manipulative proceedings which are necessary for the skilful passage of catheters or bougies.

OF THE DIFFERENT KINDS OF CATHETER.

The ordinary silver or plated catheters are too well known to require description. They, as well as the flexible ones, are made in England

and America in sizes from ½ up to 12 or 15, or even larger, according to an arbitrary gauge (*Fig.* 194). In France a more systematic plan is followed, the numbers of the instruments corresponding to their circumference in millimeters, No. 1 being 1 mm. round, No. 5, 5 mm., and so on. This principle gives more numerous subdivisions; thus there are eighteen numbers (3 to 21) between the twelve ordinary English ones (1 to 12).

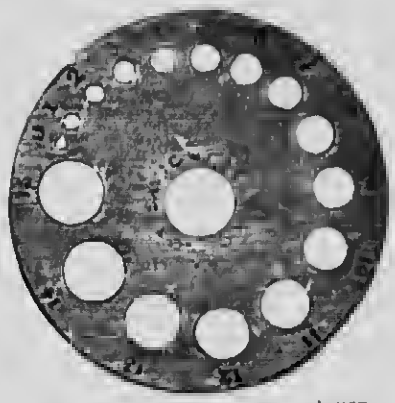


Fig. 194.—English Catheter Gauge.

With regard to the curve, the standard is commonly called "Brodie's," but many surgeons prefer to have their instruments curved according to their own ideas. *Prostatic metal catheters*, to which we shall again refer, are also generally named after Brodie. They differ from the ordinary ones in being both longer and much more boldly curved. The curve, too, should extend quite to their extremity, which is not always the case with the others (*Figs.* 195, 196).

Fig. 195.—Ordinary Silver Catheter.

Fig. 196.—Prostatic Silver Catheter.

Metal Bougies or solid instruments are of the same shape and gauge as catheters.

Lister's Bougies will often be found of great service in dilating a stricture; they differ from the ordinary bougies in that they taper towards the point, which is three sizes smaller than the shaft. The passage of the point through the stricture ensures therefore the passage of the shaft of the bougie, and each instrument in this manner prepares the way for the larger size which is to follow (*Fig.* 197).

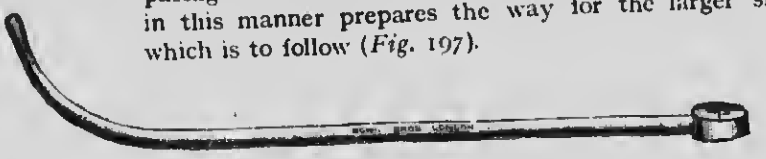


Fig. 197.—Lister's Steel Bougie.

Flexible Catheters are of several kinds, but the principal ones are made of "gum-elastic" and of india-rubber. Celluloid has also recently been used. Gum-elastic catheters are made of some preparation of gum resins, incorporated into the meshes of a woven tube, which is made of silk or linen thread.

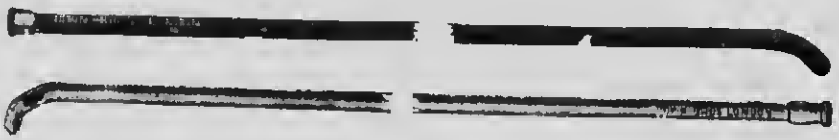
There are two chief kinds of these gum-elastic catheters, each made in several qualities. In the older kind the woven basis is stiffened by gum resins, and varnished, so that the instrument is yellowish red and shows the meshes of the silk or thread. These catheters are flexible when heated, but tolerably stiff when cold. A wire stylet of the

Fig. 198.—Olivary Gum-elastic Catheter.

ordinary catheter curve, or of any other which may be desired, is generally placed in their interior, the shape of which they will retain after it is withdrawn, even when rendered moderately flexible by warming. With regard to shape, this kind is always uniformly cylindrical, like the silver catheters.

The other kind is now in much more general use, and many forms of catheters, differing especially as to the shape of their ends, are made in it. These are the "black, soft catheters," originally of French manufacture, the employment of which is becoming much more general as compared with metal instruments. They, like the first kind, have a woven basis, into the meshes of which some resinous preparation is incorporated, but they are much more flexible, and have nearly superseded the older make.

They are sometimes made uniformly cylindrical, but more generally terminate in some special shape, designed to facilitate their passage. Of these the *bulbous* (*à boule*) or the olivary (*Fig.* 198) is the favourite with most surgeons.



Figs. 199, 200.—Elbowed Catheters. (Catheter Coudé and Bicoudé.)

The elbowed catheter again (*Figs.* 199, 200) is often extremely useful, especially in prostatic cases, as will be directly explained.

A Good Gum-elastic Catheter can be easily tied up in a knot without any cracking of the surface, and when its point is pressed upon with the finger, it should bend easily over in a uniform curve, and should not give way in an angular fashion at the eye. Care should also be taken, if the instrument be a small one, that it is properly pervious. The eye should be clear, and with perfectly smooth edges; and, inasmuch as it is at this place that cheap, badly made instruments

give way, special attention should be given to the condition of this opening, and the catheter should be broken and discarded if any crack or flaw be there discovered. The end of the catheter below the eye should be *solid*.

Pure India-rubber Catheters are of two or three varieties, the most useful being that known as "Jacques'," which is of great value from its perfect softness and flexibility. It is made of a red rubber, and is employed in cases where an instrument has to be left in the bladder, or where the patient has to pass one for himself.

Solid Bougies are made of the same shape and size as the hollow catheters in both the gum-elastic materials, and the two kinds differ from each other in respect of flexibility in just the same way.

"Bougies" proper, i.e., instruments made of wax, with some woven basis, are now rarely used; introduced before the virtues of india-rubber were appreciated, they were then almost the only kind of flexible instrument possible, but they are now unnecessary and inconvenient. Wax may be used, however, as the vehicle in some forms of medicated bougies.

Two other forms of bougies should be mentioned, namely, those made of whalebone and of catgut. They are both very useful in difficult cases, where the finest instrument can hardly be passed. This is especially true of catgut, which may with patience be made to traverse very tortuous paths. They are sometimes moulded into a twisted or corkscrew form.

GENERAL POINTS IN THE PASSAGE OF ANY URETHRAL INSTRUMENT.

There are some points common to the passage of all forms of catheters, and to a large extent of bougies also, which may be enumerated before we describe more particularly the passage of metal and flexible instruments respectively.

1. **As to Size.**—It may be laid down as a rule almost without an exception that in any given case the catheter which *should* be used is the largest which *can* be used, within the limits of the normal calibre of the urethra, so that in cases where there is no narrowing of the canal itself, a full-sized instrument should be chosen; and when there is a narrowing, as in strictures, the practice should be to work downwards from instruments which are too large, until one which will pass is reached; not upwards from those which are too small, to the same point. The reason for this rule is that, other things being equal, the smaller the instrument the harder it is to avoid catching in folds of the mucous membrane, or in the lacunæ of the urethra, and thus damaging it; on the other hand, the larger the instrument the more likely is it to remain in the canal, and by stretching the lining membrane, to obliterate folds, and to pass by lacunæ or false passages.

So, too, in cases of rupture of the urethra, a fair-sized instrument, say No. 8 or 9, may pass over the wound and into the bladder, when

a smaller one would have its point engaged in the rent, and thus matters would be made worse than before, while in any such case, if the larger one will not pass, the smaller is unlikely so to do.

In acute inflammatory conditions of the urethra, or when the canal has been lacerated, the coudé catheter will sometimes be found of much greater value than the ordinary olivary-ended instrument.

As is well known, the meatus is in most cases the narrowest part of the canal, and it is sometimes so contracted that a full-sized instrument cannot be passed. In this case it may be carefully nicked with a pair of scissors, exactly in the middle line above and below, or below only, as may be required. Usually a very slight division of the tissues suffices.

Size of Normal Urethra.—In England it is generally held that a No. 12 catheter [English measure = 20 French] represents the calibre of a full-sized urethra, or rather that if No. 10 or 12 passes easily, it may be supposed that there is no stricture. This may be taken as true for most practical purposes, but American surgeons are more liberal-minded in their ideas, both as to the size of the normal urethra, and of the instruments which may be passed along it. Otis has shown that the average calibre of the male urethra in the living is not less than 28 mm. (about No. 16 of the English catheter gauge), so that a stricture might diminish the urethral calibre 7 mm. (i.e., from No. 16 to 12), before it would be detected by what most English surgeons, and most patients, consider a full-sized instrument. Otis has further shown that normal urethras differ greatly in their calibre, and that there is a close relationship between the circumference of the penis and the tube it contains.

2. **Importance of Cleanliness.**—The surgeon should personally assure himself that the catheters he is about to use are absolutely clean; a metal or rubber catheter should, of course, be boiled, the safest way of rendering it aseptic. To use a foul catheter is to expose the patient, wantonly, to a distinct danger of blood poisoning, and it is a question whether the duty of cleansing catheters after use should ever be left to the nurses or porters.

To Clean and Sterilize a Gum-elastic Catheter.—The instrument should be well washed in a stream of running warm water, which should flow freely through the lumen of the instrument. It should then be wiped dry on a soft clean towel, and be placed in a formalin sterilizer. These sterilizers are constructed in two forms:—(*a*) A metal box, introduced by Albarran, of Paris, in which the catheters are arranged on trays. After the instruments have been placed inside the box, the open end is closed. By means of a special lamp formalin vapour is generated and passes into the sterilizer. This vapour is powerfully bactericidal, and after contact the catheters and bougies are thoroughly sterile. Before use they should be placed in distilled water or weak boracic acid solution, as the formalin is very irritating to the urethra. (*b*) A similar result to the above is obtainable by the use of glass tubes with a hollow rubber stopper (*Fig.* 201). Into the hollow part of the

stopper trioxymethylene powder or granules is introduced. This material slowly decomposes, giving off formalin vapour, which acts in a manner similar to the above on the catheter or bougie. The catheters are thoroughly sterilized after twenty-four hours.

Maw & Sons have recently introduced an apparatus for boiling gum-elastic instruments, and their special catheters will stand boiling about ten or twelve times.

With such simple methods for obtaining a satisfactory sterility of the instrument, no gum-elastic catheter or bougie should be passed which has not been subjected to some such form of treatment.

Fig. 201.—Glass Catheter Tube.

3. **Warming and Oiling.**—All instruments should be warmed and oiled before passing. A good lubricant is sterilized olive oil or vaseline, but if an antiseptic medium is desired the following may be employed:

R Hydrarg. Oxycyanidi	gr. iiiss	Tragacanthæ	gr. xlvj
Glycerini	℥vss	Aq. Dest. Steril.	ad ℥iij

4. **Constitutional Disturbance.**—The passage of any instrument, but especially if it be a metal one passed for the first time, may be followed by marked constitutional disturbance, such as rigor, or repeated rigors, high temperature, etc. This *urethral fever*, or urethral shivering, as milder cases are called, is generally transient, but may even be fatal in damaged constitutions. Therefore Paget advised that a catheter or sound should if possible be passed for the first time, not in the surgeon's consulting-room, but in the patient's own room. A dose of quinine grs. v, opium gr. j, is an excellent prophylactic if rigors are feared.

Retention of an Instrument in the Bladder.—Under certain circumstances, either to dilate a very tight stricture (passive dilatation), or to drain an inflamed or injured bladder, to prevent extravasation of urine in the milder varieties of laceration of the urethra, or to check severe bleeding from this canal, it is necessary to retain a catheter for some considerable time.

As a general rule a gum-elastic or rubber instrument should be used, and unless there is some very strong reason to the contrary it should be changed at the end of twenty-four hours.

There are several methods for securing the instrument, but it may be laid down that no method will succeed without the co-operation of the patient. A catheter cannot be tied in so firmly that the patient, if he wishes, will fail to remove it.

For the male an excellent method is one described by Carwardine: a ring of bone or rubber (an old catheter may be used, the narrow point being introduced into the lumen of the wide part, after such reduction in size as may be necessary, and the junction is made firm by a silk suture passed through the walls of the tube) is passed over

the penis and secured by tapes passing round the groins, thighs, and umbilical region (*Fig.* 202). This ring can he very firmly secured, and acts as a basis to which the catheter can be attached. The catheter is then introduced along the urethra, and is fixed to the ring by four or six silk threads. These threads are passed through the exposed end of the catheter by means of a needle, tied, and finally secured to the ring.

They can be adjusted to any length, and if a certain "play" of the catheter is required it can be allowed for. Other methods consist in fixing the catheter directly to thigh and perineal bands, to the pubic hair—a method sometimes useful in the female—or to strips of strapping placed round the penis.

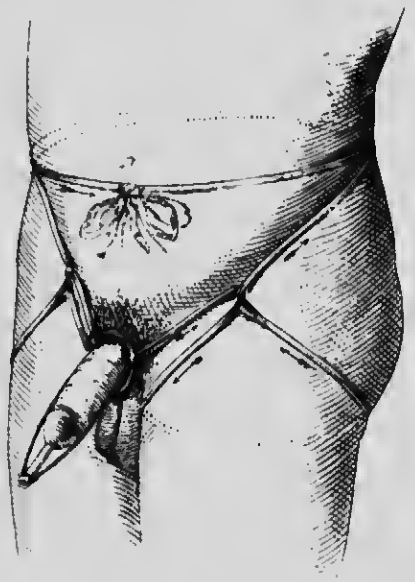


Fig. 202.—Method of tying in a Catheter.

Whichever method be adopted, there are other details to be considered. The end of the catheter, when fairly introduced into the bladder, will rest against the sensitive trigone; in many subjects this position causes great discomfort, which can be easily remedied by allowing the point of the instrument to lie in the prostatic urethra instead of in the bladder cavity. At regular intervals, every two or three hours, the catheter is pushed on into the bladder to allow that viscus to be emptied, and is then withdrawn to its original position. If the patient is intelligent he can often effect this manœuvre himself. Such a modification may be adopted in all cases unless there is a special need to keep the bladder absolutely emptied, if the patient is sensible and quiet.

It is often stated that rubber are better tolerated than gum-elastic catheters; but this is not always the case, as the surface of the rubber instrument seems slightly more irritating than the polished gum-elastic surface. Gum-elastic catheters are prone to "blister," i.e., a curious cracking of the varnish. In some cases this is due to faulty construction, in others to some irritating quality of the urine. All blistered instruments should be at once removed.

Children do not tolerate catheters *in situ* very well, and unless absolutely essential this form of treatment should not he undertaken.

A slight urethral discharge sometimes follows the tying in of a catheter, and phosphates are often deposited at the end of a catheter which has been left *in situ* for more than twelve hours.

OF THE PASSAGE OF URETHRAL INSTRUMENTS.

The Passage of Metal Catheters.—In almost all text-books which treat of the practice of surgery, a verbal description will be found of the manœuvres necessary for the introduction of a metallic catheter into the bladder, but we believe that such descriptions are only waste of space, and of the author's and reader's time. We do not think it is within the power of words to convey to a student, who has no personal experience, any real idea of the movements of the hand and wrist, or of the complex sensations which guide and inform the surgeon of the position of the point of the instrument, of the direction in which it is travelling, or of the condition of the canal which he is exploring. Such descriptions are no doubt perfectly intelligible to those who know the direction of the urethra, but these stand in no need of them.

There is only one way to learn to pass silver catheters, and that is, to pass them, at first of course under direction; and it may not be out of place to remind house surgeons and dressers that they will in all probability never again have such opportunities of practice; and although we are far from advising unnecessary catheterization, still they will do wisely to seize all legitimate occasions for acquiring that most important accomplishment, the being "a first-rate hand with a catheter."*

We have already said that in passing catheters the rule should be to proceed downwards size by size, until the largest which will pass is arrived at. This is especially true of metal instruments. The smallest sizes (Nos. $\frac{1}{2}$ to 3 English = 1 to 8 French) are difficult to pass, even along urethras which are healthy, and damage is readily inflicted by them.

Catheters of a very large size are chiefly employed in the operation of lithotrity for the removal of débris; or after perineal section; or, as has been mentioned (page 31), they may be required for the removal

* The dresser then should, from the first moment of entering upon his work, determine to learn how to catheterize, and may profitably set about it in some such way as the following. To begin with, he can conveniently learn the general direction of the urethra in children and adults, and pretty frequently, even in prostatic cases, by passing full-sized instruments in the dead-house. And he will there also learn, to a certain extent, the "feel" of the normal urethra. He should then look out for cases, which will be fairly numerous in the wards, which require the regular passage of an instrument: such cases as those of chronic cystitis, atony of the bladder, paralytic cases, and the like. Having learned the normal urethra, he should now go on to cases of chronic stricture, where the urethra presents no difficulty, such as those which are on the high road to recovery, or in which the obstruction is only commencing; thence he may proceed to the more difficult ones, and to the use of the prostatic catheter, and so on till he feels that he stands on tolerably firm ground. In all those cases the house surgeon may be of the greatest assistance to the dresser in his ward and casualty work, and he may rest assured that help thus kindly and timely rendered will never be thought lightly of, nor forgotten in after years.

of blood-clots. In passing them great care must be taken not to injure the urethra.

Silver Prostatic Catheters are longer and more boldly curved than the ordinary ones. Generally speaking, a full-sized instrument (No. 12) is very easy to pass, slipping in almost by its own weight, but the use of metal prostatic instruments of a small calibre should be avoided, except for very good reasons.

The Passage of Flexible Catheters, Bougies, etc.—The use of metal instruments is becoming every day less general, and that of flexible ones more so. The latter are less liable to produce constitutional disturbance; damage cannot so easily be inflicted to the urethra by them, and they require less skill for their introduction. For all general purposes, the olivary shape (*see Fig.* 198) will be found the best. Cheap catheters are always bad and unsafe to use.

The method of introduction of the ordinary black, flexible catheters and bougies, or of whalebone bougies, or catgut, calls for no remark, but with regard to the stiffer form of gum-elastic instrument, it should be mentioned that the stylet which serves to keep them in shape should in almost all cases be withdrawn before they are passed.

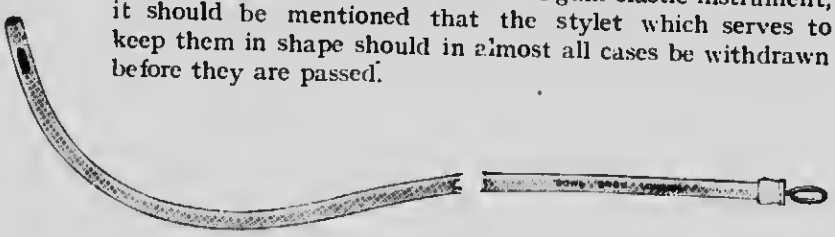


Fig. 203.—Gum-elastic Prostate Catheter.

In prostatic cases it often happens that the ordinary olivary catheter hitches against the middle lobe of the gland, and will not pass. Sometimes it will be found that a very soft india-rubber one will ride easily over the obstruction, and still more often an elbowed instrument (*coudé*) will do so. But a good deal of manœuvring may be required in such a case. Thus, the finger may be placed in the rectum, or the perineum may be supported. Another method that sometimes succeeds in difficult cases is to pass a gum-elastic catheter (*Fig.* 203) with a stylet bent to a sufficient curve, and when its passage is arrested, to withdraw the stylet for about an inch and a half. This may have the effect of raising the point of the catheter almost vertically over the lobe of the prostate, and if this occurs it will pass into the bladder upon the complete withdrawal of the stylet.

A good plan for the general run of cases is that recommended by Thompson, namely, to keep a gum-elastic catheter for a month or so upon an *over-curved stylet*; then, when it has to be used, the stylet is removed and the shaft of the catheter bent back to the ordinary curve. In the passage down the urethra, through the spring of the catheter, the over-curve is gradually re-assumed, so that by the time the prostate is reached, the point of the instrument rides over it.

Sounding for Stone.—The house surgeon will frequently have occasion to explore the bladder for the detection of a calculus. The old-fashioned sound was curved in the same manner as a catheter, and was passed in the same way. But more recently, an improved hollow cyclindrical handle has been adopted, and a short bulbous end almost at right angles to the stem (*Fig.* 204). These sounds are not so easy to introduce, but are much better fitted to thoroughly explore the bladder. Sounding should always be performed when the bladder contains a fair amount of urine; failing this, about half a pint of lukewarm boric acid solution may be injected.

Breaking of Catheter.—Lastly, it may happen, and perhaps more often than is generally supposed, that a defective instrument breaks off short at the eye, and that the fragment remains in the urethra. This accident should not occasion undue alarm, although the result may possibly be serious. If the piece can be felt in the penile or bulbous urethra, efforts may be made to work it forwards by manipulation until it can be easily seized by a pair of urethral forceps. If it can be felt, but cannot be moved, then these forceps may be very carefully passed down to it, every precaution being taken not to push

Fig. 204.—Clutton's Sound.

it backwards into the bladder; but no good can come of plunging the forceps blindly into the urethra if the fragment cannot be felt. In such a case the best course is to send the patient to bed, to direct plenty of non-irritant fluids to be taken, and to diminish local spasm by means of morphia as a suppository or hypodermically, or by opiate enemata.

In all probability the missing piece will be passed in the urine within twenty-four hours, but if this should not be the case, no personal consideration on the part of the dresser or house surgeon, and no absence of symptoms on the part of the patient, should prevent an immediate report to the visiting surgeon, on whom will devolve the responsibility of deciding, firstly, whether the piece is still in the urethra, or is in the bladder, and, secondly, what further steps should be taken for its removal.

THE CYSTOSCOPE, THE URETHROSCOPE, AND THE URINE SEPARATOR.

The student should familiarize himself with all these instruments, as they are of the greatest service in investigating renal and vesical diseases. The cystoscope is coming into general use, and after a short course of practice, enables one to ascertain with certainty the condition of the bladder and ureteric openings.

The Cystoscope (*see Fig.* 205) is a hollow metal cylinder with a lamp and prism at one end, which is known as the beak, and a lens, usually fitted with a hood, at what is known as the eyepiece. Of the various forms of instruments, Nitze's and Caspar's are in most general use, but in Caspar's instrument the beak forms a sharper angle with the tube than in the Nitze variety, and is therefore somewhat more difficult to pass. The lamp is of special manufacture, and does not become too hot when illuminated so long as there is a sufficiency of fluid in the bladder. The connection with the battery or accumulator is made at the eye-piece, and it is always better to use these means of obtaining a current in preference to a transformer, since there is less variation in the strength of the current passing through the filament. With the transformer connected to the main electric current there may be considerable variation in the voltage—enough to fuse and

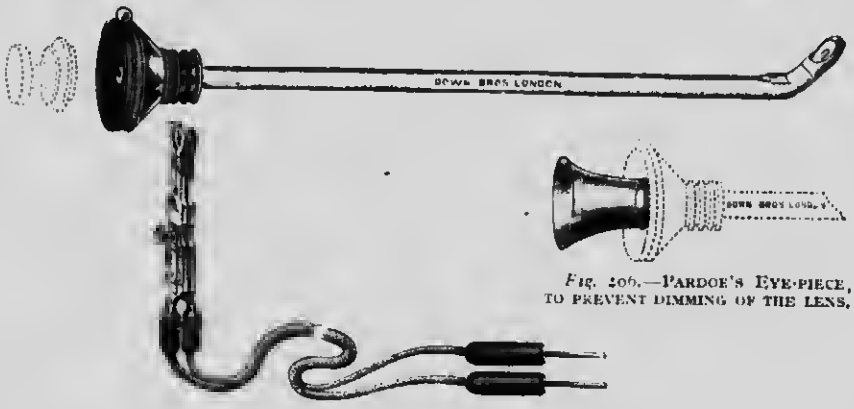


Fig. 205.—Max Nitze's Cystoscope.

Fig. 206.—Pardoe's Eye-piece, to prevent dimming of the lens.

destroy the lamp during an examination. As a general rule a current of 6 to 8 volts will be required to give a clear view of the interior of the bladder.

The usual size of the ordinary cystoscope is 19 to 21 mm. F., but smaller sizes may be obtained for use in younger patients.

To Sterilize the Cystoscope.—Some instruments are now made which can be sterilized by boiling, but the Nitze cystoscope cannot be treated in this manner. In order to render it sterile it should either be immersed in a perpendicular jar filled with strong carbolic acid solution (B.P.), the solution reaching to within an inch of the eye-piece, or the shaft and beak can be wiped over with a piece of gauze or lint soaked in this solution. The carbolic acid is then removed by dipping the cystoscope in distilled water or saline, and wiping it with a sterile cloth. It is better not to use spirit, as this may soften the setting round the lamp and prism. Care must be taken that all the carbolic acid is washed away.

To Prepare the Patient.—Either a local or a general anæsthetic may

be used. If a patient is very nervous and has a narrow urethra, it is advisable to put him under ether or chloroform, so that a thorough painless examination may be made. In most cases, however, a local anæsthetic is sufficient.

Local anæsthesia is induced by injecting 5 per cent solution of cocaine, cocaine and adrenalin (1–10,000), or β-eucaine, into the urethra. There does not seem to be any grave objection to the use of cocaine, unless there is ulceration of the canal. The technique is as follows:—

The patient lies on the operating couch, on a sheet of macintosh, a sterilized towel over the lower extremities and over the lower part of the abdomen; the genitalia are freely exposed. The penis and the meatus are well washed with a solution of lysol 1–40. A small glass pipette holding ½ to 1 drachm, with a rubber nipple, is filled with the cocaine solution; the penis is held by the fingers and thumb of the left hand, the pointed end of the pipette is inserted into the meatus, and the fluid is induced to enter the canal by pressure on the rubber nipple. As soon as the contents of the pipette have been discharged into the urethra, the fingers and thumb of the left

Fig. 207.—BLADDER SYRINGE.

hand grasp the glans somewhat firmly to prevent the escape of the fluid. (If there is much spasm the solution may be almost immediately rejected, in which case another injection should be made). If the fluid has entered the canal properly, the right hand is used to gently press and massage the fluid from the penile into the deep urethra. The left hand still retaining firm hold of the glans, the whole organ is slightly stretched, so as to pull forward the bulbar region. With a little patience it is quite easy to coax the injection into the prostatic urethra, so that when the left hand is relaxed there is no escape of the cocaine solution. If the solution escapes, the injection has not been given satisfactorily, and the deep urethra will not be anæsthetized.

The next step is to wash out the bladder, and the amount of washing needed will depend upon the degree of turbidity of the urine. In some cases it may be necessary to wash for half an hour, in others a single syringeful only may be required (*Fig.* 207).

A gum-elastic catheter, 19 to 22 F., is passed, and any urine present in the bladder is withdrawn. The washing out is now proceeded with, weak boracic acid solution or normal saline being used (either large syringes or an irrigator may be used), until the fluid which returns is *quite* clear. It must be thoroughly understood that unless this

precaution is adopted the examination will be futile. To test for clearness, let some of the fluid escape into a clean glass; hold this up to the light, and notice whether there are any white particles floating about. The washing out must be continued until these particles are absent. If there he much bleeding from a growth, or from an inflamed and ulcerated bladder, this may be checked by introducing 4 to 6 dr. adrenalin solution 1–10,000, or $AgNO_3$ 1–1000. A quantity of water—8 to 16 oz., according to the capacity of the bladder and the comfort of the patient — must be left behind after the catheter has been withdrawn. A cystoscope (Ringlib) is now in general use which allows of the bladder being washed out through the hollow metal tube which covers the lens and prism. This instrument is a great advance, as it does away with the need of passing more than one instrument.

The cystoscope should now be introduced. Glycerin is a better lubricant than oil, as the latter makes the window dirty. Before attempting to pass it, connect it up with the battery and see that the lamp is in proper working order.

The instrument is introduced with the beak upwards, the penis being held vertical, until the point impinges against the triangular ligament; the instrument is now gently depressed, and it will be felt to slip easily along the deep urethra into the bladder.

If there is a hitch at the triangular ligament, withdraw the cystoscope slightly, and then try again. If there is some obstruction in the prostatic urethra, depress the eyepiece gently between the patient's thighs.

There are a certain number of cases in which the cystoscope cannot be passed, and if it is found that after careful manipulation further progress into the bladder is arrested, the attempt should not continue. Possibly a prolonged effort might meet with success, but it will cause bleeding, and not only is this alarming to the patient, but it generally prevents the operator from getting a clear view of the interior. It is far better to accept defeat and make a fresh attempt on another occasion.

Having introduced the instrument successfully, place a block or large book (6 inches deep) under the patient's buttocks; such a step facilitates the examination considerably.

Connect the cystoscope up with the battery and examine the interior of the bladder. With the beak in the position in which it was introduced, the fundus and anterior wall will be under observation. To examine the base, rotate the whole instrument, noting the position of the beak by means of the small indicating knob on the eye-piece. When the beak looks directly downwards, the region of the trigone will be under observation. To find the ureteric openings, turn the beak of the instrument to the right or left. If we can compare the rotation of the instrument to the movements of the hands of a clock—the indicating knob corresponding to the minute hand—when this point lies in the position of the minute hand at twenty minutes past the hour, the left ureteric opening will be seen, when

at twenty minutes to the hour the right will be visible. These openings lie usually at the extremities of a prominent bar, Mercier's bar, and the localization of this bar will assist the student in finding them. In examining the bladder with the cystoscope it must be remembered that the image seen is upside down, and of two objects the one nearer to the observer appears the further off.

The details of the various pathological conditions that may be met with are beyond the scope of this work.

The Urethroscope is an instrument for examining the urethra by means of a strong light projected along a metal tube which has been introduced into the canal. It is exceedingly valuable in detecting the cause of a persistent gleet, and in locating the position of a stricture. Although it is possible to pass the inspection tube beyond the triangular ligament, this step is rarely required, and indeed the examination of the deep urethra is much less satisfactory.

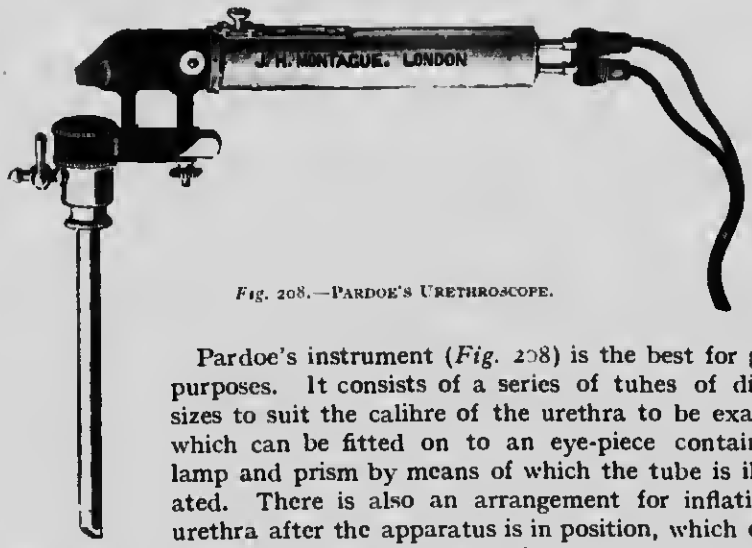


Fig. 208.—PARDOE'S URETHROSCOPE.

Pardoe's instrument (*Fig.* 208) is the best for general purposes. It consists of a series of tubes of different sizes to suit the calibre of the urethra to be examined, which can be fitted on to an eye-piece containing a lamp and prism by means of which the tube is illuminated. There is also an arrangement for inflating the urethra after the apparatus is in position, which enables the observer to distend the canal, and so obliterate any folds of mucous membrane which would interfere with a good view of the part. The tubes are mounted on blunt-ended pilots to facilitate their introduction.

To prepare the patient, follow the directions given above under "Cystoscope." Unless he is very nervous, cocaine is not required, and when employed it should only be injected into the anterior part of the canal.

Now pass the largest-sized tube that the urethra will take without causing discomfort, as far as it will go along the canal. If there is no obstruction the pilot should reach the triangular ligament. When the instrument has been passed as far as it will go, withdraw the pilot and get the patient to hold the penis steady; some care must be exercised

at this point, otherwise the sharp end of the tube may easily inflict some damage on the urethral mucous membrane, especially when inflamed. Gently mop out the tube so as to remove any moisture that is present. The best way of doing this is by means of long wooden spills, about the thickness of ordinary wooden matches, around the end of which a small pledget of cotton wool is twisted. These mops can be made very quickly and cheaply, and after use they can be thrown away or burnt. If these are not at hand a long probe will serve as a substitute, but this involves the repeated changing of the cotton-wool. In any case the canal must be thoroughly dried before any satisfactory view can be obtained. If the pledget of wool comes off the spill or probe, and remains in the urethra, it can easily be removed by means of urethral forceps introduced along the tube, and need cause no anxiety.

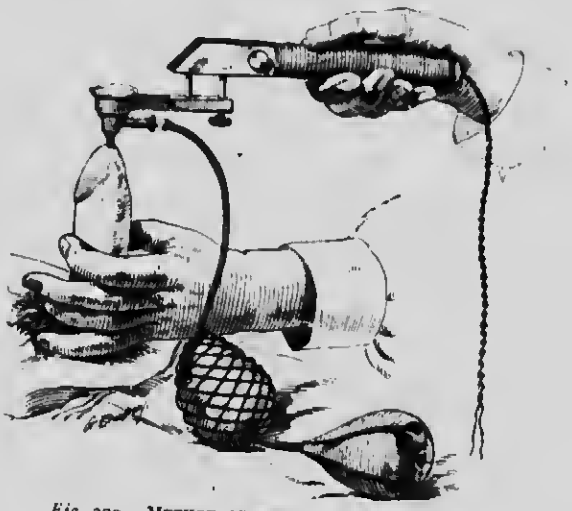


Fig. 209.—Method of using the Urethroscope.

Now connect the handle of the urethroscope to the battery and accumulator and see that it is working satisfactorily, and then fit the eye-piece on to the end of the tube which is in the urethra. Grasp the penis with the left hand so as to steady the tube, while the handle of the urethroscope is held by the right; switch on the light and examine the field which is illuminated.

Get the patient to squeeze the rubber ball of the inflating apparatus, and when the reservoir is full of air turn the small tap, which places the air-tube in communication with the urethra. The air rushes in and distends the canal, making any stricture that is present very obvious indeed. The stricture appears as a small black or dark red point in the centre of a pale pink area; a very little experience will enable the observer to recognize the various forms and the different degrees of stricture, as well as to distinguish them from false passages.

If no stricture be present, gradually withdraw the tube, which is still connected to the eye-piece, examining the walls of the canal for patches of granulations or inflamed follicles; the whole canal must he carefully and systematically examined, fresh inflation being practised if necessary, and in this manner some valuable information as to the state of the urethral tract may be obtained.

The Urine Separator, an instrument designed by Luys (*Fig.* 210) is used for the purpose of collecting the urine separately as it descends from each ureter. The same result may be obtained by means of the ureteric catheter passed along a special form of cystoscope. The manœuvre is, however, somewhat more difficult.

The separator consists of two lateral portions or catheters separated by a rubher diaphragm, which can be elevated by the turning of a screw at the handle of the instrument. There is a very deep curve at the distal end, and this makes it a difficult instrument to introduce. Further, the shape is such that bleeding may be readily caused; and

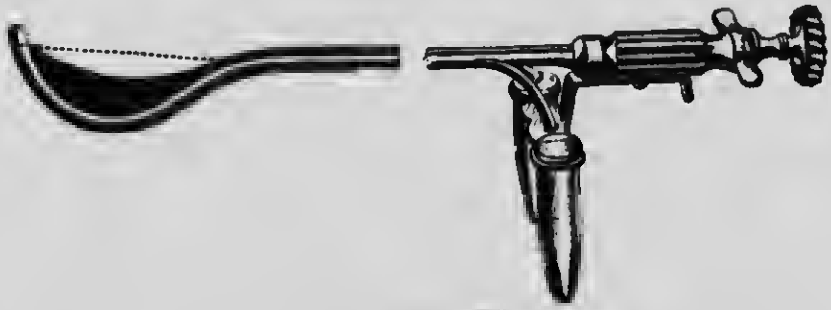


Fig. 210.—Luys's Urine Separator.

since the object in using the separator is sometimes to decide from which kidney hæmorrhage is occurring, the results obtained are rendered valueless if this bleeding takes place.

The separator is passed into the bladder after the manner of a curved metal catheter, and the convex part of the instrument should rest against the bladder base. The urine present is allowed to flow away, and then the patient is propped up into a sitting position, since in this position the separator lies in better contact with the area of the trigone.

The screw in the handle is turned in such a direction that the rubber diaphragm is raised, and this now divides the bladder into two compartments. As the urine enters the bladder from the ureteric openings it passes along a separate catheter into a collecting-glass at the end of the instrument. It is better to reject for examination purposes the first half ounce or so that is discharged, in case the bladder has been imperfectly emptied.

Under many circumstances the separator is a very useful instrument; the chief objection to it is that it causes more pain during its introduction and sojourn in the bladder than does a cystoscope or cystoscope and ureteric catheter.

Chapter XXXIV.

OF THE USE OF THE STOMACH PUMP, ETC.

Washing out of the Stomach: the use of the Stomach Pump.—The use of the stomach pump in cases of poisoning is several times alluded to in the chapter dealing with that subject, but it is employed on many other occasions as well, as for the feeding of refractory patients, or in the treatment of some forms of dyspepsia.

There are several forms of the pump, but a very common and convenient one is that here figured (*Fig.* 211), and which can also be used

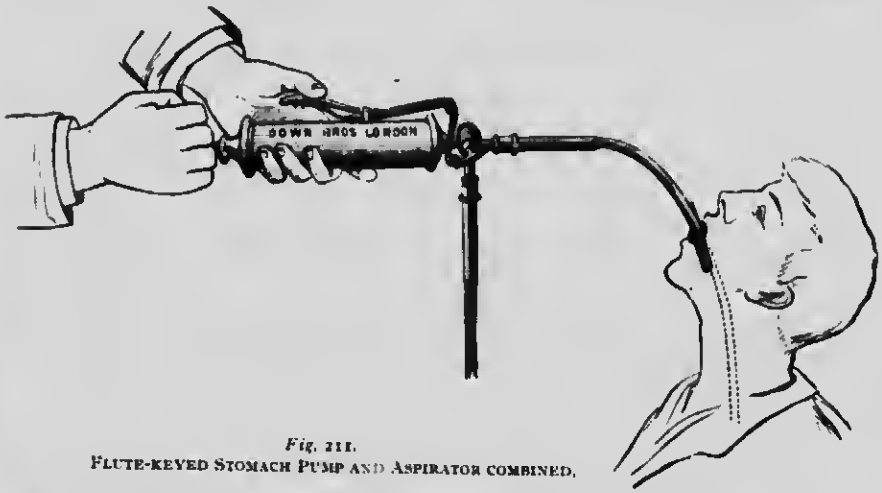


Fig. 211.
Flute-keyed Stomach Pump and Aspirator combined.

as an aspirator. It is made on what is known as the "flute-key" principle, and its action can be readily understood from the illustration. The tap of the pump is a two-wayed one, and if the piston were to be drawn out while the lever at the top in the figure remained in the position in which it is drawn, fluid would be sucked into the cylinder from the vertical tube, and similarly expelled by that tube, if the piston were afterwards pushed in. But if the lever be depressed, the vertical tube will be shut off, and the horizontal one will now be in communication with the cylinder and piston; so that, by depressing and raising the lever synchronously with the to-and-fro movement of the piston, fluids may be sucked from the vertical tube, and expelled by the horizontal one, or *vice versa*, according to the relative position of the lever and piston.

Insertion of the Tube.—This is the important point in the use of the stomach pump. In restless or refractory patients it will be necessary to use a gag, and although almost any form will do, the best is a piece of hard wood, of such a size that it will lie across the mouth between the front molar teeth, and it should be broad enough to allow of a hole being bored through its centre, through which the tube can be passed.

In other cases no gag is required, and then the tube, which is made of gum-elastic, having been well warmed and softened, can be passed with the right hand and guided by the left forefinger through the pharynx and down the gullet, with much greater ease. As soon as the end of the tube enters the œsophagus the choking usually stops. Supposing the case to be one in which the removal of something hurtful from the stomach is the object of the operation, after the tube has been passed, not less than half a pint of warm water, or of some special fluid, must be injected into the stomach before anything is sucked from it. The stomach may then safely be emptied, and the process of injection and suction repeated until the object is attained.

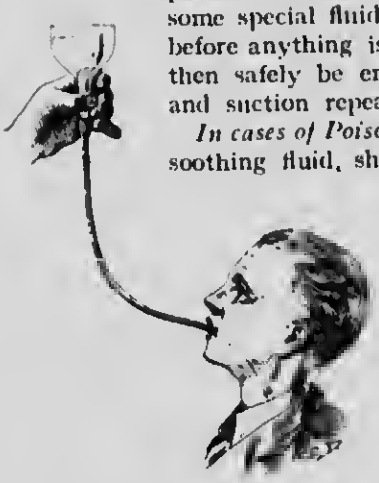


Fig. 212.—Funnel and Tube.

In cases of Poisoning, a pint of water, or of some bland, soothing fluid, should be left in the stomach; as also in the case of simple drunkenness, unless it be desired to leave an emetic injection instead. If, however, the pump has been employed for the purpose of washing the mucous membrane, and removing the fermenting secretions of water-brash, or similar forms of dyspepsia, only that amount of fluid should be left behind which the pump will not readily remove.

Washing out on the Syphon System.—But, as in the case of the bladder, the mechanism of a syringe with its taps and valves may be readily dispensed with, and the stomach washed out very easily indeed. All that is required is the tube of the stomach pump, an indiarubber tube capable of being attached to this, and a funnel (*Fig.* 212). The stomach tube having been passed, the tube and funnel are joined on, and then, by alternately pouring in fluid (the funnel being held about 2ft. 6in. above the level of the stomach) and then removing it by lowering the tube to an equal distance below, the operation of washing out the stomach can be reduced to its simplest conditions; but a certain amount of stiffness in the tube is essential.

Œsophageal Bougies are employed for the purpose of dilatation of simple strictures in this canal. They are also used for the purpose of diagnosis. With regard to their shape, etc., the best form is the olivary, as in urethral bougies, the medium and larger sizes of which are fre-

quently used for the œsophagus, although of course much larger sizes still are commonly employed. *No œsophageal bougie should ever be passed until an examination of the thorax excludes an aortic aneurysm.*

An œsophageal bougie should always be passed with very great care, and in cases of suspected malignant disease, or indeed, in all cases where the cause of the œsophageal obstruction is obscure, the house surgeon will not be justified in using this instrument on his own responsibility. On the other hand, it may be his duty, acting under his senior's instructions, to regularly dilate an œsophageal stricture by bougies. With regard to the actual passage, the manipulation is the same as for the tube of the stomach pump, the left forefinger being used as a guide, while the well-warmed bougie is passed with the right hand. But the utmost gentleness must be exercised while the bougie is in contact with the stricture.

Hypodermic Injection. — As we have been considering questions involving the use of various forms of syringes, this will be as convenient an opportunity as any to consider the performance of *hypodermic injection*. This method of administration was first introduced by Wood, and has been applied to a very large range of drugs, and also to stimulants, as strychnia and brandy.

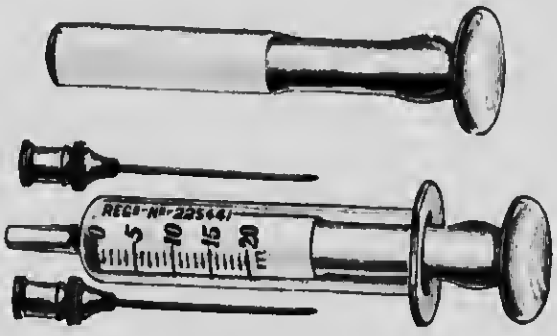


Fig. 213.—All-glass Hypodermic Syringe.

The syringe is also very commonly employed, not strictly hypodermically, for the purposes of diagnosis or for the removal of small collections of fluid.

The number of drugs exhibited for this purpose has increased very greatly of recent years, and very convenient tabloids, etc., of accurately weighed amounts, are now sold by most manufacturing chemists. The convenience of having the drugs in such a handy and portable form has been much appreciated by the medical profession. But inasmuch as the injection of morphia is so much more common than that of all the rest, and since the actual performance of the injection is almost the same in all cases, it will suffice for us to describe the rules for morphia injection.

The Hypodermic Syringe.—There are a number of patterns of hypodermic syringes, but their varieties involve no real difference of principle. They are all graduated to deliver the fluid to be injected by measured drops, and it matters little if this be effected by a screw or a thrust piston.

All-glass syringes (*Fig.* 213) have now come into general use, and they are to be strongly recommended, as they can be thoroughly sterilized by boiling. The needles should be kept in methylated spirit to prevent rusting.

The special points to be observed in inserting the hypodermic needle are :—

1. The skin should be cleaned with a little alcohol.

2. The needle should be thrust into the subcutaneous tissue at some place where it is loose and where the skin is free from veins (unless it be desired to inject into the vein cavity, as in the injection of ether for extreme syncope, or of ammonia for snake-bites).

The fluid having been injected, the needle should be withdrawn quickly, and then, the puncture being covered by the point of the finger, the injected fluid should be dispersed into the tissues by gentle rubbing.

3. Every now and again it happens that the administration of morphia in this way is followed by somewhat alarming symptoms of flushing, general pruritus, buzzing in the ears, and other signs of vasomotor disturbance, which somewhat resemble the commencement of an apoplectic fit. This derangement seems never to produce any permanent mischief, but it is well to be warned of it, lest it should produce undue alarm. The dose of the morphia does not seem to influence the occurrence.

After using the syringe, the needle should be cleaned by passing through a flame, and the silver or gold wire replaced in the needle to prevent rusting.

The introduction of the injection of antitoxins for the treatment of diphtheria and other diseases has necessitated the use of syringes made of glass, like the hypodermic syringes but much larger. They are generally marked in cubic centimetres and not in minims.

Cases of diphtheria are generally placed under the care of a house physician rather than a house surgeon, but the latter may be called upon to use the antitoxin serum for septicæmia or tetanus, though these both may be said to be still on their trial. The dose that is injected will of course depend on the strength of the antitoxin, but as a rule 5 to 10 cc. is about the amount used.

4. Lastly, and this point we would most strongly insist upon : no surgeon, house surgeon, or dresser should ever be induced to instruct a patient, or any one of the laity, in the art of self-injection. A syringe and a bottle of morphia are tools far too unsafe, and far too seductive, to leave in hands where they may be tampered with, and used, it may be unwittingly, as agents for self-destruction.

Chapter XXXV.

ON THE EXAMINATION OF THE RECTUM—THE USE OF BOUGIES, ENEMATA, ETC.

THE **Examination of the Rectum** may be conducted either digitally or instrumentally. In the latter we make use of various forms of specula, which enable the examiner to inspect the lumen of the bowel; or the sigmoidoscope, which allows of inspection of the canal up to the sigmoid flexure.

While considerable importance is to be attached to the use of the sigmoidoscope, the mode of employment will he considered later. It is especially the digital examination which the house surgeon will require. No part of the routine examination of a patient is of more importance in many diseases, and, unfortunately, no detail is so often omitted as this.

In the first place, it must he remembered that there are two principal methods of examining the rectum:—

1. With the patient lying on the back or side: the position usually adopted.

2. With the patient in the knee-elbow position, the huttocks well raised. The examiner introduces his finger into the bowel, directing it backwards into the hollow of the sacrum. With a little patience and gentle pressure the finger can be well introduced, and is then swept round the bowel, and various conditions on the front, back, and sides are carefully noted. It is better to be a little below the level of the patient's buttock, and to hold the hand nearly vertical.

Of course, such an examination is rarely possible in the female, so one must rest content with the former and less effective method.

If, when the finger has heen well introduced, the patient be told to bear down or strain, an inch or two more of the gut will be accessible to examination.

Some patients have the greatest dislike to this method of investigation, and it is always advisahle to explain to them the necessity for the step.

It may be of advantage to the student to consider some of the information that may be gathered by a careful rectal examination, and some of the conditions in which it is called for:—

1. In all cases of hæmorrhage from the rectum the finger may detect hæmorrhoids, polypus, prolapse, cancer, stricture.

If a fissure is found on inspection of the anus, it is better not to insist

on making a digital examination until the patient is anæsthetized for treatment, as the proceeding is excessively painful.

In every case of hæmorrhoids the rectum must be carefully examined, since hæmorrhoids sometimes are the first and only sign of cancer.

In cases of stricture there are usually a number of fistulous openings round the anus, and the finger will encounter a very tight obstruction.

In ischio-rectal suppuration, a foreign body may be detected.

2. In pelvic diseases in young unmarried women a rectal examination in preference to a vaginal is made, in order to ascertain the state of the ovaries and tubes.

3. In cases of suspected stone in the bladder, especially in children. In some cases the size of the stone can be accurately estimated between a finger in the rectum and a sound in the bladder.

4. In cases when the diagnosis between cystitis and pyelitis is difficult, tenderness of the bladder, as noticed on rectal examination, will be a point in favour of the former lesion.

5. In all cases of suspected enlargement of the prostate, the nature of the enlargement, whether simple, inflammatory, or malignant, can be made out.

6. In all cases of retention of urine when any doubt exists as to the cause.

7. In cases of peri-urethral suppuration, to ascertain the state of the prostate.

8. In chronic urethritis or gleet, which is often due to prostatitis or inflammation of the seminal vesicles.

9. In all cases of intestinal obstruction.

10. In cases of acute abdominal lesions when appendicitis or pyosalpinx is suspected.

11. In advanced cases of hip-joint disease up to the twenty-first year, since the acetabulum may become eroded and a pelvic abscess caused by the spread of the disease through the bone.

12. In all cases of sciatica, since this may be a symptom of carcinoma of the rectum or prostate.

13. In serious injuries to the pelvis or hip, to ascertain if the bowel is damaged.

14. In tuberculous disease of the epididymis, in order to note whether there is any thickening of the prostate or vesiculæ seminales: a point of importance not only in treatment but in diagnosis.

15. In cases of renal colic or suppression of urine, when it is thought that a stone may be impacted in the lower end of the ureter.

It will be seen from the above that much valuable information about various diseases may be obtained by rectal examination.

The Passage of Rectal Bougies, Enemata, etc.—Bougies are frequently employed in the treatment of simple and syphilitic strictures of the rectum. These instruments are made of flexible gum-elastic, vulcanite, metal, or wax. They are arranged in graduated sizes, and are either cylindrical or conical. Their passage is almost always

painful, but wax bougies give the least suffering, and metal ones the most; those of gum-elastic are in most common use. They should be warmed and oiled, and are best introduced while the patient lies on the left side. The right forefinger should be passed up to the stricture, and then the bougie passed along it, and thus guided into the aperture. No force should ever be used. As a rule the instrument is allowed to remain in some ten minutes or quarter of an hour; if the pain be great, a morphia suppository may be given either half an hour before the introduction or immediately after the withdrawal.

This method when very painful should be commenced under an anæsthetic, when existing fistulæ can be laid open or scraped.

The patient should be confined to bed during the early days of this treatment, the diet should be sparing, and the rectum should be frequently washed out with weak Condy's fluid or some non-irritating antiseptic.

If diarrhœa is present it may be necessary to check it by the use of starch and opium enemata, which will also have some anæsthetic action.

Smart bleeding often accompanies the operation, but it is readily checked with hot water. It is not advisable to dilate to any great

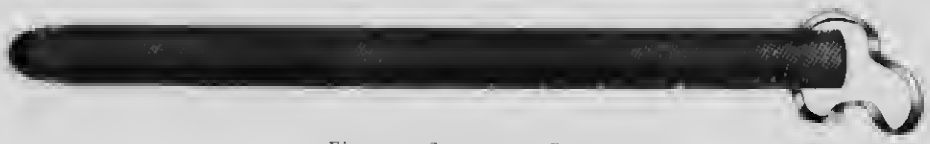


Fig. 214.—Gum-elastic Bougie.

extent the first time, since the efficacy of the treatment depends not so much upon the amount of stretching as upon its frequent application, while if, previous to the operation, the patient makes use of a hot hip-bath, the dilatation will be facilitated.

Two days afterwards a small bougie, smeared with cocaine ointment, should be carefully introduced, and left *in situ* for a period of half to one hour if it does not produce undue pain, after which it will be found that the rectum becomes increasingly tolerant, and in a week it will bear a full-sized instrument.

It is, of course, clear that such treatment is in the main palliative; for if it is not maintained for a long period, and repeated at regular intervals, the narrowing is bound to recur.

Enemata, or Clysters as they were called, consist of various drugs or foods injected into the bowel for different purposes.

We may divide enemata into several groups:—

Purgative, for causing an evacuation of the bowels; *Astringent*, a means of locally treating inflamed states of the rectum and colon; *Nutrient*, to give a patient food when the stomach is unable to retain it; *Stimulant*, to combat shock and collapse; *Sedative*, to quiet the bowel or the bladder in some inflammatory states.

Purgative Enemata.—We have a large number of enemata in common use, their main object being to dislodge fæces or flatus from the intestine.

1. *Enema Saponis* consists of a solution of soap and warm water used for the ordinary washing out of the bowel.

2. *Enema Terebinthi* is a solution of gruel or starch containing ½ oz. to 1 oz. turpentine to the pint. It is exceedingly useful in the treatment of meteorism, especially if combined with 15 gr. of asafœtida.

3. *Enema Olei Olivi* is used for cases of obstinate constipation when there are a number of scybalous masses which cannot be passed. If ox-bile be added to the oil in equal parts a greater effect is produced.

4. *Enema Glycerini.*—An injection of glycerin, either with or without other drugs, such as castor oil, is very serviceable in assisting an atonic bowel to expel its contents.

The general principle upon which all these enemata are used is the same, with the exception of the glycerin variety. Our object is to introduce them high up into the sigmoid, so that peristalsis may be set up and the hardened contents of the bowel softened before evacuation. Glycerin acts locally on the rectum, and is given in much smaller quantities.

A pint is the amount of an ordinary enema; but in adults as much as two pints may be given; in children, of course, much less.

In administering an enema the following precautions are to be observed. Prepare the enema, making sure that the solution is properly warmed (75° to 85° F.), pass the rectal tube well up into the bowel, and make the patient lie on his right side with the buttocks slightly elevated. *Inject very slowly.* An irrigator is much better than a Higginson's syringe. It takes half an hour to give an oil injection properly.

If the enema is retained, the administration of a small glycerin injection will usually cause its expulsion.

Astringent Enemata are given for the treatment of chronic colitis, hæmorrhage from the bowel, and for local conditions such as worms.

The commoner varieties are: Solutions of nitrate of silver, 1–1000 to 1–500; iced solutions of hamamelis; infusion of quassia, or solution of alum.

They are given in the same way as the others, only the buttocks should be raised well above the level of the rest of the body when it is desired that the colon be irrigated.

Nutrient Enemata are usually given after severe operations, when the patient is unable to swallow, or in diseased states of the stomach. It is sometimes necessary to employ them when there is severe post-anæsthetic vomiting. There is a good deal of discussion as to their actual value, and there is reason to believe that much larger nutrient enemata may be given with advantage than is the usual practice.

An ordinary nutrient enema consists of:—

℞ Yolk of 1 Egg		Brandy	℥ss
Beef Tea or Milk	℥j	Liq. Pancreaticus	℥ij

The bowel is first washed out with a soap-and-water or saline injection, after which the nutrient is introduced. At the end of four hours the bowel is again washed out and the injection repeated.

Stimulant Enemata are given for the relief of severe shock and bodily depression. They consist for the most part of normal saline to which brandy (1 oz. to the pint) or strong coffee has been added. A pint or more should be given if necessary every four hours. (See "Saline Infusion.")

Sedative Enemata consist of preparations of opium combined with starch or other excipient. A very useful form is:—

℞ Tinct. Opii ℥xx | Starch Mucilage ℥iv or vj

This is given for severe diarrhœa and tenesmus. Chloral hydrate and bromide of potassium, 30 gr. of each, are also given per rectum at the beginning of the treatment of tetanus.

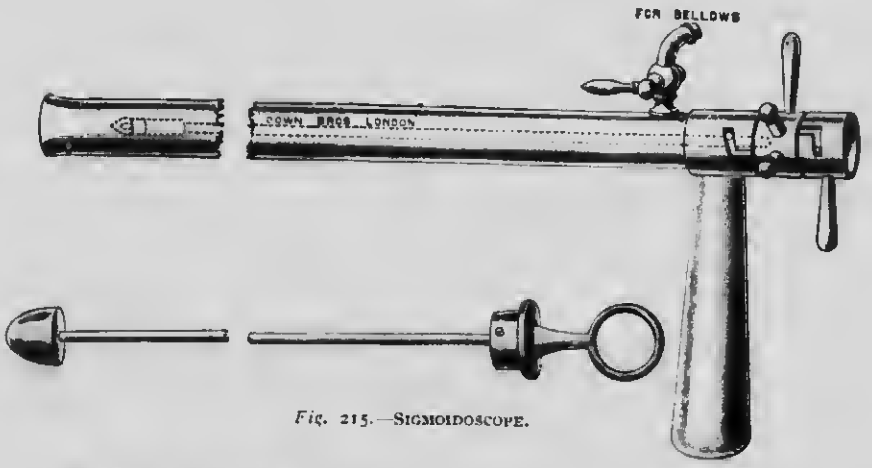


Fig. 215.—Sigmoidoscope.

The Sigmoidoscope is a modern instrument which was introduced by Strauss. It enables us to examine a considerable extent of the sigmoid flexure as well as the rectum. In this manner cases of colitis and malignant disease can be satisfactorily inspected, and a certain diagnosis of the latter condition made even when the growth is high up, far beyond the reach of the examining finger.

The instrument is of use in investigating cases of obscure hæmorrhage for which no cause can be found low down.

The sigmoidoscope consists of a long metal tube with a bulbous extremity, into which fits a rounded metal plug. This rounded end is made to enable the instrument to be introduced into the bowel without causing any damage; but even with this protection the tube must be employed with great care, as the bowel has been ruptured on more than one occasion (*Fig.* 215).

When the instrument has been fairly introduced, the metal plug is

withdrawn, and an eye-piece carrying a small lamp on a rod and a nozzle for connection with the bellows is fixed in position. By switching on the battery the lumen of the bowel opposite to the open end of the tube is illuminated and can be examined. If it is desired to push the instrument higher up, the gut is inflated by means of the

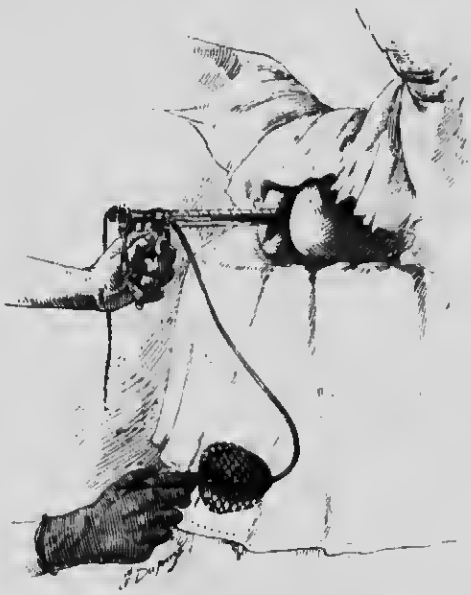


Fig. 216.—The Sigmoidoscope in use.

bellows, and as the result of this the valve-like folds of mucous membrane peculiar to the rectum are displaced, and the tube passes readily for a considerable distance.

This examination may be conducted without any anæsthesia; but if the patient is nervous, a general anæsthetic should be given.

The information gained by a thorough examination is very valuable, though a good deal of experience is necessary before the correct interpretation can be put on the picture that is seen.

Chapter XXXVI.

OF HÆMORRHOIDS AND VARIOUS MINOR OPERATIONS.

OPERATIONS ON THE RECTUM AND ANUS.

MANY operations on the rectum and anus may be performed by the house surgeon. In all these cases the importance of careful preparation of the patient should be fully realized, as his future comfort as well as the success of the operation depend upon it. It is not sufficient to order a purge; it must be seen that it acts thoroughly and that the bowel is well cleared out. As a preliminary to any operation, however trifling (unless in the course of the operation the sphincter will be divided), the sphincters should be thoroughly kneaded and stretched. It is astonishing how little pain there is after rectal operations provided this step is taken; while, on the contrary, neglect of this precaution will result in a painful and restless night even if morphia suppositories are employed.

Dilatation of the Sphincters.—As soon as the patient is fully anæsthetized, the two index fingers are introduced into the bowel, and gentle pressure is begun—outwards towards the ischiorectal fossa, and forwards and backwards towards the pubes and coccyx. After a little time the sphincters will begin to yield, when the thumbs may be substituted or the middle fingers inserted alongside the index. By gradual and progressive stretching, the muscles will be felt to give way, until the anus lies patulous before the operator and the rectal mucous membrane prolapses through the orifice.

It is astonishing how much force can be exerted without producing permanent damage. As a rough guide, it may be said that the operator should spend about five minutes over this preliminary, and he should not be content until all "grip" of the sphincters is lost. During the period of dilatation, the patient will be noticed to breathe deeply, and there is often some risk of an overdose of anæsthetic while the dilatation is proceeding. The anal region is now thoroughly washed with weak lysol, and a gauze plug, restrained by a string, is introduced into the bowel.

Internal Piles, which are easily recognized as bluish tumours with a tendency to pedunculation, are seized with clamps or Spencer Wells' forceps and dragged down well into view. It is usually quite unnecessary to remove more than four of these swellings, since the cicatrization which follows has the effect of causing any others present to shrink, and an extensive removal of mucous membrane is apt to be followed by a stricture—a very distressing complication.

The most obvious piles will be found in three situations: one anteriorly in the middle line, and one on each side; occasionally a fourth, posteriorly, requires to be treated. The piles are pulled down, and the operator snips round their base with a pair of scissors, cutting through the mucous membrane as it passes from the bowel on to the pile, the object being, as it were, to shell out the tumour. As much mucous membrane as possible should be left; and as this dissection is carried up towards the upper extremity of the pile, an attempt should be made to form a distinct pedicle in which the blood-vessels will run. It is usually quite easy in this manner to separate the swollen hæmorrhoidal vessels from the wall of the bowel, the vessels still retaining a partial covering of mucous membrane on their inner aspect.

The pedicle should now be ligatured with strong silk or thread, which should have been tested beforehand. The pedicle not only consists of a leash of hæmorrhoidal veins, but also contains a branch of the superior hæmorrhoidal artery, and unless the ligature be tied very tightly, it is liable to slip and allow bleeding to occur.

There are two reasons why the ligature is apt to slip: (1) In large hæmorrhoids the pedicle may be bulky and compressed with difficulty: (2) The ligature is applied while some tension is being exerted on the pedicle. There is always a chance of a ligature slipping when the latter condition is present: for greater security the pedicle may be transfixed. When the ligature has been firmly tied, the bulk of the pile is cut off and the ligature cut down until the ends just protrude from the anus. This renders them easy of identification in case of any bleeding, and enables the surgeon to note exactly when they separate.

After this has been done, the plug is removed, and the parts are well washed with weak lysol and powdered with iodoform. A morphia suppository, gr. $\frac{1}{8}$, may be introduced, but is not required if the sphincters have been well dilated. External piles may be snipped away, and bleeding points ligatured if necessary. Very little need be done as a rule, and the less skin sacrificed the better. A pad of gauze or wool is placed over the anus and secured in position by means of a T bandage.

In simple cases it is not necessary to introduce any plugging into the bowel, but if there is great vascularity and a tendency to oozing after the ligatures have been tied, and especially if the tissues are soft and ulcerated, the following dressing may be employed with advantage. A rubber catheter, No. 16, is pushed into the bowel, and round it ribbon gauze thoroughly soaked with sterilized vaseline, or vaseline and iodoform, is packed. This packing should not be tight; it should lie easily against the raw surfaces—its object being to assist nature in checking the hæmorrhage from the oozing surface. The catheter allows of the escape of flatus, which would otherwise be restrained by the packing, and also allows the surgeon to be quite certain that no concealed hæmorrhage is occurring.

Hæmorrhage after operations for piles is extremely disconcerting, because the bleeding points retract into the bowel and can only be reached with difficulty. When it occurs, an anæsthetic must be given, the sphincters again dilated, and an attempt made to secure the bleeding points. If this fails, the bowel must be plugged—an unsatisfactory and uncertain proceeding at the best. Rectal hæmorrhage may be exceedingly dangerous if the above precautions are not observed, owing to the blood being retained above the sphincters. In such cases the patient may bleed into his large intestine until he is blanched, before the complication is recognized.

AFTER-TREATMENT.—The wound is dressed the next day. The plugging is removed—the vaseline coat allowing it to be withdrawn with very little pain—and the anal region is well washed with some dilute antiseptic and powdered with iodoform or smeared with vaseline or with a weak antiseptic ointment such as the unguentum hydrarg. ox. flavum. The bowels should be allowed to act on the fourth day, and up to this time the diet should consist of milk and slops.

Retention of urine often follows operations on the rectum, and a catheter may be required.

In order to obtain a satisfactory and painless action, a pill or a dose of castor oil should be given over-night, and as soon as the patient feels a desire to go to stool a cocaine suppository, gr. ½, should be introduced into the anus, followed in five to ten minutes by an injection of warm olive oil, 4 to 6 oz. Attention to these details will ensure an almost painless action. Sometimes a little bleeding occurs after the first action of the bowels, but it is rarely serious. The cocaine suppository should not be required after the first evacuation, but the motions must not be allowed to become hard and scybalous. Gentle laxatives—cascara or confection of senna—should be given every night. Each day the wound is to be washed and dressed, and after the sixth day the house surgeon should introduce the forefinger into the bowel to make sure that no undue contraction is occurring; this should be done every third day until the patient is discharged.

The ligatures should come away from the seventh to the tenth day, but the patient must not be allowed to get up until fourteen days have elapsed from the time of the operation, and then only if the parts are soundly healed. Neglect of this latter precaution is a constant source of failure.

There are many other excellent operations for the treatment of hæmorrhoids, but they will not be described here, as the object of this book is to describe in detail a simple and satisfactory procedure.

It will not be out of place to remind the reader that piles may be associated with malignant disease of the rectum, as well as with cardiac and hepatic disease.

Painful Fissure or Ulcer of the Anus.—Small, but very painful cracks, or small ulcers, are often found at the margin of the anus, and although they are very insignificant in appearance, they may render life almost intolerable.

TREATMENT.—Lunar caustic, nitric acid, or a touch with the actual cautery will sometimes cure them, the treatment being combined with the use of astringent enemata; but in severe cases there will be hardly any improvement unless, in addition to such application, the superficial fibres of the sphincters in the neighbourhood of the ulcer are set at rest.

This may often be done by inserting the thumbs within the anus, and suddenly stretching the part; or a rectal dilator may be similarly employed.

But the most certain way to attain this rest is to incise the base of the fissure in its whole length, so as to divide the fibres of the sphincters which have, by their spasm and irritability, prevented the sore from healing. To do this effectually, an anæsthetic will be required, and a speculum is very necessary to ensure a complete view of the parts.

It often happens that these fissures are in connection with small piles, and occasionally with polypi. These must be removed at the time the fissure is incised.

Prolapsus Ani.—This condition is found in children and adults, but is more frequent and much less serious in the former. Infants

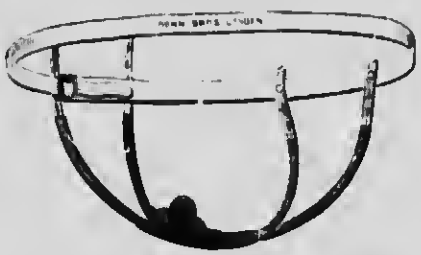


Fig. 217.—TRUSS, WITH PAD FOR PROLAPSUS ANI.

are very often brought to the casualty room with the complaint that "their body comes down" every time that the bowels are opened. The patients will generally be weakly and ill-nourished, and on enquiry it will often be found that they have been allowed to crouch for as much as a quarter, or, it may be, half-an-hour, upon a chamber utensil.

TREATMENT.—For the first few days the child should be kept in bed, the diet carefully regulated, and mild aperients given if there is constipation. The bowels should be allowed to act when the child is lying on its side, and for some time the use of the chamber or "chair" should be prohibited. The protruding anus, or rather the rectum, must be returned each time it comes down, and the opportunity may be taken to apply an astringent lotion (as 2 gr. of sulphate of iron to an ounce of water) to the part. The buttocks may be douched with cold water, anything like constipation should be avoided, and general tonics, as syrupus ferri phosphatis, given.

Under such general treatment, most cases of prolapsus in infants will very quickly get well; but if the case be more severe it may be

necessary to apply some kind of *Spring Truss*, made on the principle of those for uterine displacement, or a plug or pad, one pattern of which is shown in *Fig. 217*. The house surgeon must bear in mind that an intussusception has often been taken for a prolapsus ani, though careful examination will soon tell him what is the nature of the case he has to deal with.

When the prolapse is the result of worms or rectal polypi, the removal of these will usually effect a cure.

If the above measures fail, the child should be anæsthetized, the sphincters dilated so as to give a sufficiently full view of the part, and the prolapsed bowel lightly cauterized with the actual cautery, the lines of the cautery following the natural longitudinal folds of the anal canal. It is not necessary to burn deeply into the tissues, for the object of the treatment is to excite sufficient inflammation in the mucous and submucous tissues to cause the former to shrink up and become more firmly adherent to the latter. A little sterilized vaseline is smeared over the part, and a pad of wool applied. This treatment is very satisfactory in relapsing cases.

Prolapse in Adults is a more serious affair, and may require extensive operative treatment. Supposing that the case does not yield to a

Fig. 218.—Brodie's Fistula Probe.

patient replacement of the gut, with the application of astringent lotions, the surgeon may use a stronger caustic application, as the lunar caustic in the solid form or in strong solution, or nitric acid; or he may score the mucous membrane over with the Paquelin cautery, taking care in each case that the caustic or cauterizing action be limited to the mucous tissues. The prolapse should then be returned, and the case treated in the same way as if it were one of internal piles.

In more severe cases still, portions of the prolapsed membrane may have to be removed with the ligature, or clamp and cautery, as in the case of piles, but these measures are too serious to find a proper place here.

Fistula in Ano.—We shall here consider only the less serious form of this affection, and will suppose that in all the cases with which we have to do, the fistula is one which involves only the lower inch and a half or so of the rectum, and is thus well within the limits of safety as regards hæmorrhage. In most cases the fistulæ commence as ischio-rectal or anal abscesses, more or less acute at first, and afterwards becoming chronic. On examination a small, often a very small, aperture will be found, which on pressure will exude a little thin sero-pus; and on probing, this will be found to lead along a small channel, tending in the direction of the rectum. Fistulæ are often tuberculous: such

an origin may be suspected when the onset has been accompanied by little pain, and when there is an absence of induration round the fistulous track. The perineal region is often covered with long silky hair. If there is the slightest suspicion of the condition being tuberculous, a physician should be asked to examine the patient. Although operation is not always contra-indicated, special care and precautions must he taken.

Fig. 219.—Illustration showing Division of the Track of a Fistula on a Director.

Treatment. — The only efficient treatment for this condition is to lay the sinus open, so as to convert it into a trench opening along its whole length into the rectum, and by subsequent management to force it to heal up from the bottom.

In all fistulæ the actual operation is much easier than the conscientious carrying out of the subsequent dressing. The readiest way to cut a fistula is to take a Brodie's fistula probe (*Fig.* 218), to pass it along the sinus, and, if possible, find the natural opening into the rectum; if this is non-existent, or lies too high up, the end of the probe must be pushed through the rectal wall, wherever the sinus seems to come closest to the mucous surface.

As soon as the finger placed in the rectum feels the end of the probe, the instrument should be pushed on further and turned, so that its end comes out at the anus; the sphincters (one, or both, if both are involved) and all the tissues between the sinus and the rectum must then be divided by a curved, sharp-pointed bistoury, special care being taken to divide the sphincters at right angles to the direction of their fibres, and not obliquely.

It sometimes happens, even in the simple fistulæ we are considering, that a probe passed along the sinus cannot be turned out of the rectum in this way; if so, a director of the ordinary pattern should be passed along the track, a curved probe-pointed bistoury should then be passed along its groove till its point is felt by the forefinger of the left hand, placed in the rectum, and against the end of the director. This finger must then be kept in contact with the end of the knife while both are withdrawn. In this way the tissues between the fistula and the gut will be divided as before (*Fig.* 219).

The sinus itself having been slit up, it is necessary to perform certain trimming details, in order to ensure a sound healing. Thus the bottom

of the trench into which the sinus is now converted, should be incised along its whole extent, and oftentimes it will be wise to scrape out the granulation tissue which lines it, with the scoop which is here figured (*Fig.* 220); the unhealthy margins also should be freely clipped off, the best instrument for doing this being the fistula scissors (*Fig.* 221).

Fig. 220.—Scoop for Scraping Sinuses; etc.

When all this has been done, the wound must be carefully packed with narrow strips of gauze, and the whole secured with a T bandage. There is hardly ever any bleeding which moderate pressure will not arrest. An anæsthetic will be required.

However thoroughly a fistula may have been operated upon, the ultimate success or failure lies absolutely in the hands of the dresser.

Fig. 221.—Scissors for Trimming Edges of Fistulæ, etc.

If, through carelessness, he allows the channel to roof itself over, no good will have come of all the surgeon's efforts; he must, therefore, most patiently plug the wound quite from the bottom, so that it granulates soundly. The occasional application of lunar caustic to the sides may be of considerable value.

PHIMOSIS, PARAPHIMOSIS.

Circumcision for Phimosis in Children.—In the first place it may be stated that all children with a long foreskin will be placed in a better position, morally and physically, by being circumcised, whether they have a true phimosis or no; but these considerations apart, it is certain that many young children who have a certain amount of contraction of the aperture of the foreskin, but in whom the skin itself is not specially redundant, are subjected to circumcision quite unnecessarily. In a great number of these cases, all that is necessary is that the orifice should be dilated with a pair of dressing forceps, and the foreskin peeled from off the glans penis, to which it is generally adherent. But if the amount of the foreskin be distinctly redundant, whether the orifice be contracted or not, a circumcision should be performed, and in children this is a simple operation. An anæsthetic having been given, the foreskin should be drawn well forward over the glans, and held between the jaws of a pair of dressing forceps, but not so tightly as to bruise the parts. A special instrument has been devised, but this is not necessary.

The redundant skin should then be cut away, and if the mucous surface be adherent to the glans it should be peeled off. There will now be an extensive ring of raw surface round the glans, between the edge of the mucous membrane and the edge of the skin, which has retracted. The next step is to cut through the mucous membrane down the dorsal middle line to the level of the skin margin, and then, after removing redundant portions of the membrane so that a little frill of rather more than a quarter of an inch is left at the coronal sulcus, to attach the skin and mucous edges round the organ by a few points of suture, catgut being the best to use.

There are not more than two arteries which ever seem to require tying, but in these soft tissues ligatures are best avoided. This can always be managed by keeping a couple of Spencer Wells' or torsion forceps on the bleeding points for a minute or two. The dressing of the wound should be perfectly light and simple; a piece of lint soaked in lead lotion does as well as anything.

Circumcision and Slitting up the Prepuce in Adults.—This operation may be required, as it is in children, for congenital phimosis, and in such cases will not differ at all from that we have just described; but it may also become necessary in consequence of an acquired contraction of the foreskin, and this again may be due to an inflammatory condition present at the time of operation, or to one which has passed off.

If a long foreskin be in a state of acute inflammatory œdema, it may be necessary to expose the glans penis for urination, or for the purpose of getting at sores. In such a case no planned circumcision is called for, nor would the results be satisfactory. All that can or need be done is to pass a director under the foreskin in the middle line of the dorsum, and to cut the tissues along this with a scalpel or strong scissors down to the sulcus. The bleeding, up to a certain point, will be beneficial, but it can be easily stopped by pressure or by the ligature of any spouting vessel.

The phimosis which results from such an inflammation, but which has not required slitting up in its acute stage, may be operated on later in the more artistic method we considered first. This may sometimes be the best plan, but more often it will be found advisable to divide the prepuce along the dorsum, and then to readjust the divided skin and mucous surfaces in the most symmetrical way possible.

I have long abandoned a formal dressing in cases of circumcision. As soon as the operation is concluded, I place a piece of lint soaked in lead and opium lotion (B.P.) over the end of the penis. This lotion is antiseptic, sedative, and astringent. Over the lint a piece of oiled silk or waterproof lies to keep the bedclothes from becoming soiled. The lint should be changed every two or three hours. In the case of adults, they can be taught how to clean their hands, soak the lint, and apply it themselves. When micturition is performed the lint is removed, and after the act, a fresh piece is applied. I have noticed

that painful erections have been much less frequent since I have used this dressing.

Paraphimosis.—In this condition the glans penis, with some of the everted mucous membrane of the foreskin, is strangulated by the narrowed aperture of the natural or acquired phimosis, through which it has protruded, but cannot be returned in consequence of the œdema.

In children, a natural phimosis is generally the cause; in adults, as a rule, the case is one of balanitis with inflammatory effusion and contraction of the foreskin. In any case the condition causes pain, and will steadily get worse until it is relieved.

Reduction.—In children, and in the less severe forms in adults, the foreskin can, as a rule, be drawn over the glans without much difficulty. The part having been first well oiled, the size of the œdematous glans can be reduced by wrapping a piece of lint round it and firmly grasping it in the hand for a minute or so, after which, by pressing it directly backwards with the thumb, at the same time drawing the foreskin forwards with the first and second fingers of both hands, the prepuce will come over.

In more severe cases an ice-bag may be found useful, or the swollen tissue may be stabbed with a scalpel in several places, thus reducing the œdema.

Incision.—If these measures fail, the patient should be given an anæsthetic, and if reduction still cannot be effected, the constricting ring must be divided along the dorsum of the penis. This ring will probably be found to be very deeply imbedded in the swollen parts, so that care must be taken to identify the real seat of strangulation. If a paraphimosis be not reduced, the parts fall quickly into a sloughing condition, which will eventually relieve the constriction at the expense of deformity, through the loss of portions, or it may be of the whole, of the glans penis.

It will often be advisable to slit up the foreskin at the same time the paraphimosis is relieved by incision, but this should be done after the reduction of the glans, as the natural condition of the part can then be more accurately seen.

CORNS, WARTS, AND CONDYLOMATA.

The common **Corn** which forms about the foot deserves perhaps more notice than it generally gets, for it often occasions much suffering, and may even effect complete disablement.

These growths, like other forms of papillomata, may be removed with the knife, but this operation, small as it seems, should not be very lightly undertaken, for even small corns dip deeply into the subjacent tissues, and will certainly recur unless they are completely removed, while all cuts about the foot refuse to heal kindly, so that the patient may be laid up for a good while. Professional corn-cutters as a rule confine their efforts to diminishing the amount of direct pressure upon the sensitive papillæ, by judicious paring of the horny

layers; but when they do attempt to remove the whole growth, they commonly effect it by setting up a little suppuration about or beneath its base. In other cases, a caustic, nitric acid being the best, is applied time after time: the burnt parts being pared away.

But in the great majority of cases, palliative measures in the way of relief of pressure by properly cut corn plasters will effectually prevent pain without laying up the patient for an hour, and in the end will generally cure the corn.

"Corn plasters" as sold are too small, and are of the wrong shape. They should be cut to a pattern out of isinglass felt, or some similar adhesive material, and should be of a ⊂ shape open towards the ankle, to allow of free circulation. The sides of the ⊂ should be at least thrice the thickness of the central space, which should just admit the corn. The plasters can be taken off at night and put on again in the morning.

Warts upon the hands are common in children, and in those who have to handle animal tissues (post-mortem room men, and the like). In children they commonly disappear, vanishing sooner or later without being noticed. The best way to remove them is to touch them repeatedly with nitric acid and pare them away.

Both corns and warts may be made to disappear by the use of the following preparation of collodion, which is painted on daily:— Salicylic acid 60 gr., extract of cannabis indica 8 gr., flexile collodion. ¾ strength, 1 ounce. After a time the skin that is formed is pulled off, leaving the corn substance soft and easily removable. The painting is continued till the corn has quite gone. The only objection to this method is its slowness, which prevents some persons from persevering with it.

Urethral Caruncles occur about the aperture of the female urethra, and are exquisitely tender. It is generally necessary to give an anæsthetic before removing them, which is best done with the actual cautery, or with scissors, afterwards applying the cautery to their bases, to arrest the bleeding; or the application of a 4 per cent solution of cocaine will allow them to be snipped off, and the cautery to be applied quite painlessly.

Warty Growths of Venereal Origin are common about both the male and female genitals. They may generally be snipped off with scissors and their bases touched with lunar caustic, or nitric acid; but sometimes they are so large that it is safer to ligature them, when the method detailed for piles may be followed. In other cases, when they are more sessile, the application of nitric acid will be best.

True Condylomata, *moist cutaneous tubercles*, are sometimes treated locally with the stronger caustics; but more frequently powders, which are somewhat escharotic, but which also serve to keep the parts dry, are preferred. Thus equal parts of calomel and zinc oxide, or of subacetate and savin, may be used. These also yield to constitutional treatment much more readily than warty growths.

OTHER MINOR OPERATIONS.

Fistulous Tracks in the Groin and Elsewhere.—Sinuses in the groin are very common as the result of buboes, and once formed, will burrow to an almost unlimited extent. But wherever the sinus may be, the same line of treatment must be adopted, as has been before described for *fistula in ano*. Advantage may arise from an occasional application of lunar caustic to the edges and base of the trenches. It is hopeless to expect any healing until the tunnel has been converted into a trench, and made to heal from the bottom. The windings of the fistula must be followed up with the director and scalpel, and the details of scraping, trimming, and dressing are precisely as before described.

Ingrown Toe-nail, and Avulsion of Nails.—The great toe-nail often produces an extremely painful ulceration, on one or both sides, by an ingrowth of its margins. The irritation thus produced causes a hypertrophy of the neighbouring skin, and a condition of paronychia, so that the nail may come to be half buried in fungous granulations, with a fœtid discharge, and the patient may be unable to put his foot to the ground. There are probably very few, if any, cases of ingrown toe-nail which *cannot* be cured by measures short of pulling out the nail, but in all except the slighter forms, much time and patience will be required to achieve success.

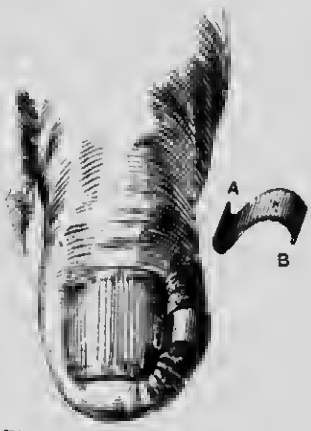


Fig. 222.—Silver Lever for Ingrown Toe-nails.

If the nail is to be kept, the common treatment is to gradually lift it up from its bed, by gently packing something, such as a pledget of cotton wool, beneath its edge, three or four times a day; and at the same time to reduce its thickness to that of a piece of note paper by rubbing it down, for which purpose pumice stone will be most serviceable. The exuberant edges may be touched with caustic; and iodoform, or the powder of the nitrate of lead, will be found good applications to the ulceration. A solution of caustic soda 1–40 will soften a nail so that it can be dealt with more readily.

The use of a small piece of sheet lead slipped beneath the nail to raise its edge has long been known, and either that or a piece of silver, about the thickness of note paper, and about ½-in. long, and ¼-in. broad, is bent to the shape of A B in *Fig. 222* (this can very conveniently be made out of a threepenny piece filed down), one end, A, being bent up to a right angle. This end is inserted underneath the nail so that the ingrown edge just rests in the groove thus formed. The rest of the plate must then be used as a lever, and pressed down upon the side of the toe until it lies against it as shown

in the illustration. By this means the edge of the nail is raised, and the exuberant granulation tissue, which is almost always present, pressed down, and away from it. The plate is then fixed in position by a circular turn of strapping, cut about an inch wide (not shown in the figure).

The relief afforded by this simple adjustment is immediate and very striking, so that patients can walk with ease as soon as the plate is fixed, and a permanent cure is generally speedy.

Working on these lines, as we have said, almost all ingrown nails can be cured, and the patient can himself assist the process greatly; but it takes time, and it may be readier and more satisfactory to remove the nail.

If the patient is willing to undergo an operation, the method advised by Watson Cheyne should be adopted. It is infinitely superior to avulsion of the nail. Under anæsthesia, an incision is made along the nail fold right down to the matrix; in this way a flap is formed of the soft parts that lie alongside the ingrowing nail. Rather less

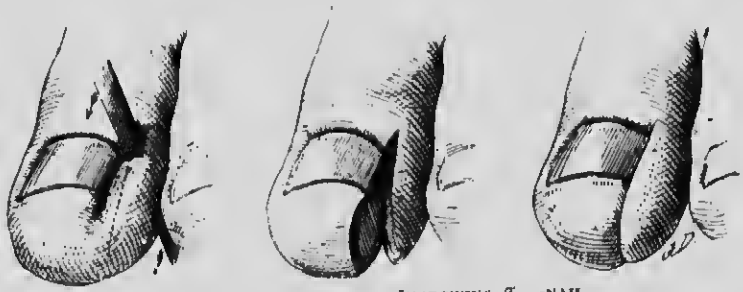


Fig. 223.—Operation for Ingrowing Toe-nail.

than half the nail is then cut away, care being taken to see that the cut extends well down to the matrix and that the nail-bed is thoroughly destroyed. If this precaution is not taken, the operation will be a failure. The flap is now readjusted, so that it lies on a lower level than the nail, and it is secured with one or two sutures. This is a radical and very satisfactory method, and one which will completely cure the trouble. Other nails, both of fingers and toes, may require removal for onychia, abscess of matrix, injury, etc., but in such cases it will generally be best, in preference to splitting the nail and wrenching it off, to gently separate the nail from its bed, until it can easily be pulled away; this is especially the case in removal of a finger nail, where great care is required lest the matrix itself should be scarred; the results will not show at the time, but as the new nail grows, the cicatrix in the matrix will cause the nail to be permanently misshapen.

Warty Growths from beneath the Nails, and especially from beneath the great toe-nails, are not infrequent. They will, if neglected, cause pain and ulceration by pressure, and it is always best to remove them.

This may generally be done by paring, and the use of some caustic; but it may be necessary to remove a portion or the whole of the nail in order to get at the base of the growth.

A Small Cancellous Exostosis is also apt to form beneath the nail of the great toe, and this is often mistaken for a warty growth, but its nature will be recognized by careful examination. It should be removed early, for if allowed to grow it will be sure to occasion inconvenience. The best method of getting it away is to pass a scalpel round its base, cutting all the tissues down to the bone, and then to snip it off with small sharp bone forceps. As in the case of warts, it may be necessary to remove a part or the whole of the nail for the sake of exposure.

Tongue-tie. — Mothers frequently bring their infants to the hospital in the belief that they are tongue-tied, when either there is nothing the matter with them, or else there is only a fragile band of membrane which can easily be broken down with the finger. But if the frænum linguæ be really too short and thick, it must be divided with a pair of blunt-pointed scissors, the points of which must turn downwards, towards the floor of the mouth. The tongue must be held up by two fingers, or by that special form of spatula with a slit in it, combined with a director, which may often be found in pocket instrument cases.

Vaginal Adhesions. — Very commonly indeed, newly-born female children are brought with the report that "the womb is shut," or some similar phrase is used: when, upon examination, a small pin-hole aperture is seen, by which the urine escapes, and at first sight the rest of the vaginal opening seems to be absent. But if a probe or director be passed into this opening, and pressed downwards, it will be seen that the parts are perfectly normal, and that there has been only an adhesion of the margins of the vaginal orifice.

No further treatment is required, and we mention the condition only because it is so often mistaken by mothers and dressers for something far more serious, whereby much anxiety is caused.

Nævi.—We will here consider *cutaneous* or *capillary nævi* (mother's marks), and the smaller subcutaneous ones. With regard to both, but especially the former, one fact is often forgotten, indeed seems hardly to be generally known, namely, that *if left alone they will very frequently disappear*. To show this, let the reader consider how very rarely the affection is met with in adults as compared with the number of children who are brought to the O.P. rooms for treatment.

It is, therefore, in infants, a good general rule to postpone treatment, for a month or two at least, after they are first seen, unless the stain be rapidly growing, or be in a very disfiguring situation.

The only way of treating *Superficial Nævi* is to destroy them with some form of caustic or cautery. *Nitric acid* will generally be found best, but Richardson's ethylate of sodium or strong chloride of zinc may also be used. It is only waste of time to employ the milder caustics, as the nitrate of silver or alum.

Sometimes the nævus is vaccinated, and the consequent inflammation may be sufficient to effect a cure, but it generally fails, and is therefore not to be recommended.

Any form of actual cautery may be successfully used, Paquelin's perhaps being the most convenient. The whole depth of the skin must be destroyed, and the parts dressed in some simple fashion while the sloughs separate.

In situations such as the face, where complete destruction of a large superficial nævus would leave a disfiguring scar, good may occasionally be done by slight superficial applications of the cautery, frequently repeated, a small portion of the nævus being done at one time. If

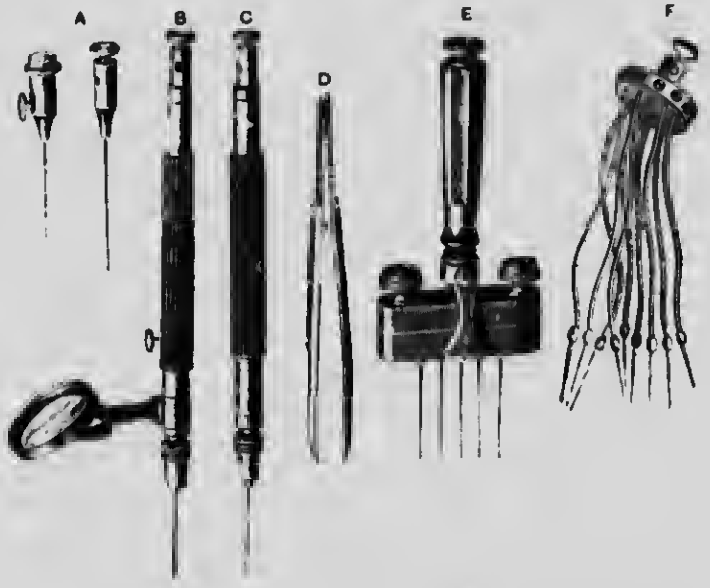


Fig. 224.—Various Needles, etc., for Electrolysis.

A. Needles with terminal. B. Needle-holder with magnifier attached. D. Forceps for epilation. E. Multiple needle-holder for nævi. F. Electrode for the destruction of tumour.

successful, a thin white scar will ultimately be formed, but the treatment is long and tedious.

Subcutaneous Nævi may be treated upon two principles; that is to say, measures may be taken which will produce sloughing out of the entire mass, or which will merely produce a consolidation and stasis of the blood-current through it, which consolidation is later followed by a gradual absorption.

By Ligature.—For the ligature of a subcutaneous nævus of ordinary size, the readiest way is to take a needle, double threaded with stout silk or whipcord, and with it to transfix the base of the growth. The needle having been cut off, there will be left two cords running below

the tumour, and these may if necessary be increased to four or six by repeating the process of transfixion. The cut ends of these ligatures have now to be knotted together very tightly, each to each, and before this is done it will almost always be advisable to cut the skin in the form of a ring at the base of the growth. The nævus will then be completely strangulated, and must be left to slough off. During its separation it may be dressed with any simple antiseptic dressing.

Sometimes elastic ligatures, or such as can be tightened up from time to time, are used; but in any case the cords must be tied very tight.

The means which may be adopted for securing consolidation of nævoid growths are numerous, but we shall mention only one or two of the principal ones.

Electrolysis, or the passage of a constant current, finds an application here, its object being to produce stasis and coagulation in the blood-vessels, but not sloughing of the tissues. The current should be just strong enough to decompose water; and the needles must be insulated with the exception of about ¼ in. at the end, to prevent the current from acting on the skin and causing sloughing. One needle is connected with each pole of the battery and inserted into the tumour, care being taken that the non-insulated portion is buried in the nævus. The current is passed until the swelling becomes white and hard; it must then be reversed for a short time to prevent hæmorrhage. If the nævus be deeply seated, the effect will have to be estimated by the hardening of the tumour. The operation frequently has to be repeated, and it is often advisable to use more than two needles, especially if the nævus be large.

The Actual Cautery may also be used, multiple punctures being made into the nævus. Cure takes place by a mixture of sloughing and consolidation.

Small subcutaneous nævi, which are distinctly encapsuled, may often be dissected out, and although the operator must carefully avoid cutting into the small tumour while it is being removed, it is a very satisfactory treatment, though not generally applicable. All bleeding ceases as soon as the nævus is taken away.

The Galvano-cautery may also be used in the treatment of nævi, when they are large and when a less conspicuous scar is required, as on the face or neck.

A small puncture is made into the nævus with a tenotome, and the cautery wire inserted into the growth; the current is then turned on, with the result that the nævus is burned 'subcutaneously.' The point may be moved about in various directions to destroy different parts of the tumour, and if care is taken very little of the skin will slough. Vaseline should be smeared over the puncture.

Carbon-dioxide snow is now used almost exclusively for the treatment of superficial nævi, and gives admirable results. *Radium* may also be employed.

Chapter XXXVII.

Of Passive Congestion (Bier's Treatment), of Venesection, Cupping, etc., and of Blisters and other Methods of Counter-Irritation.

Passive Congestion (Bier's Treatment).—This treatment, which was introduced by Bier, of Kiel, aims at an imitation of the phenomena of inflammation, the active hyperæmia of this state being copied by a passive congestion which results from obstruction of the veins.

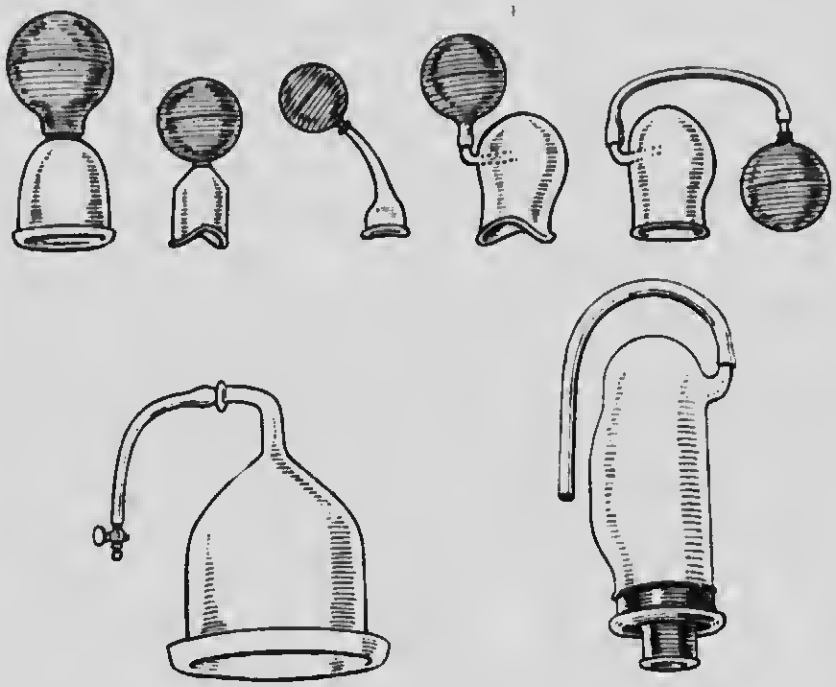


Fig. 225.—Cupping Glasses as used in Bier's Treatment.

It is applicable to a large number of different disorders, especially those of the extremities, such as whitlows and suppurative states of the joints and tendons. It is also of service in tuberculous disease, and a modification of the method may be practised for the t atment of

sinuses and similar lesions. To practise the treatment, a soft broad rubber bandage is bound round the limb on the proximal side of the lesion, and should be applied with sufficient tension to render the part below bluish-red and swollen, not cyanotic or anæmic. Above all, it must not affect the pulse, which should remain unchanged. If properly applied, except in neurotic subjects, little or no pain is caused; indeed, the throbbing agony of whitlows is markedly relieved by the application of the bandage. The length of time during which this bandage may be applied varies in different cases; it is better to start with short periods of half to three-quarters of an hour, and later the bandage may be retained in acute cases for as many as twenty out of twenty-four hours without inconvenience or injurious effect. With the application of the bandage the morbid tissues are flooded with serum, which has a beneficial effect in combating any infection which may be present. If any wounds have been made they will be found to run freely with serum during the time the bandage is applied. One important result of the treatment is that small incisions only are required for the relief of whitlows, abscesses, and septic states, the general duration of treatment being thereby shortened considerably. In the case of sinuses, which from their position are not amenable to the application of the bandage, good results can be obtained by the application of cupping-glasses or a suction apparatus; a test tube which will just fit over the margins of the sinus is an excellent substitute for a cupping-glass. The action of these glasses is to cause a free flow of curative serum over the morbid tissues, stimulating them to activity and healing. This treatment may be combined with the application of Wright's solution, which consists of 4 parts of sodium chloride and 1 part of sodium citrate to 120 parts of water.

Venesection.—The practice of venesection is so much out of fashion that probably the majority of house surgeons now in office have never seen the operation performed, still less performed it themselves. We are suffering from the reaction that followed the abuse of the practice in the earlier years of the nineteenth century, and though we sincerely hope that neither we nor succeeding generations will ever see its revival to the excess of former times, there is little doubt that it might be employed more frequently than is now the case.

The veins which are opened for the purpose of letting blood are, one of those at the bend of the elbow, the jugular, and, much more rarely, the internal saphena at the ankle. The method is much the same in each case, and we will describe in detail only the commonest, namely, of one of the veins at the bend of the elbow, usually the median basilic.

The Method.—The patient, who should be sitting, is directed to hang the arm down so as to produce turgescence of the veins. A piece of bandage is then tied tightly round the arm, a pad being placed over the trunk vein on the inside, and the bandage knotted over that. The hand should then be raised to the horizontal position, and be made to

grasp a strong pole resting on the ground (the origin of the barber's sign-pole); a broom handle will do very well, or even a bandage. The limb is thus steadied, and the forcible muscular flexion aids the venous fullness.

Supposing the median basilic to be selected, the thumb should be placed just below the spot chosen for incision, so that the vein, and the skin over it, are steadied, and the blood is prevented from spurting out. The surgeon then, with a lancet, or a very sharp knife (the former is best, from the extreme thinness of its blade) incises the vein obliquely, cutting it about half across. On removing the thumb, blood should immediately flow in a somewhat forcible stream, and this should continue until about five or six ounces have been removed; it will then generally slacken, and if more blood is to be drawn, the surgeon must rub the limb from below upwards, and direct the patient to alternately open and close the hand, or to flex and extend the elbow, so that the muscular contraction may aid the flow.

When as much blood as is required has escaped, the ligature on the arm must be relaxed, the arm raised, and a pad placed upon the wound. The pad should be secured by a double figure of 8, the ends being tied in a bow, or reef-knot, over it.

Complications of Venesection.—If the instruments are perfectly clean, diffuse inflammation can hardly occur, but in older and ruder days this was not infrequent.

A still more serious accident seems to have happened somewhat unaccountably often, namely, a puncture of the brachial artery, or an opening of it in mistake for the vein. This sometimes resulted in the formation of an arteriovenous aneurysm, or in an aneurysmal varix, and sometimes in consequences still more serious.

It is very necessary that the wound in the skin and that in the vein should exactly correspond, and every care must be taken that the former does not slip over the latter during the incision. This is best prevented by using a very sharp lancet, and by fixing the vein firmly.

In cases where the vein is difficult to find, a careful exposure of the vessel by dissection will prove of great service. (*See* "Transfusion," p. 46.)

Bleeding from the Jugular Vein is sometimes adopted in children because of the small size of the arm veins, and in adults for other reasons. The operation is conducted on the same principles as for bleeding from the arm, but the compress to produce distention of the vein must be applied very firmly above the clavicle, outside the sternomastoid, lest air should enter. The vessel is incised upon the sternomastoid, in its long axis, as the platysma fibres here cross it obliquely. The after-management is the same as before, but the pad must be placed on the wound before the compress over the clavicle is relaxed.

Arteriotomy is still more rarely performed than venesection. The temporal artery, or one of its branches, is the only vessel opened for

this purpose. It should be half cut through with a lancet, as in the case of the vein, but transversely; and when the desired amount of blood has escaped, the division of the vessel should be completed and a very firm compress applied, which should be left undisturbed for four or five days.

Cupping.—By means of "cups" the blood may either be merely drawn to the surface by taking off the atmospheric pressure, or it may, having been thither attracted, be removed by a scarificator. The former proceeding is "dry," the latter "wet," cupping. The nape of the neck and the posterior surfaces of the thorax and loins are by far the most common situations, but any part which will hold the glass will do.

Dry Cupping.—In order to cup successfully, some dexterity is required. The principle on which it depends is the creation of a considerable vacuum beneath bell-shaped glasses (*Fig.* 226), which are made in various sizes. These glasses are sometimes made so that they can be attached to an exhausting syringe, like the bell-jar of an air-pump. But in skilful hands a better vacuum is obtained by quickly rarefying the air by heat. A good cupper will do this by simply putting a lighted paper spill within the cup for an instant and immediately applying the latter to the surface of the skin; but for most people it will be easier to put a few drops of spirits of wine into the cup, and to distribute the spirit over its interior. A pledget of cotton-wool placed on a stick should then be dipped in spirit, lighted, and mopped round the inside of the glass. This will produce a large but momentary flame, and as soon as it is alight, the cup should be "clapped" upon the required place. The flame will be immediately extinguished, and the vacuum will show itself by an almost instantaneous rising of the skin.

Fig. 226.—Cupping Glass.

The essential points to attend to are, that only just so much spirit should be put into the cup as will moisten its sides, and that the rim of the cup make perfect contact with the skin, so as to exclude all air. It is hardly necessary to mention that severe blistering may result from the edge of the cup being too hot, an accident not likely to occur if only a small quantity of spirit is placed in the glass.

In cases of suppression of urine, cupping over the renal regions is an extremely valuable form of treatment. (*See also* "Bier Treatment," p. 364.)

Leeches.—If leeches are to be applied anywhere within the cavity of the body, a leech-glass from which they cannot escape should be used; but if they are required for outside surfaces, they may be placed within a pill-box, covered with a piece of lint, or held lightly in the

hand. The part to be leeched should be washed with warm water, or milk, and must be perfectly clean. Those leeches should be chosen which are thinnest and most lively, and should be allowed to remain on until they drop off.

It is estimated that a leech should extract from 1 dr. to 2 dr. of blood before it is gorged, but if a poultice be put over the bites, much more will flow.

A leech should never be allowed to bite into a vein, or troublesome hæmorrhage may follow; pressure would always stop this, in any situation where it could be applied, but it may be necessary to adopt such measures as passing a needle below the bite, and twisting silk round it.

Blisters.—These are usually produced by painting blistering fluid (liquor epispasticus P.B.) over the required area, or by applying a cantharides plaster, cut to the desired shape. If there are any hairs on the part to be blistered, they should be shaved off, and the skin washed with a strong soap, to remove the natural oil.

If the blistering fluid be used, the most convenient way to apply it is to cut a hole of the desired size in a piece of notepaper, to hold it firmly over the part, and then to paint on the fluid with a camel's-hair brush. In this way the blister is strictly limited. Another plan is to smear simple ointment round the part to be blistered.

The dresser or nurse must be careful to keep the hands well away from the eyes during the application of any blistering fluid.

When the bleb has fully formed, it may either be snipped at its most dependent part, and the serum soaked up with absorbent wool; or if it be desired that the blister should remain open for some time, the whole cuticle should be cut off, and the sore dressed with some irritant ointment, of which the unguentum savinæ is the most frequently employed. (Blisters are occasionally dressed with mercurial ointment when a powerful counter-irritation is required.)

The active principle of cantharides being soluble in oil, the blister will be found to rise better and quicker if the surface of the skin where the plaster is to be placed is moistened with olive oil.

The Actual Cautery.—We have so frequently considered the employment of different forms of the actual cautery for various surgical purposes, that we need only here remind the reader of its employment for the arrest of hæmorrhage, the removal of growths, etc. Formerly it was extensively used as a counter-irritant, and whether the cautery irons or Paquelin's instrument were used, the usual method was to "score" the skin surface over the seat of pain or disease, very much as a horse's leg is fired. But in the treatment of spinal disease by the various forms of thermo-cautery, other methods were adopted, such as the needle cautery, description of which will be found in books especially dealing with this subject.

Vaccination.—The chief *plans* of vaccination are: (1) By means of tubes containing lymph from ripe vesicles; (2) By means of tubes of calf lymph.

The chief *methods* of vaccination are:—(1) By means of small oblique punctures into the cutis vera, made with an arrow-headed lancet, charged with the lymph, this being procured direct from the vesicle, or from a tube: (2) By making numerous scratches through the cuticle within a small area, like the cross-hatching of an engraving, and then rubbing in the lymph from the vesicle, tube, or point, for a minute or two. This is the one most universally adopted at the present time.

In all cases, for a primary vaccination, at least four inoculations should be made, and the place nearly always chosen is the top of the arm, near the surface of the deltoid. Some mothers ask that their female children should be vaccinated on the leg, in order that the scars may not be noticeable when a low dress is worn in later years; there is no objection to this. We do not recommend vaccination on a nævus.

The lymph, which is enclosed in *capillary tubes*, is procured from ripe vesicles. The tubes being immediately sealed hermetically, humanized lymph will, under these circumstances, keep for a long time. When it is to be used, the ends of the tube are broken off and the contents blown out upon a clean slip of glass. The vaccination may then be performed with a lancet, or by scratching with a needle as before.

The method which ensures the most satisfactory results is as follows: Having bared the arm, rub it firmly with a wet towel so that the skin becomes a bright pink colour. This brings the blood to the surface and removes the natural grease of the skin. Break open the tube at both ends and blow out a drop in as many places on the arm as inoculations are to be made. Then, placing the hand under the arm, the skin should be stretched slightly while the scratching with the needle is made through the drops of lymph. In this way the lymph is carried down to the bottom of the scratch and inoculation is rendered almost certain. The scratching should be done sufficiently deep to make only the merest drop of blood appear, though even this is said not to be necessary. The lymph must be allowed to dry on, and on no pretext whatever rubbed off or the arm washed during the next twenty-four hours.

Calf Lymph.—The methods of vaccination with *calf* lymph are precisely the same as with the humanized kind. It may be performed direct from calf to child, or by means of tubes.

It is absolutely necessary that all instruments used for the purposes of vaccination should be scrupulously clean.

The lymph at present recommended as the best is that known as glycerinated lymph. This is made by adding to one part of lymph four parts of sterilized 50 per cent solution of water in chemically pure glycerin. After storage for a month in some place protected from the light, this lymph is said to contain no pathogenic organisms, and to produce as good vesicles and afford protection as lasting and efficacious as any other lymph.

SECTION VII.

OF SPECIAL CASES CONNECTED WITH THE HEAD AND THROAT.

CHAPTER XXXVIII.

MINOR SURGERY OF THE EYE.

BY LESLIE PATON, B.A., M.B., B.C. (Camb.), F.R.C.S.

Ophthalmic Surgeon, and Lecturer on Ophthalmology, St. Mary's Hospital; Ophthalmic Surgeon to the National Hospital for Paralysed and Epileptic, Queen Square.

IN this chapter I have restricted myself to those subjects with which a house surgeon in a general hospital may have to deal on his own responsibility. I have given only a brief clinical description of them, but in the matter of treatment I have gone into some detail, since even in such a simple operation as excision of the eye it is the careful attention to small details which makes the difference between the rapid operation of the skilful, and the slow bungling of the inexpert.

Wounds of the Eyelid.—Wounds of the eyelid, when they do not involve the lid margin, usually heal very readily. They should be carefully cleansed, and the finest silkworm gut used for stitches. When the lid margin is involved, and especially if the wound is at all a ragged one, it must always be borne in mind that restoration of a neat margin is the most important thing to aim at, and that the marginal stitch should therefore be inserted first. In doing this, care should be taken to see that there is no inversion of the skin on either side, as this may result in an ingrowing eyelash, which, rubbing on the cornea, will give rise to constant irritation.

Inflammations of the Lid Margins.—Inflammation in the hair follicles and in the sebaceous and sweat glands which open into the hair follicles is a very common disease in children (ciliary blepharitis). The inflammatory exudates form little crusts which lie along the roots of the lashes, blocking the mouths of the hair follicles, and in old-standing cases causing erosion and pitting of the skin round the hair roots. An error of refraction is in many of the cases one of the predisposing causes. In treating this condition, it is to be borne in mind that the real seat of the disease is in the depths of the hair follicles, and not on the surface, and that before any application can reach this point, as much as possible of the surface exudate must be

dissolved. In slighter cases it usually suffices to bathe with a warm alkaline lotion until all the crusts have been dissolved, and to rub in a very dilute ointment of nitrate of mercury (1 in 10 B.P. strength). In more severe cases it is advisable to pull out the lashes in the most affected part, to clip off the others, and then, after bathing thoroughly, to touch the whole of the row of hair follicles with mitigated silver stick (1 part of silver nitrate, 4 parts of potash nitrate, fused together). Another excellent method is to substitute for the mitigated stick thorough scrubbing with 25 per cent protargol. In older people a similar condition is often produced by the organism which causes chronic angular conjunctivitis (diplohacillus of Morax). For this type of inflammation, a lotion containing ½ per cent zinc sulphate, and a cream made up of zinc oxide, lanolin, and olive oil, form the best applications.

℞ Zinci Oxidi gr. xx | Olei Olivæ ʒij
Liq. Calcis ♏ x | Lanolini ad ʒj

Hordeolum (or Stye).—This is an acute inflammation of the hair follicle and glands leading into it. It usually commences by a puffy swelling of the lids, more or less localized, which later comes to a head. Early fomentation will sometimes bring about resolution. As soon as the little abscess points, it should be pricked and freely fomented.

Fig. 227.—Flat-pointed Epilation Forceps.

Epilation.—It occasionally happens, especially in cases of old-standing trachoma, that some of the eyelashes, instead of growing out, become inverted, so that they rub on the cornea or conjunctiva and keep up a constant irritation. The condition is known as trichiasis. The removal of these eyelashes is best performed v. special flat-pointed epilation forceps (*Fig. 227*). No jerking is requi. a firm, gentle pull bringing the hairs away easily and with little pain. Unfortunately the hairs usually grow again after an interval of from six weeks to three months. If they are few in number, they may be killed by electrolysis; but when the trichiasis is marked, or associated with any degree of entropion, special operative methods are required to deal with it.

Meibomian Cysts (Tarsal Cyst, Chalazion).—The Meibomian glands lie partly imbedded in the back of the tarsal plate, and can in many cases be seen as a row of paler lines shining though the conjunctiva of the everted lid. The openings of these on the inner border of the lid margin can be made out as a row of tiny dots. A chalazion is not a true retention cyst, but an accumulation of degeneration products, the seat of the change, whatever its nature, being as much in the tissue

surrounding the gland as in the gland itself. It forms a small swelling in the lid, usually visible or at least palpable from the skin surface. Secondary invasion with pus cocci sometimes supervenes, and subsequent to that, granulating masses may protrude through the conjunctival surface of the lid. Often a cyst or cysts last for many months without producing pain or any other symptom beyond the deformity of the lid.

The treatment consists of incision and free curetting. With proper precautions, the little operation may be practically painless. Evert the lid and apply one or two crystals of solid cocaine over the conjunctival surface of the swelling. Leave it to act for two minutes, then with a fine-needled hypodermic syringe inject *into the cyst* about 5

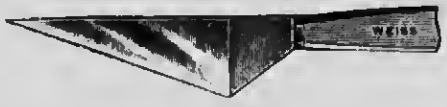


Fig. 228.—Beer's Knife.

min. of 2 per cent cocaine in 1–2000 adrenalin. Let this act again for two minutes. With a Beer's knife make a vertical incision through the conjunctival wall, and then thoroughly scrape away with a small curette all the gelatinous and diseased tissue from the walls of the cyst. It is best to apply a pad and bandage for twenty-four hours, and to have the eye bathed frequently with boric acid lotion for some days. Occasionally it may seem that a portion of the cyst has been left. This is due either to the space filling up with blood which takes some time to absorb, or to slight post-operative inflammation. The swelling usually disappears completely in a couple of weeks. In some patients a constant succession of these small cysts appear at intervals of a few months.

AFFECTIONS OF THE CONJUNCTIVA.

Injuries to the Conjunctiva, when uncomplicated with injuries to other structures, usually heal up very readily. Small tears are best left alone. Even extensive tears seldom require more than one stitch. In some people, especially in old age, a very slight blow may result in a subconjunctival hæmorrhage of some extent. (A similar result is caused sometimes by a violent fit of coughing or vomiting.) Though this looks very alarming to the patient, it is of no local consequence, and beyond the prescription of hot boric acid bathing usually requires no treatment. When subconjunctival hæmorrhages occur frequently in a seemingly healthy person, it is advisable to have a careful blood examination made. The condition may be due to some deficiency in blood-coagulating power, and may be associated with a liability to attacks of urticaria. If it is of importance for cosmetic reasons to produce more rapid absorption of the blood, dionin drops (5 per cent) may be used twice a day. In this case the patient should be warned

beforehand that the drops may produce considerable swelling of the conjunctiva (chemosis).

Foreign bodies, such as bits of grit, coal-dust, emery, etc., frequently get into the eye. If not at once washed away by the flow of tears which the irritation of their presence causes, they usually obtain a lodgement under the upper eyelid and become imbedded in the conjunctiva there. To find them it is necessary to evert the upper eyelid. They should then be removed with a small piece of moist lint.

To Evert the Upper Eyelid.—The examination of the lower conjunctival fornix is simple. The patient looks up, the lower lid is pulled downwards, and gentle pressure backwards will then reveal it in its whole extent. To get a similarly good view of the upper fornix requires the knowledge of a little manœuvre very readily acquired and yet very frequently bungled. The method I adopt requires the use of only one hand, leaving the other free for any purpose, such as painting the lids. First of all persuade the patient to look steadily downwards at the floor or at his own hands, with the head thrown slightly backwards; then place the ulnar border of the index finger on the upper lid immediately above the margin of the tarsal plate; the thumb is placed on the lower lid, pressing it gently back. Then the index finger gently presses the margin of the eyelid down on to the thumb, and by a slight movement the thumb completes the eversion. Straight pressure backwards on the eyeball will then bring the folds of the upper fornix into view. Standing in front of the patient, use the right hand for the left eye, and vice versa.

Acute Conjunctivitis.—The great majority of cases of acute conjunctivitis are caused by three organisms: the bacillus of Weeks, the pneumococcus, and the gonococcus. The first two organisms are the main causes of acute mucopurulent conjunctivitis. The gonococcus is the principal, though not the only, cause of ophthalmia neonatorum and of the acute purulent ophthalmia (blennorrhœa) of the adult. A rarer form of acute conjunctivitis, for which, however, the house surgeon must be on the outlook, is due to the diphtheria bacillus. Like other forms of diphtheritic inflammation, it is characterized by true necrotic membrane formation and by grave constitutional disturbance.

In acute conjunctivitis due to the bacillus of Weeks or the pneumococcus, the clinical picture is simple. The eye first affected commences to burn and smart, and becomes slightly photophobic. The margins of the lids become slightly red and puffy. This puffiness seems usually more marked in the lower margin of the upper lid. The palpebral conjunctiva becomes greatly congested, very red, and swollen, but usually retains a smooth surface. Only very rarely does one see any follicular enlargement in the fornices. The bulbar conjunctiva becomes of a uniform red colour. Later on, especially in adults, this becomes flecked with tiny ecchymotic patches disturbing the

uniformity of the pink. The bulbar conjunctiva usually shows only slight swelling or chemosis. Sometimes tiny swellings resembling phlyctenulæ develop at the corneal margin. In tuberculous children true phlyctenulæ may develop. In the height of the inflammation there is usually a good deal of purulent secretion along the lid margins and in the angles of the eyes, and little flakes of pus float in the conjunctival sacs. The two eyes are usually affected within a few days. The inflammation runs its course in from two to four weeks. Sometimes if untreated it tends to leave a chronic inflammation, in which there is follicular enlargement. The pneumococcal conjunctivitis is self-limited, especially when it occurs in epidemic form. It is not so infectious as the form due to the bacillus of Weeks. In epidemics it is mostly children that are infected. In severe forms it sometimes gives rise to membrane formation, but this is never a true necrotic membrane. There is probably a greater tendency to the formation of phlycten-like swellings at the limbus of the cornea, and in my experience a greater tendency to tiny ecchymoses. The essential difference is in the course of the disease, which is self-limited, reaching its climax in five or six days, and then resolving rapidly.

Fortunately, when we come to the question of treatment there is no need to differentiate between the two forms. The main essentials are efficient and regular cleansing with some simple aseptic lotion, the destruction of the organisms and their removal along with the affected tissues, and the replacing of the latter by healthy tissue. In the use of a lotion the most important effect is the mechanical cleansing and irrigation. For this purpose the lotion should produce as little irritation as possible, and should be used as warm as it can be with comfort, and in no niggardly fashion. A weak boric acid lotion in most cases fulfils these requisites, but where it produces irritation, as it sometimes does, it is best to substitute normal saline. The comfort produced by the free use of lotions is probably almost entirely due to the freeing of the conjunctival sac from portions of desquamated epithelium and flakes of pus, which act as irritants like any other foreign body. In mild cases this cleaning of the eye and the prescription of a simple ointment to prevent gumming of the lids is really all the treatment required. In more acute cases, nothing can replace the salts of silver in efficacy, and for certainty and efficiency silver nitrate is still the best, and properly used is likely to retain its position.

We are dealing now with organisms whose action is only on the surface. To rid the eye of such we have to employ some agent which will be able to attack them where they are most active. When we brush the eyelids with silver nitrate in a 1 per cent or 2 per cent solution, what we first notice is, that a faint bluish-white pellicle forms on the conjunctiva. This is due to the coagulation of the proteids of the cells by their conversion into albuminates of silver. This conversion means, of course, the setting free of a certain amount of

free nitric acid, with the consequent great irritation which invariably follows painting with silver nitrate. In other words, the silver nitrate produces a coagulation necrosis in the surface cells. The conjunctiva immediately sets itself to get rid of this surface slough, and for the next two or three hours there is an increase in the amount of secretion from the eyes, and the eyes seem to feel even more gritty than before. The contained organisms are acted on at the same time as the cells, and are thrown off with the cells, and though some undoubtedly escape, the number has at least temporarily been greatly diminished, and the supply of toxins is diminished proportionately, with the result that the irritation caused by the toxins is very greatly relieved, and you get the frequent history that, within an hour or two of the painting, the eyes feel cooler and more comfortable than at any time since the inflammation commenced.

In using silver nitrate, then, we must be fully cognizant of the results we wish to produce. As it is only the most superficial layers which are affected, it would be unwise to employ the silver nitrate in such strength as to affect the deeper-lying tissues where there are no organisms, and it would be equally unwise to employ it before the lapse of an interval long enough to allow of a complete regeneration of new epithelium to replace that thrown off. The most serious danger in using it too strong or too frequently is that, by doing so, deep sloughs may be formed, which when thrown off may leave raw surfaces in apposition, and so give rise to adhesions which may become permanent. Such a result is not uncommon from over-anxiety on the part of those in charge of a serious or important case. As a general rule, I should recommend that an interval of at least twenty-four hours be allowed to elapse between any two successive applications of silver nitrate even in severe cases, and that any excess should be always removed or neutralized by salt solution at the time of application.

The great irritation caused by the use of silver nitrate has led to numerous attempts to replace the violently irritant inorganic acid by some non-irritant organic acid. Many of these preparations exist, such as protargol, collargol, and argyrol. My personal preference is distinctly in favour of argyrol, used in strengths varying from 10 per cent to 25 per cent, and it is in this form that I always prescribe silver salts when I give them to patients for home use.

Acute Purulent Conjunctivitis (Blennorrhœa). — Ophthalmia neonatorum usually commences on the third to the fifth day after birth. It is characterized by a profuse, thin, purulent secretion. There is usually some chemosis, but very seldom the intense œdema of the conjunctiva which forms such a marked and serious feature of gonorrhœal conjunctivitis in the adult. Cases of ophthalmia neonatorum must be seen daily by the house surgeon. After washing away the secretion and examining the cornea, the conjunctival fornices are brushed out with a weak silver nitrate solution (1 per cent). The best method of examining a young child's eye is to sit opposite the

nurse, who holds the child's body and hands close down to its sides, the head being grasped in a towel between the surgeon's knees. After carefully washing away all secretion, the cornea is examined. If necessary, the lids must be retracted with small bent-wire retractors. Sometimes even with retractors it is difficult to get a view of the cornea, as it tends to roll upwards in the effort to shut the eyes. By gently increasing the pressure of the lower retractor downwards and backwards, and pulling on the upper retractor, a view can usually be obtained. It is imperative not to use ill-applied force in these cases, as there is always a danger of causing a perforation in a badly affected cornea. If the cornea is not affected, a lotion of perchloride of mercury (1–6000) is prescribed to be used freely and frequently. The nurse or mother should be instructed that the lotion must get inside the lids, and that all the secretion must be washed away at each bathing. The intervals between bathing should not be longer than two hours.

If the cornea is affected it is advisable to substitute a weak boric acid lotion for the mercuric lotion, and to put in after each daily painting a small piece of atropine ointment (1 per cent).

The eyes should never on any account be bandaged or covered up. The secretion must be allowed a free escape.

In examining or treating any case of purulent ophthalmia, both nurse and house surgeon should wear goggles.

Gonorrhœal Conjunctivitis in the Adult is mostly associated with urethritis, and is due to direct infection. Forms of purulent conjunctivitis due to other organisms occur, but are much rarer. The inflammation is of a most acute type, with very intense œdema and swelling of the eyelids and conjunctiva. It most frequently commences in the right eye in right-handed people, and one of the first duties of the house surgeon is to take measures to prevent the healthy eye being affected. To effect this, the inflamed eye should be covered with a pad soaked in some antiseptic lotion (1–2000 perchloride of mercury). The skin and lids of the healthy eye should be cleaned and scrubbed gently with lotion of the same strength, and the eye itself irrigated with a mild boric acid lotion. A Buller's shield (*Fig.* 229) should then be applied and carefully fastened down all round, except for a space at the outer part of the orbit, which is left for ventilation.

Fig. 229.—Buller's Shield.

To make a Buller's shield, take an ordinary watch-glass—the glass of the patient's own watch will do if nothing else is available—and

two squares of rubber adhesive plaster, one 4 in. square, the other nearly 5 in. Cut out of the centre of each a circle 1 in. in diameter. Fasten the larger square to the convex side of the glass and the smaller to the concave side, and the shield is complete, with about ½ in. of adhesive plaster projecting to fasten it to the skin. The fitting to the nose and the brow must be very carefully done, so as to leave no gaps.

Having secured the healthy eye against infection, the affected eye can next be dealt with. The lid œdema and congestion may be so great that no view can be obtained of the cornea, and only chemotic (œdematous) conjunctiva can be seen projecting through the inflamed lid margins. In such a case there must be no hesitation in slitting up the outer canthus with a stout pair of scissors. This, with one or two free incisions into the œdematous conjunctiva, will do much to lessen the congestion, which if unrelieved may actually give rise to sloughing of the cornea through strangulation. Frequently changed fomentations, with free irrigation of the eye at each change, must then be ordered, and at the same time a free purging with calomel, followed by a saline aperient. If the pain is very great, sometimes more relief is obtained by using iced compresses and iced lotions for bathing. The lotion used should not be stronger than 1–10,000 perchloride of mercury. In cases where the congestion is as great as the one described, it is not advisable to use silver nitrate until the congestion has been considerably reduced. In milder cases the conjunctiva is brushed over after irrigation with 2 per cent silver nitrate (see above for precautions). The eye should be irrigated every half-hour with a mild boric acid or normal saline solution, and I prefer to use a douche, so that a good flow can be directed into the eye. The most serious danger arises from corneal complications, so that great care must be exercised not to injure the cornea during any of these manipulations. No care, however, will prevent the affection of the cornea in a large percentage of cases. When this happens, atropine should at once be used, and mercurial lotions replaced by boric acid or normal saline. Boric acid ointment should always be put between the lids and over any raw surface before the patient goes to sleep. It is some hindrance to the formation of adhesions. The secretion from the eye remains capable of carrying infection as long as there is the slightest trace of inflammation.

Chronic Conjunctivitis may be a sequel of acute, and especially in gouty or rheumatic subjects the conjunctiva tends to remain in a slightly inflamed condition. Mildly astringent lotions, e.g., of zinc sulphate (1 or 2 gr. to the ounce) or of boric acid with hazeline (20 min. to the ounce) are usually sufficient to cure such cases. In gouty people, lotions containing zinc sulphate sometimes increase the irritation, and if there is definite evidence of chronic gouty inflammation in mucous membranes elsewhere, e.g., a gouty pharyngitis, it is better to use a mild alkaline lotion of biborate of soda. If the inflammation persists,

a single painting with 1 per cent silver nitrate will often work wonders, especially in gouty people. More than 50 per cent of all cases of conjunctivitis occur in the form of chronic angular conjunctivitis (diplobacillary conjunctivitis).

Chronic Angular Conjunctivitis.—The clinical picture it presents is a fairly straightforward and consistent one. It mostly occurs in adult life, and when it attacks children it is very apt to cause marginal blepharitis. The patient comes with the complaint that the lids are gummed together in the morning, or very heavy, and that they have to be bathed with warm water to get them to open at all. This process is sometimes painful, but shortly the pain passes off, and during the day the eyes feel fairly comfortable. Towards evening the eyes begin to prick, especially in the corners. This may commence so sharply that a man will assert that he has got a bit of grit into his eye, and will tell you exactly where he was when the grit went in. The neurasthenic patient will tell you that the whole upper lid feels as if a dustbin had been emptied into it, and the ball of the eye feels hot and fiery. The discomfort during the evening may be very considerable, even giving rise to headache, and is nearly always accompanied by a desire to scratch the inner angles of the eye. Usually a period of three or four days elapses between the infection of the two eyes, the incubation period of the organism (the diplobacillus of Morax) being from three to five days. Objectively the most obvious sign is the reddening and inflammation of the angles of the eye and the lid margins. The caruncle is usually bright red. Along the roots of the lashes there is a fine greyish deposit, and at the inner angle a little mass of greyish-yellow fibrinous matter, in which usually great numbers of the organism can be found. The palpebral conjunctiva is usually slightly inflamed and somewhat roughened, but the ocular conjunctiva, apart from the angles, is seldom much affected. The most characteristic feature, apart from the angular redness, is the erythematous condition of the skin of the lids. Usually the skin at both angles has a slightly eroded appearance, and the rest of the skin along the margins has a dry, crackly, semi-glazed appearance, as if it had been badly starched. The disease usually commences in a subacute fashion, becomes chronic, and persists for many months if untreated. As the symptoms are often mild, it may be many months before treatment is sought.

The Treatment to be adopted is a lotion containing one or two grains of zinc sulphate to the ounce, made up with a little cherry-laurel water. This smarts—in some cases it smarts very badly—and you have to warn people of it; but in no case must you prescribe a little cocaine with it just to take away the pain. If you do, the relief is immediate, but in a short time the congestion recurs, and, like dram-drinking, the effect is shorter with each dose, and in a week or ten days you get a sodden condition of congestion much more difficult to treat than the original inflammation. A similar condition of chronic congestion may

result from the long-continued use of a lotion or drops containing adrenalin. Argyrol is of service in some cases, but the mainstay is zinc sulphate. For the comfort of the patient it is advisable to prescribe a simple ointment, to be used at night, to prevent the gumming of the lids.

Follicular Conjunctivitis.—There are normally present in both upper and lower fornices of the conjunctival sac rows of lymphatic follicles. In certain types of children, these readily become enlarged in response to slight irritation, and form chains of small, pearly-looking granules in the fornices. The class of child who is most likely to show this condition may also have other lymphatic enlargements, e.g., hypertrophied tonsils or adenoids. The condition is of little local importance, but is of value as an indication of the necessity of revising the general circumstances of the child's life and of securing its removal from the evil influences of stuffy school-rooms and sleeping-rooms. I mention it here as it is of importance to be able to differentiate it from trachoma, one of the most severe of conjunctival diseases.

Trachoma (Granular Conjunctivitis, Egyptian Ophthalmia).—In its typical form the granules, varying in size from a small hemp-seed to a lentil, are scattered all over the tarsal surface of both lids, and are not restricted, as in follicular conjunctivitis, to the fornices. There is a form of trachoma, however, in which there are no obvious granules, but only a more or less uniform thickening and infiltration of the conjunctiva on the tarsal surface. This usually occurs when the disease has an acute onset. When the tarsal surface shows definite granules, varying in size and irregularly distributed, there is no difficulty in separating the condition from follicular conjunctivitis. The palpebral form of spring catarrh (a comparatively rare disease in this country) can usually be distinguished by the granules forming a more definitely circumscribed patch; they are flat-topped and form a mosaic somewhat like a cobble-stone pavement, and when the eyelid is everted for a few seconds the free secretion of mucus produces a bluish milky appearance. Examination of the lids alone, in the majority of cases suffices to differentiate trachoma from other forms of conjunctival disease. In doubtful cases the determining factor is the presence of pannus, the invasion of the superficial layers of the cornea underlying the epithelium by connective tissue carrying blood-vessels. To examine for the earliest stage of pannus a corneal loupe is necessary. In a normal eye the conjunctiva overlaps the margin of the cornea as a greyish translucent band with a sharp, clear-cut edge. The terminal twigs of the conjunctival vessels can be seen reaching this edge, but never passing it. In the earliest stages of pannus the edge loses its clean-cut appearance and becomes ragged, and here and there tiny vessels can be traced on to the cornea. In well-marked pannus due to trachoma, the main course of the vessels is vertical, and mostly from the upper margin. When the pannus is advancing, there is a greyish area in the cornea beyond the vascular region.

THE TREATMENT of trachoma must be both drastic and persistent. In a severe case where the trachoma bodies are well marked but not hard, they should be expressed by means of Grady's forceps (*Fig.* 230) or Knapp's roller forceps (*Fig.* 231). As this is a very painful process,

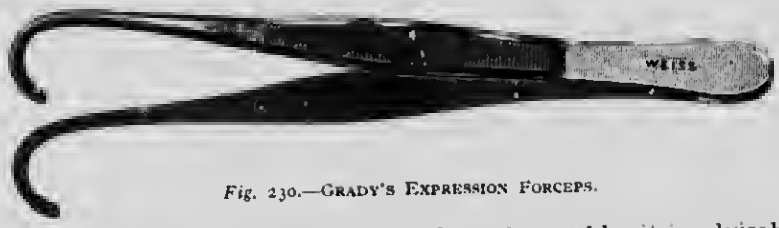


Fig. 230.—GRADY'S EXPRESSION FORCEPS.

and as it is essential that it should be done thoroughly, it is advisable to give a general anæsthetic. The operator puts on goggles, and then grasps the everted tarsal plate between the blades of the forceps and forcibly expresses the contents of the follicles. A solution of perchloride of mercury in glycerin (1-100) is then brushed in with a hard tooth-brush,

Fig. 231—KNAPP'S ROLLER FORCEPS.

the sacs are washed with boric acid lotion, and boric acid ointment is put between the lids. Where the granules are harder, expression must be replaced by scarification. The everted lid is supported on a horn spatula and scarified with a Beer's knife (*Fig.* 2 8). The first incisions should be made over the most prominent granules, and these

Fig. 232.—MEIBOMIAN CURETTE.

may be scraped out with a small Meibomian curette. After scarifying, the lids are brushed with the strong perchloride solution and treated as before.

Usually much reaction follows this treatment, and iced compresses will be found useful till it subsides. During this period the eyes should be bathed frequently with boric acid lotion, and ointment should be applied night and morning.

The subsequent treatment of these cases is the same as for milder ones. The affected surface is rubbed once daily with a stick of copper sulphate, and the patient uses a lotion of boric acid and zinc sulphate. At the end of a month the applications can be reduced to three a week, and later to two or even one a week. A marked improvement usually

manifests itself in three or four weeks, but often after a time the case seems to come to a standstill. The substitution of silver nitrate for the copper sulphate, either as a 2 per cent solution or in the solid form known as mitigated stick, will then be beneficial. In fact this variation in the treatment from time to time is advisable in all cases, and it is also useful to allow periods of freedom from any treatment other than a simple astringent lotion. Many other forms of treatment have been suggested and tried from time to time, such as *x*-rays, radium, and carbonic acid snow. Most of them have had a considerable vogue for a short time and then been relegated to the background by older methods.

AFFECTIONS OF THE CORNEA.

Injuries.—*Abrasions* of the cornea are apt to be overlooked, since when fresh the transparency of the cornea is not interfered with. When any corneal injury has taken place, and an abrasion is suspected, a drop of fluorescein will stain the denuded area a bright green. The eye is bathed, a drop of atropine is instilled, and a pad and bandage are applied. Boracic bathing should be repeated every four hours. As a rule, the pad can be taken off in twenty-four hours. If the surface is not covered in that time, another drop of atropine should be put in and the pad replaced.

Foreign Bodies imbedded in the cornea are mostly particles of steel or emery from the emery-wheel or grit from an engine. The removal must be done with as little injury to the corneal epithelium as possible, but the removal must be complete. For example, often after removing a bit of iron or steel, a brownish-red ring of rust (?) is left, which must

Fig. 233.—Corneal Spud.

also be removed. The instrument used is the corneal spud. The eye is well cocainized, and a strong light focused on it by an assistant. The patient is told to look fixedly in whatever direction enables the operator to get the best view of the object to be removed. If the spud fails

Fig. 234.—Discission Needle.

to remove it, recourse may be had to a discission needle, but in digging out foreign bodies with this, care must be exercised not to injure the cornea more deeply than is necessary. After removal, bathe carefully, put in a small piece of atropine ointment, and bandage the eye.

Perforating Wounds of the Cornea may be simple or may be complicated by prolapse of the iris, by prolapse of the ciliary body if the sclera

be involved in the wound, and by injury to the lens. If the wound is uncomplicated by any prolapse of iris, and the lens has not been wounded, the conjunctival sac must be well douched with boric acid lotion, and strong atropine ointment (2 per cent) at once put in. Both eyes should be bandaged, and the patient kept at rest in bed. Atropine ointment 1 per cent should be put in twice a day gently, and the eye should be examined once a day in view of prolapse taking place subsequently.

When there is prolapse of iris complicating a wound, it is best to give the patient a general anæsthetic. It is well to have the following instruments ready: speculum, fixation forceps, iris forceps and de Wecker's iris scissors, keratome and repositor (*see Figs.* 235–240).

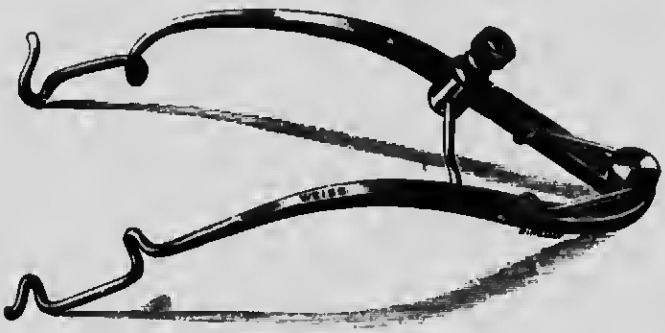


Fig. 235.—SPECULUM.

I also prefer to have ready a McKeown's wash-bottle (*Fig.* 241) filled with normal saline at 102° F. in case I may wish to wash out the anterior chamber. Thoroughly cleanse the skin round the eye, clip off the eyelashes, and douche out the sac with normal saline. Insert the speculum and then douche the wound gently. Seize the prolapsed iris with the iris forceps, and gently work the iris out of the wound, so as to have it freed from any adhesions that may have already formed. Keep it on the stretch, and cut off close to the cornea. The elasticity of the iris will then pull the pillars away from the wound. Put in some 1 per cent atropine solution, and pad and bandage both eyes.

Sometimes the iris is too firmly caught in one of the angles of a ragged wound to be freed in this way, and yet it is most essential for the safety of the eye that it should be freed. In such a case, do not try to free the iris by opening up the old wound, but make a fresh opening at the corneal margin with the keratome, choosing a point which will allow easiest access to the adherent part of the iris. Be careful not to injure the lens with the point of the keratome. Then insert the iris forceps and take a firm grip of the iris round the adherent part, draw it out through the keratome wound, and cut off with iris scissors. Get the pillars of the iris coloboma back into position with

the repositor, and then wash out the anterior chamber with the McKeown wash-bottle. Put in atropine, and treat as before.

When the wound passes from the cornea into the sclera there comes the additional danger of prolapse of the ciliary body into the wound. These cases are always a source of grave anxiety, and yet if the

Fig. 235.—Fixation Forceps.

Fig. 237.—Iris Forceps.

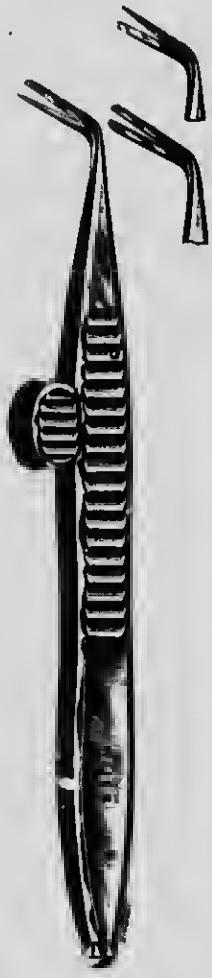


Fig. 238.—De Wecker's Iris Scissors.

wound has not been caused by a dirty implement, many eyes are saved which in earlier days would have been at once excised. In treating them, the prolapsed iris and ciliary body are first drawn out and cut off. Then a very sharp, small, curved needle armed with finest silkworm gut is passed through the superficial layers of the

edges of the scleral wound near the cornea. This must be done with as little pressure on the eyeball as possible; hence the necessity for a very sharp needle and for catching up only the superficial layers. If the wound passes far into the sclera, a second stitch may be inserted. Then bring a flap of the conjunctiva down over the wound, cutting away the conjunctiva below, so that the scleral wound is covered by conjunctiva and the conjunctival sutures are away from the scleral wound.

Injury to the lens and consequent swelling of lens matter is a serious complication in all these cases. It interferes with the freeing of the

Fig. 239.—Iridectomy Knife (or Keratome).

iris from the wound, and it presses the iris forward even when it is free, so that a subsequent adhesion may form. In addition to that, the lens capsule may be prolapsed into the wound, and the swelling lens matter seems to form a favourable culture medium for organisms, so there is greater danger of sepsis.

In all cases of perforating wounds, whether simple or complicated, the house surgeon must be carefully on the outlook for keratitis punctata. It is not the eye which passes into a condition of general suppuration which is most likely to set up sympathetic ophthalmia; such an eye is removed, and with its removal usually all danger is past; but the eye which remains inflamed and irritable, and in which

Fig. 240.—Iris Repositor.

there appears on the back of the cornea the tiny round dots of punctate keratitis, is almost certain, if left, to cause a sympathetic inflammation in the other eye. Such an eye ought to be excised at once.

Corneal Ulcers, if not severe, will usually react favourably to very simple treatment. The first essential is to secure rest for the eye. For this purpose atropine drops (½ per cent) are put in, and the eye is covered with a pad lightly bandaged on. Only in cases where the ulcer is complicated by conjunctivitis with a large amount of secretion is this latter abandoned. The atropine paralyzes the action of the iris and ciliary muscles, and so acts as a physiological splint, while the pad keeps the eyelids at rest over the cornea. Frequently during the day, the eye should be bathed with warm boric acid lotion. It is advisable in all cases of corneal ulceration to enquire into the habits of the patient. In children especially, attention should be given to

the condition of the alimentary tract. Small doses of compound rhubarb powder (10 to 15 gr.) may be prescribed, to be taken three times a day. In adults, a pill of calomel and colocynth at night, followed by a saline purge in the morning, is often of great service in initiating the treatment.

When the ulcer is of a more severe nature, it becomes necessary to adopt other local measures. Of these the most generally useful is painting with pure carbolic acid. First put in two drops of cocaine,

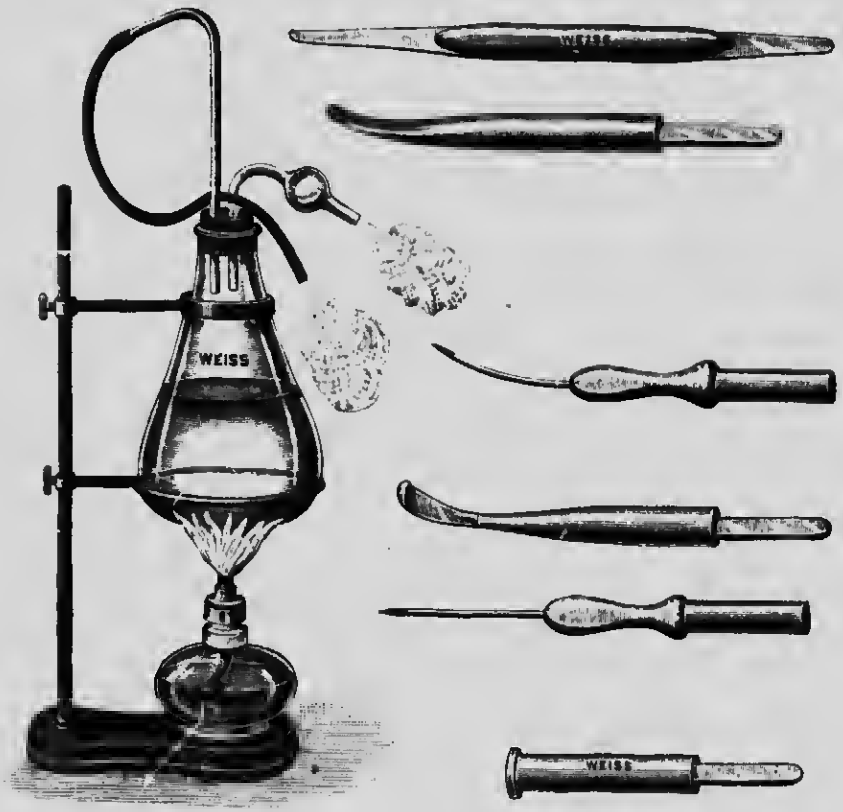


Fig. 241.—McKeown's Irrigating Apparatus.

and then a drop of fluorescein (being careful to sop up any excess with a pad of absorbent wool). After a few seconds wash out the fluorescein with cocaine, and the ulcer will be found stained bright green. With two fingers of the left hand hold the lids gently apart; dry the surface of the ulcer with a small piece of sterilized blotting-paper, and touch the whole stained surface with a small camel-hair brush soaked in pure carbolic acid. The end of a wooden match carefully pointed and soaked in carbolic is an excellent substitute for the brush. If the ulcer is of the advancing type, most attention should be devoted

to the advancing edge. The cautery can be used with equally good results. The benefit of using pure carbolic is that it is itself an anæsthetic. In using the cautery, a dull red heat is required, and the touching should be done very lightly. After cauterizing or touching with phenol, continuous boric acid fomentations, with free hot bathings at each change, and atropine drops twice a day, should be ordered.

Pus forming in the anterior chamber (hypopyon) is not in these cases a sign of serious inflammatory involvement of the iris and ciliary body. The pus is usually sterile, and its formation is due to the chemiotactic influence of strong toxins diffusing into the anterior chamber through the corneal membrane. It is probably most frequently seen in pneumococcal ulceration. It may form very rapidly, and with a healing ulcer it will absorb as rapidly as it forms. If it is necessary to perform paracentesis, the hypopyon should be washed out with normal saline.

When an ulcer is deep and there is a likelihood of perforation, no treatment is so valuable as paracentesis. If an ulcer is allowed to perforate spontaneously, it is almost certain that the iris will prolapse in the rush of aqueous that takes place, and, lying in contact with the edges of the ulcer, will certainly become adherent if it is not removed (*vide supra*, operation for removal of prolapsed iris under "Perforating Wounds of Cornea"). If the floor of the ulcer is incised (usually called Sæmisch section) and the aqueous allowed to escape gently, a valvular opening is formed; and the iris, if it does come in contact with the back of the cornea, is in contact with healthy and not with inflamed tissue. In addition, re-formation of the anterior chamber soon takes place and separates the iris from the cornea, while in spontaneous perforation it may be some days before the anterior chamber re-forms. In performing this little operation, I prefer to use an old, much-ground Graefe knife. Cocaine anæsthesia is sufficient for all cases except young children. The eyelids are held apart by a speculum, and the eye steadied with fixation forceps. Enter the knife at the edge of the ulcer farthest away from the corneal margin, holding it so that it points obliquely towards the angle of the anterior chamber. As soon as the point has perforated, depress the handle so that the knife is almost horizontal, and carry it through the base of the ulcer, so that it just reaches the healthy tissue on the other side. Put in some atropine after washing out the conjunctival sac, and pad and bandage lightly.

THE LACHRYMAL APPARATUS.

Lachrymal Obstruction.—The most frequent cause of epiphora (overflow of tears) is obstruction of the tear-duct, the result of chronic dacryocystitis. Epiphora may also be caused by displacement of the puncta lachrymalia in congestive conditions of the eyelid or in senile ectropion, but in the great majority of cases the site of the obstruction

is the upper part of the tear-duct where it leaves the sac. In treating this condition, the course of action to be adopted must vary in different cases. (1) The obstruction may be the result of simple congestion. (2) Chronic inflammatory changes may have resulted in developing a band of cicatricial tissue at the upper end of the duct. (3) The obstruction may be bony, following on syphilitic periostitis or on fracture of the bones forming the walls of the duct. (4) It may be due to a growth. In the first case the lachrymal sac will not be dilated, but in the other cases there will be a small swelling under the inner tarsal ligament (mucocele), the contents of which will regurgitate into the eye on pressure. These may be either mucous or mucopurulent in character.

Fig. 242.—Weber's Knife.

The first step in treating all these cases is to syringe out the sac carefully with boric acid lotion. A little fluid may pass into the nose, but probably it will all come back into the eye by the upper punctum. After two or three syringefuls the fluid will come back clear. If none at all has passed into the nose, a small syringeful of cocaine 2 per cent in 1–5000 adrenalin should be washed into the sac and left there for a few minutes. This will reduce the congestion and allow fluid to pass down into the nose. To finish up the treatment on the first sitting, fill the sac with 25 per cent argyrol. The patient is to be instructed to bathe the eye frequently with boric acid lotion, carefully pressing the finger into the corner of the orbit, so as to squeeze out

Fig. 243.—Stilling's Knife.

the contents of the sac between each application of the lotion. He should also be given weak zinc sulphate drops or argyrol* (10 per cent) drops, to be put into the eyes three times a day.

The syringing should be repeated daily, or at least every second day. In the simpler cases, a good passage will be established in from ten days to a fortnight, and in the others the condition of the sac walls will be much healthier. If the duct is still blocked after ten days, it becomes necessary to attempt to re-establish the passage by probing, but if the sac be very much dilated, the walls have probably become

* Argyrol should never be ordered as drops for home use without giving warning against too prolonged use. Staining has occasionally resulted from it.

atonic, and a mucocele will persist even if there is a passage established. In these cases it is better to proceed directly to excise the sac than to put the patient to the useless worry of probing.

In probing the lachrymal sac, the lower punctum is first dilated with the punctum dilator on the end of the Weber's knife. Weber's knife has a probe point which originally was curved, but is now usually made straight. The knife is passed into the dilated punctum and then held horizontally, with the edge pointing up and in. The lower lid is pulled outwards and kept on the stretch, and as the knife passes into the sac, the canaliculus wall is slit on its inner aspect. The opening is enlarged by bringing the knife to a vertical position, while keeping the lid stretched. Stilling's knife should be used to enlarge the opening into the sac. Having slit up the canaliculus, take No. 3 or No. 4 Couper's probe, dip the point in cocaine vaseline, and pass it horizontally along the open canaliculus into the sac. It should meet with no resistance until it can be felt tapping against the lachrymal bone. (Sometimes the point catches in a fold of mucous membrane.

Fig. 244.—Couper's Probes.

Do not use force to pass this.) Now rotate the probe until it is vertical, keeping the point in position with the index finger of the other hand. The probe should now point directly to the fold of the ala nasi. Keeping the point of the probe a little backwards, it will be felt to engage in the opening of the duct. If the line above indicated is kept, it will pass down the duct into the inferior meatus of the nose. A No. 6 probe should next be passed in a similar manner, and allowed to remain in position for five or ten minutes. Do not syringe *immediately* after probing. The patient must be seen daily for two or three days to prevent the canaliculus walls reuniting, and each time the sac should be gently syringed. On the fourth day a No. 4 probe should again be gently passed down the duct, and for about ten succeeding days the sac should be syringed with a mild astringent lotion. Be very chary of using any organic preparation of silver after probing. I have seen three cases of permanent black eye resulting from argyrol or protargol being driven into the orbital tissues. If the obstruction is found to be impermeable with a No. 3 Couper probe, or if the stricture is obviously bony, it will be found advisable to have the sac excised.

Excision of the lachrymal sac is much more frequently advised at present than was the case some years ago. Some *writers* go so far as

to say it should always be done if simple syringing will not cure the obstruction. To object entirely to probing is an extremist's view, but to persist in probing a duct which constantly becomes re-obstructed is folly.

Acute Dacryocystitis.—Acute inflammation of the tear-sac is most frequently an incident in the history of a chronic lachrymal obstruction. It manifests its presence by a red swelling, most marked immediately below the inner tarsal ligament. As suppuration progresses, the abscess tends to open on to the cheek just about the lower orbital margin, and after evacuation a lachrymal fistula may be left in this position. The treatment of a lachrymal abscess which does not show signs of pointing consists of slitting up the lower canaliculus freely, so as to provide a better means of escape for pus from the sac, and then free fomentation. If the abscess shows signs of coming to a head, it should be opened and evacuated freely, the sac gently scraped, and the cavity plugged with gauze and then fomented. It is most inadvisable to attempt to probe during an attack of dacryocystitis. It may set up a most severe orbital cellulitis, with retrobulbar neuritis and consequent blindness.

EXCISION OF AN EYEBALL.

The instruments required are an eye-speculum, two pairs of fixation forceps, tenotomy scissors (curved on the flat) and hook, and a stout pair of excision scissors (curved on the flat). The operation is done under a general anæsthetic. If the operation is being done as an emergency, the skin should be well washed with soap and water and then with 1–2000 perchloride of mercury, and the conjunctival sac washed out with the same lotion. Then, having inserted the speculum, catch up a fold of the conjunctiva at the side of the cornea, and snip through it between the forceps and the corneal margin. Through the hole thus made, insert both blades of the scissors and free the conjunctiva from the subconjunctival tissue, first on the upper and then on the lower side of the cornea. This enables the operator to cut the conjunctiva in its whole circumference with two cuts. Next pick up the conjunctiva, and holding it away from the globe, free it with the scissors all the way round. In doing this, keep as close to the globe as possible, so as to open Tenon's capsule freely. Then catch up each of the recti muscles in succession with the tenotomy hook and cut them close to the globe. (It is advisable to commence with the superior rectus.) If now the speculum is opened widely and pushed backwards, the globe should dislocate forwards. Catch it between the finger and thumb, and pass the closed excision scissors back close to the globe to the outside or inside, whichever is most convenient. When you feel them touching the optic nerve, they are opened, and when they embrace the nerve, push them gently backwards, and then cut through with one cut. The eye will then come forward easily,

and the removal is completed by cutting through the oblique muscles and the rest of the tissue close to the globe. Douche out the socket with very hot saline, and plug it for a short time until the bleeding stops. Then with the two pairs of fixation forceps, pick up the edges of the conjunctiva and bring them into apposition. No

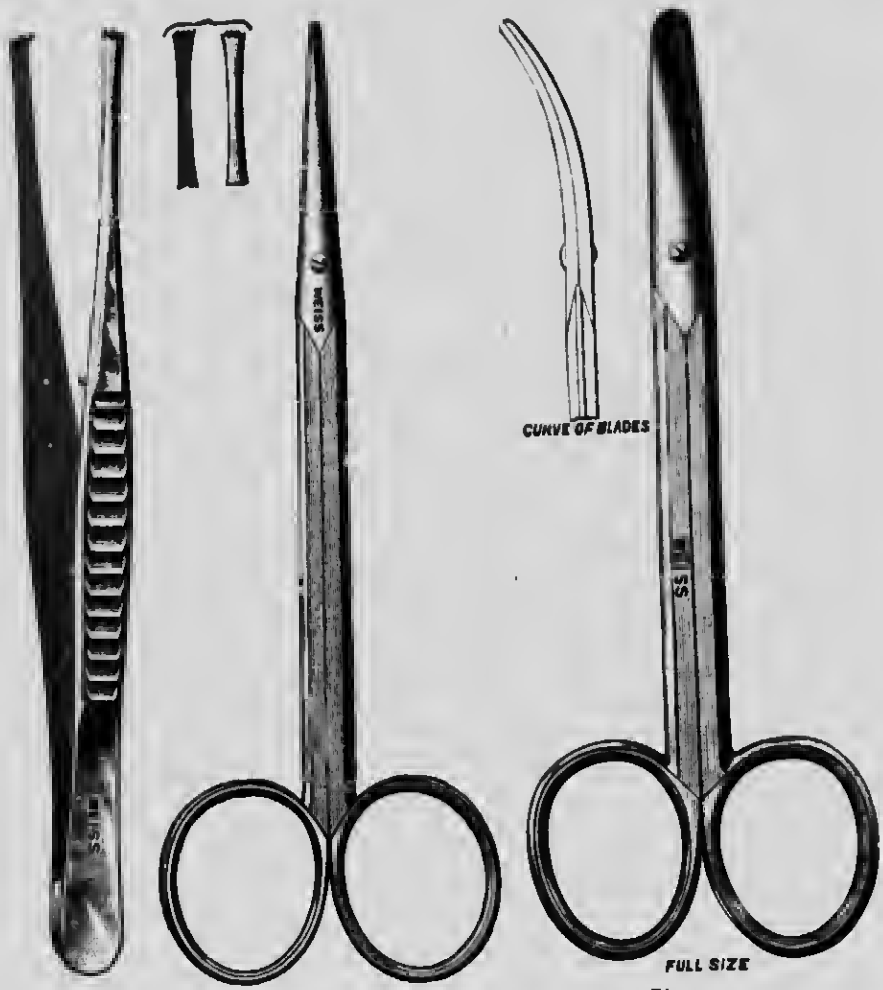


Fig. 245. FIXATION FORCEPS.

Fig. 246. TENOTOMY SCISSORS.

Fig. 247. EXCISION SCISSORS.

stitches are required. Plug the cavity outside the conjunctiva with gauze, and put on a pressure dressing. The gauze plugging is removed in twenty-four hours, and it seldom has to be renewed. Do not let adhesions form during the healing process.

SIMPLE TENOTOMY.

This operation is usually done for minor degrees of strabismus, varying from 8° to 15°. Some surgeons use the simple operation with success for even larger angles of squint than those given, but if the squint is over 20° there is little chance of tenotomy alone being sufficient to cure the error. In that case tenotomy of the one muscle (the internal rectus in convergent strabismus) is combined with advancement of its opponent (the external rectus). Tenotomy is usually done with a local anæsthetic, except in young children. The anæsthetic used is 4 per cent cocaine in 1–2000 adrenalin. The instruments required are an eye speculum, fixation forceps, tenotomy scissors (straight), and tenotomy hook. One stitch of finest silk will also be required.

A tenotomy may be done by the open method or subconjunctivally. The latter method requires more skill, and is liable to lead to certain complications, while the only disadvantage of the open method is

Fig. 248.—Hook for Use in Excision of an Eyeball.

that a stitch has to be taken out two or three days after the operation. I shall describe only the open operation for tenotomy of the internal rectus. The conjunctival sac having been anæsthetized, and then washed out with normal saline, insert the speculum. Then, standing at the side of the patient corresponding to the eye you are going to operate on, pick up the conjunctiva over the insertion of the internal rectus. (Remember that the external rectus has its insertion farther back than the internal.) Cut through the conjunctiva in a vertical direction. The cut should be about a centimetre in length. Pick up the tissue at the lower border of the tendon (Tenon's capsule) and snip through it, and clear the lower border of the tendon slightly. At this point it is advisable to apply another couple of drops of cocaine and adrenalin, leaving it to act for a minute. Then pass the point of the tenotomy hook well backwards through the hole in Tenon's capsule, and bring it gently forwards under the muscle. The point of the hook will now show at the upper border of the tendon. It should be freed from the capsule which covers it, and then the tendon can be divided with one cut of the scissors between the tenotomy hook and the globe. Pass the tenotomy hook backwards again to catch up any small strands that may have been left undivided. To finish the operation, all that is necessary is to join the lips of the conjunctival wound by a single stitch.* Wash out the conjunctival

* A tenotomy for concomitant convergent squint should never be done until the patient's refraction has been estimated, and if necessary new glasses ordered.

sac with normal saline, and bandage the eye. The eye should be bathed twice n day, and on the third day remove the stitch and at once put on the patient's correcting glasses.

CATARACT.

Treatment of a Cataract Patient.—When possible, a patient who is going to have a cataract extraction should be admitted to the hospital two days before the operation. On the evening of admission the eye to be operated on should be bathed with mild boric acid lotinn, and then covered with a pad of sterilized Gamgee tissue and bandaged.

Fig. 249.—Graefe's Cataract Knife.

The next morning this pad should be examined, and if it is clean, the eye is in good condition for operation. If not clean, the eye should be bathed frequently during the day with mild boric acid lotion, and again at night, and padded. On the second morning the pad will almost certainly be clean. Of course, any grosser inflammation of

Fig. 250.—Moorfields Curette and Cystotome.

the conjunctiva or obstruction of the tear-duct must be treated and cured before the operation ı be performed. Meantime the urine should be examined (especially for sugar). The evening before operation a mild laxative should be given; drastic purging is quite unnecessary, and may even be disadvantageous, since in some people

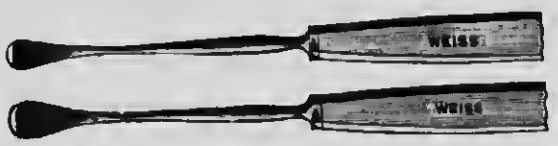


Fig. 251.—Critchett's Cataract Spoons.

it leads to constipation in the following days, and that is one of the dangers to be avoided after cataract extraction. On the same evening the eyelashes should be cut short, the skin round the eye thoroughly cleansed, and a perchloride of mercury compress substituted for the Gamgee pad. The patient should have a light, digestible breakfast

on the morning of the operation. Twenty minutes before the time fixed for operation, some 2 per cent cocaine in 1-2000 adrenalin should be dropped into the eye; this should be repeated in ten minutes, and again just before the patient goes to the theatre, the eye being kept covered between the instillations. The patient usually walks to the theatre.

The instruments which should be put out for cataract extraction with iridectomy are a speculum, two pairs of fixation forceps (one broad and one narrow), Graefe's cataract knife (the point of this should be

Fig. 252.—Taylor's Vectis.

tested on the drum and should go through the lid without the least resistance), iris forceps and iris scissors (de Wecker's), curette and cystotome, and repositor. It is also advisable to have in readiness either a lens scoop (Critchett's) or a vectis. Some surgeons use special capsule forceps to tear off a portion of the anterior lens capsule instead of cutting it with the cystotome. The instruments are placed in a special porcelain tray, and the sterilizer should be large enough to take this tray with all the instruments. It is advisable to sterilize the Graefe knife separately, lest anything should happen to the delicate point from carelessness in putting in the tray and taking it out.

Fig. 253.—Couper's Capsule Forceps.

After-treatment of Cataract Extraction.—After the operation the patient must be carried back to bed with as little disturbance as possible. To facilitate this it is desirable to have under the patient a strong canvas sheet, with places at each side through which poles can be slipped, to lift him from the operating-table to the trolley and from the trolley to the bed. He must lie perfectly quietly on his back for the first three or four days. At night the sleeves of the night-dress should be pinned down to the breast, to prevent the patient rubbing the eye during sleep or on waking in the morning. At the end of twenty-four hours the eyes are uncovered and the eyelids gently bathed until they can open. A drop of atropine is instilled, but no attempt should be made to see the wound. This bathing should be repeated on the second day, and only on the third day should the wound be examined. After the fifth day only the eye operated on

is covered, and the patient is allowed to sit up in bed. During the first three days the food should be soft. There is no need for it all to be fluid, but nothing should be given which requires mastication. If the bowels do not act naturally, no aperient should be given until after the third day. The patient must be warned not to sneeze. Any tendency to do so can be checked by pressing firmly on the middle of the upper lip. On the seventh day the patient is allowed out of bed to sit on a chair, and on the tenth day the bandages are given up and dark protective glasses are put on. During this period the atropine drops are put in once a day, but if the eye is quiet on the tenth day this may be stopped. The patient may leave the hospital as soon as the dark glasses are fitted. He should continue wearing these until the proper correcting glasses are ordered.

ACUTE GLAUCOMA.

It is very desirable for the house surgeon to know the main points in the diagnosis between acute glaucoma and acute iritis. It is necessary to realize that the intra-ocular tension may be as high in the one as in the other, so that point by itself is of little value. In acute iritis the pupil is usually small and the iris sluggish in reaction; in acute glaucoma the pupil is dilated, often oval with the long axis vertical or nearly so, and the iris is fixed. In iritis the iris looks congested and muddy; in glaucoma it looks flattened and atrophic. In iritis the anterior chamber of the eye may look deeper than normal; in glaucoma it is shallow and may be absent towards the periphery of the cornea. In glaucoma the circum-corneal congestion is apt to be coarser in character than in iritis. Even when the diagnosis remains doubtful, there are certain lines of treatment which may safely be adopted pending the arrival of the surgeon. The most important of these is to attempt to relieve congestion both by local and general means. Give a free purge (pil. calomel c. colocy. gr. v, followed by haust. alba ℥ij), and apply three or four leeches to the temple outside the bony margin of the orbit. If the diagnosis of glaucoma is certain, drop a ½ per cent solution of eserine into both eyes at once, and repeat every hour in the affected eye; but if there is any uncertainty it is advisable to wait the arrival of the visiting surgeon before using either eserine or atropine in any form. It is advisable to have the patient prepared for a general anæsthetic.

Chapter XXXIX.

Diseases of the Nose and Throat.

By H. W. CARSON, F.R.C.S.,
Senior Surgeon Prince of Wales's General Hospital, London.

DISEASES OF THE NOSE.

A KNOWLEDGE of nasal disorders is of importance for two reasons: (1) Conditions leading to nasal obstruction are very common in practice, and very distressing to the sufferer; (2) Nasal obstruction is primarily responsible for many of the disorders of the pharynx, larynx, and ears, and, as in the case of adenoids, for diminished physical and intellectual growth.

Examination of the Nose.—Examination must be conducted methodically and minutely. The patient sits facing the examiner, who reflects, by means of a forehead mirror, a strong light to the part required. The

Fig. 254.—Posterior Nares.

light should be placed just behind and above the patient's left shoulder. The nose must be examined from the front (anterior rhinoscopy) and from behind (posterior rhinoscopy).

For Anterior Rhinoscopy, the anterior nares are kept open by means of Thudichum's speculum, the spring of which is held by the left hand in front of the patient's nose. A view is obtained of the anterior part of the septum, floor, and inferior and middle turbinal bodies; and if a 2 per cent solution of cocaine be applied, the consequent shrinking of the mucous membrane will allow of a still more extended view.

Posterior Rhinoscopy requires more practice, but the trouble will be well repaid, if it is remembered that the only alternative to posterior rhinoscopy is examination with the finger, a method which is strongly objected to by children and adults—and rightly, for a finger examination, except in very young or fretful children, or for some special purpose, e.g., to estimate the consistency of a growth, is a sign of incompetence in the practitioner. For the examination, the smallest laryngoscopic mirror is chosen (it is quite unnecessary to use Michel's hinged rhinoscope), and carefully warmed by a spirit lamp; the tongue being gently depressed by a spatula held in the left hand, the mirror is passed behind the soft palate to one side or other of the uvula. The mirror is then rotated until the free edge of the septum—a pale pink vertical edge—is seen. You have now obtained your bearings, and the roof of the nasopharynx, the openings of the Eustachian tubes, and lastly the posterior parts of the turbinals, should be examined. The difficulties of the examination are nearly all of one's own making. The position of the tip of the tongue-depressor (far back, near the foramen cæcum), the amount of pressure required, the passage of the mirror along the tongue-depressor so that it does not touch the patient at all, are all matters that can be acquired by practice, and practice alone. The patient should be asked to breathe through the nose while the examination is proceeding. Some children are of course fretful and refractory at times, but most of the fretfulness is caused by clumsy pressure with the spatula.

NASAL OBSTRUCTION.

Under this heading may be grouped those conditions leading to partial or complete blocking of the nose, with the resulting necessity for mouth breathing. Of these, the commonest are adenoids (which will be considered presently), hypertrophy of the mucous membrane covering the turbinals, deviations of the septum, and polypi. In later life a unilateral obstruction may be due to malignant disease of the upper jaw.

Hypertrophy of the mucous membrane covering the turbinals (hypertrophic rhinitis) is very common. It is frequently alternating in character, first one side and then the other being affected. It is most noticeable at night, when it causes mouth breathing and morning dryness of the throat. It should be treated by cauterization, or, in advanced cases, by removal of the anterior or posterior ends of the inferior turbinal. Complete turbinectomy is not to be advised.

Deviations of the Septum are readily recognized; they may consist of displacements of the quadrilateral cartilage, or of curvatures in the bony septum as the result of injuries. The inferior turbinal on the concave side is generally hypertrophied. This condition is now treated by what is known as submucous resection, the mucous membrane covering the septum being reflected, and the cartilaginous and, if necessary, the bony septum being excised.

Polypi are pedunculated swellings resulting from an œdematous condition of the mucous membrane of the middle turbinal, and their presence generally indicates a rarefying osteitis of the bone beneath, with, very often, suppuration in one or more of the accessory sinuses. They are recognized by their pearly-grey colour, their attachment to the middle turbinal, and their free movement to the probe. They give rise to definite obstruction, and are associated with purulent or mucopurulent discharge; but bleeding is not a symptom. They are generally multiple.

Removal of Polypi.—The region of the middle turbinal should be rendered anæsthetic by the application of a wool plug moistened with cocaine 10 per cent, 1 part; adrenalin chloride, 1 part. This will cause the mucous membrane of the nose to shrink, and give a better view of the operation area. The cold wire snare should be used; a simple and easily sterilized instrument should be chosen, and particularly one which works silently. Charles Heath's snare is well designed to meet these points, while Hovell's modification of Mackenzie's snare is the very reverse. The loop is passed along the floor of the nose, and then raised to encircle the polypus. If the end of the metal shank touches the front of the pedicle of the polypus, the snare is well applied. A gentle pull on the snare before tightening will show whether it surrounds the polypus. The loop is then tightened as high up on the pedicle as possible, and the polypus removed by pulling. Care must be taken not to cut the polypus off by drawing the loop too highly, or the stump will be left. Be sure that the snare is carefully sterilized, and avoid using many instruments, such as polypus hooks, polypus forceps, and so on. In old patients, the removal of polypi is sometimes followed by brisk hæmorrhage: a point to be remembered, if it is proposed to do the operation in the out-patient room. No case of polypus should be operated upon until the condition of the sinuses has been investigated. There is a tendency for polypi to re-form, especially if there is definite ethmoiditis, and a more radical operation may be necessary, a description of which would be out of place in this book. Remember that a polypus placed far back may be visible only by posterior rhinoscopy. Do not make the common mistake of confusing enlargement of the anterior end of the inferior turbinal with a polypus. The two conditions are not in the least alike in position, in colour, in consistency, or in mobility, and yet the mistake is very common.

Foreign Body in Nose.—It has been well said that if a child has a unilateral nasal discharge, a foreign body should be suspected. Fortunately, the diagnosis is easily made, as the foreign body is generally but a short distance from the anterior nares. It is best removed by passing the spoon-shaped end of a director backwards along the nose above the level of the foreign body, until it has reached behind the object. The end of the spoon is then brought to the floor of the nose by tilting the outer end, and the foreign body is easily removed by

steady traction. *No anæsthetic is required.* The use of forceps is not advised.

Nasal Discharges.—Purulent or mucopurulent discharges from the nose result from many causes. It is difficult to classify these, but the following list may be of service :—

AGE	SITUATION	CAUSE
Before 3 months	Bilateral ..	Congenital syphilis
Childhood	Unilateral ..	Foreign body
	Bilateral ..	Adenoids
		Early atrophic rhinitis
		Acute infection, e.g., diphtheria, measles
Early adult life ..	Bilateral ..	Rhinitis
		Atrophic rhinitis
Adult life	Unilateral ..	Suppuration of antrum of Highmore
		Polypi and sinusitis
		Tertiary syphilis
	Bilateral ..	Rhinitis
		Atrophic rhinitis
		Polypi
		Sinusitis
		Tertiary syphilis
Old age	Unilateral ..	Malignant disease (rare)
	Bilateral ..	Polypi

Atrophic Rhinitis is sometimes associated with mucopurulent discharge, which readily dries and forms crusts. This process is accompanied by a penetrating odour to which the name ozæna has been given. The disease is one of early childhood, but is not generally brought for treatment till early adult life, and it is, therefore, very chronic and resistant to treatment. The odour, too, is so unpleasant, that the thorough treatment which is necessary for a cure is rarely applied. Treatment lies in the direction of removing crusts, applying antiseptic and stimulating treatment to the mucous membrane, and providing for adequate drainage. The condition of the sinuses should be investigated.

Suppuration in the Accessory Sinuses.—The sinuses are five in number on each side: the antrum of Highmore, the anterior and posterior ethmoidal cells, the frontal sinus, and the sphenoidal sinus. Suppuration in one of these is not generally limited to the sinus first affected. Thus pus in the antrum of Highmore may have originated there, or may have drained into it from the frontal or ethmoidal cells; the frontal sinus and anterior ethmoidal cells are frequently affected together, and the same is true of the sphenoidal and posterior ethmoidal. In all cases when the pus has an outlet it will appear in the middle meatus—that is to say, in the space between the inferior and middle turbinals,—and in some cases the middle turbinal will be pushed towards the septum by a mass of granulations outside it. In the case of sphenoidal and posterior ethmoidal suppuration it may be possible by careful cleansing to prove that the pus has its origin above the middle turbinal, or it may be seen only on posterior rhinoscopy, as pus from

foreeps is

from the
e, but the

, measles

more

coparrient
process is
oxæna has
generally
fore, very
npleasant,
e is rarely
, applying
rane, and
ses should

e five in
terior and
idal sinus.
sinus first
originated
idal eells ;
y affeeted
ethmoidal.
he middle
nd middle
ed towards
ne case of
possible by
the middle
pus from

PLATE III.

A. Normal

B. Suppuration in Right Antrum Highmori.

OR. BROWN KELLY'S METHOD FOR TRANSILLUMINATION OF THE ACCESSORY SINUSES OF THE NOSE.

To face page 70

this region has a tendency to pass backwards into the nasopharynx. The presence of pus is more readily detected in the antrum of Highmore than in the other sinuses. Two methods are generally adopted: (1) Transillumination; and (2) Puncture.

Transillumination is a method whereby the cavities of the cheeks are lit up by placing a lighted electric lamp in the patient's mouth—observation taking place in a dark room. In a normal case not only the cheeks, but the orbital plate, and even the pupils of the eyes, will be illuminated, and the contrast between a sound and an affected side is pronounced. In doubtful cases the question whether the cheek is illuminated or not can be settled by drawing a finger firmly along the cheek. If the antrum is illuminated the space just traversed by the finger will be found to be translucent. On the whole, transillumination is a valuable help to diagnosis, though one may be deceived in a case with very thick antral walls (*Plate III*).

Puncture is done through the nose under a local anæsthetic. The nose is first thoroughly irrigated to get rid of any pus which may be lying in the organ. A spot just below and behind the anterior end of the inferior turbinal is anæsthetized, and a trocar and cannula is driven backwards and outwards at an angle of about 45°, till it enters the antrum. The trocar is withdrawn, and the antrum irrigated with sterilized water. As the fluid escapes from the antrum, it is caught in a black papier-maché bowl, in which the pus, if present, shows plainly.

Transillumination has also been used for the *frontal sinus*, but with less success. Diagnosis by the passage of a frontal sinus catheter is not recommended for house surgeons.

TREATMENT.—The treatment of sinus suppuration requires very special skill in intranasal operations, and should not be undertaken by anyone without special training. It is essential that these cases should be referred to the special department for treatment.

Adenoids.—Hypertrophy of the adenoid tissue normally present in the roof of the nasopharynx gives rise to many troubles, some of them systemic, due to deficient oxygenation of the blood, others local, e.g., rhinitis, pharyngitis, and most ear troubles in children. The most constant symptoms of adenoids are:—Snoring at night, mouth breathing, nasal tone of voice, morning cough, tendency to colds, earache, and deafness. Children with adenoids suffer frequently from bronchitis or bronchopneumonia. The adenoid mass is liable to follicular inflammation just as are tonsils, and this often gives rise to pyrexia in children. Children with adenoids do not make much progress at school, a fact which might be explained on the ground of partial deafness. Arithmetic seems to be their worst subject. Adenoid hypertrophy frequently co-exists with enlarged tonsils. The presence of adenoids should always be suspected in a child whose upper lip is excoriated by nasal discharge, in a case of recurrent earache, in a child with middle-ear catarrh, or in a backward child with undeveloped chest and morning

cough. Diagnosis is easy by posterior rhinoscopy. Never make a digital examination if it can be avoided; it is clumsy, frigl ens the patient and distresses the parents.

TREATMENT.—Of the many methods adopted by many surgeons for the removal of adenoids, the plan adopted by the writer will be alone considered. The anæsthetic is a matter of choice. The chloroform-ether mixture is excellent, ether is good if very well given, chloroform is perhaps a little risky, and if many cases have to be done, ethyl chloride is an admirable anæsthetic in competent hands. The patient lies on the back on the table, with a small pillow under the upper part of the shoulders. When anæsthetized, the head is over-extended, the upper part of the occiput resting on the table. The mouth is kept widely open by means of a Doyen's gag (*Fig.* 255), which is untouched throughout the operation. *A finger examines the growth*, and then a St. Clair Thomson's modification of Delstanche's caged curette (*Fig.* 256) is passed into the nasopharynx and moved upwards until the septum nasi is felt. The curette is then pressed firmly back, and the central mass of adenoids is removed by one firm sweep of the curette, the cutting blade of which should not travel more than half an inch. A Gottstein's curette

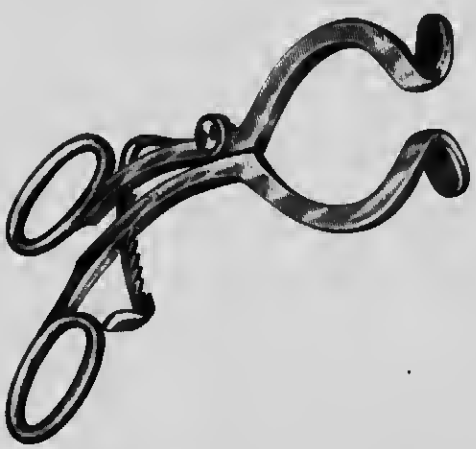
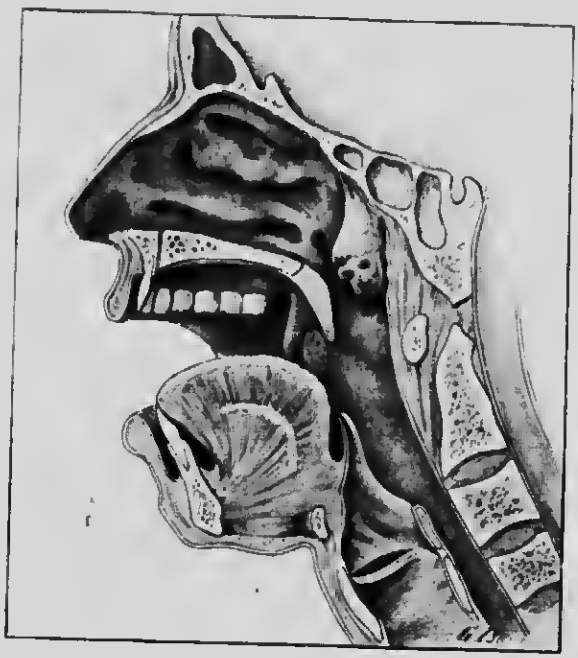


Fig. 255.—DOYEN'S GAG. (This "right-sided" gag should be "left-sided," i.e., when in position the ratchet bar should point away from the eye.)

Fig. 256.—ST. CLAIR THOMSON'S MODIFICATION OF DELSTANCHE'S CAGED CURETTE.

is then rapidly used to remove any lateral masses, and the patient is then turned over on to the right side. A finger is passed into the nasopharynx, which should be found clear of growths. The tonsils are then removed, while the patient is on the side, with a

PLATE IV.



SECTION THROUGH THE NASAL FOSSÆ AND NASOPHARYNX TO SHOW THE POSITION OF THE AOENOIO MASS.

To face page 300

PLATE V.

ENUCLEATION OF THE TONSIL BY MEANS OF THE GUILLOTINE.

Fig. A.—The tonsillotome being placed in position.

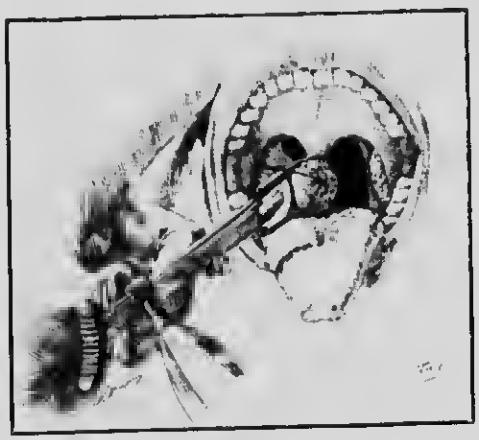


Fig. B The tonsil brought forward by the guillotine in the position for cutting off.

To face page 101

guillotine (the simpler the better), the ring of the guillotine engaging the lower pole of the tonsil first, and being guided over the rest of the tonsil by the sense of touch. After the operation the patient is kept quiet for two hours. This method requires practice, but when the knack has been acquired it will be found to work excellently. The average actual operating time is fifty seconds, but there is no need of speed after the child has been turned on the side.

DISEASES OF THE PHARYNX.

Enlarged Tonsils.—As the result of repeated attacks of inflammation, or owing to a disposition to the growth of adenoid structures, the tonsils may become so large as to give rise to serious disability. They may become the subjects of "lacunar tonsillitis," where their crypts are filled with yellowish, putty-like plugs of inspissated secretion, or they may become frequently inflamed, and so on. Very often, indeed practically always in children, hypertrophy of the tonsils is associated with adenoid hypertrophy (*q.v.*).

TREATMENT.—If there be no adenoid enlargement in the nasopharynx, the tonsils may be removed by the guillotine under a local anæsthetic. If adenoids are present also, a general anæsthetic must be given. There is a point worth remembering in the choice of the tonsillotome. If a tonsil is flat and broad-based, the largest-sized tonsillotome should be used; if the tonsils are large, prominent, and button-like, the smallest guillotine that will receive the tonsil is best.

Enucleation of Tonsils is an operation which perhaps will less often be performed by the house surgeon. It is employed in cases where it is necessary that the whole of the tonsil should be removed. A general anæsthetic is necessary. The mouth being kept open by Doyen's gag, under a good light the tonsil to be removed is seized with a volsellum forceps, and drawn well inwards. An incision is then made with a pair of scissors through the pharyngeal mucosa just above the tonsil (supra-tonsillar recess), and through this opening a finger or some blunt instrument is introduced and the tonsil separated from its bed of connective tissue. The separation is easy, and no force must be used. A few snips with the scissors free the tonsil from its attachments to the mucous membrane. In certain cases hæmorrhage may require treatment either by pressure or ligature.

Enucleation with the Guillotine.—This operation has been devised lately, and requires considerable practice. A general anæsthetic is necessary. The mouth is kept open by Doyen's gag. A tonsillotome after the pattern of Mackenzie's, with a handle set at an obtuse angle, but made specially strong and *rather blunt*, is used. The free edge of the ring of the tonsillotome is placed below and behind the tonsil with the knife blade outwards, and by means of firm pressure from behind forwards, the tonsil is made to project beneath the anterior tonsillar pillar. The forefinger of the other hand then presses on the tonsil, forcing it from before backwards through the ring of the guillotine

The cutting blade is now pressed sufficiently far home to grip the tonsil, which is levered out of its bed by rotating the handle in a half circle towards the patient's ear, the free edge of the ring of the guillotine acting as a fulcrum. The tonsil is brought well forward into the mouth and is then cut off. The right side is easier to do than the left at first, and there is a tendency for the tonsil to slip back through the ring of the guillotine during the rotation movement.

Quinsy (*Peritonsillar abscess*).—Although the name "quinsy" was formerly given to a condition known as "parenchymatous tonsillitis," the condition commonly seen in out-patient practice is not a tonsillitis at all, but rather an inflammation occurring in the cellular tissue forming the bed of the tonsil. Whether this inflammation is the result of extension from a deeply placed follicle of the tonsil, or whether it originates in the supra-tonsillar fossa, is a matter of small importance. If inflammation goes on to suppuration, an abscess forms behind and above the tonsil, and points in the region of the supra-tonsillar fossa, the anterior pillar bulging forward, and the tonsil itself being pushed inwards and slightly downwards. There is considerable constitutional disturbance; the temperature may reach 103° or 104°, with headache, constipation, furred tongue, and foul breath. Swallowing is difficult, the mouth can hardly be opened, and the voice is reduced to a typical guttural whisper.

Fig. 257.—Peritonsillar Abscess. Method of Incision.

Treatment.—A brisk purge should be given, the patient confined to bed, and an incision made into the abscess. This must be done in the following manner: The tongue and lower jaw being depressed with a broad spatula (*Fig.* 257), a small keen scalpel is chosen, and, held on the flat with cutting edge inwards, is passed directly backwards into the outermost part of the swelling, about on a level with the base of the uvula, and therefore well above the tonsil. Having entered the abscess cavity, the knife is carried inwards so as to make a horizontal incision about ½ in. long. In making this incision some fibres of the palato-glossus muscle are divided, so that the incision gapes, and good drainage is obtained subsequently. A pair of dressing-forceps is used to dilate the opening if the discharge is not free. The advantages of this method are: (1) There is no danger of injuring any vessel of importance, however deeply the knife is passed; (2) If pus is present it is always struck; and (3) Good drainage is provided. A preliminary application of cocaine does nothing to relieve pain in these conditions of acute congestion, but it is useful as a placebo.

TRACHEOTOMY.

This operation, formerly a fairly common one as performed for diphtheria, is now much more rarely required, first, because the use of antidiphtheritic serum has greatly reduced the severity of the attack, and secondly, because intubation is being more used. On the question of intubation *versus* tracheotomy, much can be said on either side. Intubation has the advantage of requiring no anæsthetic, it is quickly done, and it makes no open wound. Its disadvantages are that considerable dexterity is necessary, the tube may become blocked by membrane, and it may be coughed out. It is a good operation in capable hands where a close watch can be kept on the patient, that is, in a hospital with a resident officer. It is unsuitable for cases where the infection has spread into the trachea. There is no doubt that every house surgeon should have experience in tracheotomy, because it is certain that on more than one occasion he will be obliged when in private practice to open the trachea for dyspnœa when intubation instruments are not available.

Indications for Operation.—While tracheotomy may be required for the relief of asphyxia in many conditions, or as a preliminary step in certain operations, diphtheria is the commonest cause. Opinion is divided as to operating early or late. The general view now taken is that it is inadvisable to wait for cyanosis or signs of circulatory difficulty. It is advisable to operate when inspiration is prolonged, expiration noisy, and the lower ribs are indrawn. It is urgent if a warm bath gives no relief, and especially if cyanosis, pallor, or a failing pulse be present.

Instruments Required.—In view of the fact that tracheotomy is an operation of urgency, it is a good rule to keep a complete set of the instruments required in one receptacle. This ensures that everything wanted will be at hand without delay. The following is the list:—

Two scalpels (in case one is blunt)
Two pairs of dissecting forceps
Four pairs of Spencer Wells' pressure forceps
Straight scissors
Small-sized retractors
Director
Tracheal dilator
Tracheotomy tubes (4 sizes)—Parker's
Needles, silk, silkworm gut
Tape, feathers.

Position.—The patient lies on his back with a pillow under his shoulders, the head being thus extended somewhat. He should be put in this position before the anæsthetic is commenced, and should not be moved afterwards, as the taking up of a new position in dyspnœa under anæsthesia may lead to a stoppage of the breathing. The anæsthetist stands at the head of the table, the assistant opposite the operator.

The Operation.—The operator should, with his left hand, define the larynx and cricoid cartilage; then, lightly grasping the larynx with the thumb and second finger of the left hand, the index finger being placed in the middle line on the cricoid cartilage, a free incision is made from the cricoid downwards. This incision should divide the skin and superficial fascia. The middle line being again accurately determined, a further incision divides the deep fascia. If there is bleeding at this stage, the muscles in front of the trachea are rapidly scratched through or separated with the director, and the lateral muscular masses are seized with pressure forceps, which should be made to include as much as possible. These pressure forceps are allowed to hang down on either side, stop the bleeding, and act as retractors. If the isthmus of the thyroid gland is seen at this stage,

Fig. 255.—Tracheotomy—Opening the Trachea

it should be drawn downwards if in the way. The operator now steadies the larynx with his left hand as before, and enters the knife, edge upwards, into the trachea below the second ring, and carries it firmly upwards, dividing the upper two rings but not the cricoid (*Fig.* 258). As a rule the opening of the trachea is followed by violent coughing by the patient. The tracheal retractors are at once inserted, and a short period is allowed to elapse during which the patient clears the trachea of blood and membrane. The outer part of the silver tube, armed with a "pilot" if preferred, is then inserted into the trachea, and tied by tapes around the neck. The wound is partially closed by sutures, but drainage is provided for.

The operation is one requiring some nerve and a level head. It may be somewhat difficult in a small fat baby, with violent tracheal

excursions and congested veins, or it may be extremely easy. There must be no hurry and no clumsiness. Every step must be done in order, and no effort made to open the trachea till its rings are exposed. A sharp hook is unnecessary, and may be the cause of cessation of respiration. It is much better to stop bleeding in the manner suggested, and quicker than picking up individual bleeding points, but if there is time, the veins may be picked up before they are cut. Open the trachea slowly and quietly. Once the trachea is open and the dilator in position the object of the operation is obtained, and the introduction of the tube can be done at leisure. If respiration ceases before the trachea is opened, complete the opening and insert the dilators *before artificial respiration is started.* The passage of a feather into the trachea will often start respiration. Always pass the tracheotomy tube between the blades of the dilator: this will ensure the tube being placed within the trachea.

INTUBATION OF THE LARYNX.

This operation requires a special apparatus known as O'Dwyer's instruments. They consist of tubes of various sizes to fit the larynx, shaped with an upper flange which rests upon the false vocal cords, an introducer, an extractor, and a gag. No anæsthetic is required. The patient is placed in the sitting position, the head is held so as directly to face the operator, and a gag is introduced on the left side of the mouth. A suitable tube is chosen, a thread some 2 feet in length is passed through an eye in the flange, and the tube is then affixed to the introducer, the thread being passed through a ring on the shank of the introducer. The operator, holding the introducer and thread in his right hand, passes his left forefinger into the patient's pharynx, identifies the epiglottis, and draws this and the root of the tongue forwards. The tube is then passed on the introducer along the side of the left forefinger (*Fig.* 259) until it reaches the posterior surface of the epiglottis. The handle of the introducer is then raised, and the lower end of the tube guided into the larynx (*Fig.* 260). When the tube is felt to be

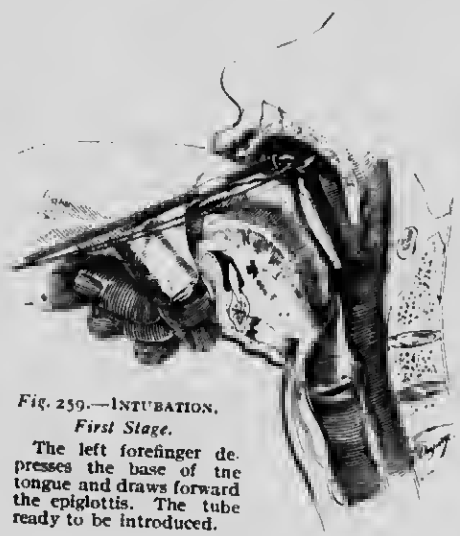


Fig. 259.—INTUBATION. *First Stage.*

The left forefinger depresses the base of the tongue and draws forward the epiglottis. The tube ready to be introduced.

in the larynx, it is pushed boldly on between the cords until the flange rests on the false vocal cords. The left forefinger is then pressed on the upper end of the tube (*Fig.* 261) and the introducer removed. The thread should be retained, the free end being fastened to the cheek by strapping. By its presence extraction is made easy. If the thread is removed, the tube may be extracted at will by means of the extractor already mentioncd. Thc operation is one of great simplieity once the knack is acquired, but considerable practice is needed. It is well to remember that the tube may push some of the membrane before it in its passage, and thus obstruct both the tube and the air-passage, so that the tracheotomy instruments must always be ready if intubation is to be done for diphtheria. Again, the passage of the tube sometimes causes the breathing to stop, a result which may be guarded against by cocainizing the larynx or by hypodermic injection of atropine.

Fig. 260.—*Second Stage.*
The left forefinger depresses the epiglottis, and the tube is passed along the forefinger and is introduced into the larynx by raising the handle of the introducer.

In some cases difficulty is experienced in feeding patients who are wearing an intubation tube. This may be due to the use of a tubc of too great a size, and in this case a change of tube will remedy the trouble. If this is not the cause, the patient should be fed lying on the back with the hcad below the level of the trunk, fluid food being administered by pouring it on to the palate from a spcon.

Fig 261.—*Third Stage.*
The tube in position, and retained by the finger during the withdrawal of the introducer.

ıtil the
is then
end of
and the
The
etained,
fastened
rapping.
ıction is
hread is
may be
means
already
peration
mplicity
cquired,
ıctice is
to re-
ıbe may
embrane
ıge, and
he tube
so that
ruments
phtheria.
thing to

PLATE VI.

EXAMINATION BY THE LARYNGEAL MIRROR.

Fig. A.

Fig. B.—Enlargement of the Laryngeal Image During Inspiration, Showing—

1. Base of tongue
2. Thyroid cartilage
3. Median glosso-epiglottidean fold
4. Epiglottis
5. Cushion of Epiglottis
6. Ventricular band
7. True vocal cord
8. Arytenoepiglottidean fold
9. Rima glottidis
10. Ventricle
11. Sinus pyriformis
12. Rings of trachea
13. Processus vocalis
14. Cartilage of Wrisberg
15. Inter-arytenoid space

To face page 407

Chapter XL.

COMMON DISEASES OF THE LARYNX.

By H. W. CARSON, F.R.C.S.,
Senior Surgeon Prince of Wales's General Hospital, London.

METHOD OF EXAMINATION.

THE larynx is examined by artificial light reflected from a head mirror in a manner similar to that adopted for examination of the nose, but the light is further reflected into the larynx from a small mirror (laryngeal mirror) fixed in a handle and held in front of the soft palate. The patient is told to breathe quietly throughout the examination, and to say "ah" or "ee" if desired. The head mirror having been so adjusted that the light can be focused directly on the patient's pharynx, a laryngeal mirror, the larger the better, is carefully warmed by holding it for a few seconds above the flame of a spirit-lamp. The patient is then directed to open his mouth and protrude the tongue as far as possible. A tongue cloth is laid on the fore part of the tongue, and the tongue is firmly held between the examiner's thumb (above) and middle finger (below) of the left hand, the forefinger being placed on the patient's upper lip to keep the moustache, if any, out of the way. The laryngeal mirror is then passed backwards till it touches the uvula, which is gently pressed upwards and backwards. The mirror then reflects a picture of the larynx, the epiglottis appearing in the upper part, the arytenoid cartilages in the lower, and the true and false vocal cords and the ventricles of the larynx, in the centre (*Plate VI*). The patient is then requested to phonate, and thus the true vocal cords are more clearly seen, and their appearance and mobility can be studied. The examination requires some dexterity, as any clumsy movement may cause retching or straining. The points to be remembered are: (1) Use a large laryngeal mirror; (2) Do not make the mirror too hot; (3) Hold the tongue firmly, but do not pull; (4) Pass the mirror back without touching the tongue or teeth; (5) Do not make a prolonged examination. It is necessary to accustom oneself to holding the mirror in either hand.

FOREIGN BODY IN THE AIR-PASSAGES.

The accidental entrance of a foreign body into the air-passages is not very uncommon, but it is always a source of danger, and it may be almost immediately fatal. This is due to the fact that a foreign body, if impacted in the upper part of the larynx, will not only cause more or less suffocation, but may also cause serious or even fatal

collapse by reflex inhibitory action on the heart. The foreign body may lodge in various situations; thus sharp objects, such as pins or fishbones, if they pass the pharynx, generally lodge in the sinus pyriformis or in the aryteno-epiglottic fold; small round bodies frequently pass between the cords and reach the trachea or bronchus; larger bodies become fixed in the upper part of the larynx or between the cords.

Symptoms.—If the foreign body be impacted in the **Upper Larynx** it may cause sudden asphyxia and death by collapse. If the obstruction is not complete, violent inspiratory efforts and cough occur, with salivation, and perhaps vomiting, and in many cases the violence of the efforts is sufficient to expel the foreign body.

TREATMENT.—The foreign body can generally be removed by forceps or the finger. Inversion and succussion may be tried. If these methods

FIG. 262.—THE TRACHEAL TUBE HAVING BEEN INTRODUCED, THE TUBE SPATULA, SEPARATED INTO ITS TWO PIECES, IS REMOVED.

are unsuccessful, no time should be wasted in further efforts, but laryngotomy should be performed. Laryngotomy is chosen instead of tracheotomy because it is easier and can be done more quickly. A vertical incision is made through the skin and subcutaneous tissue and fascia, and the larynx is opened by a horizontal incision through the crico-thyroid membrane, the incision being placed as near the cricoid cartilage as possible, to avoid injuring the crico-thyroid branch of the superior thyroid artery. Anæsthetics should not be given.

If the foreign body pass through the larynx into the **Trachea,** violent spasmodic cough is caused, the foreign body being driven against the under surface of the cord, and recurrent attacks of suffocation result. After a shorter or longer period the foreign body becomes less mobile

owing to the excessive secretion of mucus, and the spasms may abate, to be renewed if the patient coughs or makes a sudden movement.

TREATMENT.—Until recently the treatment of foreign body in the trachea consisted of the performance of a low tracheotomy and the searching for the foreign body—rather aimlessly, it is true—with forceps. With the discovery of the *x*-rays, the search was made somewhat more easy, but the greatest and most recent improvement in diagnosis and treatment followed the invention of the tracheo-bronchoscope by Killian, in 1897. The method of performing the examination is thus described by Killian. He uses a "tube spatula" (*Figs.* 262 and 263, illustrations kindly lent by Dr. P. Watson Williams), which is widened in front and divided into two halves along its length, so that it can be easily removed from any tube introduced through it.

Fig. 263.—PROF. KILLIAN'S BRONCHOSCOPY THROUGH A TRACHEOTOMY WOUND IN THE DORSAL POSITION.

A general anæsthetic should be given both to adults and children, and the patient placed with head hanging over top of table. The widened end of the tube spatula is passed over the middle of the tongue to its base, and placed between it and the epiglottis. By suitable pressure the interior of the larynx is exposed and brushed with 20 per cent cocaine. The point of the spatula is then passed over the epiglottis, which is pulled upwards, and a view obtained into the trachea. A tube of suitable calibre is then chosen and passed through the tube spatula into the deeper parts for the examination of the lower trachea and larger bronchi, the tube spatula being removed. By means of specially designed hooks and forceps (Guisez) a foreign body can be readily removed through the examination tube. Illumination is

provided by the Kirstein head lamp, but any powerful light may be reflected by means of a head mirror. In certain cases the tube may be passed through a low tracheotomy wound (lower bronchoscopy) (*Fig.* 263). Of the two methods, Killian prefers the former, but lower bronchoscopy may be used when urgent dyspnœa is present, when the lungs are affected and the bodily strength is reduced, or when the foreign body is large and irregular.

CATARRHAL LARYNGITIS.

This may occur as an acute or chronic manifestation.

Acute Catarrhal Laryngitis is an extremely common complaint, and many persons have a laryngeal attack whenever they have a "cold." It is probable that in these cases a slight chronic inflammatory condition exists, the "cold" causing an exacerbation. Cold, sudden changes of temperature, and over-use of the voice are the common causes. Influenza is often complicated by laryngitis.

Symptoms.—The attack commences with irritation in the throat, leading to a dry cough. The voice is at once affected, and this hoarseness may in severe cases become a definite aphonia. A mucopurulent secretion follows, and there may be pyrexia and even a rigor. Swallowing is often painful.

In laryngoscopic examination the interior of the larynx looks much more red than usual, and the mucous membrane of the false vocal cords is swollen so as to prevent, in some cases, a view being obtained of the true cords. If these are seen they will appear generally reddened and swollen, and their mobility may be somewhat impaired.

Diagnosis.—This is easy in adults, the fact that it is *never unilateral* differentiating it at once from many other laryngeal conditions. In children it may be confused with laryngismus stridulus or laryngeal diphtheria. From the former it is distinguished by its onset (fever, coryza) and by the persistent hoarseness; from the latter, unless membrane be seen or coughed up, diagnosis is very difficult, but the facial appearance, the enlargement of the glands, and the albuminuria of diphtheria may make diagnosis possible.

TREATMENT.—In an uncomplicated case, treatment of a simple character will lead to early recovery. Rest to the voice is essential. Local applications by means of inhalations (tinct. beozoini co. or menthol vapour, 5 gr. to the ounce of parolein in an atomizer) are of value, or adrenalin chloride (1–5000) may be sprayed into the larynx. An aperient should be given and the patient confined to bed. If the attack is of a more serious character, œdema of the glottis may supervene, and the patient may be suddenly in great danger. In such a case preparation should be made for tracheotomy, the low operation being preferred; but much relief can be obtained by local punctures with Mackenzie's lancet, by spraying with equal parts of cocaine 10 per cent and adrenalin chloride 1–1000, the subcutaneous injection of pilocarpine, and the application of ice compresses.

Chronic Laryngitis may follow a neglected acute attack, but is more commonly due to over-use of the voice or to some condition causing constant irritation of the larynx, e.g., chronic rhinitis, pharyngitis, or some pulmonary affection leading to frequent coughing. In most cases of chronic laryngitis, the primary cause is in the nose, whether it be atrophic rhinitis, sinus trouble, or chronic hypertrophy of the nasal mucous membrane causing obstruction, and the posterior pharyngeal wall may be glazed with a thin layer of mucopus. It must not be forgotten that a simple laryngitis may occur in a patient with pulmonary tuberculosis. Hoarseness, and a loss of control of the voice, are the chief symptoms; but associated with them are symptoms due to the causative lesion, e.g., nasal obstruction, morning cough, dryness of throat, mucopurulent expectoration, etc.

Laryngoscopic Examination.—The chief alteration in the appearance of the larynx is in the inter-arytenoid region, where, as the result of constant irritation, there is an overgrowth of the tissues (sub-epithelial) between and covering the arytenoid cartilages. In some cases this thickening (smooth, firm, opaque, white) may extend forward on to the posterior ends of the vocal cords (pachydermia laryngis). In other cases the cords themselves may be chiefly affected, the changes consisting of thickening and irregularity, and in some cases distinct nodules form resembling minute papillomata. There is generally an increase of mucoid secretion, which can be seen on and between the cords and covering the inter-arytenoid space. Most of this comes from the nose and nasopharynx.

TREATMENT.—Any pathological condition of the upper respiratory tract must be treated. Locally much may be done by rest to the voice and the application of sedatives or astringents, as the condition may require. In many cases of "singer's nodes," a form of chronic laryngitis due to over-use or misuse of the voice, an immediate improvement follows the correction of faults in voice-production and the use of Holbrook Curtis's exercises.

LARYNGEAL TUBERCULOSIS.

This is nearly always secondary to pulmonary tuberculosis, of which it is a common complication (30 per cent). It occurs most commonly in males between the ages of twenty and thirty, and is frequently unilateral in the early stages. It may be well to point out that a laryngeal affection occurring in a phthisical subject is not necessarily tuberculous. Thus a simple laryngitis is very common in phthisical patients, and syphilitic lesions may occur. The first symptom is weakness of the voice, hardly amounting to hoarseness, with cough and expectoration. In some cases aphonia has been the first sign, and, occurring without any obvious lesion, has been diagnosed as "hysterical aphonia." As the disease progresses, a whispering hoarseness becomes pronounced and dysphagia occurs, associated with cough, hæmoptysis, night sweats, and wasting.

Laryngoscopic Examination.—There will be anæmia of the palate and fauces, though this may be only part of a general anæmia. The examination of the larynx may be very difficult owing to irritability and cough, and even when a good view is obtained the laryngeal mucous membrane may be covered with a milky-white secretion. There are three common forms of laryngeal tuberculosis: (1) Aryteno-epiglottic; (2) Chorditic; (3) Inter-arytenoid.

1. **Aryteno-epiglottic Tuberculosis** starts in the crico-arytenoid joint and extends along the aryteno-epiglottic fold. It is usually bilateral, forming two cushion-like masses on either side of the upper opening of the larynx. If the epiglottis is also affected, the clinical picture is typical and cannot be mistaken, as the only condition resembling it is œdema of the larynx. Ulceration is rare, but dysphagia common. If the epiglottis is little affected, the condition must be diagnosed from:—

Syphilis, which is generally unilateral and painless, with a tendency to ulcerate early.

Epithelioma, which is unilateral, dusky red, and leads to early impairment of mobility.

If the epiglottis is much affected the condition must be diagnosed from:—

Syphilis, which affects the lingual surface rather than the laryngeal. If the epiglottis alone is affected, it is probably syphilitic, as tubercle affects the epiglottis late, and in association with arytenoid swelling.

Lupus, which affects the epiglottis only, occurring in characteristic red firm nodules with the formation of scar tissue. It is rarely the only manifestation, the face, nose, or palate being often simultaneously affected. There is little pain, if any.

2. The **Chorditic** form is that in which the cords only are affected. At first a simple redness, differing from catarrhal laryngitis by being more marked on one side than the other, the condition advances till one cord presents the appearance of a band of granulation tissue, or a nodular mass. The condition affects the posterior half of the cord, a point of distinction from *syphilis*, which attacks the anterior half. If ulceration occurs, the syphilitic ulcer is much more sharply defined than the tuberculous, and has a hyperæmic edge and a flat base. The weak whispering hoarseness of tubercle is in marked contrast to the rough grating hoarseness of syphilis. From *cancer* the chorditic form differs in that a warty growth, common in cancer, is rare in tubercle; cancer is rare before the age of forty, affects one cord only, and causes early loss of mobility.

3. The **Inter-arytenoid** form occurs as soft semi-translucent granulations in the inter-arytenoid region, and if ulceration is present the condition is diagnostic of tubercle. It can only be mistaken for pachydermia laryngis (*cf.* "Chronic Laryngitis"), but in pachydermia the outgrowths are whiter and firmer and more symmetrical.

TREATMENT.—But little can be said here on so large a subject as the

treatment of tuberculous laryngitis, but a few general rules are appended.

1. In early cases before ulceration has occurred, treatment should be on ordinary sanatorium lines, with absolute silence.

2. If dysphagia is severe, relief may be obtained by curetting the arytenoid region or removing the epiglottis, but the propriety of active surgical interference depends upon the general condition of the patient.

3. If ulceration has occurred, and the general condition does not contra-indicate, great improvement may be expected from the frequent application of such drugs as lactic acid, carbolic acid, menthol, formalin, etc. The insufflation of orthoform is of value in dysphagia.

LARYNGEAL SYPHILIS.

This may come as a secondary or tertiary manifestation.

Secondary Syphilis affects the larynx a few weeks after infection, frequently existing at the same time as the rash. It consists of a hyperæmia of the mucous membrane and of the cords, occurring in patches and resembling catarrhal laryngitis very closely.

Tertiary Syphilis occurs as a gummatous infiltration, with a tendency to break down and form typical syphilitic ulcerations. The epiglottis is the part most commonly affected, the ulceration attacking the lingual surface. If the cords are affected, the anterior half is the seat of election, but in some rare cases syphilis may attack solely the inter-arytenoid region. The lesions run a typical course: ulceration is extensive and destructive, there is a tendency to the formation of dense scar tissue, and in intractable cases the cartilage of the larynx is itself affected. The crico-arytenoid joint may become ankylosed, leading to fixation of the affected cord, or the same result may follow the destruction of the muscles themselves, either by infiltration or nerve lesions.

Symptoms.—In the early stages hoarseness, cough, and perhaps slight respiratory difficulty will be the chief symptoms. The hoarseness is of a typical raucous nature, and is in itself almost diagnostic. Later, as the result of cicatrization, dyspnœa is the most important symptom, with hoarseness. There is little pain throughout, and the lesions may be surprisingly extensive and out of all proportion to the sufferings of the patient.

TREATMENT.—The treatment is on the lines laid down for syphilis elsewhere; but if, as the result of scarring from the healing of gummatous ulcers, dyspnœa occurs, it may be necessary to do tracheotomy or, if possible, intubation.

NEW GROWTHS OF THE LARYNX.

While many forms of benign tumour may occur in the larynx, papilloma and fibroma are by far the most common.

Papillomata occur most commonly in children, and are multiple. They grow from the cords or the ventricular bands, and may form large

cauliflower-like masses. They give rise to hoarseness, and in children to a characteristic cough, but dyspnœa is unusual.

TREATMENT.—An isolated papilloma should be removed by endo-laryngeal methods with forceps or curette. The multiple papillomata of children are best dealt with by thyrotomy, the growths being curetted or snipped away with scissors, but great care is necessary to prevent recurrence. For many years tracheotomy was advocated with a view to giving complete rest to the larynx, and is still advised by many laryngologists. Removal by the endo-laryngeal method, assisted by Killian's tube-spatula, has given some good results, some such caustic as lactic acid being applied to the pedicles.

Fibromata are generally single, grow from the vocal cord, and occur in adults. They may be pedunculated or sessile. They give rise to hoarseness and, if pedunculated, to occasional aphonia. Dyspnœa occurs only if the growth is very large.

TREATMENT.—These growths must be removed by endo-laryngeal manipulations, and their removal should not be attempted by anyone not skilled in laryngeal work. The pedunculated are more easy to remove than the sessile, but either kind is sufficiently difficult.

Malignant Growths of the Larynx are much more rare than benign growths. They occur more commonly in men than in women, and are a disease of late life. They are classified clinically, according to their position, as *intrinsic* and *extrinsic*. *Intrinsic* tumours are those occurring within the laryngeal cartilages, e.g., growths of the cord, ventricular bands, ventricles, and the sub-glottic region; *extrinsic* tumours grow from the epiglottis, the ary-epiglottic folds, the inter-arytenoid space, and the pyriform sinuses. The distinction is important, as intrinsic growths increase very slowly and rarely disseminate or cause lymphatic involvement, while extrinsic growths are rapid in their development and metastasis is common enough. The lymphatics from the supra-glottic region (epiglottis, inter-arytenoid space, etc.) pass out through the thyro-hyoid membrane to a gland beneath the posterior belly of the digastric, and thence to the concatenate chain. The lymphatics from the sub-glottic region pass out through the crico-thyroid membrane, or between the cricoid and the trachea laterally, and enter the chain of lymphatics round the internal jugular vein. From the interior of the larynx itself there is very little lymphatic outflow owing to the small amount of submucous tissue.

Carcinoma of the larynx occurs on one or other vocal cord in 50 per cent of cases. It begins as an elevated nodule, or as a warty growth, or rarely as an ulceration. Infiltration with œdema follows, and impairment of mobility is an early sign. Diagnosis is extremely difficult at an early stage, and every case of hoarseness due to thickening of one cord which resists treatment must be viewed with suspicion if occurring in a man over fifty. Pain is not generally complained of in intrinsic cancer, nor is the general health materially affected in the early stages. Dyspnœa occurs late if at all, though if glandular enlargement is present

dyspnœa is probable towards the end. In extrinsic cancer, growth is much more rapid, there is a great deal of pain on swallowing, cough and mucopurulent expectoration occur, and cachexia supervenes early, due largely to the difficulty of swallowing. The pain is often referred to the ear on the affected side, a point to be remembered if an old man complains of earache and no ear symptoms are present.

TREATMENT.—In the early stage great success has attended the removal of intrinsic carcinoma by thyrotomy. Extrinsic growths and advanced intrinsic require complete removal of the affected part and the tissues wide of the disease, with the lymphatics of the region concerned. The operation of laryngectomy, whether partial or total, is a formidable measure, and can rarely be conducted on set lines.

NERVOUS AFFECTIONS OF THE LARYNX.

Functional Aphonia is not infrequently seen in girls of fifteen to eighteen years. The onset is sudden, the patient losing all vocal power except a thin whisper. There is no pain or discomfort as a rule. Frequently a history can be obtained of previous attacks, lasting perhaps for several months and resulting in a sudden spontaneous cure. Examination is generally easy, patients with this condition being very tolerant to laryngeal manipulation. The movements of the cords will be capricious—now quite free, now halting,—and attempts to phonate will increase this. The very greatest care must be taken in diagnosis, which must be made by a process of exclusion. Particularly one must remember that an apparently causeless aphonia may be the first sign of tuberculous laryngitis, and the lungs must be carefully examined.

TREATMENT.—Brisk swabbing of the interior of the larynx with a small swab of wool on a holder, followed by an earnest attempt at speaking, will often result in cure. If this is not successful, the application of the interrupted current endolaryngeally will generally be effective. The general health of the patient should be looked to, anæmia being very common in these cases.

PARALYSIS OF THE RECURRENT LARYNGEAL NERVE.

The recurrent laryngeal branch of the pneumogastric nerve supplies all the muscles of the larynx except the crico-thyroid, ary-epiglottic, and thyro-epiglottic muscles, and the arytenoideus partly, and it is purely a motor nerve. On the *right* side the nerve arises in front of the first part of the subclavian artery. It hooks round the artery, passing below and then behind, and runs upwards and slightly inwards, crossing obliquely behind the common carotid artery. Reaching the side of the trachea, it turns upwards in the groove between the trachea and œsophagus with the inferior thyroid artery, and enters the larynx by passing under the lower border of the inferior constrictor of the pharynx. On the *left* side the nerve rises in front of the transverse

part of the arch of the aorta, and winds round the arch just behind the obliterated ductus arteriosus. It passes obliquely behind the root of the left carotid artery to gain the groove between the trachea and œsophagus, where it follows a similar course to the right nerve.

Unilateral Paralysis.—The effect on the cord is a complete paralysis of abduction and of adduction. The cord lies in what is known as the "cadaveric" position, i.e., midway between adduction and abduction. Paralysis is due, in the great majority of cases, to pressure on the vagus or on the recurrent nerve. On the left side the principal cause is an aneurysm of the arch of the aorta, on the right side subclavian aneurysm or pleural thickening, the result of tuberculosis of the apex of the lung. In addition either nerve may be compressed by carcinoma of the œsophagus, goitre (innocent or malignant), mediastinal tumour, or glandular enlargements.

Symptoms.—There may be no symptoms whatever in a unilateral paralysis, the condition being discovered only on laryngeal examination. The voice is usually normal, but may be feeble or hoarse. Exertion may cause breathlessness, but there is not much interference with air entry as a rule.

Laryngoscopic Examination.—The affected cord is immobile, lying a little nearer the middle line than in normal respiration. The free border is concave. On phonation the unaffected cord is adducted and generally crosses the middle line to meet the paralyzed cord, the arytenoid cartilage of the sound side passing in front of the other.

TREATMENT must be directed to the cause of the pressure, it being obvious that no local treatment is likely to avail so long as the causative lesion persists.

Chapter XLI.

COMMON COMPLAINTS OF THE EAR.

By H. W. CARSON, F.R.C.S.,
Senior Surgeon Prince of Wales's General Hospital, London.

THE examination of a case of disease of the ear must be conducted on very methodical lines, for it must be remembered that the great majority of ear complaints are secondary to pathological conditions of the nose or nasopharynx. It will not be sufficient, therefore, merely to examine the ear itself, but a routine examination must be made of the nose, nasopharynx, and throat as well. It is a good plan, in investigating an ear case, to examine the ear last, the order being nose, throat, nasopharynx, ear. In that way it is impossible to overlook a definite cause of the trouble, which untreated, would render all efforts at cure abortive. The patient must be placed in such a position that the ear is on a level with the eye of the examiner, a powerful lamp is placed slightly above and behind the patient's left shoulder, and the light is reflected on to the ear from a concave mirror fixed to the observer's forehead by a band of webbing (not elastic) or mounted on a spectacle frame. The observer should look through the hole in the centre of the mirror. A speculum is essential, and the surgeon should provide himself with various sizes, as an ill-fitting speculum seriously interferes with a satisfactory view. The aural part of the speculum may be round or oval, the latter being the more generally useful. Brunton's otoscope should not be used, as the light is more difficult to manage, and manipulations, such as swabbing out discharges, etc., are impossible. There is nothing to be gained by magnifying the field of examination. The surgeon should be supplied with a few cotton-wool holders (wooden "spills" are best, the wool being twisted on to the previously moistened end, so that a soft loose mop is made, rather like a minute feather broom), a pair of angular aural forceps, and a probe, bent so that the hand holding it is out of the line of sight. It is important to remember that even the slightest manipulation within the external meatus is a source of discomfort to the patient, and the most scrupulous gentleness must be observed, especially in children.

Diseases of the ear are readily divided into three classes: Those affecting (1) The external ear; (2) The middle ear; (3) The internal ear.

DISEASES OF THE EXTERNAL EAR.

Cerumen.—One of the commonest causes of deafness is the over-secretion of cerumen by the glands lining the cartilaginous meatus.

The glands exist in the outer third of the external meatus, and the plug of cerumen is therefore generally near the orifice. So long as the plug does not entirely block up the meatus, hearing is not impaired, but the wax readily swells if it becomes moist (e.g., from bathing), and deafness results. Patients will frequently give a history of sudden deafness coming on after a bath. If the plug has been in position a considerable time, a dermatitis may result and epithelial débris is added to the mass, but impaction of cerumen does not tend to cause middle-ear disease, though in some cases of prolonged impaction the membrana tympani looks thickened. The plug does not generally extend as far as the membrana tympani. As impaction of cerumen is occasionally associated with adhesive processes in the middle ear, it is well not to give a favourable prognosis until the wax has been removed and the ear examined.

TREATMENT.—In the majority of cases the wax can be easily removed by syringing. A large syringe with a long narrow nozzle should be used, the pinna should be gently drawn backwards and upwards to straighten the meatus, and a stream of warm water directed along the roof of the meatus. If the wax is very hard, it may be at once softened by instilling a few drops of peroxide of hydrogen into the meatus. In two or three minutes the plug may be washed out. If peroxide of hydrogen be used it will never be necessary to remove the wax by instrumental means.

Foreign Bodies.—The diagnosis of a foreign body is a simple matter if a careful examination be made with a good light. It is rarely deeply placed in the meatus unless unsuccessful efforts have been made to remove it. The only condition with which it is possible to confound it is impaction of cerumen. A touch with the probe will settle the diagnosis. Efforts must be made to remove these foreign bodies by syringing. This method is nearly always successful, but if it fails, the patient, if a child, *must be anæsthetized* before any effort is made to remove it by instruments. The best form of instrument is a bent probe or an incus hook, which should be passed on the flat beyond the foreign body, turned through 90°, and withdrawn. It is not advisable to try to withdraw a foreign body with forceps; this rarely succeeds, and often the offending matter is pushed in farther. In rare cases it may be necessary to remove the foreign body through an incision behind the ear, the cartilaginous meatus being incised after drawing forward the pinna. This should not be done in the out-patient department.

Furunculosis.—A follicular inflammation originating in a sweat gland or hair follicle occasionally occurs in the external meatus. From the nature of its origin it is confined to the outer third of the meatus. It may occur without ascertainable cause, or during the course of a middle-ear suppuration, or in eczema of the meatus. The first symptom is that of severe pain in the ear radiating to the side of the head and face. The pain is aggravated by touching the pinna

or by moving the lower jaw. A swelling follows, obliterating the furrow between the pinna and the mastoid, and extending on to the mastoid, simulating suppuration in the mastoid process. In some cases there is swelling in front of the ear also. It is very important that this condition should be differentiated from mastoid disease. The following are the principal points of difference :—

1. A furuncle gives rise to much more pain and tenderness than mastoid disease.

2. The furuncle gives rise to early swelling and often to pre-auricular glandular enlargement; in mastoid disease, swelling is late or absent, and the pre-auricular glands are not affected.

Fig. 264.—Posterior view of a case of Mastoid Disease. Note furrow between mastoid and ear, and compare with *Fig.* 265.

Fig. 265.—Case of Meatal Furunculosis. Note loss of furrow between mastoid and ear, and compare with *Fig.* 264.

3. If there be mastoid swelling, it tends, in the case of a furuncle, to be diffuse and to obliterate the furrow between the auricle and the mastoid, while in mastoid disease the swelling is more circumscribed and the furrow persists.

4. The furuncle is *always* placed in the external half of the meatus, and is therefore never so deep, never so near the membrane, as the drooping of the meatal wall so characteristic of mastoid disease. The furuncle is not confined to the posterior superior quadrant, and may be multiple.

5. Furunculosis rarely, except in children, causes rise of temperature.

Treatment consists in incision through the furuncle, followed by hot fomentations and the use of boracic lotion and peroxide of hydrogen locally. A brisk purge should be given.

MIDDLE-EAR DISEASES.

The middle-ear disease most commonly met with is a catarrh, leading to thickening of the lining membrane of the middle ear and interference

with the movements of the ossicles, or, if sepsis has occurred, to suppuration. In both these conditions it must be understood that the middle ear is not primarily at fault, but that the catarrhal condition has extended from a disordered nasopharynx by way of the Eustachian tube. It is obvious, therefore, that in treating middle-ear troubles the nose, throat, and nasopharynx must be thoroughly examined, and any abnormality corrected as the first step in the cure.

Subacute Middle-ear Catarrh.—This condition is very commonly met with in out-patient departments, and is responsible for the great majority of cases of earache. The symptoms are a sense of fullness or actual pain in the ear, accompanied by more or less deafness. The membrana tympani loses its lustrous appearance, and may look dark-grey, or reddish if the catarrh is acute. Occasionally a definite inflammatory condition of the membrana tympani is present (myringitis). Owing to retraction of the membrane, the cone of light is shortened, but is seldom absent. The handle of the malleus shows plainly through the membrane, the short process seeming to press through the upper part. A prominent fold, concave anteriorly, may be seen passing down from the short process along the posterior edge of the membrane. In cases where there is a serous exudation in the middle ear, it may be possible to recognize the level of the fluid as a concave line across the membrane. Treatment must be directed to the relief of the causal condition. In the great majority of cases of recurrent earache in children, adenoids are present, in other cases catarrhal rhinitis and pharyngitis. The introduction of air into the middle ear generally gives immediate relief.

Chronic Non-suppurative Middle-ear Catarrh.—This condition results from neglected or inadequately treated catarrhal conditions, and is always dependent on some disorder of the nose, throat, or naso-pharynx. It produces a form of obstructive deafness which is very resistant to treatment, though the chance of success depends almost entirely on the duration of the disorder. The symptoms are deafness and, in many cases, noises in the head. The external meatus is generally wide, and free from cerumen, thus permitting a clear view of the membrana tympani. The membrane is indrawn, thickened, and its movement, when tested by Siegle's pneumatic speculum, is markedly deficient. The handle of the malleus and the short process are prominent, the posterior fold (described under "Subacute Catarrh") is present, and the cone of light is shortened, distorted, or absent. The deafness is of the middle-ear type, i.e., deafness due to defect of the sound-conducting apparatus, not of the sound-perceiving (auditory nerve) apparatus. It conforms to the following tests:—

1. *The perception of sound through the ear (air-conduction) is diminished.* This is usually tested with a watch, or an apparatus designed to give a sound of definite intensity (acoumeter) may be used.

2. *The perception of sound through the cranial bones (bone-conduction)*

is increased (Rinné's test).—A vibrating tuning-fork is held close to the ear, and when the patient can no longer hear it, the plate of the fork is applied to the mastoid process. The sound will then be again perceived by the patient for a varying period.

3. If the plate of a vibrating tuning-fork be applied to the vertex in the middle line, the sound will be heard better in the affected ear (Weber's test).

4. Hearing for high notes is not much affected. For the sake of comparison, the points of difference between middle-ear deafness and internal-ear (nerve) deafness may be summarized in parallel columns.

Middle-Ear Deafness.	Nerve Deafness.
1. May occur at any age.	1. If not following some definite illness, patient probably old.
2. History of gradual onset associated with nose or throat troubles.	2. In young or middle-aged patients, probably following upon syphilis or influenza.
3. Nose, throat, or nasopharynx shows signs of chronic disorder.	3. Nose, throat, and nasopharynx normal.
4. External meatus wide and free from cerumen.	4. External meatus normal.
5. Membrana tympani altered in curvature, consistency, or mobility.	5. Unless middle-ear catarrh co-exist, membrana tympani normal.
6. Perception of low notes impaired, of high notes maintained.	6. Diminished perception of high notes.
7. Bone-conduction (increased) greater than air-conduction (diminished).	7. Bone-conduction (diminished) less than air-conduction (diminished).
8. Inflation through Eustachian catheter may show obstruction.	8. No Eustachian obstruction.

Treatment.—This must be directed primarily to the cure of the causative factor, which will be found in the nose, throat, or nasopharynx. Local treatment consists in restoring and maintaining the patency of the Eustachian tube, and in improving the mobility of the membrana tympani and of the ossicles by some form of massage. This may be administered either by inflating the middle ear with air or medicated vapour through the Eustachian tube, or by alternate rarefaction and condensation of the air in the external meatus. The latter method is achieved by an instrument which, by means of regulating the length and frequency of a piston stroke, can be made to rarefy and condense at will the air in the external meatus. Its easy application is perhaps its chief recommendation.

Inflation of the middle ear must always be done by catheter if the patient is old enough to permit of the passage of the instrument. The method of inflation by Politzer's bag should be given up for several reasons: First, it is quite ineffectual except in early deafness due to Eustachian catarrh; second, it does not allow of the admission of vapours into the middle ear; third, its effects cannot be limited to the affected ear. It is obvious that the inflation of the sound ear when treating a unilateral affection is an entirely unjustifiable proceeding. The use of Politzer's bag should then be reserved for children, upon whom it may be impossible to pass a catheter.

The Passage of a Eustachian Catheter.—It is a good plan to cocainize

the patient's nose on the affected side by placing along the floor a pledget of wool moistened with a 2 per cent solution of cocaine. The patient sits facing the operator, the chin and face slightly depressed. The patient's ear must be connected with that of the operator by a rubber tube having bone terminals for fixing in the external meatus. This is absolutely necessary if the operator wishes to know the results of the inflation. The catheter, carefully sterilized, is held by the big end, and the small end is placed on the floor of the nose and rapidly and *smoothly* passed backwards until the posterior pharyngeal wall is reached. The catheter is then slowly withdrawn for about half an inch, slight pressure being used to rotate the point outwards. The point will be felt to pass over the posterior lip of the pharyngeal orifice of the Eustachian tube and slip into a position directed outwards and a little upwards. The ring on the big end points in the direction of the small end. The point is in the Eustachian orifice if the catheter cannot be drawn further forward. When in position, the ring and the large end are held between the thumb and forefinger of the left hand. The nozzle of an inflation bag is inserted into the catheter, and air is introduced. To prevent " dragging," the inflation bag should be hung to a coat button and should have a long tube. Medicated vapours or sprays may be introduced by using an atomizer connected with a compressed air cylinder instead of the inflation bag, or by placing a drop or two of the required solution in the wide end of the catheter before inserting the nozzle.

Middle-ear Suppuration.—This form of disease of the ear is very common, and is only too frequently looked upon as an unpleasant and offensive condition which can be best disposed of by ordering a lotion to be syringed into the ear. The subject is too large to be adequately discussed here, but a few hints in the management of the cases and the recognition of complications may be useful.

1. Speaking in general terms, a discharge from the ear indicates middle-ear suppuration with a perforation of the membrana tympani.

2. The external meatus must be *mopped dry* with small cotton-wool swabs before examination.

3. Occasional bleeding from a discharging ear indicates the presence of granulations.

4. The size and situation of the perforation must be noted.

5. Discharges which cease and recur at intervals should make one suspect the presence of adenoids in children.

6. Always examine the nose, throat, and nasopharynx.

7. Granulations (polypi) grow from the middle ear through the perforation, so that a probe passed round them finds no point of attachment.

8. Bacteriological examination of the discharge shows that a pure culture (generally *Staphylococcus aureus*) is rare. The *Bacillus coli communis* is common enough in mixed cultures, and causes offensive discharges which are very resistant to treatment.

9. Children with offensive discharges from the ears frequently have carious teeth.

10. Narrowing of the meatus or sagging of the posterior superior quadrant of the meatal wall makes one suspect mastoid disease in prolonged suppuration (for differential diagnosis between furunculosis and mastoid disease, *vide supra*, p. 419).

TREATMENT OF MIDDLE-EAR SUPPURATION. — First treat any pathological condition of the nose or nasopharynx, such as rhinitis or adenoids, which, if left untreated, would render local treatment useless. See to the patient's general health, particularly looking out for anæmia. Local treatment consists in obtaining free drainage of the middle ear and introducing antiseptics to combat the suppuration.

Free drainage is essential. It is for this reason that it is necessary to note the size and position of the perforation. In *acute* middle-ear suppuration before perforation, an opening must be made in the membrana tympani, and this opening *must be free* and in a dependent part. To make a small incision is merely to inflict pain without a compensatory advantage. In more *chronic* cases, the perforation, if too small for adequate drainage, must be enlarged.

In ordering lotions for syringing, it must be remembered that a lotion, syringed into the meatus by unskilled hands, does not reach the middle ear, and therefore treatment by lotions is not enough. They do, however, remove the discharge lying in the external meatus, and are therefore of value as a preliminary to other treatment; but it is not necessary to order lotions of high bactericidal properties, nor is it advisable to give out-patients highly poisonous lotions. Antiseptic powders should not be ordered to be blown into the ear, as out-patients in their zeal use too much, and there is a risk of "caking" and consequent interference with drainage. It is best to order a lotion to be gently run into the meatus to remove the discharge, followed by a few drops of a spirituous solution. Rectified spirit, if slightly diluted, is a powerful antiseptic, and will penetrate through the perforation. As it evaporates it leaves behind the antiseptic which had been dissolved in it. Among such spirituous solutions may be mentioned:—

℞ Rectified spirit (10 per cent, 25 per cent, 50 per cent, 75 per cent).

℞ Boric acid gr. x
Rectified spirit (in various percentages) ℥j.

or:

℞ Argyrol gr. ij
Rectified spirit (in various percentages) ℥j.

Peroxide of hydrogen is a valuable application which has the advantage that it is painless (which cannot be said of rectified spirit) and is a powerful antiseptic. The discharge must be carefully removed before this is instilled, or a foam is formed which will prevent the peroxide reaching the middle ear.

If a chronic middle-ear suppuration does not yield to treatment carried on for, say, six months, and especially if granulations recur after removal, it is probable that the attic or the mastoid antrum is involved, and the question of the advisability of a radical operation must be considered.

Complications of Middle-ear Suppuration.

Mastoid Disease generally occurs in cases of prolonged suppuration, but it may arise early in some cases, e.g., after influenza, or it may be the first sign of ear disease in tuberculous mastoiditis, the onset of which is very insidious. It is characterized by the occurrence of *pain*, starting in the ear or the mastoid process, and tending to radiate over the side of the head, *local tenderness and heat* (by no means constant), *pyrexia*, *malaise*, and in some cases *giddiness and nausea*. The discharge may cease from time to time, this being the signal for the occurrence of symptoms which pass away when discharge recurs. We must not expect to find any mastoid swelling in the majority of cases. When it is present the disease is far advanced. The swelling is limited to the mastoid, and only in the late stages does the groove between the mastoid and the pinna become obliterated. Through the speculum, the external meatus is found to be narrowed by the drooping of the posterior superior quadrant near the membrane, and granulations may be present. The differential diagnosis between mastoid disease and furunculosis, which is most important, is fully described on p. 419.

After-treatment of Mastoid Operations.—In the acute form, the antrum will be drained from behind the ear; in chronic cases drainage will be arranged for through the posterior wall of the meatus. As a rule, the cavity of the antrum is packed with ribbon gauze, and the dressing consists in removing this, cleansing the cavity, and replacing the packing. The dressing is painful, and must therefore be done very delicately and carefully. The first dressing is generally done on the second day, though the time varies according to the condition found at the operation. The operation should have been so planned that the whole of the cavity of the antrum and middle ear can be inspected. The original gauze packing is moistened with peroxide of hydrogen, and can then be withdrawn with but slight pain. The cavity is then inspected through a large-sized speculum by means of reflected light, and cleansed either by mopping out or syringing. The packing is then replaced through the speculum, the greatest care being taken to pack the gauze lightly but evenly into the cavity. After the first dressing, the packing should be removed and replaced daily, the patient being allowed out of bed at the end of a week if all is well. When the cavity is covered by granulations, it may advantageously be painted occasionally with some stimulating preparation, such as a saturated solution of iodoform in ether, or lotio rubra, to aid in the epithelialization of the cavity if grafting has not been employed. The patient may be discharged from hospital in about a fortnight.

Lateral Sinus Thrombosis gives rise to a train of symptoms which is very characteristic. The patient is obviously very ill. Headache and vomiting are early and well marked. The temperature rises rapidly to 104° or 105°, with fluctuations of a remittent type. The pulse is small, rapid, and thready. Rigors occur early, are often repeated, and increase in frequency as the case proceeds. The tongue is dry and coated, and the breath foul. There may be mastoid swelling, which, if it occur over the mastoid emissary vein, is very significant. Pressure over the upper part of the internal jugular vein causes pain, and the vein may be felt to be thrombosed.

After-treatment.—It is the usual practice to tie the internal jugular vein at the time of operation, and the greatest care must be taken to prevent the incision becoming infected from the septic wound above. It is a good plan, if the patient is a child, to do the first dressing under a general anæsthetic, as the removal of the packing in the lateral sinus groove and its replacement are done with more accuracy if the patient is still. The general treatment is on the lines laid down for septicæmia.

Abscess of the Brain.—This may occur either in the cerebellum or in the temporosphenoidal lobe as the result of mastoid disease. Both cerebral and cerebellar abscesses have certain symptoms in common. These are: fixed headache; slow cerebration; normal or subnormal temperature, the temperature being raised on the opposite side of the body if the lesion is situated in the corneal plane through the Rolandic area (Victor Horsley); slow regular full pulse, and slow respiration, and later on marked emaciation. (Acute abscess differs in some respects from this clinical picture.) In either, vomiting and optic neuritis may occur, though neither sign is constant. Optic neuritis, if double and equal on both sides, points to meningitis rather than abscess. In abscess, the optic neuritis affects first the upper part of the disc of the affected side.

In *temporosphenoidal abscess* there may be paralysis of the opposite side owing to pressure on the Rolandic area across the fissure of Sylvius, affecting the face first, and then the arm, the leg generally escaping. If on the left side, aphasia may occur. The 3rd nerve on the side of the lesion may be paralyzed, leading to dilatation and immobility of the pupil on the same side. In abscess, the superficial reflexes, if affected at all, are affected unilaterally and disappear slowly. The abdominal reflexes are affected sooner than the knee-jerk, and therefore from the diagnostic point of view are more important.

In *cerebellar* abscess there may be muscular rigidity affecting the limbs of the same side, conjugate deviation of the eyes to the other side, nystagmus, lateral or rotatory according as the abscess is in the lateral or central lobe, exaggerated knee-jerks on the same side, and vertigo with a tendency to fall towards the side opposite the lesion. Patients lie curled up on the side opposite the lesion in cerebellar, but on the side of the lesion in cerebral abscess.

Chapter XLII.

THE TREATMENT OF THE TEETH.

By NORMAN G. BENNETT, M.A., M.B., B.C. (Camb.), L.D.S. (Eng.),
Dental Surgeon, Royal Dental Hospital, London;
Dental Surgeon, St. George's Hospital.

THE treatment of the teeth has now become definitely established as a special branch of surgery practised by dental surgeons, and the preservation of the teeth by conservative treatment is not usually attempted by medical men; but the general practitioner in country places, and the surgeon in the army or navy, are frequently called upon to relieve pain caused by the teeth, either by palliative measures or extraction. Furthermore, it becomes the duty of the family doctor to advise parents as to the care of children's teeth, and the means of preventing the ravages of decay and loss of valuable permanent teeth, unfortunately so prevalent at quite an early age.

It becomes necessary, therefore, that the medical man should know something of the hygiene of the mouth and of the evils arising from needless extraction of the teeth, especially during childhood; that he should be able to diagnose the seat of dental pain and afford temporary relief whenever possible with a view to subsequent treatment by a dental surgeon; and that finally, as a last resource, he should be able to extract a diseased tooth or root expeditiously, though deliberately, with a minimum of pain to the patient and of damage to the surrounding tissues. The scope of this manual will only permit of oral hygiene being dealt with very briefly, but the details of diagnosis will be considered at some length, and the use of the dental forceps will be fully described, because there is scarcely any operation of minor surgery which the surgeon usually executes so unskilfully, or undertakes so reluctantly, as tooth extraction.

Dental caries is especially a disease of childhood and early adolescence, and it is by no means unusual for the temporary molars to be seriously affected, or even rendered useless, before the first permanent molars commence to erupt behind the temporary molars during the seventh year. Dental caries is also a locally infective disease; and it consequently follows that the first permanent molars, which should be the chief organs of mastication between the ages of seven and twelve, are soon hopelessly decayed and possibly the cause of abscesses or sinuses. In a healthy mouth the natural replacement of the temporary dentition by the permanent takes place in such a way that the child is adequately provided with organs of mastication during the years when assimilation and growth are most rapid. But

when this process is interfered with by disease, and consequently by premature loss or undue retention of temporary teeth or roots, several evil results follow: painful or tender teeth prevent proper mastication, septic conditions of the mouth cause ill-health and malnutrition, extraction of the temporary teeth entirely deprives the child of the organs of mastication, and interference with the normal sequence of events causes irregularity and crowding of the teeth of the permanent dentition. If the first permanent molars become carious, as so frequently happens, and have to be extracted, the necessary stimulus to the growth of the jaws afforded by use is removed and small jaws with narrow arches are the usual result.

Correct diet, preventive treatment, and hygienic measures will very greatly diminish the incidence of dental caries in childhood, and palliative treatment will serve to allay pain until such time as conservative treatment can be undertaken by a dental surgeon; but in spite of the developmental irregularities occasioned by early loss of the temporary teeth and first permanent molars, whenever these teeth are so far carious as to interfere with mastication, or cause abscesses or sinuses, or a general septic condition of the mouth, they should undoubtedly be removed. Carious temporary teeth and first permanent molars are a fruitful source of enlarged submaxillary glands which may ultimately be the seat of tuberculous infection, and septic mouths are the prime origin of many of the ills of childhood; there can be no doubt in such cases that of two evils extraction is by far the less. It is surprising how children improve in health after the removal of septic teeth and roots, even if the masticating power is insufficient, provided the diet is adapted to the conditions.

In the case of the permanent dentition it is now generally recognized that a sound set of teeth is a very valuable asset to their possessor throughout life, and the ruthless extraction of teeth that could be saved by a pleasanter and less heroic method is greatly to be deprecated.

Teeth which are the seat of active caries must be distinguished from those affected by two different conditions, namely, hypoplasia of enamel and arrested caries. The former condition is characterized by deficiency and discoloration of the enamel, and unevenness of the surface in the form of pits and transverse lines. The more common variety, in which the coronal surfaces of the first molars and the edges of the central incisors have deficient or pitted enamel, is caused by ill-health and malnutrition in early infancy; and the less frequent variety, in which transverse lines are seen on the incisors, is due to exanthematous fevers or other acute illnesses. Arrested caries differs from active caries in its hard, smooth, and polished surface, and generally shows a deeply stained, dark brown discoloration. Teeth affected in either of these ways are often useful organs, and need careful inspection with a mouth-mirror and probe before being condemned. For a fuller description the reader is referred to works on dental pathology.

DENTAL CARIES AND DISEASE.

Prophylaxis and Preventive Treatment.—There can be little doubt that the prevalence of dental caries at the present day is intimately connected with the character of the diet, although general conditions of health affecting the condition of the saliva are also important factors and are responsible for the periodic attacks of dental caries which sometimes occur. The initial process of caries consists in a decalcification of the enamel by lactic acid, produced by fermentation of carbohydrates remaining about the teeth and the interstices between them. Starchy substances are more likely so to remain than sugars, and it is thought that the modern use of roller-ground flour instead of stone-milled flour conduces to this end. But sugars dissolved in the saliva may remain around the teeth at the points of contact by capillarity, and it is probable that the monosaccharide glucoses now used in sweetstuffs are more readily decomposed than the disaccharide cane sugar of former times, which must be "inverted" before being decomposed. The fibrous portions are now very generally removed from food-stuffs, and the result is a more sticky and adhesive material than the more natural product.

Children are usually given a diet which is too largely composed of much prepared starchy and sticky substances; it is not generally recognized that after three years of age or thereabouts, a healthy child is capable of masticating, and should be taught to masticate, most of the ordinary digestible food-stuffs used by adults; and although rich foods, soups, spiced and seasoned articles, and stimulants should be excluded from a child's dietary, it is very undesirable to go to the other extreme, and continue to feed a child, after three years of age, on food suitable for the transitional period between infancy and childhood when the temporary teeth are erupting.

Milk, bread, butter, eggs, farinaceous foods, simple puddings, fish, chicken, beef, mutton, natural gravy, certain vegetables, certain fruits raw or cooked, should form the principal items of a child's dietary, and these substances should be given as far as possible separately, not as sloppy or sticky mixtures. If these principles were more generally acted upon, much of the dental caries so prevalent at the present day would be prevented.

More direct preventive treatment in children or adults consists in removal of food particles and deposit by means of the tooth-brush and suitable tooth-powder. The brush should be small, and with rather stiff bristles not too closely set together. It should be used the first thing in the morning and the last thing at night after the last meal, and should be moved up and down rather than across the teeth, so as to allow the bristles to pass into the interstices. A suitable tooth powder contains as its chief ingredient precipitated chalk, together with soap and an antiseptic. A useful prescription is:—

R	Pulv. Saponis dur.		Olei Caryoph.	℥ij
	Pulv. Iridis	ää gr. xxx	Cretæ Præcip.	ad ℥j

Misce.

A more perfect method of cleaning the teeth consists in passing a strand of floss silk dipped in tooth-powder between the teeth all round the mouth, but very few people will spend the necessary time.

Periodical inspection by a dental surgeon will enable small cavities to be detected and "filled" with the least amount of trouble to patient and operator, and will almost ensure the preservation of the teeth in a functional condition throughout life.

Diagnosis.—The relief of pain caused by dental disease is the usual reason why a patient seeks treatment. Such pain may be felt in or around a tooth or be referred to some other part; in the former case it is called odontalgia and in the latter neuralgia. Odontalgia may arise from several causes [illegible] to inflammation or suppuration of the pulp, or to inflammation of the periodontal membrane or a connected alveolar abscess. In either case the initial cause is generally dental caries, leading to exposure of the pulp, to irritation by heat, cold, acid or sweet substances, or variations in pressure, and to septic infection of the pulp, all usually accompanied by more or less severe pain. Gangrene of the pulp follows, and the dead pulp undergoes decomposition. Should any of this septic material pass through the apical foramen of the root, or be forced through by mastication inflammation of the periodontal membrane results. This periodontitis may temporarily subside, but sooner or later, if untreated, often gives rise to alveolar abscess.

Other less frequent causes of odontalgia are secondary calcification in the pulp, direct traumatism, cementosis, exposure of the cementum from alveolar absorption, pin-point absorption of the apex, and necrosis of the root.

Neuralgia may be caused by general diseases such as diabetes or gout. Excepting pain of this origin, neuralgia is divided into two classes: (1) Epileptiform neuralgia, or tic-douloureux; (2) Neuralgia minor; the latter being sub-divided into (*a*) True neuralgia minor, (*b*) Visceral referred neuralgia.

Epileptiform neuralgia is a rare disease and is usually of central origin; it arises independently of disease in the teeth, is intense and spasmodic in character, and is felt in the region of distribution of the trigeminal nerve on one side of the face.

True neuralgia minor may very closely resemble the more serious disease in its distribution, but there is always definite organic disease, which is the real cause of the attacks of pain. This disease is generally situated in the pulp of a tooth rather than in the periodontal membrane, but may be any of those described as giving rise to odontalgia. Disease of a tooth in one jaw may give rise to pain in the corresponding tooth or another tooth in the other jaw; disease in the third molar frequently causes pain in a premolar in the same jaw. The cause and seat of the pain are always on the same side of the head.

Visceral referred neuralgia differs from the two preceding in several particulars. It is not always strictly neuralgic in character, but may

be a fixed pain in certain regions; it occurs in areas which do not correspond to the distribution of the fifth nerve, and is associated with tender areas which are very sensitive to tactile impressions. This form of neuralgia has, like true neuralgia minor, a definite objective cause, which may be any of those detailed above, and the tender areas have a fairly definite relationship to the various teeth of the same side. These areas have been carefully mapped out by Dr. Head.

It is obvious, then, that care has to be taken in diagnosing between the different kinds of neuralgia, and in finding the real seat of pain.

When the cause of the pain has been located in a particular tooth, there remains the need, for the purposes of treatment, to distinguish broadly between disease of the pulp and disease of the periodontal membrane.

The pain of pulpitis is of a sharp, stabbing character; it is intermittent, is accentuated by hot or cold fluids, or by pressure or contact with food particles which find their way into the cavity, and is generally worse at night. As the result of irritation, there may be acute throbbing pain which gradually subsides, but should suppuration of the pulp supervene, the throbbing becomes more continuous. The tooth itself is not necessarily, or usually, tender to pressure or percussion.

The pain of periodontitis is more continuous, deep-seated, dull and persistently throbbing, especially when suppuration is commencing. The tooth itself becomes raised in the socket and is intensely sensitive to pressure, so that the patient avoids biting the teeth together. The pain is less affected by changes of temperature than pulp pain, but is increased by much warmth or extreme cold. Should alveolar abscess supervene, accompanied by much swelling, the pain ceases owing to the escape of the pus through the absorbed alveolus into the more distensible tissues without. The abscess may point inside the mouth or on the face. There is usually much œdema, and the skin becomes red, shiny, and tense, especially over any spot where the abscess may tend to point. Inflammation of the pulp and periodontal membrane may sometimes co-exist, as from injury, or by extension from the pulp to the periosteum.

Palliative Treatment.—The pain of acute pulpitis is usually very amenable to treatment having for its object the ultimate preservation of the tooth. The cavity should first be cleared of all loose débris and of as much of the decalcified dentine as can be removed without pressure being put upon the pulp. The cavity should then be made as dry as possible with cotton-wool and, if possible, with small pieces of amadou, and by warm air being gently blown upon it. It should then be carefully but thoroughly swabbed out with warm oil of cloves. This treatment usually relieves the pain almost at once, but if the cavity cannot be got reasonably dry, it is of little use, as the oil of cloves does not penetrate to the pulp; in that case, and as a subsequent treatment, the best method is to insert a small piece of cotton-wool dipped in carbolized resin—Phenol ʒiv, powdered resin ʒiv, chloro-

form ℥ij—and slightly squeezed, and to cover this with another pledget of cotton-wool, saturated with a solution of gum-mastic or gum-sandarac in chloroform or ether, and only lightly packed into the cavity. Subsequent treatment by a dentist will consist in "devitalizing" the pulp with an application of arsenious acid, removing the dead pulp, and filling the root canals, or in removing the pulp under "pressure anæsthesia" with the aid of cocaine, and filling the root canals.

In periodontitis the septic material has already passed through the apical foramen of a root, and only a very thorough antiseptic treatment of the pulp chambers and root canals is of any use; counter-irritation may, however, avail to alleviate pain and ward off the formation of an abscess. A small quantity of tincture of aconite and iodine should be painted on the gum around the tooth, and the patient should then rinse out the mouth. Or a small capsicum plaster should be applied to the gum over the root of the tooth on the buccal side, and left there until all the capsicum has become washed away by the saliva. If the inflammation does not resolve, or if the pain continues, hot fomentations applied round the tooth inside the mouth will often give relief. Half-a-dozen poppy capsules should be broken up, the seeds removed, and the remainder stewed in a quart of water until it has boiled down to a pint. Small sponges squeezed out of this lotion quite hot, and applied in succession to the gum, will frequently give relief. The patient should avoid swallowing the liquid. Fomentations should on no account be applied to the face, as this encourages the forming abscess to point outside the mouth, and leads to a sinus and permanent scar.

In case such palliative treatment proves successful, the subsequent treatment of periodontitis by a dentist will consist in rendering the cavity and root canals as aseptic as possible and, after drainage and subsidence of inflammation, filling the root canals. It should be said, however, that a tooth which is the seat of periodontitis, especially if chronic, is less likely to become eventually a useful organ than one affected by inflammation of the pulp, and therefore that radical treatment by extraction is more justifiable.

Chronic Suppurative Periodontitis (*Pyorrhœa alveolaris*).—A chronically inflamed condition of the periodontal membrane may arise independently of sepsis derived from a dead pulp, and proceeds apparently from a superficial marginal gingivitis. The inflammation usually affects sound teeth and spreads down the tooth-sockets, separating the gum from the teeth and producing pockets. The alveolus becomes the seat of a rarefying osteitis, and pus in variable amounts is generated. The necks of the teeth are usually covered by tartar, and the teeth gradually loosen and eventually fall out. The gums may be inflamed and hyperæmic, or of a pale anæmic appearance suggestive of absorption. The active cause is bacterial invasion of the tissue around the necks of the teeth, and of the pockets formed in

the progress of the disease, but no specific organism has been isolated. Constitutional conditions are said to predispose to or influence the course of the local affection.

Treatment.—If undertaken early this is usually successful in checking or curing the disease, but chronic cases of long standing are very intractable. In the hands of the dentist, treatment consists in removing all deposit from the teeth and in the application of antiseptic and astringent drugs, such as sulphate of copper, tincture of iodine, or peroxide of hydrogen. Ionic medication with chloride of zinc, iodine, or argyrol is very beneficial in some cases. Vaccine therapy has been tried with apparent success, but further experience is needed before a definite statement can be made as to its efficiency.

Oral Sepsis.—The ingestion of pus and septic material derived from the sockets of teeth, or from carious roots surrounded by an area of gingivitis, may be, and often is, the cause of serious illness. When pyorrhœa cannot be cured, or at any rate kept well in check, the teeth should be removed; and carious roots should almost always be extracted if they cannot be treated by conservative methods, such as crowning with artificial teeth.

EXTRACTION.

Extraction of diseased teeth may become necessary on account of looseness, or of mechanical roughness or sharpness, causing disease of the tongue, cheek, or gums; or from urgency or inability to procure special treatment; or for some of the reasons already mentioned. The extraction of sound teeth of the deciduous dentition may be called for by their undue retention, and consequent interference with the normal eruption of the permanent teeth; and extraction of the teeth of either set may be necessary as the result of injury or disease of the jaws. The extraction of permanent teeth on account of irregularity in position should, as a rule, only be undertaken after consultation with a dental surgeon.

Principles of Extraction.—No mere verbal description of extraction will suffice to make the student proficient without observation of, and teaching by, the skilful operator, and frequent actual performance of the operation itself. It is of the utmost importance for the student to realize that *pulling or the application of violent force or indiscriminate wrenching* is likely to have no other result than fracture of the tooth, and possible serious injury to the jaw.

The patient should be sitting in a firm, strong chair, with the neck and head well supported; and the head should be leaning slightly backwards. The light should fall on the patient from the front, but slightly from his left and above his own level. The operator is always on the patient's right side, sometimes in front and sometimes behind, according to the tooth to be extracted.

Extraction is performed with forceps or elevators, which vary in shape and character with the teeth for which they are adapted. Forceps

should be of sufficiently heavy pattern not to bend or spring under any strain which may be put upon them, as any such weakness greatly diminishes the sense of touch of the operator, and his ability to estimate quickly the resistance encountered. The handles of the forceps should be long enough to reach the interval between the thenar and hypothenar eminences; they are usually made rather too short for large hands, and are then apt to shift in the palm when in use. The thumb should be pressed firmly between the handles close up to the hinge, so as to counteract the pressure exercised by the hand until the tooth or root is firmly grasped, when the thumb may be slipped along on to the face of the hinge to avoid being pinched in case the tooth should be crushed by undue pressure or insufficient penetration of the blades of the forceps, or the forceps should slip off the tooth or root (*Figs.* 266, 267). The elevator should be held with the handle firmly in the palm and the fore-finger along the blade and reaching nearly to the end.

Fig. 266.—Showing manner of Holding Upper-Forceps.

The left hand should be used to keep the soft parts out of the way and so obtain a clear view, and to grasp the alveolus, and also guard against a tooth or root falling down the pharynx, in case, as sometimes happens, it should shoot from the socket under the closing pressure

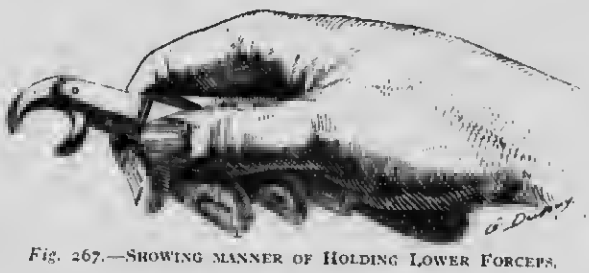


Fig. 267.—Showing manner of Holding Lower Forceps.

of the blades of the forceps. When lower teeth are being extracted, the hand should also be used to support the mandible.

A general knowledge of the anatomy of the teeth and jaws on the part of readers of this manual is assumed, but an examination of *Plate VII* will show the usual arrangement of the sockets. Two chief

points have to be remembered: (1) The teeth of the normal and complete arch are in close apposition, and the points of contact are nearer to their buccal than their lingual surfaces; in other words, the individual teeth are roughly wedge-shaped and form part of a continuous arch; (2) The alveolus, except in the case of the third lower molar, is thinner and weaker on the buccal than on the lingual aspect (*Fig.* 268). For both these reasons it is obvious that a tooth can be moved more easily outwards than inwards, and in the case of most teeth this is the chief movement which separates the tooth from the bone.

An important preliminary to extraction is a careful examination of the tooth or root in order to ascertain whether any abnormality is likely to be met with, such as cementosis, or adhesion to the bones from chronic periodontitis. Abnormality of the roots may sometimes be surmised from an unusual shape of the crown, especially in the case of an upper molar. The density of the bone varies considerably in different patients, men generally having denser bone than women, and women denser than children. Roots partly covered by gum should be carefully examined with a probe in order to define the edges.

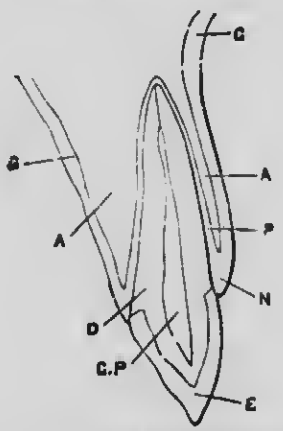


Fig. 268.—Diagram of Section through Upper Tooth and Alveolus.

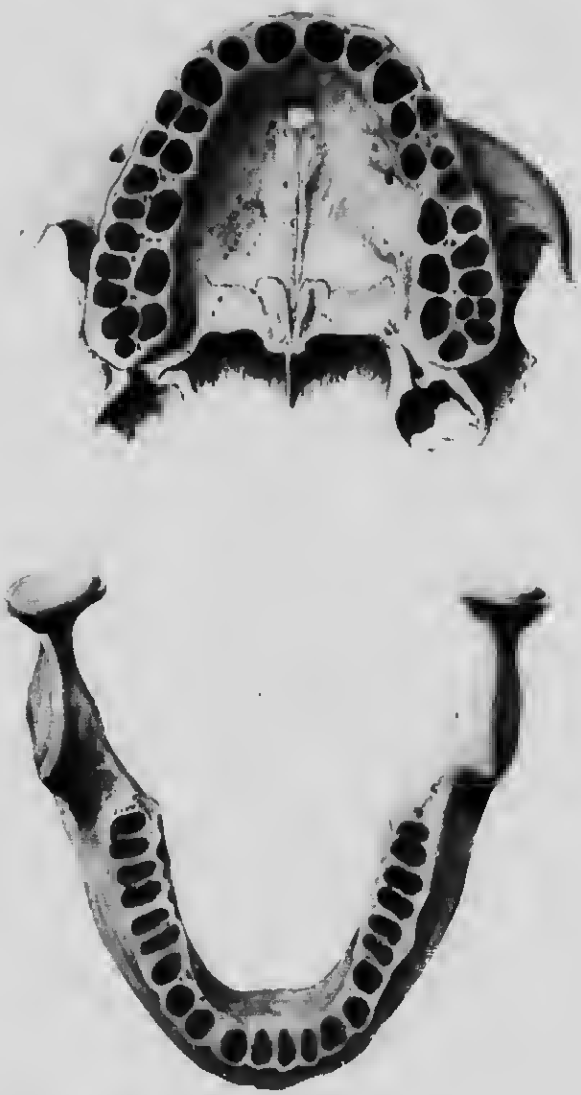
A A, Inner and Outer Alveolus; G, Gum; D, Dentine; E, Enamel; C P, Pulp Cavity.

Extraction with forceps consists of three stages: (1) Adaptation to the tooth or root; (2) Separation from the alveolus; (3) Removal from the socket and mouth.

In the first of these the blades should pass between the gum and the root, and be pressed firmly down with a slightly oscillating movement before being tightly closed. As a rule the inner blade should be applied first, but the exact method depends upon circumstances, and will be dealt with when the individual teeth are considered.

In the second stage the tooth is first slightly tilted inwards, and then steadily levered outwards until the outer plate of alveolus is fractured or sufficiently bent, and the periodontal membrane on the inner side ruptured; it is then levered inwards in a similar manner, but to a less degree, and the process is repeated until the tooth is separated from the bone. In the case of teeth with single conical roots, such as the upper incisors and lower premolars, rotation combined with tilting may be employed, but rotation alone without fracture or bending of the outer plate of alveolus is not usually sufficient. It is important to remember that, so far from being pulled from the socket,

PLATE VII.



USUAL ARRANGEMENT OF THE SOCKETS OF THE TEETH.

(From Cryer's *Internal Anatomy of the Face.*)

To face page 434

the tooth should rather be kept pressed firmly into the socket, especially when alveolar resistance is considerable. Neglect of this principle and loose closing of the blades are fruitful sources of horizontal fracture.

The third stage consists simply in withdrawing the tooth from the socket after it has been sufficiently loosened, and it will often be found, even in the case of multiple-rooted teeth, that a slight rotatory movement combined with gentle traction will effect this best. The thumb and fingers of the left hand should closely surround the blades of the forceps until the tooth is removed from the mouth, and the tooth should not be lost sight of until this is safely accomplished.

The elevator should not as a rule be used except by fairly experienced operators, but the method of using will be considered in connection with the teeth for which it is best adapted.

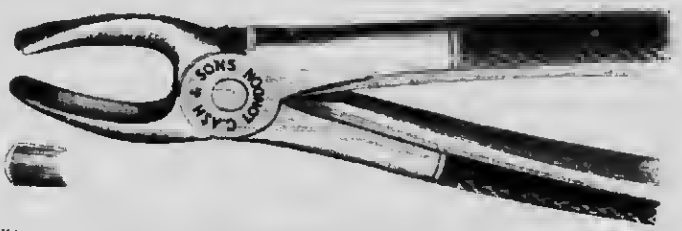


Fig. 269.—Forceps for Upper Incisors, Canines, and First Premolars.

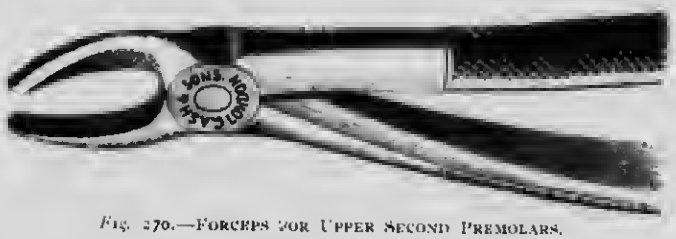


Fig. 270.—Forceps for Upper Second Premolars.

Methods Applicable to Individual Teeth.

Upper Incisors. — Straight forceps as shown in *Fig.* 269 should be used. The operator stands, as is always the case, on the patient's right side, and slightly in front. The inner blade should be applied first and the tooth tilted slightly inwards and then levered outwards and rotated at the same time. The forefinger and thumb of the left hand grasp the alveolus, the former also holding the lip out of the way (*Figs.* 271, 272).

Upper Canines.—The method is similar, but on account of the length and shape of the root, more force is necessary and rotation is less useful.

Upper Premolars.—Straight forceps should be used for the first premolar, and may be used for the second, but for the latter it is usually advisable to use slightly curved forceps, as shown in *Fig.* 270.

The roots are flattened and do not permit of rotation, and that of the first premolar is usually bifurcated. The operator stands as for

Fig. 271.—Showing Use of Left Hand when Operating on Left Side of Upper Jaw.

incisors, applies the inner blade first, then tilts the tooth slightly inwards, and then firmly outwards. If the alveolus does not give

Fig. 272.—Showing Use of Left Hand when Operating on Right Side of Upper Jaw.

way, a more forcible inward, followed by the outward, movement should be repeated. The tooth should not be pulled, but rather kept firmly pressed into the socket.

Upper Molars (first and second).—The forceps used should be strongly, and rather heavily, but not clumsily, made. An upper molar tooth has two small roots on the buccal side, and one large on the palatal; different forceps are therefore required for the two sides, as shown in *Figs.* 273 and 274. The outer blade in each case is pointed and has two grooves, and the inner blade has one larger groove. It is important to remember, when applying the forceps, that the inner blade should be distinctly posterior to the outer, and that the latter should be kept well forward on the anterior buccal root; also that the handles should be kept well back, and the lower lip prevented

Figs. 273, 274.—Forceps for Upper Molars (Right and Left).

from being pinched between them and the lower teeth. The position of the operator and the method of loosening the tooth from its socket are the same as for premolars, but it will often be found that for removing the tooth from the socket after loosening it a slight rotation of the outer blade forwards is useful.

Upper Molars (third).—The same forceps may be used, but, as the tooth is less accessible and the roots are usually smaller and sometimes fused, a pair of forceps with a greater curvature, and with two blades similar to the palatine blade of the molar forceps, is generally more efficient. It is important to apply the blades very carefully, as there is some risk of tearing the gum, or even of fracturing the tuberosity.

Upper Molar Roots.—When the crown of the tooth is much broken down and caries extends below the gum level, root forceps, as shown in *Fig. 275*, should be used, to grasp usually the anterior buccal and palatine roots. One blade should be applied first to the root which is less decayed, and then the other blade very carefully to the root more decayed below the gum. Tilting should be first towards the more decayed root, and the forceps should be pushed firmly up at the same time, the thumb and forefinger of the left hand grasping

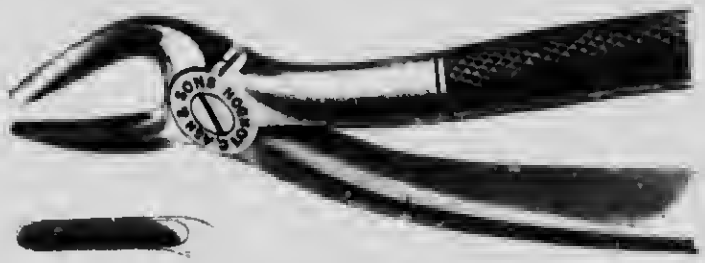


Fig. 275.—Forceps for Upper Molar United Roots.

the alveolus firmly and preventing slipping. Movement to loosen the roots should be almost entirely in the direction of the more decayed root. When it is found impossible to loosen the roots in this way, or when all the roots are much decayed below the gum, it will sometimes be found that by applying the outer blade to the posterior buccal root and the inner blade anterior to the palatine root, the roots may be divided and one or more brought away at the first attempt.

Fig. 276.—Forceps for Upper Molar Separated Roots.

When the roots are divided they may easily be removed separately with a slight movement of rotation. For the removal of single roots of an upper molar, rather finely-pointed, bayonet-shaped forceps, as shown in *Fig. 276*, are usually employed.

Lower Incisors and Canines.—Forceps as shown in *Fig. 277* should be used. The patient should be on a low level, and the operator should stand on his right side and slightly in front. The lingual blade should be applied first, and the same methods followed as for upper premolar teeth. The lip should be kept out of the way with the forefinger of the left hand, and the tongue with the second finger, the thumb being used to support the chin (*Fig. 278*).

Lower Premolars.—The same forceps are used, and as the roots are more or less conical, rotation alone, or more usually in combination with tilting, may be employed. The position of the operator in extracting on the left side of the mouth is the same as for incisors, but for teeth on the right side he should stand behind the patient and bring the left arm

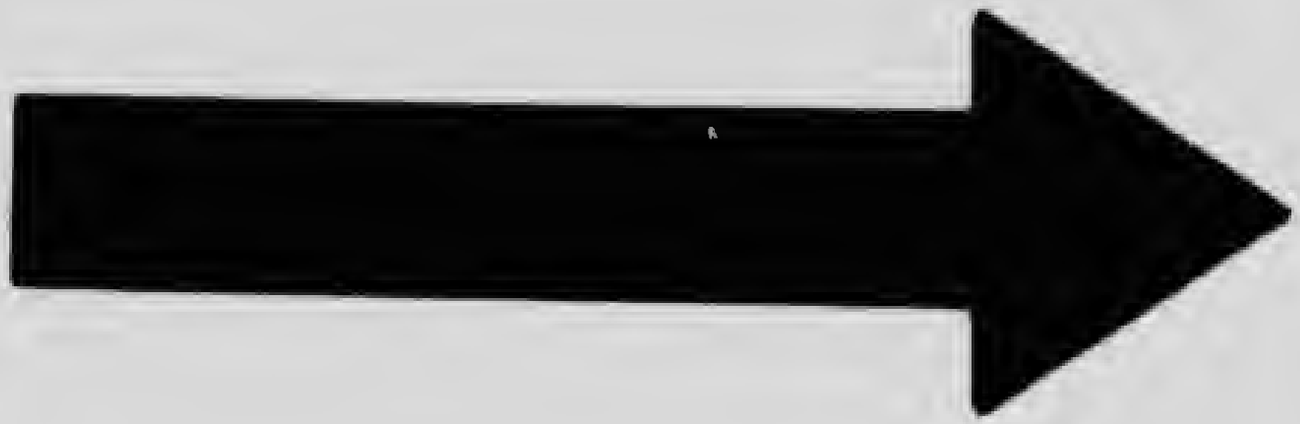
Fig. 277.—Forceps for Lower Incisors, Canines, Premolars, and Molar Roots.

round the patient's left side. The alveolus should be grasped with the thumb on the lingual side and the forefinger on the buccal side, and the other fingers should be used to support the mandible (*Fig. 279*).

Lower Molars (*first and second*).—Forceps as shown in *Fig. 280* should be used, the points of the blades passing between the two roots. The

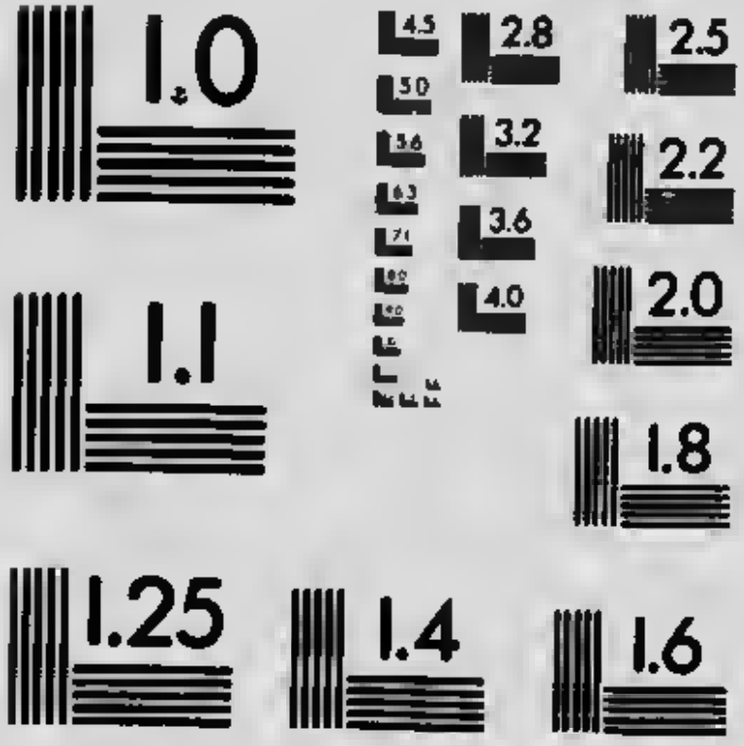
Fig. 278.—Showing Use of Left Hand when Operating on Left Side of Lower Jaw.

position of the operator and the use of the left hand are the same as for premolars. The inner blade should be applied first, and it is important to be careful that the forceps are square to the tooth, with the hinge well back. The forceps should be pressed firmly down with the left hand, the second finger being used on the left side and



MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

the thumb on the right ; and the handles should be on a higher level than the blades, because the teeth usually lean inwards. Until the tooth is thoroughly loosened from its socket, no movement of traction should be made : the tooth should rather be kept firmly pressed into its socket to avoid fracture.

Fig. 279.—Showing Use of Left Hand when Operating on Right Side of Lower Jaw

Lower Molars (*third*).—The same forceps may be used, and the same positions adopted as for first and second molars ; or a pair of forceps with straight handles and curved blades may be used, the operator then standing in front when extracting on either side. In loosening this tooth from its socket, inward tilting is more useful than outward,

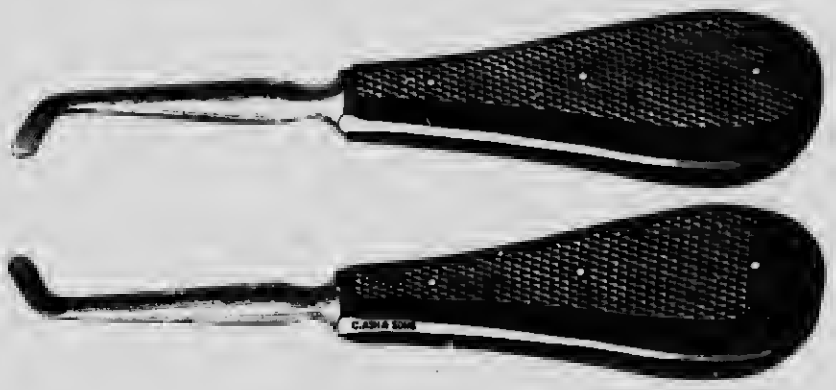
Fig. 280.—Forceps for Lower Molars.

because of the thickness of the outer alveolar plate. The best instrument for raising a lower wisdom tooth from its socket is a straight elevator, *Fig.* 281. This should be held as previously described, with the handle in the palm of the hand and the forefinger along the blade ; when extracting a tooth from the left side of the jaw the

operator stands in front of the patient and has his forefinger along the flat side of the blade of the elevator, and when extracting from the right side he stands behind and has his forefinger along the convex side of the blade. The root or roots of the tooth usually curve backwards. If, therefore, the point of the elevator is firmly pressed down between the anterior surface of the root and the alveolus on the buccal side (that is to say, into the interval between the second and third molars), with the flat side next the tooth, and the handle is pressed

Fig. 281.—Straight Elevator.

downwards, the tooth will be tilted backwards. The point should then be pressed further down with a slightly rotary movement and the process repeated. After the tooth has been loosened in this way, it is sometimes convenient to remove it with forceps. It is important to guard the tongue and soft parts with the left hand in case of the instrument slipping; and as there is some risk of the operator cutting his finger it is wise to be cautious about using the elevator in septic mouths or those affected by specific disease.



Figs. 282, 283.—Curved Elevators.

Lower Molar Roots.—When a lower molar is so far carious that the roots are nearly separated, the same forceps as for incisors and premolars should be used, and applied to the stronger of the two roots. When one root has been removed it is usually easy to remove the other by means of a curved elevator (*Figs.* 282, 283). The point should be passed down to the bottom of the socket of the extracted root and through the bony septum, and the handle so rotated as to force the root up from below; or the point may be pressed between the root

and the adjacent tooth, and the handle rotated so as to force the root into the socket of the extracted root.

Temporary Teeth are removed in a similar way with smaller instruments. The blades should not be pressed down too far for fear of injuring the permanent teeth below. It should be remembered that when temporary teeth are removed before the roots have become absorbed, the pain of extraction, when an anæsthetic is not being used, is considerable, and children should never be deceived as to the amount of pain likely to be suffered. Such a course is unfair, and causes entire loss of confidence by the child.

Complications and Casualties of Extractions.

Fracture of the Tooth—This is generally due to the blades of the forceps not penetrating deeply enough, or not being closed firmly, one blade thus being allowed to slip slightly; or to the forceps not being kept firmly pressed down until the tooth is loosened from its socket; or to hurry in manipulation. The roots should be carefully defined and removed if possible, but if this proves difficult they may be left for a few days, when inflammation will probably have made the operation easier. Failing this they will eventually rise from the sockets.

Extraction of the Wrong, or an Adjacent, Tooth.—The tooth should be washed in warm water and replaced in its socket, and the mandible should be fixed with a four-tail bandage. The patient should be advised to consult a dentist with a view to possible future treatment of the pulp.

Fracture of Bone.—Fracture of a small portion of alveolus is of little consequence. More extensive fractures must be treated with appropriate splints.

Trismus.—An anæsthetic should be administered and the mouth opened with a Mason's gag.

Laceration of the Gum.—Torn portions of gum usually reunite if pressed into place. A fragment only adhering by a thin pedicle should be removed with scissors.

Hæmorrhage following tooth extraction may be serious, and demands prompt treatment. It may be due to the hæmorrhagic diathesis known as hæmophilia, and the extraction of a tooth for a patient known to be the subject of this disease to a marked degree should not be undertaken except from absolute necessity. When it is necessary to extract teeth for a patient known to bleed freely or for a long time from small wounds, an endeavour should be made to get the patient into as good general condition as possible, and chloride or lactate of calcium in 10-gr. doses three times a day may be given for three or four days beforehand. The operation should be done in the morning, and only one tooth should be removed at the first sitting.

Hæmorrhage after extraction may be primary, reactionary, or secondary. In the first case very hot or ice-cold water with some tincture of hamamelis should first be tried, and the patient should allow the blood and water to run from his mouth, as spitting, by

causing suction, encourages hæmorrhage. If this fails, the socket must be cleared of clot as well as possible and plugged with a strip of boracic gauze, soaked in adrenalin chloride and lightly squeezed out, and carrying as much tannin as it will take up. The gauze should be firmly packed into and above the socket, and firm pressure maintained on it, and on both sides of the gum and alveolus, with the fingers. This will usually check the bleeding, and the jaw may then be fixed with a four-tailed bandage, so that the upper teeth bite firmly on the packing and keep it pressed well down; the plug may have any loose portions above the socket cut away after twelve to twenty-four hours, but should not be removed entire until it has become loose by itself. Sometimes the extracted tooth, after being washed, may be used as a plug, either alone or with a layer of gauze intervening, and kept in position by the opposing tooth with the aid of a four-tail bandage. A dose of gallic acid, 15 gr., may be given, and repeated every two hours for the next twelve hours if the hæmorrhage does not cease. The patient should be kept under observation, and fed on cold liquids, and be told to remain quiet, and not lie down at all, or at least not without the head well propped up.

Reactionary hæmorrhage usually commences some hours after extraction. It may be from the gum, but is usually from the socket. In the former case it is easily dealt with, and in the latter the same local treatment as that described for primary hæmorrhage should be adopted. Suture of the gum over the socket after or before packing is sometimes employed. In cases where the blood shows but little tendency to coagulate, hæmostatic drugs, such as gallic acid or perchloride of iron, should be given internally; but where the blood coagulates in the mouth a more suitable drug is one which causes contraction of the vessel walls, and a hypodermic injection of ergot may be given; an objection to ergot is that it raises the blood-pressure. Pressure on the common carotid may be employed, and failing these measures surgical interference may be necessary.

Secondary hæmorrhage, which is comparatively rare, requires similar treatment.

Pain Continuing after Extraction usually subsides without treatment, but hot fomentations inside the mouth over the socket will give relief. Pain continuing for long after extraction is generally due to septic inflammation. The socket should be swabbed out with a small quantity of carbolic acid, 1–20, and kept frequently syringed with a more dilute antiseptic. Injury to the inferior dental, and to the lingual nerve, has been recorded.

Dislocation of the Mandible occasionally happens, usually under an anæsthetic, but reduction is easily effected.

Extraction under Anæsthetics.—The general principles for extracting under anæsthetics are the same as described above, but there are a few points worthy of special remark.

With short periods of anæsthesia it is unwise to attempt to do too

much in the time; and although the operator should of course have everything ready, in order to commence operating immediately the face-piece is removed, time is never wasted in applying the forceps carefully and thoroughly, or in reapplying them if the grasp is unsatisfactory. Experience alone will enable the operator to estimate at once by his sense of touch the amount of force necessary to loosen the tooth from its socket.

When extracting lower teeth, it is important not to depress unduly the root of the tongue or the mandible. A momentary pressure on the tongue with the thumb or a finger of the left hand, while the inner blade of the forceps is being applied, is permissible, if respiration is not impeded. The mandible should be well supported with the left hand.

The removal of the tooth from the mouth should be done with care, and during the whole operation of extraction the thumb and one or more fingers of the left hand should surround the tooth, in order to avoid risk of the tooth dropping down the pharynx, and possibly into the trachea. This precaution is especially necessary when upper molar teeth or roots are being extracted. If a tooth or root slips from the forceps into the mouth, the patient's head should at once be tilted forwards, and the tooth found and removed before any further operation is proceeded with; in case the tooth drops on to the root of the tongue care should be taken not to push the tooth further back or induce a deep inspiration by trying to hook the tooth forward with the forefinger. It is better for the patient to swallow a tooth or root than to inhale it, but if the head be kept well tilted forward neither accident is likely to happen.

When several teeth are being extracted, the lower teeth should be removed first, so as to avoid as far as possible the difficulties occasioned by hæmorrhage, and for the same reason the most posterior lower teeth should be removed first of all.

The extraction of a large number of teeth under a long period of anæsthesia is an operation not altogether to be commended, on account of the risk of septic absorption through extensive damage to the tissues, or of septic pneumonia and gangrene of the lung. Furthermore, the condition of the patient for a week or two afterwards is a somewhat unhappy one; mastication is impossible, and a milk diet necessary. For the last reason, extraction limited to one side of the mouth at a time is to be recommended; but in the case of a very septic mouth this half-measure is less advisable than the removal of only a few teeth, or a complete clearance of all septic teeth and roots at one sitting, because the opportunities for septic absorption are at their maximum.

When extractions are being carried out on both sides of both jaws, the best order of procedure depends to some extent on the number of teeth to be removed from the lower jaw. When several lower teeth on each side are to be removed, the operator should commence at the back of that side of the mandible in which there are most, then cross

to the other side, then extract the upper teeth on the same side, and finally the upper teeth on the side on which he first started, in each case proceeding from the back forwards. This plan involves the shifting of the gag twice, but is the quickest and best in the end. When, however, there are only a few teeth to be removed on one side of the lower jaw, and these are not likely to give much trouble, it is justifiable to complete the other side first, both upper and lower, and insert a large sponge, which will be held in position with the Mason's gag. It should be remembered that some of the unpleasant after-effects, especially vomiting, are occasioned more by the swallowing of blood than by the anæsthetic itself, and this should be prevented as far as possible by frequent sponging with moist sponges squeezed as dry as possible.

After-treatment.—In all cases where a large number of teeth have been removed, and in many others where the mouth is more than ordinarily septic, or the tissues have been much damaged, a mouth-wash should be prescribed, to be used morning and evening, and after every meal. In some cases, it may be advisable to syringe an antiseptic lotion into the socket or sockets. A useful mouth-wash is

℞ Liq. Potassæ	℥j	Tinct. Cocci	q.s.
Acid. Carbol. Liq.	℥ss	Aq.	ad ℥j

Misce. Sig.: *Not to be taken.* Use one teaspoonful in half a tumbler of warm water.

Or, of a milder character:—

℞ Acidi Borici	gr. x	Aq.	ad ℥j
Zinci Sulph.	gr. iij		

Misce.

TREATMENT OF ALVEOLAR ABSCESS.

In order to prevent serious conditions and symptoms supervening, and to avoid the pointing of the abscess outside the mouth, the first essential is to evacuate the pus. This may be done in two ways, namely by removing the tooth or by incising the abscess. When the general swelling is considerable, and there seems to be any possibility of cellulitis spreading to the neck, or when the abscess is about to point outside the mouth, the former course should always be adopted. The tooth should be extracted at once; and if the pus is not freely evacuated through the socket, or if the abscess is pointing inside the mouth and at some distance from the tooth, the abscess should be freely incised as well. When, however, the symptoms are less urgent, incision of the abscess will suffice to give immediate relief, and subsequent treatment by a dental surgeon may restore the tooth to a healthy condition, especially in the case of an acute abscess arising for the first time in connection with a particular tooth. This course is particularly desirable in the case of upper incisors and canine teeth when circumstances permit. A lotion for use as a mouth-wash or for syringing the abscess cavity should be prescribed, and the patient should be given a purge.

SECTION VIII.

OF CERTAIN EMERGENCIES, SURGICAL AND GENERAL

CHAPTER XLIII.

ASPIRATION AND TAPPING OF THE BLADDER. RETENTION AND SUPPRESSION OF URINE, ETC.

ASPIRATION of the Bladder over the Pubes.—This has become the common way of emptying the bladder by other than the natural passage, since it has been recognized that the operation may safely be repeated at short intervals; as many as a dozen aspirations being frequently performed.

The instrument used may be the one previously mentioned (*see* under "Abscesses," p. 306), or an ordinary fine trocar and cannula. In any case the operation is of the simplest; the points to bear in mind are: (1) That the condition of the bladder must be accurately

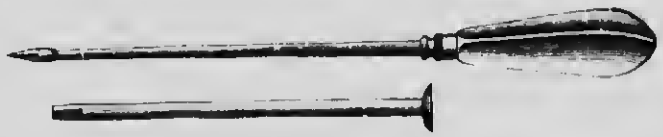


Fig. 284.—BLADDER TROCAR.

made out, and the thickness of its walls estimated as far as possible, for a bladder may be over-distended, and yet, through the muscular hypertrophy of its walls, may rise only a very little way over the pubic crest; (2) That the aspirating trocar must be very sharp, so that the bladder walls, if thus thickened, may be readily pierced; and (3) That the bladder must be entered fairly at right angles, just above the pubes; (4) That the bladder must form a definite tumour; it is not sufficient to rely on dullness alone; (5) That care must be taken not to mistake distention of the organ with blood for distention with urine. A fine trocar and cannula, not a pen-pointed hollow needle, must be used, and the best pattern is that in which the trocar acts as a piston, and when withdrawn through the cannula, allows the urine to escape by a side branch. The patient must be lying down while the aspiration is being performed, and the operation done with all antiseptic precautions. The depth at which the bladder

is reached depends upon the amount of fat present, and upon the thickness of the bladder. The length of the trocar and cannula should be at least 4 inches.

Washing out the Bladder.—This treatment is often required in cases of cystitis, whatever be the cause of the condition, and although the operation is easy enough, it requires some care to avoid giving needless pain or harmful irritation. The fluid used should always be warmed to about 98° or 100° F., and should contain some antiseptic, such as perchloride of mercury (1–4,000), carbolic acid (1–500), sulphate of quinine (2 to 4 gr. to the ounce), boric acid (saturated solution), acetate of lead (½ gr. to the ounce), or nitrate of silver (½ gr. to the ounce).

Before proceeding to wash out the bladder it should always be emptied by drawing off the urine with a soft catheter. The amount injected must vary with the capacity of the bladder, but not more than two or three ounces should be injected, unless a double-channelled catheter is used, or the capacity of the bladder is known.

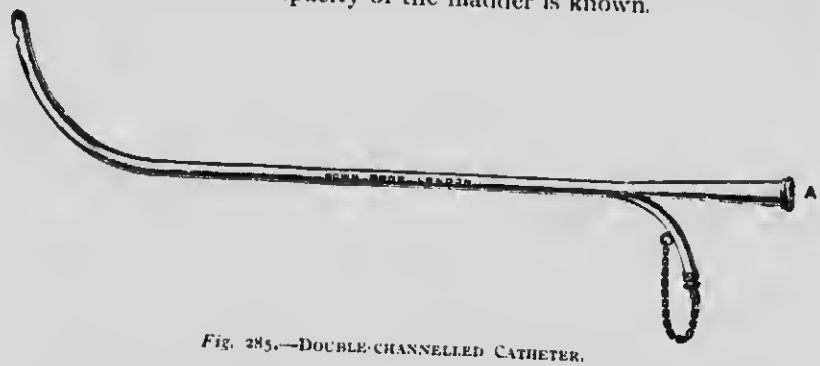


Fig. 285.—Double-channelled Catheter.

A Two-wayed Catheter (Fig. 285) is often used for this purpose, and does well, although no better than other simpler plans. The instrument, which is made in silver or gum-elastic, and which contains, as shown in the figure, two channels, with separate apertures, is inserted in the ordinary fashion; the catheter end *A* is connected to the tube of a small irrigator, or the fluid is introduced by means of a glass or metal syringe.

With Syringe and Catheter.—Another method is to pass a full-sized metal or flexible catheter, and to inject as before, but limiting the amount to well within the capacity of the bladder; when the syringe is disconnected the bladder will eject the fluid, and the washing may be repeated.

With Tube, Funnel, and Catheter.—All the advantages of the two-wayed catheter, without its complications, may be secured by passing a large catheter and attaching to it a tube with a funnel at one end. The tube should be not less than three feet long, and the funnel should first be held about a foot above the level of the bladder, and a sufficient

quantity of fluid poured into it until the bladder is filled; this being done, the funnel should be depressed below the bladder level; both funnel and tube will now act as parts of a syphon, and the fluid will be drawn off from the cavity of the bladder. The greatest care must be taken that air does not enter the organ and no washing out should be done when acute cystitis is present. Distention of the bladder, when acutely inflamed, is exceedingly painful, and it is better merely to introduce 1 to 2 oz. of some sedative solution—boroglyceride 1–20,—and allow it to be expelled naturally.

This method we believe to be the simplest and the best, but in it, as in all others, care must be taken not to distend the bladder walls, and also, not to inject any air into the bladder cavity. The suffering which the presence of air there causes, and the difficulty with which it is expelled, are somewhat remarkable, when both the tolerance, and the power of expulsion of gas, shown by the neighbouring viscus, the rectum, are considered.

To Wash out the Urethra.—The urethra itself has to be washed out in the treatment of gonorrhœa, and very rarely in that of other affections of that canal. The injection of warm lotion is generally done by the patient himself, with a glass syringe holding two or three ounces; a single syringeful being thrown up, retained for a couple of minutes, and then ejected.

This method does well enough for affections of the spongy or membranous urethra, but may not effectually wash out the prostatic portion. When this is required to be done, a good plan is to pass a short silver catheter, e.g., a female one, to just beyond the compressor urethræ muscle; then to inject 10 oz. of a mild astringent lotion into the bladder, and afterwards to allow it to be slowly and naturally expelled, so that the prostatic urethra is twice washed over.

(*See* Janet's method of irrigation, under "Gonorrhœa," p. 248).

RETENTION OF URINE.

In any large general hospital it is a matter of almost daily experience that cases of disease or injury present themselves in which the condition demands that immediate action must be taken; and it will sometimes happen that it is not possible for the resident medical officer to obtain the attendance of one of the visiting staff quickly enough to be of any use.

It is quite impossible to draw any line within which he may feel free to exercise his own responsibility, for the rules at different hospitals vary, and much will depend upon the length of service and personal experience of the particular officer; for example, in a case of retention of urine, with a practically impassable stricture, a house surgeon recently appointed should not proceed beyond a fair attempt at catheterization before he sends for help, while another who has served a year or more might be justified in going on to aspiration of the bladder.

Still, to the following rule there can be no exception: *In all cases of doubt the house surgeon must send for the visiting surgeon at once*, and if the case be urgent he can but do his best in the meantime, adopting curative or temporizing measures, whichever seem to him to be right.

We shall discuss some measures which border upon major surgery, such, for example, as deep perineal incisions, chiefly because they are the logical sequence of the failure of less severe proceedings, and in order that the junior surgeon should not feel as if with these failures the end of all resources had been arrived at, although the operative steps themselves are most frequently undertaken upon the advice and under the direction of his senior.

Cases of obstruction to the flow of urine, "*retention cases*" as they are termed, form a class which probably gives house surgeons more anxiety than any other, and certainly no subdivision of surgical practice can show a worse record of damage done through careless or ignorant treatment.

The *causes* of retention of urine may be grouped as follows:—

Phimosis, as a cause of acute retention, is usually met with in infants, and is frequently associated with an extreme degree of contraction of the meatus. The symptoms produced are those of bladder irritability, and vesical calculus is often suspected. Further, the hypertrophied muscular fasciculi of the bladder will often give a peculiar sensation when a sound is introduced, which may be mistaken for a stone.

In later years phimosis, even if untreated, rarely leads to retention; but if to the original contracted state of the opening there be added the effects of inflammation and ulceration, and possibly of preputial calculi, retention will occur.

The Impaction of a Calculus in the urethra is a second cause, more frequent in those of tender years, but not confined to them.

The Introduction of a Foreign Body, or *the ligation of the penis by a string*, are other conditions which occasionally demand recognition. These are also most frequent in young patients, but occur in those of riper years. A string is occasionally tied round the penis of a child who suffers from nocturnal incontinence.

Gonorrhœa may lead to retention of urine from three distinct causes: (1) Congestion of the swollen mucous membrane and spasm of the compressor urethræ muscle—the so-called spasmodic stricture. This is of rare occurrence, though we shall have occasion to refer to spasm as a cause of retention later on; (2) Acute prostatitis. This follows an extension of the infective process, and is a more frequent occurrence than that just mentioned; (3) A peri-urethral abscess. This, developing in the course of an acute urethritis, leads to the formation of a quantity of pus, either in the superficial or deep perineal pouch. Such a collection, being as it were encapsulated and restrained by the fascial envelopes of the perineum, presses back against the urethra and prevents the flow of urine.

Stricture.—The fibrous narrowing of the canal secondary to injury or gonorrhœa leads, if untreated, to retention of two types:—

In the first there is a gradual narrowing of the lumen of the urethra, contraction of the bladder, and frequency of micturition. Ultimately a final stage is reached, when the bladder becomes distended and powerless to expel its contents properly. In many of these cases there may be no obvious tumour in the hypogastric region, such as is supposed to be associated with a true retention. This is due to the fact that the capacity of the bladder is so reduced that even when filled to its extreme limits it does not rise much above the level of the symphysis.

This type of retention is the most insidious and dangerous. The term retention with overflow, or false incontinence, has often been given to it, but it would be better to confine this term to those cases where the bladder is obviously distended, as in enlargement of the prostate, and to apply the term *latent retention* to the form just described.

In this form the patient comes up for treatment stinking of urine, which, constantly escaping from the urethra, undergoes decomposition on the clothing. Such cases may be mistaken for incontinence, and be treated with belladonna in the hope of diminishing the irritability of the bladder. Not only is the stricture exceedingly tight in such cases, but the general state of the patient is infinitely worse than in the form which we shall next discuss. As the result of obstruction extending over a number of years, the kidneys are grossly damaged, and a fatal termination unfortunately often follows even the gentlest methods of treatment. Because such a patient can pass some water, the urgency of his condition is often overlooked, whereas, by comparison with other cases of acute retention, although perhaps the patient suffers less, the condition and outlook are far more serious.

The second form of retention is one of sudden and absolute retention occurring in a patient who is suffering from stricture, and often in one who is under treatment for the same. After a bout of alcoholic excess, a sudden chill, or prolonged pressure on the perineum, retention suddenly sets in. The bladder distends, the sufferings of the patient increase, but timely treatment promptly brings complete relief. It is not quite clear how these three factors—alcohol, chill, and perineal pressure—lead to the same condition of retention. Alcohol probably causes a weakness or temporary paralysis of the already overstrained muscular mechanism of the bladder; while a chill, and possibly also pressure on the perineum, lead to congestion of the narrowed urethra, or spasm of the constrictor muscle. In some instances retention has followed a long bicycle ride.

An Enlarged Prostate, whether inflammatory or neoplastic, is a common cause of retention of urine. Acute inflammatory conditions have been previously considered. Chronic parenchymatous prostatitis only rarely leads to this state. In the senile forms of enlargement, both in the simple adenomatous variety and in the carcinomatous

mass, retention may occur. In some cases this complication sets in quite suddenly; sometimes it is the first and only symptom of prostatic enlargement that is noticed. In others the onset is more gradual, a progressive accumulation of residual urine leading in time to an atonic distended bladder, with a constantly recurring dribbling from the urethra—that is, to retention with overflow. This retention with overflow is not always productive either of pain or inconvenience. Some patients are seen with a bladder distended up to the umbilicus, who appear quite comfortable and who resent the suggestion of a catheter or other operative procedure. Nor, again, does the urine always merely dribble away. The patient may micturate at definite intervals, passing several ounces at a time, without appreciable diminution of the vesical swelling. Sudden retention in prostatic enlargement appears dependent upon factors similar to those concerned in retention from stricture, namely, alcohol, cold, inflammation, drugs. Alcohol and chill will act as before described. Inflammation may complicate an adenomatous growth, especially if calculi are present, and may lead to retention and prostatic abscess. Drugs, sometimes prescribed for vesical irritation, for example belladonna and more rarely morphine, may produce retention. They should never be given without the closest observation, in cases of enlarged prostate, or indeed in any case where there is known to be obstruction to the outflow of the urine.

Severe Hæmorrhage into the Bladder will cause retention from the coagulation of blood on the bladder base. The condition is not very common. The four main causes of profuse hæmorrhage are: (1) Clots descending from the kidneys after injury, in new growth, and more rarely in tubercle of these organs; (2) Hæmorrhage from ruptured varicose veins on the bladder base, the retention which follows free hæmaturia being the first and only symptom of the trouble; (3) Hæmorrhage from a growth of the bladder, usually a villous tumour; (4) Hæmorrhage from prostatic enlargement, either spontaneous, or after the passage of instruments; (5) Acute cystitis, especially that form produced by the *B. coli*.

Retention following Injuries to the Perineum and Urethra.—It often happens that retention occurs as a sequel to a tranma, which produces either a rupture, a laceration, or a bruising of the urethra. In all cases such a condition of retention is purely protective, since the flooding of bruised or lacerated parts with urine, apart from the intense pain that it will cause, necessarily increases the risk of extravasation and peri-urethral suppuration. In all cases of urethral damage, the patient should not be permitted to pass his water naturally until some means have been taken, as quickly as possible, to deal with the condition.

Spasm.—Simple spasm, without any organic lesion of the urethra, may produce retention. How far such a condition is associated with some as yet undemonstrated lesion of the nervous system it is difficult

to say. There is probably a close relation between retention due to simple spasm and hysterical retention. We meet with many degrees, from the stammering bladder described by Paget, where the patient cannot micturate in a public urinal, a condition obviously due to imperfect nervous control, up to cases where retention is absolute and complete.

Injuries and Diseases of the Nervous System.—The commonest interference with the act of micturition following injuries of the spinal cord is retention. This may be said to occur at first in all cases of extensive damage of the cord, or even of the cauda equina. Later, it may give way to reflex or to true incontinence. Urinary troubles are certainly variable both in injuries and diseases of the nervous system, and this is no doubt due to the complex nature of the nervous mechanism which controls the bladder.

In head injuries with compression of the brain, retention usually results, while of the more chronic diseases which produce this symptom, tabes and bilateral lesions of the pyramidal tracts are the most important. The special clinical importance of these latter cases is that the nerve lesion is sometimes overlooked in the attention paid to the retention. It is advisable always, when possible, to diagnose a stricture with the urethroscope rather than with a sound. In some cases the urethra is lax in front of the triangular ligament; if a small instrument, especially a small gum-elastic catheter, be introduced, there is a chance of its being caught against this obstruction, and a diagnosis of stricture may be made, the real condition of tabes being overlooked.

Post-operative Retention.—This is a temporary condition following operations, especially in the pelvic organs, and will be considered later.

One form of post-operative retention must be specially considered, now that prostatectomy is more frequently performed, namely, retention some weeks after the operation from the formation of a phosphatic stone in the prostatic pouch.

Females are more free from the above urinary troubles than are males, for anatomical reasons. On the other hand, retention from incarceration of the gravid uterus is a condition which we may be at any time called upon to treat.

TREATMENT.—It will be advisable first of all to enumerate the various measures we have at our disposal, and then to consider which particular remedy should be applied in an individual case. The following have to be considered, namely:—

1. Removal of foreign body, stone, or ligature, incision of abscess.
2. The introduction of a catheter, as a temporary measure.
3. Tying in a catheter, so as to drain the bladder, or passively dilate a stricture.
4. Suprapubic puncture of the bladder.
5. External urethrotomy.
6. Suprapubic cystotomy.

Domestic remedies, such as a hot bath, an enema, a sponge wrung

out of hot water and placed on the hypogastrium, are measures easy of application, which should always be employed in the more simple cases of retention, such as the post-operative form, before recourse to surgical procedures. A hot bath (102 to 104° F.) is of great value when much spasm is present, and the patient should be kept in it until the muscles become relaxed.

In the treatment of phimosis with retention, it may be impossible to pass a catheter owing to the contracted condition of the prepuce. Under these circumstances the swollen prepuce should be dilated with dressing forceps. If this fails, the prepuce must be slit up along the dorsum, and the meatus enlarged so that a catheter of a size consistent with the patient's age can be introduced. Unless there be any special reason to the contrary, such as active venereal inflammation, it is well, now that the patient is under an anæsthetic, to circumcise him and also to perform a meatotomy. This little operation is best

Fig. 286.—Thompson's Urethral Forceps.

Fig. 287.—Thompson's Urethral Forceps, with double joint.

performed by incising the meatus downwards and passing a fine catgut stitch through the cut edges on either side, so as to drag up the urethral lining to the margins of the meatus (*see* p. 358).

When a calculus or a foreign body becomes impacted in the urethra, the treatment will differ according to the nature and position of the obstruction. A calculus, when diagnosed in the anterior part of the penile urethra, can usually be extracted with the special urethral forceps designed by Sir Henry Thompson (*Figs.* 286, 287), but it will be necessary freely to enlarge the meatus before the stone can be grasped. If impacted farther back—in the region of the triangular ligament—either of the two following forms of treatment may be adopted: (1) An external urethrotomy is performed and the stone extracted; (2) The stone is pushed back into the bladder and crushed or removed by other methods. Unless the stone lies near the bladder in the prostatic urethra and immediately yields to the pressure of the catheter, it is better not to adopt this latter form of treatment; since, while it is

true that the immediate retention can be relieved, the further treatment of stone in the bladder of a young child is not always a matter of entire simplicity. On the other hand, provided the stone has come well down into the perineum, and incision can be made directly over it, it can be extracted with a minimal amount of damage, and the cut edges of the urethra can be accurately approximated with catgut sutures: the external wound should be allowed to heal by granulation.

The wound heals quickly and kindly in about ten days, and there is hardly any leakage of urine. It is better not to tie in a catheter in young children. There can be no risk of stricture in a linear incision accurately closed. On the other hand, if an attempt be made to force a stone back into the bladder the urethra may be badly lacerated. There is one precaution, however, that should be taken in these cases, and that is to sound the bladder after the stone has been extracted, whether by the meatus or by external urethrotomy, since a second stone is sometimes present.

In the case of foreign bodies the same rules may be applied, provided the nature of the body is known. Foreign bodies of irregular shape, and therefore likely to produce extensive laceration, are best dealt with by perineal incision. It is never advisable to push a foreign body back into the bladder. In calculus the condition of affairs is quite different: the obstructing agent has come from the bladder; *ergo*, it ought fairly readily to go back there. Once in the bladder it may occasionally be dealt with by crushing, so that an open operation is avoided. On the other hand, a foreign body has been introduced from the outside, and is usually arrested in front of the triangular ligament; to attempt to push it into the bladder is to drive it through the narrowest and least dilatable portion of the urethra.

Retention in Gonorrhœa. — Here, again, the form of treatment will depend upon the cause of the retention. When acute prostatitis is present, as shown by a fullness and tenderness of the prostate on rectal examination, a trial may be made of a suppository of morphine and belladonna extract, half a grain of each, followed in one hour by a hot enema. If this fails, or if the distention of the bladder is extreme, the urethra should be washed out with permanganate of potash solution or oxycyanide of mercury 1–5000, and a catheter should be passed. A well-oiled *coudé* gum-elastic instrument, or a blunt round-end catheter, is to be preferred.

When the retention is due to spasm or congestion of the canal, similar treatment may be tried, and again recourse had to the *coudè* catheter. For many reasons this instrument is the best. It is true the rubber Jacques catheter can be thoroughly sterilized by boiling, but it does not glide so smoothly along the canal as the gum-elastic form, and anything like hesitation or delay in introducing the instrument is to be deprecated, as it causes great suffering. Ordinary oval-ended catheters are to be avoided, as in these acute inflammatory states they are more likely to catch in the urethral folds and produce

tears or false passages, for it must be remembered that the mucous membrane is engorged, swollen and softened.

A fair-sized instrument, 10 to 12 English, will be more serviceable than a small one. There seems to be some idea that a small instrument causes less pain than a large one. This is not the case, so long as a moderate size only is employed. Again, a small instrument is much more likely to catch in the urethral folds. As to the risk of the production of cystitis by carrying the organisms of contagion into the bladder, there does not appear to be much truth in it, especially if the urethra be washed out as a preliminary. Theoretically, it seems wrong to pass a catheter along a canal teeming with micro-organisms into a sensitive cavity like the bladder; but, practically, we may do it without hesitation and without any bad effects. So long as there has been no gross damage to the organ, and the patient is kept quiet in bed, any microbes which happen to have entered the viscus are either swept away in the stream of urine or are inert, and it is consoling to reflect that the mere introduction of micro-organisms into a healthy bladder is not in itself sufficient to cause cystitis. There is always an alternative, suprapubic puncture, to relieve the acute state of retention until the suppositories and the enemata have had time to lessen the congestion.

If a peri-urethral abscess is present, a median incision and evacuation of the pus is all that is required. The urethra should not be damaged —of this the greatest care should he taken,—and the cavity of the abscess should not be tightly plugged.

Stricture.—When retention is caused by a stricture, the line of treatment must depend upon several points: (1) Whether the patient is a catheter subject, in which case a careful attempt with a catheter will invariably be rewarded by success. (2) Whether there has been any previous attempt to pass an instrument; if so, did much bleeding accompany the attempt? (3) Are we dealing with one of the cases of latent retention, or is the bladder obviously distended?

Now, these cases of latent retention are the most serious. There is no great distention of the viscus, and in most instances the kidneys are extensively damaged. Some of these patients are intolerant of instrumentation; the urethra is sensitive and rotten, and on several occasions extravasation has occurred after recourse to the catheter Again, cystitis is usually present. In such cases suprapubic puncture should never he tried. Two courses are open to us: (1) To perform an external urethrotomy at once; (2) To pass a catheter—this is a difficult procedure, and a very small size (No. 1 or 2) will alone be admitted,—and to tie it in.

Sometimes a bougie will pass better than a catheter, and a trial may be made of tying in this instrument, as it passively dilates the urethra and allows the urine to escape alongside it.

If no instrument can be introduced, preparations should be made for performing external urethrotomy.

Stricture with Spasm.—If the case is seen before any attempt has been made to pass an instrument, trial should be made of the gum-elastic catheters and bougies. With a little patience success is the rule, as although there may be a fairly tight stricture, the spasm which is also present is the chief agent producing the retention. In cases where instrumentation has been previously tried without success, it is usually no use to waste time with soft instruments. While gum-elastic catheters are admirable for the "virgin" urethra, they are very unsatisfactory when false passages are present; there is so much difficulty in controlling the point that they should be abandoned for the metal instrument. With the forefinger of the left hand in the rectum, the metal instrument is of the greatest value.

Different opinions are held as to the amount that should be done with a view to dilate the stricture. This must depend on the individual case. If it is found that the narrowing is long, tortuous, and extremely resistant, we may rest content with the introduction of a small gum-elastic catheter, which should be tied in. If, on the other hand, the stricture appears to yield readily, and the condition to be due to associated spasm, there can be no harm in careful dilatation up to 7 or 8 English.

The injection of a 5 per cent solution of cocaine, followed by warm oil, facilitates the passage of instruments along the urethra.

Suprapubic puncture is generally advised in those cases where instrumentation fails, and where it is not considered wise to administer an anæsthetic. The operation is a simple one, can be performed aseptically, affords immediate relief, and can be repeated; indeed, the cannula can be left *in situ* above the pubes, so as to drain the bladder.

Certainly there are risks. Thus the bladder has been ruptured, and fatal cellulitis, due to the escape of stinking urine, has supervened, but with care such accidents can be avoided. If a very fine trocar and cannula be employed, if the point is sharp—an important detail—and if the bladder can be *felt* as a definite hypogastric tumour, the danger of the operation is slight. It is not sufficient to rely on percussion dullness alone before introducing the trocar. If a patient is stout, a fat-loaded omentum may cause dullness above the pubes, and although in some cases retention is present, the bladder does not reach up into the abdomen. When it is known that cystitis is present, suprapubic aspiration is contraindicated, and external urethrotomy should be performed.

Briefly, then, in the treatment of a stricture-retention, if the case is clearly one of long standing, with damaged kidneys and cystitis, external urethrotomy should be performed. In other cases, first gentle attempts with various sizes of gum-elastic sounds and catheters under cocaine; this failing, a second attempt under general anæsthesia. If false passages are present, abandon soft instruments for metal ones. If catheters are used, and a small size can be introduced, tie it in, and

later the stricture can be dilated or cut. If instruments fail, perform external urethrotomy or suprapubic puncture.

Retention due to Enlargement of the Prostate can usually be relieved by the catheter. In most cases the *coudé* or *bicoudé* instrument will pass easily; but when one lobe of the gland is chiefly affected, and when the urethra is displaced laterally, a rubber catheter armed with a stilette or stiffened with a fine gum-elastic core succeeds better. Should instrumentation fail, the bladder may be punctured above the pubes. If the patient appears to be suffering from the retention of a large quantity of residual urine—"retention with overflow,"—a considerable risk attends the withdrawal of the whole amount of retained urine. In some cases severe hæmorrhage from the kidneys is said to have occurred; in others suppression has supervened. If there appears to be a larger quantity than 10 to 12 ounces, it is better not to withdraw the entire amount, but to repeat the catheterization in a few hours' time; or if the urine is offensive, to withdraw the whole amount and inject 6 to 10 ounces of warm boracic solution into the bladder and leave it there.

When the retention is caused by **Retained Blood-clot,** the first thing is to make a diagnosis of the source of the hæmorrhage: whether the blood comes from kidney, bladder, or prostate. In the case of the prostate, a rectal examination will usually afford sufficient information. When the blood comes from the kidney there will be a history of injury to the loin, of previous bleeding, or of the passage of clots, and possibly a renal tumour may be palpated. When the bladder is the source, if a papilloma or malignant growth be the cause, a history of previous hæmorrhages can almost always be obtained, whereas profuse hæmorrhage from a ruptured vein comes on without any previous warning.

Warning.—If a patient has a very large prostate causing retention, a catheter may enter a false passage in the deep part of the gland, or reach what is described by Freyer as a preprostatic pouch, a kind of loculus in the urethra; and when the catheter is withdrawn with the eye choked with clot, it may be thought that the whole viscus full of blood. The character of the blood in the eye of the catheter will help to make matters clear. If from a recent injury to the gland, it will be bright red; if from a coagulum on the bladder base, it will be black.

Having settled that the case is one of retention from clot in the bladder, the treatment will vary according to the degree of distention of the viscus and the cause. If there is reason to believe that the hæmorrhage is coming from the kidney or bladder, a suprapubic cystotomy should be performed, the clot removed, and the renal or vesical lesion receive appropriate treatment. If the hæmorrhage is coming from the prostate and is not severe, it is well to follow the advice of Mr. Christopher Heath, and to introduce a suppository of morphine and belladonna extract (½ gr. each) and wait.

Urine has a solvent action upon blood-clot, and if the retention is not urgent, this treatment is often followed by the free passage of urine and blood. It must be clearly understood that there is no urgency.

When the condition is more severe, it may be advisable to introduce a gum-elastic catheter and to twist it round in the bladder to break up the clot; then, after withdrawing it, to insert the tube of a Bigelow's evacuator, and by means of the evacuator withdraw the blood-clot. This treatment is rarely satisfactory. The introduction of these large instruments causes fresh bleeding, and there is some risk in injecting more fluid by means of the powerful rubber bulb into a bladder already distended; in such cases we act in our patient's best interest by opening the bladder above the pubes without delay.

Retention following Injuries to the Perineum.—In all cases where there is reason to suspect injury to the urethra, the first step should be an attempt to introduce a catheter; a *coudé* gum-elastic instrument will be found more serviceable than any other. Should such introduction fail, external urethrotomy should be performed at once. If the catheter has been passed into the bladder, it is better to tie it in, at least for twenty-four hours. Of course, if there appears to be merely a slight urethral bruising, this step need not be adopted, and it is well to be guided by the amount of bleeding that has taken place from the urethra and the amount of difficulty experienced in the introduction of the instrument. In all cases where a catheter has been tied in, the closest watch must be kept over the perineum for signs of peri-urethral suppuration.

Retention due to Spasm without any gross organic mischief in the urethra is diagnosed by means of the urethroscope; it is best treated by bromides and belladonna and the occasional passage of a large metal bougie.

Hysterical and Post-operative Retention must not be confounded with suppression of urine. Instruments should not be used until various domestic remedies have been tried.

A **Phosphatic Calculus** in the prostatic cavity must be removed by opening up the suprapubic wound.

When retention occurs during the course of **Nervous Diseases** we have to deal with a condition of affairs very different from the preceding varieties. In many cases the retention is a permanent malady; in others, weeks or months may elapse before the catheter can be dispensed with. The greatest care must be taken to avoid sepsis. (*See* "Injuries to the Spine," p. 185.)

RUPTURE OF THE URETHRA AND EXTRAVASATION OF URINE.

There are two main causes of extravasation of urine. The first is the infliction of some injury to the perineum; the second is due to the gradual weakening or increasing rottenness of the tube, caused by low

inflammatory changes following on an old-standing stricture, with a more or less complete retention.

In both cases the extravasation is strictly a "surgical emergency," and requires prompt and decided treatment.

Traumatic Rupture of the Urethra.—It will be found that these cases are mostly caused by a heavy fall on the crutch, or by a kick or blow there, but they may be due to an incised or punctured wound. The *symptoms* pointing to an injury of the urethra are a constant and extreme desire to pass water, with inability to do so, or at least only in a few drops, while there is a varying amount of hæmorrhage from the meatus. There are also bruising and great tenderness in the perineum. These symptoms indicate that the urethra has been torn, and unless a catheter can be immediately passed, and kept in the bladder, symptoms of extravasation will soon occur.

Under no circumstances should the patient be allowed to pass his water, if it can be prevented, until the state of the urethra has been investigated.

Management of Catheter.—In the first place then, a very gentle and patient attempt should be made to pass a catheter, using by preference a No. 8 or 9 soft, olivary-shaped one, or better still, a *coudé* instrument, and if this fails, a silver one, taking particular care to keep *along the roof of the canal.*

If a moderate-sized catheter will not pass, a smaller one may be tried, but will probably fail to get through, and the attempt must not be persisted in.

In the fortunate event of an instrument having been passed into the bladder, it should be tied in, in the manner already described, and the after-treatment of the case may be left to the visiting surgeon. The patient will, in most cases, do well.

But very often it is not possible to pass an instrument. In this case it would be unwise to wait for any length of time, for extravasation of urine might take place and put the patient in a very hazardous position. A house surgeon should therefore send for his chief, and make all preparations for a perineal section, which is described below.

Median Perineal Incision.—The patient should at once be put under an anæsthetic, and being placed in the lithotomy position, a deep incision should be made absolutely in the middle line, down to the urethra in the perineum. The opportunity of the anæsthesia may be used for a final attempt at the passage of a catheter.

The knife will be found to cut into tissues which have a semi-gelatinous appearance, due to infiltration with urine, which will at once begin to drain away from them, gradually relieving the bladder. No mere surface incision is to be made, but the urethra or its immediate neighbourhood must be thoroughly opened up.

A median incision made thus early will often be sufficient to prevent further extravasation, but it frequently happens that the patient is not seen until the urine has made its way into the scrotum, and may

be traced, travelling along the folds of the groin upwards on to the abdomen, its progress being marked by a dusky brawny infiltration.

The anatomical reasons why the usual traumatic rupture of the urethra in front of the triangular ligament is followed by extravasation into the scrotum and upwards on to the abdomen, but not down towards the thighs, are well known. But cases do sometimes occur of rupture between the layers of the ligament; the urine will then travel in a different direction.

Free incisions wherever the tissues are involved offer, in such a case, the only chance of preventing the most extensive sloughing, with all the attendant risks of septicæmia. The median one in the perineum should never be omitted, but in addition, the scrotum and penis may have to be incised in two or three places, while the same relief will frequently have to be afforded to the skin of the lower part of the abdomen. In spite of all, however, some sloughing is sure to occur, and this, with the smell caused by the constant escape of urine, generally makes it desirable that the patient should be isolated.

The parts may be fomented well with boric lint or some mild antiseptic preparation. Frequent washing and syringing with permanganate of potash, or carbolic acid lotions, will be called for, and as soon as the patient is able to do so, he should frequently sit in a bath of weak warm permanganate of potash or boric acid.

Extravasation as a result of Stricture.—The other fashion in which the urethral walls may give way occurs when a long-standing and neglected stricture produces a condition of partial or (more rarely) of complete retention. A low form of inflammatory softening of the walls of the canal takes place, and, distended beyond their power of resistance in that condition, they give way; the result is the formation of urinary abscesses and extravasation. The symptoms do not differ materially from the traumatic form, save in this, that the extravasation commences as soon as the urethra gives way, whereas in the traumatic cases there is no escape of urine until the patient attempts to pass water. It must be clearly understood that in many cases the symptoms of extravasation come on gradually. The first manifestation of a urethral leakage may be a tender swelling in the perineum, or peri-urethral abscess.

Peri-urethral Abscess.—There are three common causes for this condition: (1) Gonorrhœa, already considered; (2) Prostatic abscess which tracks down into the perineum; (3) Extravasation behind a stricture. It is most essential that the cause of the abscess should be recognized as soon as possible, as the treatment differs in the three cases.

In the case of a prostatic abscess, rectal examination will reveal a swollen tender prostate, and the pus must be evacuated by a deep perineal incision; it is not always necessary to open the urethra.

But when a peri-urethral abscess arises from softening of the urethra behind a stricture, the patient's history, and an examination of the

canal with a sound, or better, the urethroscope, will give sufficient information. The treatment to be adopted is external urethrotomy.

Main Lines of Treatment of Extravasation.—The question of the passage of an instrument should be left to the discretion of the visiting surgeon, for, as a rule, the tissues are not in a condition to allow of successful catheterization until the operation of perineal section has been performed, and further damage may easily be done in the attempt. But there must be no hesitation or delay in relieving the extravasation by free incisions, whenever they are required, the one in the middle line of the perineum being, as before, the most important.

The *prognosis* in these cases is unfavourable. From the nature of the disease it follows that the patient is broken down constitutionally; ver[illegible] probably his kidneys are diseased—"surgical kidneys."—and the infiltration, suppuration, and sloughing which result are apt to bring about a condition of septicæmia which is generally fatal. In any case stimulants, such as alcohol, carbonate of ammonia, etc., and a generous diet will be required, while with regard to the local dressing, the management will be similar to that which was advised for traumatic cases.

We do not here consider the surgical questions which arise in connection with the urinary fistulæ which so often are the result of extravasation, however produced.

RUPTURE OF THE BLADDER.

This is a form of injury frequently met with in the accident wards of a hospital, and although the active treatment of the injury belongs to major surgery, the recognition of this serious lesion is the duty of the house surgeon.

Rupture is often produced by a fall or a blow on the abdomen, when the organ is in a state of distention, but the accident may accompany a crush or fracture of the pelvis; indeed, the most serious forms of injury are associated with this condition.

In any case when a patient has fallen from a great height, or has been crushed or run over, it is the duty of the house surgeon to ascertain as soon as possible whether the bladder has been damaged.

The rupture may involve the peritoneal or non-peritoneal surface of the viscus; and although it may not be possible at first to distinguish between these two varieties of injury, some information can be obtained on examination, which will make it clear that the bladder has been lacerated. There is usually profound shock, and as this condition in itself may lead to a temporary cessation of the renal function, the fact that the patient is unable to pass water does not attract the attention due to it. In some cases where the rupture is extra-peritoneal, there is an intense desire to micturate, but inability to do so.

Supposing then that a patient is brought in after a severe crush

between the buffers of a train, a careful examination is made of the pelvis in order to ascertain if the bones are broken. In any case the next step is to pass a gum-elastic catheter into the bladder. Should blood-stained urine be withdrawn, there is strong but not conclusive evidence that the bladder has been injured; the blood may come from a bruised or lacerated kidney. (*See* "Fractures of the Pelvis," p. 150.)

SUPPRESSION OF URINE.

It sometimes happens that in the course of his surgical work a house surgeon is called upon to deal with a case of suppression of urine. Of the many causes which lead to the condition, stricture and prostatic enlargement are the most common, apart of course from the various medical forms of nephritis. It is quite beyond the scope of this work to discuss all the conditions which may give rise to suppression of urine or anuria, but a brief list will be given and the non-operative treatment of suppression considered in detail.

Obstructive Suppression occurs when both ureters or the ureter of a single working kidney become blocked by a calculus, and the same result occurs when the ureters become entangled in a malignant growth. The special point is the prompt recognition of the condition, which although rare is occasionally met with.

Non-obstructive Anuria occurs in many different forms.

In *Anuria from Nephritis*, the tubules of the kidney become choked by inflammatory débris, and a partial or total suppression of function supervenes.

Reflex Anuria occurs after renal and abdominal operations, or after some operation on the urinary tract: it may be only the passage of a catheter, or a more severe proceeding, such as urethrotomy or prostatectomy.

It is this last form of suppression which will be considered. It must be borne in mind that patients who have suffered for any length of time from stricture, stone, or prostatic enlargement, have sustained a certain amount of damage to their kidneys. They are therefore less able to withstand any operative procedure than an individual who is free from these disorders.

The treatment may be considered from two points of view: (1) Prophylactic treatment, directed to minimize the chances of the supervention of suppression; (2) The treatment of suppression when once it is established.

1. The greatest attention should be paid to the preparation of all cases of stricture and enlarged prostate before any operative procedure; every effort should be made to improve the condition of the kidneys by drugs and dieting, and the vicarious action of the skin and bowels in carrying off the excretions encouraged to the fullest extent. Warmth and quiet are absolute essentials.

Digitalis and urotropin are exceedingly valuable, and the diet should consist of milk with a fair amount of diluent drink, such as distilled

water, barley-water, and linseed tea. It has been argued that diuretics should be prohibited, as tending to overstrain the damaged kidneys. We do not hold this view, especially if the diuretics are harmless and sedative, as barley-water and linseed tea. As a rule, in the damaged kidney there is no difficulty in the watery element of the urine making its exit: the trouble is with the urea and extractives; dilution will assist the kidney in getting rid of them, and a certain increase in the fluid of the blood will favour diaphoresis and free purgation.

It is a natural corollary from these precautions that, if renal inadequacy is recognized, operative treatment should be condemned as being likely to precipitate anuria.

But in practice it is necessary to bear in mind that the cause of the renal disease, if left alone, will itself shortly bring about a fatal issue; in other words, that stricture and enlarged prostate, if not relieved, will end in death. It is not always possible to form an opinion, upon examination of the urine, as to the patient's chances of surviving an operation. At the same time the urine in a case of genito-urinary disease should be submitted to the most careful examination. *It is not sufficient to rely upon a chance specimen. The total amount passed in twenty-four hours should be collected, the amount of urea and salts estimated, and then some idea can be formed as to the capacity of the patient to withstand any operation that may be under consideration.*

2. If a patient, shortly after the passage of a catheter or after an operation, has a rigor, the house surgeon should at once become suspicious about his case. The urine should, if possible, be collected, and if there is a diminution in the amount passed, suppression is to be feared. The first thing to do is to get the bowels well open with a drachm of pulv. jalapæ co., or 5 gr. of calomel, and to apply dry cups or linseed poultices over the loins. These are simple and most efficient remedies, prompt recourse to which has saved many cases. Digitalis may be given, but sparteine sulphate in ½-gr. doses hypodermically is now said to give better results.

If, in spite of all, absolute suppression intervenes, the house surgeon must give his patient a hot pack, the cupping being repeated subsequently.

The hot pack is given as follows: The patient is wrapped up in a blanket, and lies on a mackintosh sheet. A cradle covered with a blanket and a mackintosh is placed over him, so that only his head is exposed. At the bottom of the bed a kettle is kept boiling by means of a spirit lamp; to the spout of the kettle a long metal funnel is attached, which is passed underneath the cradle, so that the steam circulates round the patient's body. A thermometer should be placed underneath the cradle, and the temperature should be raised to 120° F. It is sometimes necessary to allow a higher point to be reached if free sweating does not occur, but 120° F. may be taken as a usual temperature.

The patient should be kept in the apparatus for twenty minutes to

half an hour; from time to time the forehead should be felt to ascertain if the skin is acting freely, and the state of the temporal pulse noted, since there is some risk of cardiac failure. Stimulants—brandy and strychnine—should be at hand in case this supervenes. When the skin is acting freely the cradle is removed, and the patient is wrapped up in warm dry blankets and covered up. The object of the bath is to induce the skin to carry off the products of metabolism with which the kidneys are unable to deal, and it is a very valuable remedy. During the time the patient is being thus treated he should be given diuretics, barley-water, etc.

Pilocarpine is sometimes employed; it is a dangerous drug, and its use must depend upon the opinion of the surgeon in charge of the case.

The infusion of saline into the veins has sometimes been successful in promoting diuresis; it should be tried, but not until the bowels have acted thoroughly, and it must be done with care, as there is already an increase of vascular tension present in these cases.

Chapter XLIV.

OF HERNIA, INTESTINAL OBSTRUCTION, AND ACUTE ABDOMINAL LESIONS.

CASES of rupture, with symptoms of obstruction more or less marked, are of very frequent occurrence in any large hospital, and the proper discrimination of the different kinds and degrees of this condition is a most difficult and responsible part of a house surgeon's work. It is true that the actual herniotomy is usually performed by the visiting surgeon, but this may be the simplest part of the whole treatment, while the house surgeon has to decide upon points which are often obscure, such as whether the question of operation ought at once to be raised, or whether taxis should first be tried, and if so, for how long, whether a preliminary bath should be given, and so on. Here the rule already laid down most strictly applies, namely, *when in doubt send for the visiting surgeon.*

Typical Case of Strangulation.—In considering the rules which should govern the management of these cases, we will take first a typical hospital case, in which symptoms of well-marked strangulation have existed, we will suppose, for twenty-four hours, and where without the use of an anæsthetic the hernia has not been reduced by moderate taxis. It will, first of all, be important to know if the hernia be one of long standing which has suddenly become much larger, or whether this is the occasion of its first appearance, and, in the former case, whether or not a truss has been habitually worn. These questions bear upon the amount of taxis which it may be safe to employ. Thus, a small hernia, down for the first time, is probably more tightly nipped and requires more tender handling than an old-standing one in which the canal is certainly dilated, and a portion, at any rate, of the gut is accustomed to slip to and fro.

The house surgeon must then exercise his discretion as to whether a further trial may fairly be made of the taxis, then and there; but as a rule, unless distinct gurgling or other indications show that the strangulation is very slight, he will be wise if he confines his manipulations to those which are necessary for the ascertaining of the condition of affairs.

He must next decide between sending for the visiting surgeon at once, or first trying the effects of a hot bath, to be, perhaps, followed up by an injection of starch and laudanum. The former is now the usual course adopted. But should the bath be decided on it should be hot (102° to 104° F.), and the patient should stay in it until there is a slight feeling of faintness. Taxis *may* then be tried in the bath, but it

can be performed more conveniently on the bed, the patient lying between blankets. Only a moderate amount of taxis should be tried, for it is often found that the vitality of the strangulated gut has been further jeopardized by the free manipulations made in attempting to reduce the rupture. If the hernia cannot be reduced, no time should be lost in sending for the visiting surgeon, and preparing for herniotomy.

In the case of a very acute strangulation in a rupture down for the first time, there is no doubt that operation should not be delayed, for with the antiseptic methods now in practice the risks of the operation itself are comparatively small, and time occupied in giving a bath and attempting further taxis may, or probably will, only lead to greater congestion of the strangulated part and increase the chances of gangrene of the intestine. The house surgeon then should at once send for his chief and make all preparations for the operation.

In the cases we have hitherto considered, the strangulation has not been supposed to have been of more than twenty-four hours' duration. Unfortunately, a large proportion of hospital cases of strangulated rupture are not sent in until the symptoms have been present for days. In such a case it will always be at any rate doubtful as to whether the intestine can bear even the gentlest taxis, and it may be in a condition in which it would not be right to return it into the abdomen, even if it were possible to do so. Here every hour's delay is hurtful, and the house surgeon should immediately send for the visiting surgeon, get everything ready for herniotomy, and leave the question of making any attempt at reduction by taxis to his senior's discretion and responsibility.

Cases of Doubtful Strangulation.—But all ruptures which cannot be returned, or are difficult to return, are not strangulated, even though in some cases there be a certain amount of distress and nausea. Clinical experience, not to be learned from books, will alone enable these to be distinguished with certainty, but, although some will remain doubtful until cleared up by the course of events, the house surgeon will generally be able to distinguish readily enough whether strangulation is really present.

The cases which require most discretion are those in which at first there are no symptoms indicating that the gut is nipped, beyond the fact that it cannot be returned, and then gradually the case becomes doubtfully, and at last distinctly, one of strangulation.

Although in such a case the visiting surgeon will very probably have some difficulty in deciding when to operate, still it is certain that he should be given the opportunity of doing so early; so that the plain duty of the house surgeon is to send for him as soon as any question of the existence of strangulation arises, and it should be remembered that in cases of umbilical herniæ of long standing the symptoms of strangulation are frequently very indefinite.

A rupture should never be thought lightly of because it is small; on the contrary, it is the small knuckles of intestine which get most tightly

nipped, especially in femoral herniæ, and, as we have said before, those which suddenly develop in consequence of some strain are more likely to be very acutely strangulated than long-standing ones.

Taxis.—A word or two may be said as to the performance of *taxis*. Whether an anæsthetic be used or not, the leg and trunk must be put into the position which will mechanically relax the margins of the apertures, and the greatest possible gentleness should be exercised. This must be specially kept in mind when the patient is under ether or chloroform, when absence of complaints does away with one safeguard. *The amount of damage which may be done by rough taxis must be seen to be believed.* The gut may be ruptured or bruised into gangrene, and the sac, or the more superficial tissues, may be so gravely injured that they will presently slough. Many surgeons object altogether to the practice of taxis; but if carefully carried out it may be employed in suitable cases. The following rules with regard to it will be found useful:—

1. Place the patient in a recumbent position, the head being supported by a pillow, the pelvis slightly higher than the shoulders; the hips and knees should be bent, and the soles of the feet should rest on the bed. The bladder should be emptied. Uniform pressure is to be exerted upon the hernia, in a direction upwards and outwards for the inguinal variety, inwards and upwards for the femoral.

2. Never apply taxis for a longer period than five minutes; this includes an attempt with and without an anæsthetic.

3. Use no force: only that amount of pressure that can be brought to bear by the fingers and hand.

4. Never attempt taxis if the hernia has been strangulated (definite symptoms, vomiting, etc.) for more than twenty-four hours.

5. Do not attempt it in cases where the first appearance of a hernia is associated with signs of strangulation. In such cases the contents are very tightly nipped, and taxis will almost certainly fail.

6. In femoral hernia taxis is more dangerous than in the inguinal variety.

7. If the taxis is apparently successful, always admit the patient and watch him carefully for twenty-four hours. If the symptoms persist, they are due to some mischance in connection with the taxis, and immediate operation is required.

Before taxis, and above all before any operation is performed, see that the bladder is empty.

Ruptures Without Strangulation. — Ruptures which are difficult or impossible to reduce, but which are not strangulated, can hardly be said to be emergencies; nevertheless we may here shortly consider them. Very often a few hours' rest in bed, in the supine position, with the buttocks slightly raised on a pillow, will enable reduction to be effected, and, in old-standing cases especially, the patient should be allowed to try to put the rupture back himself if he can, for he will often succeed when the surgeon would fail.

The *ice-bag*, or in old people a fomentation, may be of use occasionally, but the recognition of such cases is difficult, and it is far better to relieve even an unstrangulated hernia by operation than to wait for a possible but doubtful relief to be gained by an ice-bag. An irreducible hernia must always be looked on as a danger.

The warm bath, followed by a simple enema, or one containing opium as before described, is here also frequently of great service; but in the absence of disquieting symptoms, patience and rest in bed are the great agents for effecting the reduction.

A rupture is sometimes permanently irreducible in whole or part, in which case, if operation is contraindicated, the only thing to do is to have a truss of a special shape made for its support and protection.

Cases of Intestinal Obstruction which usually require immediate operation, only come under notice here in connection with the examination and preparation which the house surgeon should make.

When a given case of obstruction is admitted to the hospital, there may or may not be considerable doubt as to the accuracy of the diagnosis, and although the house surgeon will naturally inform his chief, he can by a thorough preliminary examination give his surgeon considerable assistance.

In obtaining a history of the case the points of special importance to be noted are:—

1. Mode of onset, with or without pain; if with pain, its position and extent.
2. History of previous attacks in any way similar.
3. The character, frequency, and duration of the vomiting.
4. The state of the pulse and temperature.
5. The condition of the abdomen: (*a*) Distended or not; (*b*) Visible peristalsis; (*c*) The presence of any lump or mass; (*d*) Local tenderness or area of muscular rigidity.
6. The appearance of the hernial orifices. *These must be systematically examined in all cases of obstruction*, or a small strangulated hernia may be overlooked.
7. *The result of a rectal examination.* This examination must never be omitted. In many cases it affords some information as to the cause of the obstruction. Many cases of carcinoma of the rectum first present themselves with symptoms of acute obstruction, and in intussusception a mass can be felt in a fair number of cases.

Having paid due attention to these details, if the diagnosis is doubtful, and the vomiting is not urgent, and the pulse is quiet and of good volume, the house surgeon should order an enema—at first an oil injection slowly given, followed by a turpentine solution. If these produce no result, he may try the effect of an enema made up as follows:—

R	Magnes. Sulph.	℥j	Ol. Ricini	℥j
	Calomel	gr. x	Glycerini	℥vj

Such an enema is useful in cases where the previous enemata have been retained.

If the above treatment produces no effect, the patient will probably require an operation, and all preparations should be made pending the arrival of the surgeon. *In no case of suspected obstruction should the house surgeon ever order a purge.*

Obstruction from Accumulation of Fæces must be considered. The obstruction is situated usually in the upper part of the rectum or sigmoid flexure, and occurs most commonly in women or in children as a sequel to some severe illness, such as typhoid fever, but examples may be found in patients of either sex, and at any age.

Usually a history will be given of habitual constipation, steadily getting more and more difficult to overcome, until finally there may have been no relief by the anus for a period to be measured by weeks. In other cases some fæces may have been passed, but the bowel has never been properly unloaded. On examining the patient, it will probably be found that the intestines are greatly distended with flatus, while in the left iliac region a soft doughy tumour is to be felt, the shape of which may be altered by manipulation, which is generally borne well, although it may be that a certain degree of inflammation of the surrounding parts has been set up. In any case distress and nausea will be present, and the symptoms may be sufficiently severe to mask the real nature of the trouble and to make it resemble a case of acute obstruction due to some mass of new growth in the situation of the sigmoid flexure, or to an intussusception or volvulus of the bowel. A thorough digital examination of the rectum ought never to be omitted.

The treatment in these cases consists in unloading the sigmoid flexure and rectum as speedily as possible. In the first place all the fæcal matter which can be dislodged from the rectum by the finger or a spoon should be so removed, and masses somewhat higher up may be got at by a scoop or spoon with a longer handle. A pewter tablespoon, bent so as to diminish the width of the bowl, will do, or a lithotomy scoop. But these masses are frequently very hard, almost stony, and often they can hardly be dislodged without previous softening, while those that lie still higher up in the canal are out of reach altogether. The removal of these must be achieved by enemata injected high up into the bowel by means of a long tube. These injections must be frequently repeated, and it may be necessary to play a stream from an enema upon the hardened collections for a long time. But although the clearing out of the canal may be very troublesome, we believe it can always be effected by the careful use of a scoop for such masses as may come within reach, and of enemata; these may be copious ones of warm water, or, in more obstinate cases, of warm olive oil. Again, to about a pint of the oil an ounce of turpentine may be added. The tube of a stomach pump will do in the absence of a special apparatus for the administration of these enemata.

The intestine will be left in a very atonic state for a long time after the fæces have been removed, and a recurrence of the condition must

be guarded against by the frequent use of simple or astringent enemata, vegetable or saline purges, and the like. Often much good is effected by shampooing and kneading the abdomen, especially if flatus be the most prominent symptom.

Acute Abdominal Lesions.—Apart from the previously described conditions of intestinal obstruction, and apart also from the various injuries that may result from blows or crushes of the abdomen, there remains an important group of cases which present symptoms of an acute abdominal catastrophe. The chief causes of this condition are acute appendicitis, perforation of a gastric or duodenal ulcer, rupture of a pyosalpinx, or an extra-uterine gestation. It is often impossible in the early stages of a case to make an accurate diagnosis, but it is very essential to recognize the important features which denote its severity, and the routine examination and course of treatment that are to be adopted until some definite conclusion can be arrived at.

In the first place it must be remembered that the three colics—renal, biliary, and intestinal (lead)—may all present features which closely simulate those of a more serious lesion; and care must be taken as far as possible to eliminate these confusing conditions.

Again, the gastric crises in tabes are sometimes so acute that a gastric perforation is simulated; and, lastly, it has been repeatedly pointed out that pulmonary diseases, such as pneumonia and pleurisy, may present a train of signs and symptoms closely simulating appendicitis. Ptomaine poisoning must also be considered.

It will be obvious, therefore, that in any given case admitted during the earlier stages of an acute disease a very careful examination will be required.

1. The urine must be systematically and carefully examined for blood, albumin, and crystals.

2. The conjunctivæ must be examined for signs of jaundice.

3. The patient's occupation should be noted, and lead-poisoning excluded.

4. The knee-jerks are to be tested, and other signs of tabes looked for in a suspicious case.

5. The lungs are to be very carefully examined.

6. The presence or absence of any vaginal discharge is to be noted; also enquiries are to be made as to any irregularities or peculiarities with regard to menstruation, especially in those cases where the lesion appears situated in the pelvic region.

7. A rectal and, if necessary, a vaginal examination should be made.

Having carried out this investigation with as little disturbance of the patient as possible (it must be left to the discretion of the house surgeon to recognize when vaginal or rectal examinations are best omitted), the next step is to consider carefully the condition of the abdomen and of the patient generally.

For the first few hours after perforation of the intestinal tract there is usually a considerable amount of shock. This may pass off in a few

hours, and the observer must not be misled by the fact that when he is called to the patient the temperature may be normal and the pulse 70 to 80. As the case is watched the temperature will be seen to rise unless profound shock is present, and the pulse-rate will increase. *This is a most important point.*

The general aspect of the patient is suggestive of some grave condition. The face is usually pale, and there is a slight contraction of the forehead, giving the so-called anxious or abdominal expression. The patient is usually in great pain and is restless, turning the head from side to side, throwing up the arms, and placing the hands behind the head.

The body is kept still. The patient usually lies on the back, and *does not roll about or writhe* in pain as in cases of biliary or renal colic. Vomiting may or may not be a prominent feature. The vomit should be inspected for evidence of blood.

On inspection, the abdominal wall will be found retracted, and will not move with respiration. When the hand is placed upon it the muscles feel hard and boardlike, and *they do not relax during the respiratory movements.* This is an observation of the greatest value. Some doubtful cases present signs closely similar to those of a perforated gastric ulcer; there is a fair amount of rigidity, pain, etc.; but a gentle pressure of the hand will often succeed in overcoming the rigidity, especially if the patient's attention is distracted, and the muscles may be felt to yield during inspiration.

The skin on the surface of the abdomen is hyperæsthetic, and the lightest percussion causes a further muscular spasm, and the patient flinches and complains of great pain. When light percussion elicits this sign, taken in conjunction with the other symptoms, it is diagnostic of peritonitis.

There may be evidence of free gas in the peritoneal cavity, as shown by loss of liver dullness; or of free fluid, by an increased dullness in the flanks. These signs are not of much value, and the diagnosis of a perforative peritonitis must not depend upon their presence or absence.

Given a case where most of the above signs and symptoms are present, the house surgeon may conclude that he has some serious abdominal lesion before him that will, in all probability, require an immediate operation. He will, therefore, notify his surgeon, and make the necessary preparations.

Supposing, however, that the symptoms are not quite definite, he must watch the case, keeping in mind the importance of an increase in pulse-rate and the development of muscular rigidity.

He must undertake no active treatment. No food must be given, and no drugs. Above all, he must not give morphia. If the collapse is profound he may transfuse the patient and inject strychnine hypodermically. For the relief of pain he may order a fomentation for the abdomen. Nothing further that he can do will be likely to benefit the patient, while the exhibition of morphia or other forms of treatment are certain to be injurious.

Chapter XLV.

OF THE TREATMENT OF CASES OF POISONING.

By WILLIAM HENRY WILLCOX, B.Sc., M.D.

Lecturer on Public Health, Pathology, Chemistry, and Forensic Medicine, St. Mary's Hospital Medical School; Physician to Out-Patients, St. Mary's Hospital, Paddington, W.

WE have now to consider the measures which should be taken when some one of the substances which are commonly used as poisons, or which may be so used, has been taken into the body in sufficient quantity to produce toxic symptoms. The following are the chief of these substances, and we will consider them in the order in which they are here given:—

General Poisons.

1. Alcohol
2. Ether
3. Paraffin oil
4. Opium
5. Strychnine
6. Belladonna
7. Prussic acid
8. Nitro-benzol
9. Chloral

Irritant and Corrosive Poisons.

1. Carbolic, Oxalic, Sulphuric, Hydrochloric, Nitric and other — Acids
2. Corrosive sublimate
3. Arsenic
4. Antimony
5. Phosphorus
6. Caustic alkalies

Poisonous Foods.

Shell fish | Mushrooms.

The general poisons vary too greatly among themselves to admit of any general description, and must be considered separately.

Acute Alcoholic Poisoning may be conveniently divided into *Drunkenness*, and *Acute Alcoholism with insensibility or coma*. The former is not in itself dangerous, and usually the best course to take with drunken men or women is to leave them to sleep off the effects of the alcohol. Nevertheless, even a moderate grade of drunkenness may be *dangerous in old or feeble people*, with degenerated tissues and weak circulation, for it may be the cause of a grave cerebral disturbance (generally of the nature of an apoplexy), or of a failure of the heart's action. The latter event must be particularly guarded against in cold weather, for, in consequence of the dilated condition of the arterioles of the skin, drunken people lose heat very quickly. Care must be taken, therefore, in thus leaving drunkards alone, that their conditions are such that there is no chance of their becoming dangerously cold.

Emetics.—It often happens, in the casualty department, that it is desirable to make a patient sober as soon as possible. For this purpose nothing is more effectual than a brisk emetic: one of the safest and best is a dessertspoonful of powdered mustard in half a tumbler of warm water; instead of this a solution of a dessertspoonful of common salt dissolved in half a tumbler of warm water may be given, or ½-dr. doses of carbonate of ammonia dissolved in water. Sulphate of zinc in ½-dr. doses has been recommended as a safe emetic, but it is better to try the above non-poisonous substances first if possible. For children 1 dr. of ipecacuanha wine is an excellent emetic.

The use of substances like tartar emetic, vinum antimoniale, copper sulphate, and apomorphine is to be avoided, since they are poisonous in themselves. Apomorphine is a very powerful cardiac depressant, and it is a dangerous drug to give in doses sufficient to cause vomiting. If possible, the stomach should be washed out with warm water, the contents being withdrawn; for this purpose a soft tube should be passed and the proximal end of this attached to the stomach pump, or else to a piece of rubber tubing about three feet in length, at the end of which is a glass funnel. If the stomach pump is used, a little warm water is first passed in and the stomach contents are withdrawn. Fresh quantities of warm water are passed in and withdrawn in like manner until the liquid comes away fairly clear. The rubber tubing and funnel can be used in a similar manner: warm water being poured into the funnel, which when raised allows the water to pass into the stomach; on lowering the funnel the gastric contents can be syphoned away, and thus the stomach washed out.

Faradism.—For the common occurrence of a drunken and disorderly person being brought to the hospital, and refusing to give his or her name and address, faradism, strong enough to produce painful contraction of the muscles, will generally prove effectual when the proceeding is really worth while.

Acute Alcoholism.—A short experience will enable the dresser to separate ordinary cases of drunkenness from other forms of poisoning, and we need not particularize its symptoms. It is undesirable also to attempt a hard and fast differential diagnosis between the higher grades of acute alcoholism and other grave conditions, but this is for a different reason, namely, because it is now not an alternative question, "drunk or dying?" but a positive statement, "drunk, *and* dying." Any patient who has swallowed enough alcohol to produce symptoms which may be confounded with apoplexy or any other severe illness, must be considered to be poisoned, and to be in need of careful treatment. If brought to hospital he should be kept in until the severe symptoms have passed away, since it may be impossible to distinguish severe alcoholic poisoning from cerebral hæmorrhage.

In these cases the condition of the circulation and respiration will be the best guide as to whether the patient may be left to recover from his stupor without further measures beyond those which are required

for keeping him warm, or whether the *stomach pump* should be used; but in most cases it will be best to wash the stomach out with warm water, and this should always be done if there be any sign of failure of the heart's action, or if the breathing be suspiciously shallow. Alcohol may remain for a long time nearly unchanged in the stomach, and should therefore be removed, to prevent further absorption. In extreme cases, artificial respiration may be called for, but these are generally speedily fatal.

In acute alcoholic poisoning, as distinguished from simple drunkenness, if the stomach pump be not at hand, emetics may be used, but as it is undesirable to irritate further the already injured stomach, preference should always be given to the pump if possible. This irritable condition of the stomach should always be kept in mind in the treatment of the case after the acute stage has passed.

In acute alcoholic poisoning, after withdrawing the contents of the stomach or after the use of an emetic, about a pint of strong warm coffee should be given. The patient should be kept warm, and if there is heart failure, 5 min. liq. strychninæ may be given hypodermically, and repeated if necessary.

Ether.—This form of intoxication is hardly known in England, but attention has been called to its frequent occurrence in some parts of Ireland. As a result of inhalation, it is of daily occurrence in all hospitals. When it is swallowed, its effects nearly resemble those of alcohol, but the period of excitement is more marked, and that of stupor less so. It is much more rapidly eliminated, so that the whole intoxication is shorter, and is less poisonous, although fatal cases have been recorded. Its treatment does not differ from that of alcoholic poisoning.

Paraffin or one of the so-called mineral oils may be taken accidentally or with suicidal intent, and when swallowed produces flushing and excitement, followed by drowsiness. In these cases the major part of the oil is generally vomited spontaneously, but the stomach-pump should in all cases be used, or failing that, an emetic should be given.

Opium Poisoning, or Poisoning by its Alkaloids, is very common, and is becoming more so, not from any increase of suicide by this means, but from inadvertence occurring amongst the growing class of people who have acquired the habit of administering the drug to themselves.

When opium is taken for suicidal purposes, laudanum is generally employed, and it often happens that the suicide swallows a very large quantity. This very frequently leads to failure of the attempt, through the active vomiting which is set up.

The Symptoms of opium poisoning are generally distinct enough. The slow shallow respiration and feeble fluttering pulse, the pallid, almost livid skin, covered with a cold sweat, the obstinate drowsiness or profound stupor, and above all, the fixed contracted pupils, are sufficient evidence of the condition, even without any external or circumstantial proofs.

TREATMENT.—In this condition the respiratory centre is the part in greatest danger of striking work, and it must be kept going until the poison has been eliminated. By every possible means the patient must be roused, and *kept awake.*

If the poison has been taken by the mouth, the stomach should be immediately washed out by means of the pump or soft tube, as described above, and the contents withdrawn. If no stomach pump or tube is available, an emetic will be necessary (*vide supra*, under "Alcoholic Poisoning"). As soon as the contents of the stomach have been removed, a solution of permanganate of potash should be given as an antidote. Two ounces of the liq. potass. permang., B.P., diluted with 10 oz. of water, or 10 gr. of potassium permanganate crystals dissolved in half a pint of water, are suitable quantities for administration. It is most important that the respiration of the patient be kept up; thus ammonia vapour should be applied to the nostrils in the form of smelling-salts, and in severe cases artificial respiration is always to be resorted to. Faradic stimulation of the phrenic nerve is useful, and oxygen should be administered in severe cases.

Both atropine and strychnine are useful antidotes in opium poisoning, and should be administered hypodermically. Thus an injection of liq. strychninæ 6 min., and liq. atrop. sulph. 3 min., should be given in a severe case at once. After half an hour to an hour the stomach should be again washed out, and about a pint of very strong warm coffee introduced, or if no stomach pump is available, the coffee is given without removal of the gastric contents. The patient must be kept warm, and the respiration kept going by the above means. Hypodermic injections of strychnine 3 min. every two hours should be continued until the breathing improves. In severe cases of opium poisoning it is unwise to walk the patient about, as this often leads to heart failure.

When improvement has once commenced, it is generally continuous. The pupils may remain contracted for a long time, but when the respiration and circulation appear to be well established, and the patient is able to keep himself awake, the best treatment will be warmth in bed, when natural sleep will probably soon come on and may be encouraged. The patient should be watched, however, lest the respiration should again begin to fail and other symptoms of poisoning re-develop. It is important also to keep a close watch on the pulse and condition of the heart, since attacks of heart failure are common after the patient has apparently recovered from the symptoms of respiratory failure. Rest in bed for a few days is essential. Hypodermic injections of strychnine should be continued for two or three days, and ammonia and digitalis given by the mouth in a suitable mixture. Alcoholic stimulants seem to be hurtful in all stages of the poisoning.

Strychnine.—This alkaloid is a common ingredient of "vermin powders," "beetle paste," and the like, so that strychnine poisoning by misadventure is rather frequent. The symptoms of this condition may be mistaken for those of acute tetanus, but this error can hardly

be made if attention be carefully given to the case for a short time. The condition is, of course, a "tetanus" in both cases; but in that of the poisoning, the rapid development and acuteness of the attack, the universality of the convulsions, as opposed to the almost invariable spreading from the neck and jaw muscles in the ordinary tetanus, the nearly complete relaxation in the intermittent periods, and the fact that the duration of the whole attack is to be measured by hours—all these will enable a diagnosis to be made with almost absolute certainty, although indeed this is of the less importance in that the treatment may be much the same in either case. It is stated that in strychnine convulsions consciousness is usually retained. This is by no means always the case, since sometimes during the convulsions the patient is unconscious and the condition resembles an epileptic fit; however, between the convulsions consciousness usually returns, while in the "status epilepticus" of epilepsy the patient remains deeply comatose. In a case presenting severe convulsions where strychnine poisoning is suspected, careful enquiries should be made as to the taking of drugs, medicines, food, etc., since the symptoms are usually rapid in onset. The convulsions of acute meningitis, uræmia, and cerebral irritation from local lesions are distinguished by the marked associated symptoms, and by the less sudden nature of the onset.

Symptoms.—In strychnine poisoning there is a very short period of abnormal restlessness, quickly followed by a general trembling, and then a general convulsion occurs, with complete opisthotonos, and marked "risus sardonicus" and cyanosis. In half a minute, or a minute, the spasm relaxes, and there is a period of exhaustion and respite, to be succeeded on the slightest irritation, or apparently without any cause, by a similar storm of reflex contraction. If death occurs, it will generally be from asphyxia or exhaustion, and will very often take place in less than an hour. If the dose has not been a fatal one, the convulsions will gradually diminish in frequency and force.

TREATMENT.—The main reliance must be placed upon inhalations of chloroform, and when the patient is under the anæsthetic the stomach should be washed out (*vide supra*) and large and frequently repeated doses of chloral hydrate and bromide of potassium given. Chloral hydrate may be given hypodermically in 5-gr. doses dissolved in water, and frequently repeated. Nitrite of amyl may be inhaled, and artificial respiration performed if possible. The administration of oxygen is of service in severe cases. If by any means the first few hours can be tided over, hopes of recovery may be fairly entertained.

Belladonna Poisoning is generally accidental, as from eating the berries of the deadly nightshade (*Atropa belladonna*), swallowing belladonna liniment (which contains spirit and camphor in addition to belladonna), or glycerin and belladonna, or some preparation containing atropine or belladonna, or through some similar mistake. The *symptoms* are very characteristic. The pupils are widely dilated, and the skin capillaries injected, producing a rash like that of scarlatina.

There is much cerebral excitement; the delirium is generally chattering and restless, but may be extremely violent. The mouth is always parched, the skin very dry, and the temperature often raised.

TREATMENT.—*Emesis* must be produced by the stomach pump, or by a suitable emetic (*vide* under "Alcoholic Poisoning"), and following this, stimulants given in the shape of alcohol or ether, as well as strong tea or coffee, which are also useful from the tannin they contain. Artificial respiration may be necessary in very severe cases, and in others external stimuli, such as douche, faradization, etc.

Both morphia and chloral have an antagonistic action to atropia, but this is in neither case so distinct as that of pilocarpine. Tabloids containing from $\frac{1}{10}$ gr. to $\frac{1}{2}$ gr. of the nitrate of pilocarpine are now procurable, and are very convenient when it is desirable to use the drug in an emergency. One-third of a grain of nitrate of pilocarpine in solution should be given hypodermically, and repeated every two hours until the skin becomes moist. In cases where there is much delirium, morphia hypodermically in $\frac{1}{4}$-gr. doses of the tartrate may be substituted for the pilocarpine. Hot coffee should be given by the mouth. The patient should be kept warm, and oxygen administered if there is collapse; artificial respiration may be necessary in severe cases.

Retention of urine is common in these cases, calling for the use of the catheter.

Prussic Acid Poisoning. — The action of hydrocyanic acid is so intense that death is often almost instantaneous, or there may be just time enough for a cry of agony. Even in less acute cases the symptoms come on within a few minutes. There is first respiratory difficulty, and then a period of violent convulsive movements, which are general throughout the body but especially affect the expiratory muscles. Vomiting, and involuntary urination and defæcation occur. This stage is followed by a period of calm, with rapidly deepening paralysis and cyanosis. This usually is quickly followed by death. In fact the whole attack is one of acute asphyxia.

TREATMENT.—Should there be time for any attempts at restoration, an emetic should be given, or the stomach pump used, if it can be employed *at once*, and then ammonia on a handkerchief, as strong as can be borne by the patient, should be inhaled, and other stimulants freely given by the mouth if they can be swallowed; if not, then brandy and ether should be given hypodermically. Stimulant enemata may also be made use of. Alternate douches of cold and hot water are powerful stimuli to respiration, and strong faradization should always be applied if possible. Artificial respiration will most probably be called for as soon as the convulsive stage is over, and must be persevered in, although the condition may seem to be almost hopeless. Atropine should be given hypodermically, e.g., 4 min. of the liquor atrop. sulph. B.P., immediately, and this should be repeated if necessary.

The materials used for prussic acid poisoning are usually either impure bitter almond oil, or the pharmacopœial or "Scheele's"

acid, or potassium cyanide, which is used by photographers, or by gardeners to destroy wasps and hornets in their nests.

Nitrobenzene.—This is an oily liquid smelling of almonds; it is sometimes known as commercial oil of bitter almonds. If taken internally, symptoms commence in a quarter of an hour to two or three hours. Headache, vomiting, marked cyanosis, and giddiness, with much collapse, are the characteristic features of a case, and if much poison is absorbed coma is likely to supervene.

TREATMENT.—The stomach should be thoroughly washed out or an emetic given at once. Stimulants and external warmth, liq. strychninæ 3 min. every hour for a few hours. Oxygen inhalations and artificial respiration may be necessary.

Chloral.—The symptoms resemble in great measure those of opium poisoning, but the fixed contraction of the pupils is absent, and the circulation is affected quite as much as is the respiration.

TREATMENT.—The stomach should be washed out at once, or an emetic given. The patient must be kept warm. A pint of hot coffee should be given by the mouth. Inject. strychninæ hypoderm. 5 min. should be given at once and repeated in half an hour if necessary. Oxygen inhalations are beneficial, and artificial respiration will be necessary in a severe case. The subsequent treatment is directed against the heart failure which is likely to supervene (*vide supra*, "Opium Poisoning").

Irritant and Corrosive Poisons may conveniently be grouped together, for the symptoms of the latter differ from the former only in their greater intensity. Moreover, many of the substances in our list are irritant poisons in weaker solutions, and corrosive poisons when concentrated. In most cases the local effects are so marked that any constitutional results of their absorption are unnoticed.

Symptoms.—The following is the general sequence of events after an irritant poison has been swallowed. There is first a burning metallic taste in the mouth and throat, and then a sense of intolerable pain referred to the chest, behind the sternum (heartburn). This is followed by increasing general abdominal pain, so that the legs are drawn up, as in peritonitis, and the belly becomes tumid. Vomiting is almost invariably present, and there is generally great thirst.

If the poison has been taken in a quantity insufficient to cause speedy death, and if it be *irritant* only, and not corrosive, the above are the chief symptoms. In less severe cases these may, with appropriate treatment, be subdued; if, however, the dose be a fatal one, the symptoms of irritation will quickly be followed by dyspnœa and increasing collapse, and the patient looks to be in the algid stage of cholera, and this will continue until death by syncope occurs.

But if the substance be truly *corrosive* in its action, such as one of the concentrated mineral acids, the symptoms are even more severe, and run a much more acute course; it is probable that no recovery has ever taken place after such a poison has been swallowed, so that

any considerable quantity has passed into the stomach, although instances are common of great damage to the throat and œsophagus being followed by recovery; or, we should rather say, by recovery in the first instance, for generally the consequent cicatrization has led to contraction and stricture.

The damage to the lips and throat is the first and most prominent symptom, and gives the measure of the extent of the corrosion of the parts lower down. The corners of the mouth may be marked, and the tongue and palate covered, with a whitish coat of slough, "like a coat of white paint," if sulphuric or hydrochloric acid or corrosive sublimate has been used; or with a yellow stain, in the case of nitric acid.

In the presence of these signs of corrosion a very few minutes will decide whether the poison has been really swallowed. If so, the symptoms which have just been detailed will develop, but more rapidly and more acutely. The *stage of collapse* is reached more quickly, and there are signs of actual corrosion of the viscera. The vomit contains shreds of sloughing mucous membrane, or it may be, casts of whole sections of the œsophagus. The abdomen becomes enormously distended with gas. The dyspnœa and dysphagia are both intense, and death usually occurs within a few hours.

TREATMENT.—In many respects the treatment of poisoning by irritant and corrosive substances is common to them all; and again, with regard to many, there are some particular antidotal drugs, or some special measures to be taken or avoided.

With corrosive poisons, such as sulphuric, hydrochloric, or nitric acids, and the caustic alkalies, it is unsafe to use the stomach pump or to give emetics, as there would be great risk of perforation. The appropriate antidote should be given freely, and by it the poison is readily neutralized. In the case of the irritant poisons, such as oxalic acid, carbolic acid, and corrosive sublimate, which are only to a slight extent corrosive, the appropriate antidote should be given at once, and then the contents of the stomach may be carefully withdrawn and a fresh quantity of antidote introduced.

As soon as the stomach has been relieved of the poison, raw egg albumen, milk, barley-water, arrowroot, or whatever mucilaginous fluid can be most readily procured, should be given. Egg albumen, raw, is probably the best of all in all cases, as well as having a special action on corrosive sublimate. Salad oil may generally be given with good results, except in the case of phosphorus poisoning. The rest of the general treatment of irritant poisoning will be directed towards the symptoms of peritonitis and collapse. The pain must be subdued with full doses of opiates. The warmth of the body must be maintained, and the other signs of shock combated by such stimulation as the inhalation of ammonia or nitrite of amyl, the subcutaneous injection of liq. strychninæ or of ether and brandy, stimulant enemata, faradization of the extremities, etc. Morphia by hypodermic injection will also generally be indicated.

Special Points in the Treatment of particular Irritant and Corrosive Poisons.

1. *Irritant and Corrosive Acids.*—These comprise sulphuric, nitric, hydrochloric, oxalic, and carbolic acids; the symptoms in the case of the first three will be similar, and in accordance with those results of swallowing any corrosive fluid which have just been described. The acuteness of the symptoms will vary directly with the strength of the solution, and inversely with the quantity of food in the stomach. In all, if a strong solution be actually swallowed, the symptoms will be of the most urgent kind and will be rapidly fatal if not at once counteracted, so that time is of the utmost importance. The stomach pump may not safely be used. The charring in the case of nitric acid is yellow, and the vomit possesses a nitrous smell. In sulphuric and hydrochloric acids, the lips and mouth are whitish, and the vomit dark or black, containing charred shreds of mucous membrane.

The TREATMENT lies in diluting and neutralizing the acid as quickly as possible, so that all remedies should themselves be copiously diluted. Oxide of magnesia and water, lime-water (the saccharated is the best), whiting and water, chalk and water, ordinary washing soda, or the bicarbonates of soda or potash, in solution, are all useful alkaline remedies. Some of them will almost certainly be at hand in any given case, and it should always be borne in mind that the nearest remedy is the best.

In addition to alkalies, milk, olive oil, and the other demulcents mentioned above are all useful.

After administering the antidote in full amounts to neutralize the acid, it is best to avoid giving food by the mouth, but to give rectal injections of warm saline, and to keep the patient warm and guard against collapse as far as possible. Morphia hypodermically will be called for to relieve pain, and strychnine hypodermically for the collapse, with the addition of brandy if necessary.

In poisoning by *Oxalic Acid* or by *Salts of Sorrel* (the acid oxalate of potash) the main special point to bear in mind is that the alkaline oxalates are soluble and poisonous, so that chalk, whiting, or lime-water must be used to neutralize the acid, and not soda, potash, or ammonia, or the carbonates of any of these. Oxalic acid poisoning is rather common, and is frequently suicidal. The symptoms are those already detailed, save that collapse is often disproportionately marked, and that death may be very speedy.

The best antidote to give is a mixture of whiting with saccharated lime-water. After giving this the stomach may be carefully washed out in a few minutes. Strychnine, and also brandy or spirits of ether, hypodermically, must be given to counteract the collapse. The patient must be kept warm, and oxygen given, and brandy by the mouth if necessary.

Carbolic Acid Poisoning is now perhaps the commonest of all forms of poisoning by misadventure, and is also used for the purposes of

suicide. Its corrosive action is, in concentrated solutions, very conspicuous, but the destruction does not extend deeply into the tissues. The mouth and jaws are usually covered with a white, leathery pellicle. The symptoms are those of poisoning by any corrosive fluid, but pain is less intense than in the case of other acids, owing to the anæsthetic action of the acid on the nerve terminations. The symptoms are less acute than in the case of the corrosive acids, but collapse is likely to occur early and coma to supervene. Suppression of urine may occur.

TREATMENT.—Saccharated lime-water should be given freely (one or two pints), since this converts the phenol into an inert compound (ordinary lime-water has the same effect, but more is necessary). The stomach should be washed out with warm water, or with the same alkaline solution, three or four times, half a pint or so of the solution being afterwards left in the stomach. In the absence of the stomach-pump, vomiting must be produced by mustard and water. Later on, demulcents, such as barley-water, olive oil, etc., may be given, or an ounce of castor oil.

Shock is often very marked, and must be treated by frictional warmth, ammonia, etc., as before stated. Hypodermic injections of strychnine should be administered, and oxygen inhalations.

The urine is often dark and scanty, and may be suppressed in acute carbolic acid poisoning. The carboluria is then a grave symptom, but it often happens in surgical cases that carbolic acid, not necessarily used in very large quantities, is absorbed and produces a similar inky urine. Some patients seem to be especially susceptible to this mild form of carbolic acid poisoning, which apparently does them no harm provided the source of the poison is removed as soon as possible.

2. For *Corrosive Sublimate* (perchloride of mercury), the acid nitrate of mercury, etc., albumen in any shape (even gluten of flour is better than none, but raw white of egg is best) should be freely given, as an insoluble albuminate is thus formed. Emesis should be encouraged by warm water or mustard and water, if vomiting be not active without such aid. If the solution has been concentrated, the stomach-pump must only be used with great care. Afterwards the patient must be kept warm, and morphia administered hypodermically, with starch and opium enemata if necessary to allay the purging which often occurs. Strychnine hypodermically may be required for collapse.

3. *Arsenical Poisoning* is generally effected by arsenious acid (white arsenic), sometimes given with criminal intent. The symptoms come on usually in one-half to one hour after taking the poison. The vomiting and purging resemble at first an intensely violent bilious attack; afterwards the symptoms are more like acute cholera, and the diagnosis is often obscure. The emesis must be encouraged, and the stomach should be thoroughly washed out with warm water, and the contents removed. Freshly precipitated ferric hydrate should be given as an antidote: this may be prepared by diluting half an

ounce of the tincture of perchloride of iron with half a tumblerful of water and adding half an ounce of a strong solution of carbonate of soda (until the mixture is definitely alkaline); the precipitate is well stirred up in the liquid, and the mixture given at once. In place of the ferric hydrate, drachm doses of the solution of dialyzed iron diluted with water may be administered. Saccharated lime-water freely given might be of service in the place of the iron preparations. For the collapse which follows, warmth and stimulants, e.g., brandy, and strychnine hypodermically, are necessary. Morphia hypodermically will be necessary for the diarrhœa and vomiting, and starch and opium enemata will relieve the tenesmus and purging.

If the diagnosis of the acute form of this poisoning is not generally easy, that of chronic arsenical poisoning is always difficult, but this condition does not fall under the heading of emergencies.

4. *Antimony* (*Tartar Emetic*).—The symptoms come on soon, and generally the vomiting is so violent that the whole of the poison is soon ejected. If not, the symptoms resemble those of arsenical poisoning, but there is more depression. The treatment is the same as in arsenical poisoning; but in addition *tannin* should be given in the form of very strong tea or coffee, or by means of preparations of oak or cinchona bark, or of tannic acid itself.

5. *Phosphorus.*—This is usually taken in the form of beetle paste, or rat paste, or sometimes by swallowing the heads of lucifer matches. In these cases the symptoms declare themselves quickly after the poison has been taken, and are generally prolonged over days, or it may be weeks. The prominent symptoms are great thirst, heart-burn, and violent vomiting, the vomit being phosphorescent in the dark and frequently black and grumous from altered blood, and the breath smells strongly of the poison.

The result will mainly depend on whether the vomiting be sufficiently active to prevent an absorption of a really poisonous amount. If the quantity absorbed be large, the symptoms remain acute; hæma-temesis and bloody purging are often present, with cramps, and finally coma. But if only a small, but still poisonous quantity has been taken (say ½ to 1 gr.), after the first indications of irritation have passed over, the symptoms usually subside for a day or two, and then symptoms like those of acute atrophy of the liver begin to declare themselves. The jaundice deepens, and a comatose typhoid condition, with delirium, generally ends in death in a few days, although in some of the milder cases recovery may take place. The early treatment of the poisoning does not differ from that of other irritants, save that *oil*, in which phosphorus is soluble, *should never be employed* with the idea of soothing the intestinal mucous membrane. After the stomach has been emptied of its contents, either naturally or with the stomach-pump, permanganate of potash solution (*vide* "Opium Poisoning") should be given by the mouth, or Sanitas in 4-dr. doses well diluted, or the French oil of turpentine in doses of ½ dr. suspended in mucilage and frequently

repeated. These antidotes contain nascent oxygen, which will convert the phosphorus into the non-poisonous phosphoric acid. The subsequent treatment is similar to that of arsenical poisoning in its later stages. *Chronic phosphorus poisoning*, phosphorus necrosis, etc., are not here discussed, for they do not occur as emergencies.

6. *Caustic Alkalies and their Carbonates.*—This form of poisoning is rare, but potash or soda lye is sometimes taken. The symptoms are those of ordinary corrosive poisoning, except that violent purging is generally a prominent symptom. In the treatment the use of the stomach-pump must be avoided. Weak acids, such as vinegar and water, or any of the dilute non-poisonous acids, such as citric or tartaric acids, 4 dr. dissolved in a pint of water, should always be given. The subsequent treatment is similar to that of corrosive acids in the later stages.

Poisonous Foods.—A form of acute gastro-intestinal irritation, often so severe as to justify the term poisoning, is not infrequent as a result of eating shell-fish, especially mussels.

In the treatment, an emetic should be given in the first place, and afterwards a full dose of castor oil with 20 min. of laudanum. Warmth and stimulants are necessary for the collapse. Morphia hypodermically should be given for the vomiting and diarrhœa, and a starch and opium enema if necessary.

Mushroom Poisoning should not go without mention. Most fungi, edible or inedible, may produce, if improperly cooked, symptoms of a mild degree of irritant poisoning, similar to those which have been mentioned, and may be treated in a similar way. But cases of true *muscarine* poisoning exhibit a much higher grade of toxic symptoms. The fungi which contain muscarine or some similar alkaloid are not very numerous in England, the principal one being the fly fungus (*Amanita muscaria*). When the more actively poisonous fungi have been eaten, as a rule great cerebral excitement is caused, in addition to the more strictly irritative effects on the alimentary tract.

In the antagonism between *muscarine* and *atropia* we have perhaps the best example of this mode of the physiological action of drugs. Digitalis also, though in a less degree, is antagonistic to muscarine. Whenever, therefore, the symptoms of mushroom poisoning are grave, and especially if there be delirium or mania, atropia should be given, say 3 to 5 min. of the liq. atropinæ by the mouth, or 2 min. subcutaneously, or as an alternative treatment, full doses of the tincture or infusion of digitalis may be administered. In other respects the treatment should consist in removing the poison from the alimentary tract as soon as possible, by means of the stomach-pump or an emetic, and by the administration of an ounce of castor oil as a purgative. Where there are marked gastro-intestinal symptoms, morphia hypodermically should be given, and starch and opium enemata, warmth, and stimulants are necessary for the collapse.

Chapter XLVI.

HEAD INJURIES.

By H. W. CARSON, F.R.C.S.

Senior Surgeon, Prince of Wales's General Hospital, London.

INJURIES to the head and brain are among the most important cases with which house surgeons have to deal. There is no doubt that it is impossible always to estimate the amount of damage sustained, nor is it possible, even with undoubted severe injury, to diagnose the exact seat and extent of the mischief in every case. It follows then that it is imperative to examine these cases with the most scrupulous care, to consult with one's colleagues in case of doubt, and to treat as severe every case that is not obviously simple and uncomplicated. This may lead to the admission of some cases unnecessarily, but this is far better than the overlooking of a fracture of the base and the consequent discharge of a patient who is in peril of his life. It is particularly necessary to train oneself to avoid prejudgment in "unconscious" cases. In the casualty department we see so much drunkenness that we may be unconsciously biased in favour of a diagnosis of alcoholism, especially if we get our first impressions from the police officer in charge of the ambulance, who has, as a rule, only one idea as to the cause of unconsciousness, and is willing to express it firmly and without qualification We must remember, too, that many unconscious patients fall at first into the hands of the modern "Good Samaritan," who, as a rule, props his victim in a sitting position against the nearest railings and pours brandy into his mouth, thus giving to the patient's breath the alcoholic odour which is looked upon as diagnostic by the careless or inexact observer. The differential diagnosis of "coma" cases will be discussed in parallel columns later in the chapter.

INJURIES OF THE SCALP.

The importance of scalp wounds lies in the possibility of their association with some injury to the bones of the skull. The presence of loose cellular tissue between the aponeurotic layer and the pericranium allows of a considerable degree of movement of the scalp on the underlying bone, and this minimizes the effect upon the bones of the skull of any but direct blows. The scalp is very well supplied with blood, with the result that comparatively trifling injuries may lead to a considerable hæmorrhage.

Contused Wounds lead to extravasations of blood: (1) Between the layers of the scalp itself; (2) Beneath the aponeurosis; or (3) (in children) beneath the pericranium. A hæmatoma in the first situation results from a direct blow, remains definitely circumscribed, and may be felt to move with the scalp. As the effused blood coagulates, the edges solidify sooner than the centre, and to palpation the impression is given of a raised hard edge, and a depressed centre simulating a depressed fracture. To differentiate between the two conditions, firm pressure should be made on the edge with the finger; in the case of a hæmatoma the edge at the point of pressure will disappear, while of course the fracture will be unaffected.

Hæmatoma under the Aponeurosis results from glancing blows, and may be of considerable extent. Its importance lies in the possibility of infection, leading on to diffuse cellulitis.

Hæmatoma under the Pericranium is most common in children, forming the well-known cephalhæmatoma.

As the result of a blow a wound of the scalp may occur which resembles closely an incised wound, but a close examination will show that the edges are bruised. In rare cases a blow on the scalp will cause rupture of the aponeurosis without a skin wound. It is often difficult to distinguish between such a condition and a fissured or depressed fracture of the vault.

Wounds of the scalp require particular attention for two reasons:

1. They may be associated with a fracture of the skull, the fracture and the wound not necessarily coinciding in position or extent.

2. Owing to the impossibility of making the scalp surgically clean, the risk of suppuration must be remembered and drainage provided for. Nevertheless, every effort must be made, by shaving, scrubbing, and douching with antiseptics, to cleanse the wound, if necessary under an anæsthetic. On the whole, scalp wounds heal well, and sloughing is practically unknown, however extensive the injury, owing to the abundant blood-supply.

FRACTURES OF THE SKULL.

Fissured Fractures of the Vault may be impossible to diagnose if not compound, the only sign being perhaps a linear tenderness. If there is an open wound a fracture is easily recognized. It must not be confused with a suture, from which it differs in being straight, and occasionally blood is seen oozing along the course of the fracture. It must be remembered that a fissured fracture may extend into the base.

Depressed Fractures of the Vault are readily recognized, the only condition resembling them being hæmatoma (*q.v.*). The effect on the inner table is generally greater than that on the external, and for this reason it is advisable to submit all depressed fractures, whether simple or compound, to operation.

Fractures of the Base must be diagnosed by attention to symptoms rather than by direct examination of the seat of injury. The symptoms differ according as the fracture affects the anterior, middle, or posterior fossa. The symptoms depend on the escape of blood and cerebrospinal fluid extracranially, the injury of meningeal vessels, or nervous lesions.

Extracranial Bleeding occurs from the *nose* as the result of fracture of the ethmoid (cribriform) plate in anterior fossa fractures, and from the *ear* in middle fossa fractures. At a later stage, hæmorrhage under the eyelids or conjunctiva occurs in anterior fossa fractures, into the tissues over the mastoid process in middle fossa fractures, and over the occipital region in posterior fossa fractures. Fracture through the basilar process of the sphenoid bone may give rise to pharyngeal hæmorrhage. All these hæmorrhages are free, in distinct contrast to the bleeding that may occur as the result of a purely local injury, e.g., rupture of the membrana tympani or injury to the cartilage lining the meatus auditorius externus. In addition, cerebrospinal fluid may escape, and its presence is diagnostic of basal fracture. It possesses the following characters: It does not give the reaction for albumin, but contains sodium chloride and a substance (pyrocatechin) which gives the sugar reaction with Fehling's solution.

The commonest meningeal vessel to be injured is the middle meningeal artery in or near its passage through the foramen spinosum or in its groove on the temporal bone. Injury to this vessel gives rise to the well-known symptoms of compression due to extradural hæmorrhage, with the characteristic "interval" between concussion and compression. The cavernous, longitudinal, or lateral sinus may be wounded more rarely, giving rise to their characteristic signs.

Injury to the nerves occurs near their foramina of exit. The most commonly affected is the facial, then the abducens. Often groups are affected: the 5th and 3rd together; the 6th, 7th, and 8th; or the 9th, 10th, and 11th. The following table shows the symptoms of basal fracture in parallel columns.

SYMPTOMS OF BASAL FRACTURE.

SYMPTOM	ANTERIOR FOSSA	MIDDLE FOSSA	POSTERIOR FOSSA
A. Hæmorrhage and escape of cerebrospinal fluid	(*a*) From the nose (*b*) Into the orbit (later)	(*a*) From the ear (*b*) Over mastoid (later)	(*a*) Into the pharynx (*b*) Into the cellular tissue of the occipital region (later)
B. Injury to intracranial vessels		(*a*) Middle meningeal artery (*b*) Cavernous sinus	Lateral or occipital sinus
C. Injury to nerves	Olfactory Optic	3rd and 5th 6th, 7th, and 8th	9th, 10th, and 11th

COMPLICATIONS OF HEAD INJURIES.

There are three main complications of head injuries affecting the brain which may be described, viz., concussion, contusion or laceration, and compression. Each of these conditions gives rise to symptoms peculiar to itself, but it must be understood that it is often difficult to draw a definite distinction between any two of them, to say when concussion merges into laceration or either into compression.

Concussion is the name given to the state of unconsciousness immediately following upon a blow on the head. The patient is, in a word, stunned. The symptoms appear immediatoly on receipt of the injury, and two stages are recognized: (1) The stage of collapse; (2) The stage of reaction.

In the Collapse stage there is insensibility of varying severity. The patient can generally be roused, but relapses into insensibility. The pupils are equal, often contracted, and react to light. The pulse is slow and weak, the respirations slow, shallow, and irregular. The muscles are relaxed, but there is no actual paralysis: the reflexes are present; there are incontinence of fæces and urine and a subnormal temperature.

When Reaction occurs, there is a gradual return to consciousness; vomiting may occur, but does not persist. The pulse increases in rate and volume, and the respirations become deeper and more regular. The extremities become warmer, and the body temperature may rise to a degree or so above normal.

Contusion or Laceration gives rise to symptoms resembling concussion, but generally of greater severity, the period of unconsciousness being considerably prolonged. The typical symptoms may not appear for three or four days. If the laceration is in the sensori-motor area, clonic spasms may occur affecting certain groups of muscles, or in more severe lacerations, paralysis may result. A group of symptoms apart from sensori-motor symptoms may occur, to which the name of *cerebral irritation* has been given. The patient lies curled up on his side, eyes closed, pupils contracted and equal, pulse slow and weak, and temperature subnormal. He can be roused, but resents interference, and will often keep his eyes tightly closed if an examination of them is attempted. The urine and fæces are passed into the bed. This condition may last for several weeks, but tends to recovery. In the early stages of laceration a lumbar puncture will demonstrate the presence of blood in the subarachnoid space.

Compression due to pressure by blood extravasated between the brain and the cranial bones, generally from injury to the middle meningeal artery (subcranial hæmorrhage) naturally comes on gradually, and steadily increases in severity as long as hæmorrhage is unchecked. In subcranial hæmorrhage, symptoms of concussion are present at first, but these pass off, the patient recovering consciousness, to relapse into a deeper unconsciousness as pressure on the brain becomes established. This "interval" is the typical sign of compression. If the hæmorrhage

be subdural or subarachnoid, the interval of consciousness does not occur. Here again a lumbar puncture is of value in diagnosis. The general condition is one of drowsiness passing into coma. The patient cannot be roused, and insensibility is complete; the pupils are dilated and do not react to light; if the pressure is unilateral, the pupil *on the side of the lesion* will be the more dilated at first, but in the later stages both pupils will be dilated and immobile. The pulse is slow, full, and heaving. This pulse is characteristic of compression, but in later stages it becomes quick, small, and irregular. Respirations are slow and deep; owing to paralysis of the palate and buccinator muscles, stertor is present, and the cheeks are blown out with each expiration. In the later stages respirations become hurried, shallow, and irregular, and may imitate the Cheyne-Stokes type. There is general paralysis, though hemiplegia may be present in the early stages of a unilateral lesion where the clot presses on the motor area. The reflexes, superficial and deep, are lost. Incontinence of fæces occurs, and, owing to paralysis of the bladder, false incontinence, i.e., retention with overflow from the full bladder, is the rule. The temperature, at first subnormal, tends to rise in later stages, especially in cases terminating fatally. In unilateral pressure, the temperature of the side paralyzed, i.e., the side opposite the lesion, is slightly raised. The differential diagnosis between concussion and compression is subjoined:—

DIFFERENTIAL DIAGNOSIS OF CONCUSSION AND COMPRESSION.

	CONCUSSION	COMPRESSION
Onset	Sudden	Gradual
General condition	Can be roused	Cannot be roused
Pupils	Equal, react	Dilated, immobile, perhaps unequal
Pulse	Slow and weak	Slow, full, heaving
Respirations	Slow, shallow, irregular	Slow, deep, stertorous
Muscles	Relaxed (functional paralysis)	Organic paralysis
Reflexes	Present	Absent
Rectum	Incontinence of fæces	Incontinence of fæces
Bladder	Incontinence of urine	False incontinence
Temperature	Subnormal	Subnormal, rising in late stages: may be unequal on the two sides

TREATMENT OF COMPLICATIONS.

Concussion must be treated according to the stage at which the case is seen. In the first stage the condition is one of shock, and treatment must be on similar lines, viz., the patient is placed in the recumbent position with the head low, and efforts are made by the application of warmth, and in severe cases by stimulants, to counteract the circulatory depression. The traditional ice-cap should not be applied in this stage, nor should a purge be given, as both tend to

depress. When reaction occurs, the patient must be kept very quiet, and must be constantly watched in order that the first signs of any further complication, such as compression, may be noted. A few grains of calomel should be administered, and a castor oil enema, but the application of an ice-cap is inadvisable. In some cases a catheter has to be passed. The patient should be confined to bed until the pulse-rate has become steady and normal, and until headache has quite disappeared.

Contusion and Laceration are treated on similar lines, but, speaking generally, the patient must be confined to bed for a longer period. There is rarely any necessity for operative procedures.

The treatment of **Compression** is from the first operative. The pressure must be relieved and the injured vessel secured. The methods that have been adopted are trephining, venesection, and lumbar puncture. Of these, venesection and lumbar puncture may be unhesitatingly condemned. Of venesection, it may be said that while it may reduce the amount of hæmorrhage from the injured cerebral vessel, it will still further increase the cerebral anæmia which is the chief danger to life. Lumbar puncture, at any rate in cases of high intracranial tension, is a very dangerous proceeding, and several sudden deaths have resulted from it, owing, it is supposed, to the medulla being jammed in the foramen magnum when the support of the spinal fluid is removed.

Compression may be due to extravasation of blood between the bone and the dura, between the dura and the brain, or in the brain itself. The extradural hæmorrhage is the most common and the most amenable to treatment.

Extradural Hæmorrhage generally results from injury to the middle meningeal artery either as it passes through the foramen spinosum or in the groove on the temporal bone; hæmorrhage from a venous sinus is much more rare, because the venous pressure is so low that the dura is not stripped up from the bone. The clot generally forms in the temporal region, but its exact position may be impossible to ascertain previous to operation; indeed it may be very difficult to decide whether the lesion is on the right or left side. If focal symptoms occur, the diagnosis will be simplified, but these must be looked for early, before the onset of coma. Dilatation of one pupil points to that side as the side of the lesion.

Operation.—The whole head should be shaved and prepared. A flap with its convexity upwards should be turned down from the temporal region, including the temporal muscle. The middle meningeal artery should be exposed at the point where it crosses the middle of the temporal fossa. It is easily reached here, and there is a better chance of securing it if it is injured low down than if a higher trephining is done. A simple surface marking is Vogt's "two fingers' breadth above the zygoma and a thumb's breadth behind the vertical process of the malar," a rough but effective marking of the main trunk.

If the correct side has been chosen, the removal of the disc of bone will at once disclose the clot. This should be removed and the bleeding vessel ligated or plugged. The depressed surface of the dura does not expand at once, so that the disc of bone cannot usually be replaced. If the dura is intact, hernia cerebri will not occur.

Operations for subdural hæmorrhage are rarely called for, nor are they justifiable unless there are symptoms of pressure on the medulla.

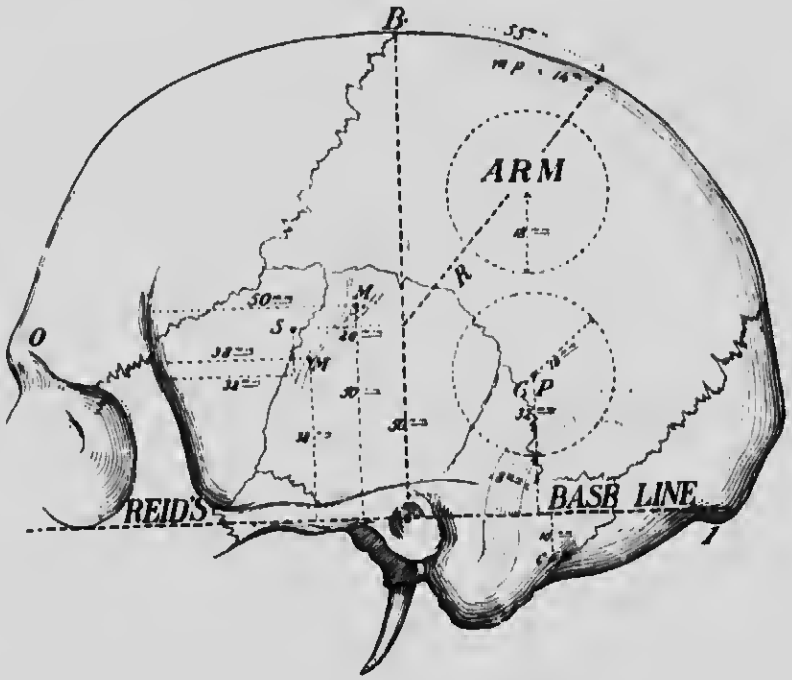


Fig. 288.—Surface Marking of Skull.

The effusion of blood is generally basal, and the operation is performed more to relieve pressure than to arrest hæmorrhage. As little as possible should be done, but there is a definite risk of post-operative hernia cerebri.

Hernia Cerebri.—If a condition of intracranial tension exist as the result of tumour, sepsis, or whatever cause, and if an opening is made in the skull and dura mater, a prolapse of brain matter will occur through the opening, and this is known as a *hernia cerebri*. If, as the result of an injury, the soft parts covering the opening are deficient, the brain matter is exposed and a *fungus cerebri* results. A hernia cerebri is often made with intent in cases of cerebral tumour, and acts as a safety-valve in reducing intracranial tension, thus prolonging life, saving eyesight, and relieving headache. A hernia cerebri properly

protected by intact soft parts is not a danger to life. On the other hand, a fungus cerebri may be a source of much embarrassment. It generally results from a compound fracture of the skull when the dura has been injured. The wound is infected, and a localized meningitis and encephalitis follow. As the result there is intracranial tension, and n protrusion occurs at the point of least resistance. The mass, which may reach n considerable size, consists chiefly of granulation tissue, with some necrotic nerve fibres and cells. While the fungus itself is not dangerous, there is a great danger in the co-existing meningitis nnd encephalitis, and many of these cases end fatally.

Treatment must be directed entirely to obtaining and maintaining surgical cleanliness. There is nothing to be gained by applying pressure, and shaving off the prominent portion is of very slight if any value. As granulation tissue forms the bulk of the tumour, the application of pure spirit is advisable, and this is also a valuable antiseptic. Frequent irrigation and minute cleanliness are the main indications. Lumbar puncture has been suggested in the early stages; this can be of but temporary value. The opening of the skull may be enlarged to assist drainage and relieve the intracranial tension, and, not infrequently, during the course of such an operation, an abscess very near the surface is opened, with excellent results on the hernia. (Abscess of the Brain is discussed elsewhere; *see* p. 425.)

COMA CASES.

It will fall to the lot of every house surgeon to be called upon to diagnose and treat patients who are brought to the casualty department in an unconscious condition. Some of these cases are simple and straightforward, others may be most difficult and complicated, and yet in no class of case are correct diagnosis and treatment more essential. And another point must be considered, namely, that, while in many coma cases the most accurate diagnosis and treatment are of no avail to save life, the death of a patient following a faulty diagnosis and discharge from hospital does the reputation of the institution and the medical profession an immense amount of harm. The diagnosis of the cause of coma is beset with difficulties. There is no history in many cases either of the actual onset of the present trouble or of the previous health of the patient; no information can be gleaned as to the character of the "fit" in its early stages from chance witnesses, who are curiously unobservant; and one may be easily misled by the signs of an injury which may after all be the result and not the cause of the coma, or by an alcoholic odour in the breath which is merely the result of the misdirected sympathies of the "first-aid" enthusiast. Coma arises from so many causes, both surgical and medical, ranging from malingering to sunstroke, that every case must be approached with an absolutely open mind.

Examination.—While a hasty examination is made to assure oneself that the patient is in no immediate danger, a history of the occurrence

—whether blood or vomit was seen, etc.—should be sought from the patient's companions or helpers. A knowledge of the patient's age is often very valuable. A detailed and systematic examination is then undertaken. The depth of the coma is ascertained by making efforts to rouse the patient; the skull is examined with special reference to the presence of wounds, contusions, or signs of bleeding or discharge from the nose, mouth, or ears. The tongue should be examined, as it may be bitten in epilepsy or present the dry, red, glazed appearance of diabetes. The odour of the breath may be of service, as it is distinctive in cases of alcoholism, uræmia, diabetic coma, and opium poisoning. Examination of the eyes may be of great value, the pin-point pupils of opium poisoning, the dilated pupils of alcoholism, and the unequal pupils of unilateral compression being characteristic. The rate and character of the pulse and respiration are noted, particular attention being paid to the degree of rigidity of the arteries and the type of respiration (I have seen one or two drunken men brought in with broken necks). The muscular tone is noted, the reflexes are tried, and other signs of organic paralysis sought for. The temperature should be taken on both sides. The amount of bladder distention must be noted, and the urine tested for albumin, blood, and sugar. In a case of probable alcoholism or narcotic poisoning, the stomach may be washed out and the contents noted. Finally, if any doubt as to the serious character of the condition exists, the patient *must* be admitted and kept under strict observation. While coma may occur as the last stage in many diseases, there are certain conditions in which coma is the rule, and it is to these that attention is particularly directed.

COMMON	LESS COMMON
Alcohol	Malingering
Apoplexy	Sunstroke
Epilepsy	Exposure to cold
Concussion	Cerebral abscess
Compression (traumatic)	Poisoning, e.g., Belladonna. Phosphorus
Opium poisoning	
Uræmia	Acute yellow atrophy of liver
	Diabetes

The common causes may be grouped under the well-known "memorizer":—

A. { Alcohol / Apoplexy
E. Epilepsy
I. { Injury { Concussion / Compression
O. Opium poisoning
U. Uræmia

The symptoms peculiar to each are arranged for the purpose of differential diagnosis in parallel columns in the following table:—

COMA CASES

	ALCOHOLISM	APOPLEXY	COMPRESSION	CONCUSSION	POST-EPILEPTIC	OPIUM POISONING	UREMIA
Onset	Gradual	Sudden	Gradual	Sudden	Preceded by fit	Gradual	Sudden or gradual
General condition	Can be roused	Cannot be roused	Cannot be roused	Can be roused	Cannot be roused	Cannot be roused	Cannot be roused
Pupils	Dilated	Dilated, immobile	Dilated, immobile, unequal	Equal, react	Variable	Pin-point	Variable, probably contracted
Pulse	Full	Slow, full, tension +	Slow, full, heaving	Slow and weak	Becoming less rapid	Slow and compressible	High tension
Respiration	Deep, slight stertor	Slow, sterterous	Slow, deep, stertorous	Slow, shallow, irregular	Noisy or sterterous	Laboured, irregular, stertor	
Muscles	Twitching	Hemiplegia	Organic Paralysis	Functional paralysis	Relaxed	Relaxed	Recurrent convulsions
Reflexes	Present	Absent	Absent	Present	Increased	Present	
Bladder		Involuntary micturition	False incontinence	Incontinence	May be incontinence	False incontinence	
Rectum		Involuntary passing of faces	Incontinence of faces	Incontinence	May be incontinence	No evacuation	
Temperature	Subnormal	Subnormal (high in pontine)	Subnormal, rising later. May be unequal on the two sides	Subnormal	Raised		Subnormal
Special points	Face flushed Absence of Alcoholic odour in breath excludes	Face cyanosed or grey Conjugate deviation of eyes towards lesion May be albumin in urine			Cyanosis, decreasing Tongue bitten	Odour of breath Face pallid Skin sweating All secretions except sweat diminished	Look for retinitis Albumin in urine Tongue furred Breath foul

Chapter XLVII.

OF DROWNING AND SOME OTHER FORMS OF SUFFOCATION.

Asphyxia.—In all forms of asphyxia it is important to recollect, first, that insensibility comes on very soon, some time before the convulsive struggles cease, and is succeeded by a paralysis of all the voluntary muscles, including those of respiration; and secondly, that the *heart's action may continue* for a long time after the ordinary muscular movements are abolished.

The actual cause of death is probably the hyper-distention of the right side of the heart, and it can easily be shown in animals that recovery from asphyxia is possible even after the heart has ceased to beat, if the right heart be rapidly unloaded of its blood by opening the jugular vein. In man, it is very doubtful if such a recovery has ever taken place: but it certainly seems that prompt venesection, although it is very rarely resorted to, offers in extreme cases almost the only chance. It should be remembered, too, that the performance of artificial respiration, to be directly described, in addition to re-oxygenating the blood, also relieves the distention of the right ventricle, by facilitating the passage of the blood through the capillaries of the lungs.

It will probably save needless repetition if we here consider the steps to be taken with the object of restoring suspended animation in ordinary cases of drowning; and taking this account as a typical case of suffocation, to leave it to the reader's common sense to fill in the details of the slight variations which are called for by the different circumstances of other forms.

Drowning.—Several causes are generally present here to produce a condition of lifelessness, in addition to the asphyxia itself. Thus, *shock* is often present, and may be a very important factor. *Exhaustion* from long-continued struggling, and the effects of *exposure to cold*, are also common, and have to be dealt with.

Still, the great agent in producing the condition is suffocation, and this must first of all be combated.

Supposing, then, that the body of an apparently drowned person has been recovered from the water, and that respiration is found to have stopped, it may well be that the breathing can be set going again by simply making sudden forcible pressure at the pit of the stomach some three or four times, at intervals of three or four seconds; but should this not be quickly followed by respiratory movements, artificial respiration proper should at once be begun.

Artificial Respiration.—For this method to be of the least avail, all its details must be carried out regularly and thoroughly; the object being so far to imitate the natural thoracic and abdominal movements, that air may be sucked into, and squeezed out of, the chest.

Fig. 289.—Sylvester's Method. Inspiration.

In Sylvester's Method (*Figs.* 289, 290) the arms are used as levers, acting so as to expand the chest walls by means of the muscles placed between the limbs and the trunk, the origins of the muscles acting now as insertions, and vice versa.

Fig. 290.—Sylvester's Method. Expiration.

The patient should first be *laid on his back*, and some convenient support be placed under the shoulders, so that the chest may be thrown out, and the neck extended, with the head thrown back. (*See figures.*)

If this be properly managed, there will not generally be any necessity for the tongue to be drawn out of the mouth, for the larynx will be kept open by the chin being kept well up. But it may sometimes be desirable for an assistant to *draw forward the tongue*, and if so, the best way to hold it, in the absence of proper forceps, is with the corner of a handkerchief between the finger and thumb. This is much better than trying to fasten the organ down to the chin with an india-rubber band.

Everything which in the least confines the neck, or chest, or abdomen, must be loosened, and the mouth and nostrils cleansed from any mud, etc. Should there be any water lying in the pharynx, the patient may be *turned over on one side* to let it run out of the mouth, but no direct attempt should be made to empty the stomach.

These preparations should occupy only a few moments. As a rule, in ambulance demonstrations they are done in the most leisurely way, and if the subject were a real patient he would be dead long before artificial respiration was begun.

The surgeon then kneeling at the patient's head must take hold of the arms above the wrists, and carry them well over the head right back as far as they will go, as shown in *Fig.* 289. The chest walls will then be expanded, and generally air can be heard passing through the glottis. The arms must then be brought down against the sides, and the forearms crossed over the pit of the stomach. Leaning now with his weight upon them, the surgeon makes forcible pressure upon the abdomen, so as to press up the diaphragm, and if there is water in the air passage produce bubbles at the nostrils. This should elicit a distinct grunt from the patient; if it does not, it is doubtful if air has entered the chest cavity at all; the whole process is then repeated.

Rate of Artificial Respiration.—This should vary with the age of the patient, and be about the rate of normal breathing for that age, say, for an adult, 17 times a minute. Most persons, the first time they perform artificial respiration, do it very much too quickly. Slow, forcible movements are the best, but not so forcible as to break the ribs, which has been known to occur.

If recovery be going to take place, a very few minutes will usually be sufficient to restore natural breathing movements, and then care must be taken not to interfere with the short gasps with which natural respiration begins; but the patient must still be carefully watched, for the condition, like that of shock, is one very prone to relapse, and the respiration may fail again after it has been restored.

While this principal restorative process is being carried out, other *secondary aids to recovery* should be attended to. These do not differ greatly from those already described for shock. A *warm bath* should be prepared, and the dripping clothes exchanged for dry warm blankets. *Frictional warmth* is a very useful agent, and the extremities and flanks may be energetically rubbed in the direction of the venous circulation.

As soon as respiration has been fairly established, the hot bath, if procurable, may be used. The temperature must be high, say 104° F., and the time of immersion short. The patient may then be put to bed between blankets, with hot-water bottles; and some stimulant,

Fig. 291.—Schäfer's Method. Inspiration.

such as hot brandy and water, may be given, especially if there be still feebleness of the heart's action, or shivering.

Sylvester's method is applicable to many surgical emergencies, as, for example, failure of respiration under anæsthesia; for the apparently

Fig. 292.—Schäfer's Method. Expiration.

drowned the method of choice is that recently recommended by Schäfer.

Schäfer's Method.—Place the patient face downwards on the ground, preferably with a folded coat under the lower part of the chest,

Do not lose time in attempting to remove his clothing. Begin artificial respiration as follows:—

1. Place yourself athwart or on one side of the patient's body in a kneeling posture and facing his head.

2. Place your hands flat over the lower part of the back (on the lowest ribs), one on each side, and gradually throw the weight of your body forward on to them, so as to produce firm pressure—which must not be violent—upon the patient's chest.

3. Raise your body slowly, so as to remove the pressure, but leaving your hands in position.

4. Repeat this forward and backward movement every four or five seconds (*Figs.* 291, 292).

This course must be pursued for at least half an hour, or until the natural respirations are resumed. When breathing has been established, the patient may be turned on his back and active means employed to promote the circulation by friction of the limbs in a direction towards the heart, the application of hot flannels, hot bottles, etc. As soon as the patient can swallow, small quantities of wine, warm brandy and water, beef tea, or coffee may be administered. He should then be put to bed and encouraged to sleep.

Other forms of Suffocation.—In *suffocation by the fumes of charcoal or coke*, by the *carbonic acid in brewing vats*, by the *choke damp* of mining accidents, or by *hanging*, we have examples of suffocation, in all of which the great agent for resuscitation must be artificial respiration. As a rule the conditions are more simple than in drowning, as shock, or exhaustion, or cold, the effects of which in drowning have to be overcome, is not generally present, but the main principles of the treatment remain the same. The inhalation of oxygen gas may prove of value in these cases.

We have mentioned a ready, when considering the treatment of extreme shock and syncope, most of the other measures which are accessory to artificial respiration in cases of suspended animation from whatever cause arising; but although *faradization* has been alluded to in connection with the recovery from some poisons, such as opium, chloral, or prussic acid, and also on other occasions, the details of the administration of the electric current have not yet been given. The following are in brief the directions which should be followed.

The faradic current is usually employed, but the interrupted galvanic current might answer the purpose.

Graduate the current to a strength sufficient to produce vigorous contractions of the muscles of the ball of the thumb. Then press the electrodes firmly over the phrenic nerves, between the sternomastoid and scalene muscles; or, put one electrode over one phrenic nerve and the other in the seventh intercostal space.

Interrupt the current about three times a minute, while the assistant presses firmly on the abdomen, pausing occasionally to observe the effect.

If no inspiratory movements appear after a number of interruptions, increase the strength of the current.

The electrodes must be large, and well moistened.

The resuscitation of stillborn infants, though carried out on the same general principles as those of the other cases of suffocation, does not come within the list of emergencies to which we have limited ourselves.

Foreign Bodies in the Œsophagus.—Two forms of suffocation must be especially mentioned, those namely which are due to the lodgment of a foreign body in the commencement of the œsophagus, or somewhere in the larynx or trachea.

Commonly enough a piece of hard meat is "bolted," and is arrested at the narrowest part of the œsophagus, namely, at the top, just behind the cricoid cartilage. Great distress, and even dangerous symptoms of suffocation, may thus be caused, which if not relieved immediately may result in death from asphyxia. Sometimes it is possible to reach the lump with the finger, in which case naturally the best thing to do is to hook it up. Failing this, the next best, and the more common plan, is to push it gently onwards. Frequently,

Fig. 293.—Expanding Probang.

too, the lump may be moulded into a more convenient shape by pressure from the outside of the throat. So soon as the mass passes the commencement of the œsophagus, it may be trusted to go down of itself.

A good deal of distress is frequently caused by the sticking in the throat of a *fish bone*, or some other small pointed or jagged foreign body. If the body be quite soft and flexible, probably the best way to get rid of it is to swallow a good mouthful of bread and to drink some water; but if there be any reason to suspect that injury to the lining mucous membrane may thus arise, it must not wilfully be pushed on, but an effort must be made to extract it.

For small bodies, such as a *pin*, *small sharp splinters of bone*, and the like, the best instrument to use is a probang with bristles arranged so that they occupy little room as it is passed down, but which on its withdrawal can be expanded into a form something like a chimney-sweep's brush, in the meshes of which the object may be entangled (*Fig.* 293).

But if this expedient should fail, or if the foreign body should be larger (and we may adduce as the most common examples, a set of false teeth, and coins), it would not be safe to use a probang, and patient

attempts must be made to extract it by means of forceps of special construction, of which some examples are here given (*Figs.* 294, 295, 296), or by means of a coin-catcher or snare. If the body can be touched at all, or its locality made out with the fingers, extraction will generally be easy enough; but if not, it may be extremely hard to lay hold of, and the greatest patience and skill will be required.

If all these attempts should fail, the question of operative measures will have to be raised, but as we do not here propose to discuss these, we have only further to express the opinion that *it is bad surgery to*

Fig. 294.—Pharyngeal Forceps.

produce vomiting (as has been recommended) under any circumstances, and also that the dresser or house surgeon should never on his own responsibility attempt to push onwards into the stomach a foreign body which he has failed to extract, unless that body be of such a shape and nature—as the lump of meat or soft fish-bone mentioned before—that its presence there will not be hurtful.

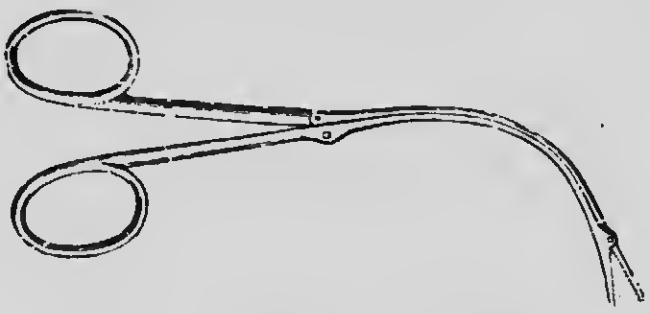


Fig. 295.—Pharyngeal or Laryngeal Forceps.

The exact position of a piece of metal, such as a coin, needle, or pin, in the œsophagus may be readily located by means of the Röntgen rays, which may assist greatly in the use of a coin-catcher or in an operation.

When any foreign substance (other than a poison) has once passed into the stomach, no attempt should be made to recover it by means of vomiting, nor should purgatives be given. The diet should be of a kind which will give the substance the best chance of being enveloped in pultaceous material, and the stools of course should be carefully watched. Under such circumstances, bodies such as coins, marbles, etc., may be confidently expected to be passed in the course of a few days, and even such irregular bodies as plates for several false teeth, with numerous pointed hooks, have been harmlessly expelled.

Fig. 296.—Cross-lever Laryngeal Forceps.

It is a somewhat curious fact that very irregular and jagged bodies often pass through the whole length of the alimentary tract, without causing any pain or trouble, until they are within an inch or two of the anus, when they are arrested, and may give rise to ulceration and hæmorrhage, ischio-rectal suppuration, or other serious mischief.

In modern surgery the use of Killian's or Brüning's tubes enables the operator to view the air-passages and the œsophagus directly, and to extract a foreign body with much greater certainty. Only in the absence of these instruments should the above more uncertain methods be employed.

SECTION IX.

OF THE ADMINISTRATION OF ANÆSTHETICS.

CHAPTER XLVIII.

ANÆSTHESIA.

BY JOSEPH BLUMFELD, M.D.
Senior Anæsthetist, St. George's Hospital, London, etc.

A GENERAL knowledge is presupposed on the part of the reader of the physiological and chemical properties of those bodies which are in common use for the production of anæsthesia; no space is therefore given here to the purely scientific or historical side of anæsthetics, and I proceed at once to the practical questions of their selection and administration.

CHOICE OF THE ANÆSTHETIC.

There are certain general considerations to be taken into account in all cases. (1) The safety of the patient; (2) The convenience of the surgeon in the performance of his operation; and (3) The comfort of the patient and his freedom from after-effects. From the point of view of both safety and comfort, **Nitrous Oxide,** with or without oxygen, ranks first among anæsthetics, and will therefore always be chosen when possible. The continuous administration of nitrous oxide, however, involves an amount of labour and an accumulation of cylinders which render its use impracticable for any but short operations. Moreover, relaxation of muscles cannot be relied upon under its influence; therefore when this condition is essential to success, nitrous oxide is not to be chosen. Neither should it be chosen for such operations as the breaking down of joint adhesions, for instance, in which severe pain is felt immediately on return of consciousness; some anæsthetic is to be preferred with which this return is more gradual, and, generally speaking, **Gas and Ether,** used for a few minutes, gives an ideal result, perfect relaxation of muscles being achieved and the patient only gradually awakening to a deadened sense of pain. Broadly speaking, any operation that is to last not more than five to ten minutes, that does not require muscular relaxation, and that does not interfere with especially sensitive parts of the body, may be best performed under nitrous oxide When used over several minutes, the gas is of course

inhaled with air or oxygen as described later. Opening of abscesses, removal of teeth, of sebaceous cysts and small innocent tumours, of gauze plugs from the abdominal cavity, of tonsils, etc., are examples of the kind of case in which nitrous oxide is available with the most gratifying results for those who have become proficient in its use. In a case of empyema in which the subject was extremely ill and weak, I have found nitrous oxide and oxygen serve for anæsthesia during removal of ribs, with a freedom from dangerous symptoms that I believe no other anæsthetic could have given.

The next safest anæsthetic to nitrous oxide is **Ether,** and this should be our routine agent for longer cases. In many conditions where, from the condition of the patient or the site of the operation, ether is inadvisable, **Chloroform** is required. In other cases some **Mixture of Ether and Chloroform** may be the most suitable agent, and in yet others **Ethyl Chloride** is best chosen. The administration of these different anæsthetics will shortly be described in the order named.

In choosing the anæsthetic most suitable for a particular case, we are further guided by (1) The physical and mental condition of the patient ; (2) The nature and site of the operation to be performed.

Too much stress cannot be laid upon the importance of noticing carefully both the patient's nature, physical and temperamental, and any variation from the normal due to the disorder for which operation is required. For instance, the muscular, red-faced, thick-necked sailor is best anæsthetized by treatment very different from that appropriate to the pale, flabby, overworked maidservant, though both may be at the time in ordinary good health and about to undergo the same operation. Nor will that treatment be the same in either case if the sailor has acute laryngitis from smoke and drink, or the maidservant an empyema. The day has gone by when an anæsthetist should be content to say, " I give chloroform," or " I give ether." To get the best results he must vary the choice of his anæsthetic in accordance with the requirements of each case. Nevertheless, for those who, not being professed anæsthetists, cannot acquire a large experience with all kinds of anæsthetics, it is best to use the same agent as often as possible, and to become thereby proficient in the use of that one rather than only partially competent to use all. For such routine use in all cases I recommend the C.E. mixture (chloroform 2 parts, ether 3 parts), with which the vast majority of cases can be well managed. Ether, though safer, has not so wide an applicability, for it is not suited to any persons suffering from acute affections of the respiratory tract, diphtheria, bronchitis, etc., nor is it a convenient agent with which to manage long operations upon the face or within the mouth or nose.

Briefly, then, rules for choice of anæsthetics may be stated as follows :—

1. If opportunity does not permit the acquisition of wide experience with all anæsthetics, use C.E. mixture as a routine.

2. Supposing this disability not to exist, use *nitrous oxide* with air or oxygen for operations lasting up to ten minutes where muscular relaxation is not essential and which are not followed by much pain. Never use nitrous oxide in cases where there is pressure on larynx or trachea, e.g., angina Ludovici, mediastinal tumour.

3. For longer operations in healthy subjects, use *ether*. In the very young and in the old, and in the case of long operations, especially upon the abdomen, this will be given by the open method. In other cases use Clover's inhaler, preceding the ether for choice by nitrous oxide.

4. In cases of acute affections of any part of the respiratory tract, use *chloroform*; this applies also to cases of active phthisis. In these cases it is often of great advantage to administer oxygen together with the chloroform.

5. Except on account of rule 4 never induce anæsthesia by chloroform. In cases such as long operations upon the tongue, larynx, nose, pharynx, etc., where chloroform has often to be used during operation, induce anæsthesia with gas and ether or C.E. mixture according to the case.

6. For operations upon the neck, head, and face, choose *C.E. mixture*. Gas and ether cause extra vascularity and hæmorrhage. This applies also to cases of tonsils, and adenoids. For operations upon the brain use *chloroform*. For exophthalmic goitre use "open ether."

7. For operations within the thorax, use *chloroform* unless the patient's condition is extremely bad; in that case use ether by the open method.

8. For abdominal operations (*vide* rule 5) when the patient is particularly muscular, or much accustomed to alcohol or tobacco, and the operation requires very complete relaxation, as, e.g., prostatectomy, give $\frac{1}{3}$ gr. morphia hypodermically half an hour before operation, in combination with atropine, $\frac{1}{100}$ gr.

9. For rectal operations and operations upon the genito-urinary tract, use ether, unless contraindicated by the patient's general condition.

10. Some special cases may be mentioned where the best practice differs perhaps from the above rules. *Enucleation of the eye* is generally best performed with the patient under ether. The extra vascularity does not matter in the same way that it does in operations on the surface of an eye. If ether be given continuously for about ten minutes, a deep anæsthesia being caused, the apparatus may then be removed and no further anæsthetic required during the operation. *Circumcision* in infants should always be performed under ether. In every operation upon the *nose* and *tongue* it is best first to get the patient deeply under the influence of ether, then give chloroform, allowing the congestion to pass off, and continue with chloroform from a Junker's tube throughout the operation. This practice enables chloroform to be given safely to persons in the sitting posture during long periods of time. The same rule applies to removal of

the *Gasserian ganglion* in the sitting position. In feeble subjects, for tongue operations use ether throughout, continuing by means of Crile's apparatus.

EXAMINATION AND PREPARATION OF PATIENT.

Before giving any anæsthetic, it is well to examine roughly the state of (1) The *circulation*, by carefully feeling the pulse; (2) The *respiration*, by laying the hand lightly on the chest while the patient breathes deeply; (3) The *inside of the mouth*, by inspection. False teeth, etc., will be removed, and if inspection shows evidence of nasal insufficiency or of very accurately meeting teeth, a small prop will be put between the teeth before administration is begun. The condition of the urine should also be known. A Mason's gag (*Fig.* 297), and a wooden wedge (*Fig.* 298) for opening the mouth if necessary, and a tongue forceps (*Fig.* 299) should be at hand, as well as a small sponge for swabbing the pharynx in case of need. On the rare occasions when it is necessary to hold the

Fig. 297.—Mason's Gag.

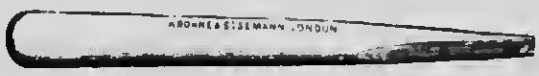


Fig. 298.—Wooden Wedge.

tongue forward for a length of time, this is best done by a stout piece of silk passed through it in the middle line about half an inch from the tip. This causes less damage than any form of tongue forceps, though a pair of these may be necessary for drawing the tongue out.

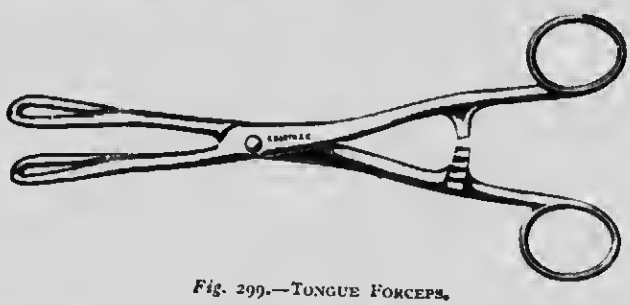


Fig. 299.—Tongue Forceps.

Whenever possible, a purge should be given thirty-six hours before operation, and an enema, too, a few hours before. Ordinary diet, light and in small quantity, should be taken during the two days preceding operation, and no food for the six hours immediately

preceding it. In the case of infants, operation should take place at what would be a feeding-time. Very feeble or aged persons must of course not be subjected to the long deprivation of food; thin broth, and in some cases neat brandy even, shortly before the administration, are good in such instances.

ADMINISTRATION OF THE ANÆSTHETIC.

For the Administration of Nitrous Oxide two side-valve cylinders (*Fig.* 300) are necessary, each yielding 25 gallons of the gas, with stand, double union, and foot-key. For hospital work larger cylinders are commonly used. The cylinders are joined by an indiarubber tube to a bag capable of holding 2 gallons of the gas, and this is connected with the face-piece by a metal-valved stop-cock. The cylinders are not to be used alternately, but the foot-key is kept upon one which is employed till it is exhausted. The other is then used and the empty one replaced by a full cylinder. Before using, test the apparatus by letting a little gas into the bag and squeezing it out through the expiratory valve. Place the cylinder in such a position that the foot-piece is easily used while the face-piece is being held to the patient's face. Fill the bag about two-thirds full, with the valve *B* off and *A* open. Place a small prop (*Fig.* 301) between the patient's teeth. With the patient lying or sitting, as required, apply the face-piece gently but accurately. If the patient is in a dental chair, be sure that the head is not over-extended; there is a tendency to throw it back. If there is a moustache or beard, it should be moistened with water where the face-piece lies upon the hair. Hold the face-piece in position with the left hand, keeping the little finger below the patient's chin. Ask him to breathe in

Fig. 300.—Nitrous Oxide Cylinders, with stand, bag, and mouthpiece.

Fig. 301.—A Small Wooden Mouth-prop.

and out of the mouth, and turn on *B* with your right hand. Turn the foot-key so that gas streams gently into the bag. Nitrous oxide is now being breathed from the bag, and expirations are passing out through *A*. During the first few breaths, there is often rapid twitching of the eyelids. After about twenty breaths the respiration is quicker and deeper than natural, the face dusky, and the pupils dilated. After about thirty breaths the jerky, guttural, stertor-like inspiration arises which is characteristic of nitrous oxide anæsthesia, and the conjunctival reflex is now generally gone, the corneal persisting. The face-piece is then to be removed. Sometimes clonic twitching of fingers or limbs —" jactitation movements "—arise before the stertor, and are equally an indication to stop the administration. If the longest anæsthesia possible is aimed at, instead of removing the face-piece when these symptoms arise, breaths of air are admitted through *A* till the stertor or jactitations have subsided, and then further gas is admitted. In this way, by giving four or five breaths of nitrous oxide, then one or two of air, then nitrous oxide again, and so on, the patient is able to be charged up with the maximum amount of the gas. When the operation is not one upon the face or inside the mouth, this process may go on and anæsthesia be maintained conveniently for ten minutes or so. It is used with dental cases when several teeth are to be extracted; when only one or two easy extractions are to be effected, it is only necessary to give the nitrous oxide uninterruptedly till the advent of twitchings or of stertor, and then stop the administration. Very occasionally signs of faintness will arise before these stopping symptoms. The administration must then of course terminate without waiting for stertor or jactitation. In many cases considerable muscular excitement occurs. The treatment is steady perseverance with the gas, admitting a breath of air if the colour is markedly dusky. The common mistake with nitrous oxide is not to give enough. To prolong anæsthesia without admitting air and to a less extent than by the method described, some anæsthetists close the expiration valve when stertor arises, allowing re-breathing for a few breaths before removing the face-piece. When this is done the bag must be properly cleansed before the next administration. When no re-breathing is permitted, it is enough to cleanse the face-piece. In hospital dental practice it is essential therefore to have several face-pieces in use in rotation, one remaining in perchloride 1–2000 while the other is employed. The use of *nitrous oxide and oxygen* together requires special apparatus, and is not recommended except for the expert. It will not therefore be described here.

Ether.—Next to nitrous oxide in point of safety comes ether. This may be administered by closed, open, or semi-open methods. The semi-open are rarely of special advantage; the open are most suitable for continuing an administration or for weakly subjects; so we first describe a closed method which is practically suitable for any average patient between the ages of five and seventy. The apparatus

recommended is Hewitt's wide-bore modification of Clover's inhaler (*Fig.* 302), and the administration is carried out as follows: The patient's head being to one side and the face-piece screwed on to the ether chamber in such a way that the filler is in a convenient position for pouring in, gently apply the face-piece so that the narrow end rests on the forehead just above the bridge of the nose. Grasp the face-piece with the left hand, the little finger resting below the chin and keeping it gently raised. Instruct the patient to breathe quietly in and out of the mouth, and raise the apparatus with the right hand so that the lower end of the face-piece is off the face during the first three inspirations. The expirations are caught in the bag as the lower end of the face-piece is re-applied. Now, with the patient breathing into and from the bag, take out the stopper and pour in 1½ oz. of ether. The indicator, which is figured from "0" onwards, has hitherto stood at "0." It is now pushed forward with each inspiration in such a way that a minute is taken to reach "¼." After this point the indicator is pushed on more rapidly if there is no coughing or holding of the breath, either of which symptoms indicates too rapid increase in the strength of the ether vapour inhaled. When the index reaches "½," give one breath of air. By the time this point is reached consciousness should be fully abolished, as shown by no response being made when the patient is loudly told to raise an arm. At this time there will be some duskiness of the face, and both pulse and breathing are quickened. There should be also (1) Loss of conjunctival reflex, (2) Stertorous inspirations, (3) Flaccidity of muscles; the arm, if raised, dropping limply to the side when released.

Fig. 302.—Wide-bore Clover's Inhaler.

Should the patient be a woman, child, or slightly built man, it is not necessary to increase the strength of the ether vapour further, but the index should be kept at "½" till the skin incision is made. In the case of strong subjects, it is better to push on to "F" before this is done, replacing the index to "½" if no reflex is evoked by the cut. When full anæsthesia has been reached, as shown by the symptoms just enumerated and reduction of the corneal reflex to a faint response, air must be admitted in a sufficient quantity to keep the colour entirely free from any blueness. Either the bag must be left off, admitting air continuously through the top of the instrument, or else, if the

bag is used, the face-piece must be lifted frequently. One breath of air to four breaths from the apparatus generally suffices, but the anæsthetist must be guided by the colour, cyanosis being entirely avoided. Care must be taken to keep the lower jaw well forward, so that there is no obstruction due to the base of the tongue having been drawn back with inspiration. It is often necessary to open the mouth slightly and ensure the patient's breathing freely through the mouth throughout. The insertion vertically of the small prop (*Fig.* 301) will generally secure this. Very rarely the tongue requires to be held forward, the frequency with which this occurs being inversely to the experience of the anæsthetist. In the course of an induction as just described, there will occasionally, in alcoholic or very muscular subjects, be a period of muscular excitement and spasm. This is to be met by keeping the face-piece steadily applied and increasing the admission of ether, which will soon replace the spasm by relaxation.

When ether is preceded by nitrous oxide, the principle of administration is the same as with the method just described. The nitrous oxide

Fig. 303.—Ormsby's Inhaler.

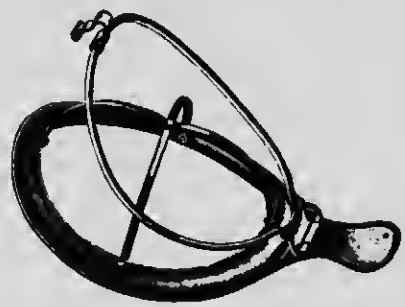


Fig. 304.—Schimmelbusch's Mask.

apparatus (*Fig.* 300) is used, the gas-bag fitting on the top of the Clover instead of on the face-piece. The administration is begun by admitting nitrous oxide alone for the first four breaths; ether is then inserted into the Clover, and the index being slowly advanced, the patient breathes nitrous oxide, but with an increasing amount of ether vapour. When "$\frac{1}{2}$" is reached, the stopcock admitting N_2O is turned off, the large bag replaced by the small one, and the administration continued as with ether only. This method is pleasanter to the patient, and unconsciousness comes more quickly. It involves much apparatus, however, and needs considerable practice in order to get the best results. It is, generally speaking, therefore best left for those only who are constantly administering anæsthetics. *Ormsby's* inhaler is another useful instrument for giving ether by the closed method (*Fig.* 303). It is much more simple than a "Clover," but it is not so well adapted for comfortably inducing anæsthesia, since the gradual admission of the vapour is not regulated. This is achieved simply by holding the inhaler at some distance from the face and

gradually advancing it till it rests there. Half an ounce of ether is first poured upon the sponge, and this must be replaced from time to time, for which purpose, as well as for air admission, the inhaler is removed from the face.

For giving ether by the *open method*, a mask is required of the Schimmelbusch kind (*Fig.* 304), on which are stretched eight layers of surgical gauze or three or four of domette. A coil of gauze is laid upon the patient's face, and on this the mask rests. He is encouraged to breathe in and out through the mouth, and then drops of ether are allowed to fall upon the mask opposite to the mouth in gradually increasing quantities. Eventually the mask is kept saturated with ether. Induction takes considerably longer than by the closed method, but is accompanied by less spasm and less secretion of mucus. For a strong subject, large quantities of ether are necessary, and the air of the operating-room becomes considerably laden with the vapour. To be certain of success with " open ether " the administration should be preceded by a hypodermic injection of morphia gr. $\frac{1}{4}$, atropine gr. $\frac{1}{120}$, given three-quarters of an hour before the time of operation. Some anæsthetists prefer to add scopolamine (gr. $\frac{1}{100}$) to these drugs.

Ether is often given *immediately preceded by ethyl chloride.* The combination is effective and acts with extreme rapidity ; but is not without risk, and is best reserved for patients of a very resistant kind, such as muscular alcoholics. A small prop is always to be inserted between the teeth before beginning, for much spasm of the jaws may arise. A Clover's apparatus is used, the small bag being fitted with a tap through which the ethyl chloride is to be inserted. Charge the inhaler with ether, squirt 4 cc. of ethyl chloride into the bag, and put the inhaler on the face in such a way that the bag hangs down. Raise the bag during the first three breaths, so that it comes into line with the inhaler. Turn ether on to " $\frac{1}{4}$." If the conjunctival reflex is gone, push on to " $\frac{1}{2}$." By this time stertor will be present. Remove the bag, thus admitting air to the patient. Press what vapour is in the bag out of it, and replace it so as to catch an expiration. Continue as with ether alone.

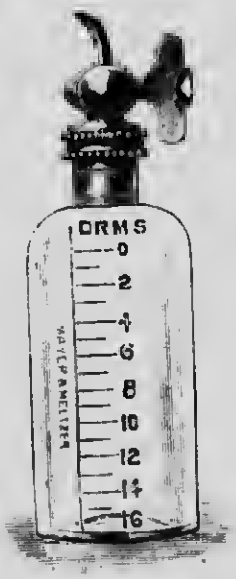


Fig. 305.—Drop-Bottle.

Chloroform.—This anæsthetic has always to be administered with a large admixture of air. About 2 per cent of chloroform vapour to 98 per cent of air is recognized as the safe strength, and the problem for the administrator is to supply his patient uniformly with a weak and constant atmosphere. The regulating inhalers hitherto introduced are

not sufficiently convenient or widely applicable to be described in a purely practical book of this kind, and we pass on to methods by which chloroform can be safely administered with the simplest apparatus. By use of a *drop-bottle and an open mask* (Skinner's or Schimmelbusch's, *Figs.* 305 and 304) the required strength of chloroform vapour can be supplied. The mask should have not more than one thickness of flannel, lint, or domette. The exact percentage given in this way is not known, but we have experimental evidence that if by *never letting the mask touch the face* a layer of air is kept between the two, it is difficult to exceed greatly the safe 2 per cent, even if a large portion of the mask is kept wet with chloroform. The drop-bottle should hold at least two ounces, and be supplied with a Thomas's or Hewitt's stopper. Either of these permits pouring on the liquid in single drops or a continuous stream, according as the stopper is arranged. Start with the mask at least two inches off the face, and with the chloroform at first drop by drop. It is best for the first few breaths to give no chloroform at all, and the patient is encouraged by noticing nothing; then with the very weak vapour supplied by a few drops he is not put off his breathing, so to speak, but will inhale freely until, with constant and increasing amounts being put on the mask, and the lowering of this till it is within half an inch of the face, he is lulled into unconsciousness. The process till complete anæsthesia is reached should take at least six minutes in a healthy adult. Safety lies in starting slowly enough, and in the management of the stage of spasm should this occur. With muscular and alcoholic individuals, it is not rare for considerable rigidity of muscles to arise, with holding of the breath, throwing out of legs and arms, and spasm of jaws. This happens when all control of the higher faculties is gone, and though the patient might hear uttered directions, he could not carry them out. This period of chloroform inhalation is associated with danger owing to the strain thrown on the right side of the heart by the embarrassed or abolished respiration. Where such a stage is very pronounced, the safest plan is to substitute ether for chloroform till the spasm is over. In strong subjects, have at hand, before beginning, an Ormsby's inhaler and two ounces of ether. When the spasm is fully developed, replace the chloroform mask by the Ormsby loaded with an ounce of ether. Full anæsthesia with relaxation of muscles will quickly be established. In weaker subjects it is enough to pour ether on the open mask instead of chloroform, until the spasmodic stage is over. Throughout the administration of chloroform, when anæsthesia is once fully obtained, a very much smaller dosage is employed than for induction. It is generally quite enough if a quarter of the mask, which should be made with domette, is kept moist. The drug must be added by drops, and it must be the anæsthetist's aim, by frequently adding very small amounts, to apply a uniformly weak vapour. Roughly speaking, a drachm should last five minutes during an operation upon an adult. The chief guide to the condition of the patient is his respiration, which

must be continuously and closely watched. Nothing but a perfectly regular respiration, at least as vigorous as that of normal sleep, must be regarded as satisfactory. The corneal reflex and the pupil are valuable indications. The former should, as a general rule, be kept just perceptible, and the latter in a moderately contracted state. The condition of the pupil is rarely, however, a safe guide till operation has been in progress for some minutes. Shallow breathing, pallor, a dilated pupil, an absent corneal reflex, and sweating are signs of overdose. On the other hand, shallow breathing, with pallor, a small pupil, and a perceptible corneal reflex, generally mean that anæsthesia is too light, and that vomiting will begin if the lips are not briskly rubbed to stimulate respiration, and more chloroform offered for inhalation.

After the drop-bottle and open mask, the next most generally applicable method of giving chloroform is by means of *Junker's inhaler*

Fig. 306.—JUNKER'S INHALER.

Fig. 307.
TUBE FOR USE WITH JUNKER'S INHALER.

(*Fig.* 306). This instrument is of particular service, is indeed indispensable, in giving a continuous supply of chloroform during the performance of long operations upon the tongue, nose, pharynx, etc., when a mask cannot be held over the face without interfering with the surgeon. On such occasions the chloroform vapour is pumped through a metal tube (*Fig.* 307) placed on the tongue well back at one side of the mouth, or along a soft catheter inserted through a nostril till its end in the posterior nares just overhangs the upper aperture of the larynx. Soft catheters are used, with special mounts for fitting on the rubber tube of the Junker. In cases where this method is required, the patient is to be first put under chloroform to the degree of surgical anæsthesia, and then, before operation is begun, the anæsthetist tests the efficiency of his nasal or intra-oral means of continuing the anæsthesia. If, without doing this, the operation is begun during a comparatively light anæsthesia, and then, with the mouth open as is generally the case in these instances, the anæsthetist inserts his catheter, he is apt to find it impossible to attain the necessary depth of narcosis

by his Junker. When the Junker is used for ordinary cases the tube or catheter is replaced by a light mask covered with lint or domette. This is held in front of the nose and mouth, and with each inspiration of the patient the indiarubber ball of the instrument is gently compressed. Weak squeezes are to be used at first, and, as the patient gets accustomed to the very faint vapour of chloroform applied, the strength of this is increased, the mask allowed to rest upon the face, and finally after three or four minutes the ball is squeezed nearly flat with each inspiration and the full strength of vapour given that the instrument can supply. Before using a Junker, it is important to see that the rubber parts are pliable, a little dry warmth being applied to them if they are stiff, and also that the connections are properly made and that it is impossible for liquid chloroform to be pumped up and reach the patient. Through allowing the bottle to be much tilted during administration, an anæsthetist has incurred this accident, with grave damage to his patient.

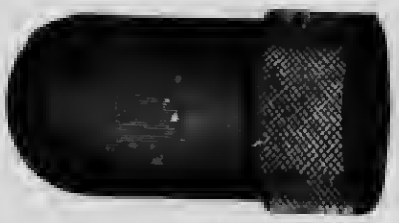


Fig. 308.—RENDLE'S INHALER, with Flannel Bag holding Sponge.

Reference has been made to the value of the *C.E. mixture* (chloroform two parts by bulk, ether three parts) which, as regards method of administration, may be held to include the A.C.E. mixture (alcohol one, chloroform two, ether three parts). The best method of administration is the same as that described in connection with chloroform given by the drop-bottle and mask. The principle of gradual administration with free air-supply is to be just as rigidly observed, but larger quantities of the agent are required than with pure chloroform, and in the case of a robust subject it is well to have two layers of material instead of one upon the mask. If even this prove insufficient, as shown by too slow approach of unconsciousness or too prolonged a stage of muscular excitement, use Rendle's (*Fig.* 308) or Allis's inhaler. With these instruments the air-supply is to some extent curtailed. They are used by pouring a couple of drachms of the mixture upon the sponge and renewing as frequently as the dryness of the sponge shows to be necessary. By means of the holes at the top of the Rendle, the mixture may be added from the drop-bottle without removing the inhaler from the face.

Ethyl Chloride.—The indications for use have been briefly mentioned, and a few words may be said in explanation of the way in which to give this drug. It is supplied in tubes of various kinds, the best-fitted perhaps being those of Duncan, Flockhart & Co. The tubes are graduated in cubic centimetres, and generally speaking the dose to be used for a child up to four years of age should be 2 cc. ; up to ten years, 3 cc. ; for older children and women, 4 cc. ; for men, 5 cc. The patient may

in the lying or sitting position. A small mouth prop, or Doyen's gag, in tonsil or adenoid cases, is to be put between the teeth before beginning. The dose to be used is sprayed into the small bag with the tap fitting described in connection with the use of ethyl chloride and ether (*Fig.* 309). This bag fits straight into the face-piece ; the patient is asked to breathe quietly and forcibly, and the face-piece being gently applied and expirations being seen to distend the bag, this is raised till, at the end of the third breath, it is in a line at right angles to the face (*Figs.* 309, 310).

Unconsciousness is induced with remarkable rapidity. Often two breaths in the case of a child, and three or four with an adult, when the face-piece is accurately adapted to the face so that no air is admitted, are enough to abolish consciousness. Stertor is not always present, and the fixed globe of the eye, with absent conjunctival reflex and dilated pupil, are the signs of anæsthesia. The average duration of

Fig. 309.—Ethyl Chloride from bag of Clover's Inhaler.

Fig. 310.—The same.—Middle of Administration.

anæsthesia is about seventy-five seconds. Recovery is rapid, but is more often associated with sickness or headache than in the case of nitrous oxide. If several minutes' anæsthesia are required, three breaths of air are to be admitted every three breaths, and more ethyl chloride squirted into the bag, 2 cc. at a time. After administration, the face-piece should be thoroughly cleansed and the bag washed out with warm water. The great convenience of ethyl chloride must not blind us to the fact that it has been associated with many fatalities, and that therefore, when nitrous oxide meets the case, this should be chosen. Safety with etbyl chloride is best assured by care in strictly limiting the amounts used and in giving breaths of air with sufficient frequency. Ethyl chloride may be used upon an open mask as a preliminary to C.E. or open ether in the induction of anæsthesia. Such use is of great advantage in the case of a frightened child, as unconsciousness is very quickly obtained.

CONDITIONS OF DANGER.

When conditions of danger arise during inhalation of an anæsthetic, their presence is shown by failing respiration, or circulation, or both. The first steps to be taken are: (1) Withdraw the anæsthetic; (2) Stimulate respiration by briskly rubbing the lips and face with a towel; and (3) Lower the head. If respiration actually stops, (1) Compress the chest twice with a hand pressed against each side from the front; (2) Lower the head, open the mouth, and draw out the tongue. If breathing does not now start again, give care of the tongue to someone else and start systematic artificial respiration by Sylvester's method. Stand well over the patient and use your weight to give effective pressure.

It is important to perform artificial respiration with sufficient slowness. The complete movement should be carried out at a rate of not more than eighteen to the minute. Effective artificial respiration is the most important remedial measure in anæsthetic collapse, and the anæsthetist should give it his whole attention. While he is thus employed, injection of strychnine or of adrenalin may be made by someone else if thought advisable. When artificial respiration fails to restore animation after five minutes, *massaging the heart* should be tried. In the case of children this is to be effected by means of a hand placed over the region of the heart and another pressing up below the left costal arch. With the comparatively rigid thorax of an adult such a procedure is useless unless the subject is very thin. If the operation is one for which the abdomen is already open, the heart may be massaged by fingers pressing upon it from below the diaphragm. Such a measure has succeeded where all else had failed. It is doubtful whether the abdomen should ever be opened for the express purpose of massaging the heart.

In cases of shock during operation, transfusion with saline solution is often of great service, and the anæsthetist should always have at hand a simple apparatus by which the injection may be made, subcutaneously or, if thought necessary, into the veins.

After-effects.—Next to care in the selection and administration of anæsthetics, the most important point with regard to the patient's satisfactory recovery from their effects is to move him as little and as gently as possible till consciousness is completely restored. Generally speaking, no solid food is to be allowed during the first twelve hours after operation, and only small quantities of thin liquid, such as tea, which is often found the most welcome beverage to start with. If retching or vomiting continue, a drink of 20 grains sod. bicarb. in half a pint of water should be swallowed. This will generally cause an urgent and final vomit. In nervous persons in whom retching persists, an enema of potassium bromide or a hypodermic injection of morphia is to be employed.

SPINAL ANÆSTHESIA.

This method of inducing anæsthesia over the lower abdominal and lower extremity areas is being largely practised. Although it is too early yet to pronounce definitely as to the scope and limitations of the practice, it is, nevertheless, one which has a distinct value for operations upon these regions when the condition of the parts is such as to render the employment of a general anæsthetic a matter of considerable risk and danger: as, for example, in serious cases of peritonitis, or when the patient is suffering from pulmonary and cardiac weakness, and in severe crushes of the lower extremity. The method is not invariably successful, though in all probability the failures result rather from imperfect technique than from the want of anæsthetic power with the drugs employed. When first introduced cocaine was injected, but the toxic properties of this drug being greater than those possessed hy novocaine and stovaine, most surgeons prefer to use these substitutes. The drug may be used in normal saline solution, with or without the addition of suprarenal extract. The strength of the solution of novocaine is usually 5 per cent, of which 3 cc. to 8 cc. may be injected according to the extent of the operation. If weaker solutions are used, larger injections are to be made. The technique is as follows:—

The patient is seated on the operating-table, and the lower part of the lumbar spine is carefully cleaned and sterilized. The highest point of the iliac crest is taken on either side, and these two points are joined together by a transverse line. This line corresponds to the position of the fourth lumbar spinous process. A long exploring needle is now taken, the best being one of platinum-iridium, about 12 cm. long and 1 mm. in diameter. The patient is directed to bend forward and make a "great back," and the puncture is made either at a level between the fourth and fiftl. spinous processes, or between the third and fourth. If the back is sufficiently arched the middle line may be entered, but many surgeons prefer to introduce the instrument slightly to the side of the middle line, so as to avoid the veins. The needle is pushed home until a loss of resistance informs the operator that the spinal theca has been entered, which will usually take place at a depth of two to two and a half inches. It may be necessary to alter the direction of the needle if it strikes against bone, and even occasionally to withdraw it altogether and re-introduce it. For general purposes it may be said that it should be directed slightly upwards from the point marked out on the skin. As soon as the needle has entered the theca the cerebrospinal fluid, clear and limpid, should escape drop by drop. The syringe is now attached to the needle, and a quantity of cerebrospinal fluid, equal to the amount of the anæsthetic solution which it is proposed to inject, should be withdrawn. In this way a sudden increase of the intraspinal pressure is avoided. The needle is disconnected from the syringe, the cerebrospinal fluid

emptied out, and the measured quantity of novocaine solution drawn up into the barrel. The syringe is reconnected to the needle, and the solution slowly injected into the spinal canal. The needle is then withdrawn and the puncture sealed with a dressing. The patient is now placed upon his back, with the shoulders raised on a pillow, so that the anæsthetic does not gravitate towards the vital parts of the spinal cord. If necessary, the buttocks are somewhat elevated to allow the drug to exert its effect upon the lower dorsal nerves. Anæsthesia is established in five to ten minutes, and lasts on an average three-quarters to one and a half hours. Sometimes when the needle is introduced blood flows freely from it. This is due to injury of a vein, and the needle should be withdrawn and re-introduced. Certain complications occasionally attend the use of this anæsthetic. They are headache, vomiting, and more rarely collapse; but those surgeons who have employed it extensively speak in high terms of its value. There are many different ways of performing the injection, but two principles are common to them all: (1) That absolute asepsis should be maintained; and (2) That a quantity of cerebrospinal fluid equal to that of the anæsthetic injected should be withdrawn.

LOCAL ANÆSTHESIA.

Local anæsthesia consists in injecting by means of a hypodermic syringe a solution of cocaine, stovaine, or eucaine, in order that small operations may be performed without discomfort to the patient. As a matter of fact many major operations can be carried out successfully under local anæsthesia, though the method requires a certain amount of practice before it may be employed even in minor surgery. On the whole, eucaine in a 1 per cent solution gives the most satisfactory results. It may be combined with advantage with adrenalin at a strength of 1–10,000, which limits the anæsthesia more strictly to the site of injection. The technique is as follows:—

The skin over the affected region having been carefully prepared, a fine hypodermic needle connected with a syringe filled with the eucaine solution is introduced into the skin. It is necessary to see that the needle at first does not enter the subcutaneous tissues, since the sensitive part is the papillary layer, which should be anæsthetized first. If properly introduced, the injection of a few drops of the solution will cause a blanching of the skin and the formation of a round or oval swelling, "*la boule anæsthétique.*" The needle is then pushed on, its course running nearly parallel with the surface until successive regions in the neighbourhood of the original puncture are anæsthetized, and in this way, by altering the direction of the needle either to the right or left, a considerable area can be rendered completely insensitive by a single puncture. If wider effects are desired, the needle should be withdrawn and re-introduced at the margin of the last anæmic point, until the whole region likely to be exposed by the primary incision

has been anæsthetized. Usually not more than 15 or 20 minims will be required for this. If it is necessary in the course of the operation to proceed deeper, the needle is now thrust into the subcutaneous tissues, and 10 to 20 minims are allowed to penetrate more deeply. If the operation is performed upon an extremity, the position of the main nerves should be located, and the needle introduced as near them as possible, the fluid in this way being injected round the nerves which will chiefly affect the sensation of the patient. In the case of whitlows it is often sufficient to inject a few drops of a 1 per cent solution in the position of the digital nerves, in order to render an operation for the relief of the condition perfectly painless. Absolute asepsis must be maintained, for it is in small operations of this kind that carelessness is apt to lead to the introduction of septic organisms. The best syringes for local and spinal anæsthesia are those composed entirely of glass, which can be thoroughly sterilized by boiling.

SECTION X.

MISCELLANEOUS

CHAPTER XLIX.

OF THE PREPARATION OF PATIENTS FOR OPERATION, AND THEIR AFTER-TREATMENT.

THE PREPARATION OF PATIENTS FOR OPERATION.

IN the case of an operation upon a child, the house surgeon should always be sure that its parents, or responsible relatives, understand and consent to its performance. In many cases it will be found much harder to gain this consent than if the operation had to be performed upon the persons of the parents themselves. With most hospital patients argument is of little avail, and a plain statement of the facts and issues of the case will be found to outweigh any eloquence. The ward sister will also be found an invaluable auxiliary in cases where persuasiveness is required.

No operation should ever be performed on an adult without his consent, and here also tact will be required; patients much more commonly object to come into a hospital for an operation, than refuse to undergo it when it is put to them after they have been in the wards a short time, when they have learned to know and trust the surgical and nursing staffs, and to recognize that the large majority of patients operated upon recover. It is therefore sometimes wise to defer the question of the necessity of an operation until the patient has been admitted for a little time, and has become used to the ward.

But although a patient may be so far managed for his own benefit, mere good faith demands that in all cases the necessity or desirability of the operation, its possible results, and its risks, should be fully explained to every person, before they submit themselves to it, and neither honesty nor policy demands that its importance should be minimized. We do not mean by this that any view but the most cheerful one should be taken. It is not wise or necessary, for example, that a woman with a scirrhous growth in the breast should have the statistics of recurrence forced upon her attention, but the facts should rather be emphasized that life is undoubtedly prolonged, and health and comfort retained, by an operation which is not in itself dangerous, and that complete removal has resulted in permanent cure.

In women, the date of an operation should be arranged to fall as far as possible from a menstrual period, unless they have ceased to menstruate, but in cases ot urgency the flow of the menses should not be made a bar to the operation.

Of recent years far more attention has been directed to the preparation of patients before operation, and there can be no doubt that the improvement in surgical statistics has resulted in no small measure from this practice. In the first place general measures which are applicable to most operations will be considered, and later the special treatment of diseases of certain parts—head, mouth, etc.

General Treatment.—All operations should be approached with certain definite objects in view, viz., to raise the resistance of the patient so that he may support what is often a severe strain on his recuperative powers, to diminish the risk of sepsis, and at the same time to prevent shock and undue hæmorrhage. These are the cardinal principles of pre-operative treatment, and are applicable to every kind of operation.

We should feed the patient who is in poor health on stimulating and nourishing foods, and make free use of saline and other injections, to which reference will be made later. No operations but those of urgency should be undertaken if the temperature is raised above the normal.

The stomach should he empty before the administration of the anæsthetic, so that the vomiting may be controlled, and the patient should be purged. This purging is an important detail which will be specially considered in connection with rectal operations, but it is necessary at this point to dwell on its value and influence.

In most people confinement to bed induces a sluggishness of the bowels, so that if the intestines are not thoroughly cleared out as a preliminary, there may be considerable difficulty in opening them subsequently; during this time there will be present a residue which will undergo putrefactive changes in the stagnant colon, and not only is the virulence of the *Bacillus coli* increased thereby, and so the dangers of blood infection augmented, but the patient may absorb a quantity of toxic products, which will have an injurious influence on the progress of the case. The actual drug that is to be employed is a matter of opinion and custom, and depends to some extent upon the nature of the operation and the habits of the patient. Cascara is quite sufficient for minor cases, if the bowels usually act regularly; calomel or castor oil are the best purges for use before abdominal operations; some patients are, however, very susceptible to the action of calomel.

Enemata are to be employed alone or as accessories to the purge in the form of simple soap-and-water injections, but in cases where suppuration is suspected in the lower part of the abdomen, they must be omitted, or employed with the greatest caution: a localized abscess may be ruptured by the administration of a large enema. It is better

in most cases, if possible, to purge the patient two days before the operation, and to administer the enema the evening before, so that if Wednesday be the day fixed, catharsis should be induced by Tuesday morning, and on Tuesday night the bowels should be well washed out by a soap-and-water injection. If there is any uneasiness on the day of the operation, and especially if this has been arranged for the afternoon, another enema may be given, four hours at least before the patient goes to the theatre.

Preparation of the Skin.—There are many different methods in use for the preparation of the skin, some surgeons avoiding antiseptic compresses altogether. Without entering into a discussion on this subject, we shall describe a method that is commonly employed, which can be modified according to the views of the surgeon in charge of the case.

Two days before the operation the part is thoroughly scrubbed with soap and hot water; if necessary the hair is shaved over the region of the operation. The soap is washed away with fresh water, and the part is dried. It is next wiped over with a swab soaked in turpentine, and this turpentine in turn is removed with ether, or absolute alcohol. A dry cyanide gauze dressing, or if preferred, a compress (i.e., a layer of lint) soaked in 1–60 carbolic or 1-2000 biniodide of mercury, is placed on the skin, covered with protective and wool, and the whole is firmly bandaged.

On the day preceding the operation, the patient may have a warm bath, and the preparation should be repeated in detail as before. If the bath is omitted the compress should be changed.

Before the operation is begun, the whole area should be well washed with ether soap and dried. A final swabbing with a sponge soaked in biniodide of mercury in spirit 1–2000 completes the toilet.

The iodine method is now usually employed, with excellent results. The skin is shaved, if necessary, and painted with: (1) benzene, (2) acetone, (3) iodine 2 per cent in rectified spirit. This is done the day before the operation, and the solutions may be reapplied the same night. No compress is necessary. When the patient is on the table, the wound area is again painted with iodine. This method does away with the need for preliminary dressings, is entirely adequate, and it enables the surgeon to see that a sufficiently wide area has been prepared.

The Prevention of Undue Hæmorrhage during the Operation.—It is obvious that this is mainly in the hands of the operator and his assistant; nevertheless a good deal can be done by preliminary treatment to check its occurrence.

In cases of jaundice, which are very liable to bleed profusely, or in operations where a large number of vessels may be cut, chloride of calcium or lactate of calcium should be given in doses of 10 grains three times a day. The drug should be given for two or three days prior to the operation, and should be continued after its completion.

Chloride of calcium, however, must not be used indiscriminately in cases where much bleeding is expected; for if large doses are given to a patient whose "coagulating power" is high, there is considerable risk of thrombosis setting in. It is always advisable to test the coagulation period of the blood in any case before the drug is given.

Shock.—To obviate the shock of a prolonged and serious operation we have many measures at our disposal: see Chapter V, on "Shock."

THE PREPARATION OF SPECIAL CASES.

Operations on the Head.—We are generally concerned with two classes: the emergency fracture, and the tumour or abscess which permits of more leisure in diagnosis and treatment.

The fracture may be simple or compound; if the latter, we have no option but to proceed at once with the operative treatment which may be necessary; but if there is no open wound, and the symptoms, although calling for operation, are not urgent, it will be wise to postpone matters until the head has been carefully cleansed.

In all cases where there is no immediate demand for operative proceedings, but where there is a prospect of their ultimate employment, the whole head should be washed and shaved, and efforts made with lotions and compresses to promote asepsis some days before the operation is undertaken. The ordinary wash, shave, and brush-up which are often rushed through at the last minute, are entirely inadequate to the needs of the case.

The Mouth and Tongue.—Care should be taken with these patients to get the mouth thoroughly clean. Carious teeth should be extracted, and those remaining, if covered with tartar, should be scaled or thoroughly well brushed. The mouth should be washed out several times a day with alternate solutions of bicarbonate of soda 20 gr. to the ounce, and carbolic acid 1–100, or any other antiseptic solution suitable for the purpose.

There is no doubt that careful attention to oral hygiene diminishes the risk of septic pneumonia, the most dangerous and common complication of operation upon the mouth and throat. Not less than a week should be spent in this preparation if the mouth is unclean.

The Abdomen.—The patient should be confined to bed for a few days beforehand: the actual number must depend upon the operation to be performed and the condition of the patient. The practice of "rushing" patients into the theatre is to be strongly condemned. When a patient is about to undergo a serious abdominal operation, a week should be spent in properly preparing him. It is not necessary that he should be confined to bed all this time, but he can gradually become acclimatized to his new condition. Again, apart from the ordinary purging, it is advisable to administer drugs that have some influence upon intestinal decomposition, e.g., salol, β-naphthol, and cyllin (one of the best intestinal antiseptics), especially if there is likely

to be some interference with the intestine. As to the merits of these intestinal antiseptics there is some difference of opinion; but if they are capable of inhibiting bacterial activity, even though they are not able to completely eliminate the micro-organisms, they should be employed.

The diet should consist of foods which are easily assimilated and which leave little residue. It is not necessary to starve a patient before abdominal section, but indiscreet dieting may cause a great deal of trouble afterwards.

The Rectum.—Under this heading such cases as complete excision of a cancerous growth will be considered. When any operation which aims at obtaining primary healing of a wound in the anal and rectal region is attempted, preparation must be most carefully undertaken.

It is not sufficient to administer a purge a day or so beforehand, and to conclude that the bowel has been emptied, nor to give an enema on the morning of the operation and imagine that the rectum has been cleansed.

In many of these patients there is a considerable amount of obstruction: not enough perhaps to give rise to distinct symptoms, but sufficient to prevent the bowels acting freely, the result being that there is sometimes an action very shortly after an operation has been performed in the rectal region.

Petersen has shown that the worst accident that can occur during the after-treatment of cases of excision of the rectum is an attack of diarrhœa; if this occurs, fæcal matter is forced into the various recesses of the wound before protective adhesions and granulations have had time to form.

Many Continental surgeons who have had a large experience of rectal surgery prepare their cases as follows: Some eight or ten days before the date fixed for operating, the patient is admitted and is thoroughly purged, a process which extends over three days, after which the bowels are kept at rest by the administration of bismuth and opium before and for some days after the operation.

A diet is given which will leave a minimal residue, and at the same time have a maximal stimulating effect, such as meat extracts, raw meat juice, peptonized milk, fish, and eggs. Each morning the rectum is well washed out with a weak solution of permanganate of potash, and some ammoniated mercury ointment is applied to the anal region. With some slight modifications we may accept this as the best form of pre-operative treatment for rectal cases. As a rule, if treatment starts six days prior to the operation it will be sufficient, and the bismuth and opium should be combined with salol two days before and three days after the operation:—

℞ Bismuthi Subnitratis gr. xx
Tinct. Opii ℥iv
Salol gr. x
Tinct. Cardamomi Co. ℥ss
Aq. Chlorof. ad ℥j

Fiat Mist. Two tablespoonfuls three times a day.

A weak solution (1–1000) of formalin may be used instead of the permanganate of potash.

With reference to the practice of keeping the bowels confined for several days after operation, it has been said that additional trouble is caused in getting the bowels open subsequently owing to the formation of scybalous masses in the large intestine. This is true only if the bowel has not been thoroughly cleared out beforehand. Provided this has been done, and the diet has been carefully regulated, scybala will not give trouble, and the bowels may be kept at rest for five or six days.

The Genito-urinary Tract.—We consider here operations upon the kidney, bladder, prostate, and urethra—a large and very important group of surgical cases. In the majority of patients who suffer from extensive disease of these organs the renal function is impaired. There can be no doubt that the simplest operative procedure makes serious demands upon the tissues of the body, especially upon the kidneys, and unless they are moderately healthy, they will be unable to stand the strain.

It is no unusual occurrence for a patient who has been subjected to an operation for the relief of stricture or for prostatic enlargement to succumb within a few days from suppression of urine. In most cases this complication is due to previous damage to the kidneys, and the shock of the operation, and possibly other factors, such as acute urinary infection, have combined to bring about a most serious state of affairs. In order to prevent this as far as possible, pre-operative treatment must be very carefully carried out.

If definite evidence of renal damage is forthcoming in the shape of a dry skin, bilateral renal pain and tenderness, thirst, and a diminished excretion of urea, all operations but those of urgency should be deferred.

The patient should be confined to his bed or house for some days before any operation is attempted, and he must be warned to avoid draughts and chills.

Milk, fish, and eggs are the best diet; meat should be given sparingly. If stimulants are required, whisky or gin appear to be most suitable. The skin must be made to act by warm baths and friction, since by its vicarious action the kidneys can be relieved of a considerable amount of work. The patient should drink at least two pints of barley-water or lemonade during the day. Contrexéville or Vichy water should be given as a routine.

The bowels must be made to act well: they are often sluggish in this class of case. If pus is present in the urine, quinine, urotropin, and acid sodium phosphate may be given; if there is much tendency to phosphatic deposit, nitrohydrochloric acid should replace the latter drug.

Digitalis and strychnine are also valuable drugs for stimulating a failing kidney.

If the bladder is very foul, it will be necessary to wash it out regularly twice a day, or even to open and drain it, in those cases where the more serious step of removal of an enlarged prostate is contemplated.

POST-OPERATIVE TREATMENT.

It is obviously beyond the scope of this work to deal with all the various details of post-operative treatment, or with the many complications that may arise during the progress of the case, and only the more important points will be considered. (The two serious complications, hæmorrhage and shock, have already been mentioned.)

In the general management of a case after an operation has been performed, the following details will require attention.

Return to Consciousness.—While the effects of the anæsthetic are passing off the patient must be very carefully watched. In the state of stupefaction before consciousness has fully returned, patients may try to get out of bed, and do themselves serious damage. The vomiting which is usual at this period must be looked after, the head being turned on the side and the opposite shoulder raised so as to assist the expulsion of the vomited matter. If this care is not taken, the vomit may be sucked down the trachea into the lung.

Position.—The particular position which a patient should assume depends upon the operation that has been performed, and upon other considerations—age, etc. In the majority of cases the patient is placed on his back, with the shoulders and head slightly raised—the supine position; this is usually chosen for an ordinary abdominal case. A pillow should be placed under the knees so as to slightly flex them and take the tension off the abdominal muscles.

In cases where special drainage of an abscess, e.g., an appendicular abscess, is required, or to facilitate the flow of the contents of the gall-bladder in cholecystostomy, the patient is usually placed on his side with a pillow supporting the back—the lateral position.

If the patient is suffering from severe forms of peritonitis, it is now the practice of many surgeons to prop him up in bed (Fowler's position), so that the fluid exudate can gravitate towards the pelvis and escape along the pelvic drainage tube. (This treatment is usually combined with the continuous administration of saline per rectum.) A similar position should be assumed if there is any tendency to chest complications, as the lungs and heart are better able to work in this position in cases of hypostatic congestion or bronchitis than when the patient is flat on his back.

If any difficulty is experienced in maintaining this attitude, a pillow should be placed beneath the thighs, the knees being flexed over it, and it should be secured by strong cords to the posts on either side of the head of the bed. In this manner it acts as a sling, and keeps the patient from slipping down.

If there is a wound of the back or buttock, the patient should be put in the prone position. Although at first there may be some

inconvenience in maintaining this unusual posture, it is wonderful how soon patients get accustomed to it. Such a position markedly facilitates the draining of abdominal abscesses, and may be rendered necessary by the development of bedsores during the course of a case.

In whatever position the patient is placed, it is very necessary to see that as far as possible comfort is obtained. We are not now so strict as to the movement of cases after abdominal section as formerly, and many surgeons will allow their patients to be turned on to the side if that position gives greater ease, rather than compel them to pass a night of discomfort in the position of orthodox supination.

In children it is even more important not to impose any unnecessary restraint which is likely to make them restless and irritable, and they may be allowed to move about fairly freely. One note of warning must, however, be sounded in this respect. Children do not stand abdominal operations well, and there is often some need for hurry towards the end of an abdominal section; this may result in the wound being closed by a single layer of sutures. There seems to be a greater tendency for the abdominal contents to protrude in children than in adults, and if the case is not watched, the house surgeon may find some coils of intestine prolapsed through the abdominal incision. This is a fairly common complication after an operation for intussusception. It is always advisable to apply a broad piece of strapping over the first layer of dressings in such cases, to prevent this accident.

Sleeplessness and Pain.—The importance of adequate rest during the treatment of surgical lesions must be fully realized. Although a patient may be free from severe pain he may be unable to sleep, either because of the position which he is compelled to assume, or because of his general surroundings. If a patient passes a restless and sleepless night, he cannot make satisfactory surgical progress. These remarks are not to be taken as a suggestion that every patient who suffers from sleeplessness is to be deluged with soporific drugs, for there are other means of attaining our ends. Emphasis has already been laid upon the importance of a comfortable position, and a house surgeon should see that splints, bandages, etc. are in good position and not unduly tight.

In the satisfactory treatment of his cases, a house surgeon must steer between two extremes; the one of giving sedatives too readily and over too long a period, and the other of withholding rest- and sleep-giving drugs from a patient who is restless and in pain.

Solutions of opium or nepenthe are frequently of much more value than morphia, and should often be employed in preference to this latter drug. Omnopon is an excellent substitute for morphia and produces few bad effects.

It must be remembered that morphia, although a sedative, does not always produce sleep: the drug may lull the sensibility of the patient to pain without producing further action; but if in addition to a hypodermic injection of 4 min. morphia, chloral hydrate 7 to 10 gr.

or potassium bromide 10 to 12 gr. be administered, pain will be diminished and sleep induced.

Morphia must be given with the greatest care in abdominal cases, since it tends to produce tympanites from its paralyzing action on the bowel wall. The indications for its use are: severe pain, which cannot be controlled by local measures such as fomentations to the abdomen, great restlessness, and persistent vomiting. In such cases it should begin in conjunction with atropine:—

℞ Liq. Morph. Hypoderm. ℥iv | Liq. Atrop. Sulph. ℥j
Fiat injectio.

Sometimes aspirin in 10-gr. doses has an excellent effect on the pain caused by abdominal lesions.

Children are very susceptible to the action of opium and its alkaloids. Following an operation for intussusception, 2 to 3 1-min. doses of the tinct. opii may be given to a young child to keep the intestine quiet, but in most other cases it should be withheld.

As a substitute for morphia, veronal may be employed in 5- to 10-gr. doses. It seems a harmless and satisfactory drug in small doses.

In cases of septicæmia or severe intoxication, a pill containing opium 1 gr., quin. sulph. 3 gr., is very satisfactory.

The use of these drugs must be discontinued as soon as possible. If a patient seems to depend too much upon them, and if the pain has greatly diminished, a harmless deception may be practised, namely, the administration of a hypodermic of distilled water instead of a solution of morphia. This injection will often act by "suggestion," and patients will sleep quite peacefully after its administration.

Stimulants are drugs which increase the patient's strength and power of resistance, and they are to be employed when there is a great drain on the vitality, as for example in cases of peritonitis or prolonged suppuration, or when shock is present as the result of injury or operation (*see* "Shock," Chapter V).

The value of strychnine as a stimulant has been previously discussed, and it will be well to repeat that when it has been thought advisable to employ it in doses of 3 to 5 minims every four or six hours for any length of time, it should not be suddenly discontinued, but the amount should be gradually diminished and the interval between the injections gradually increased.

Alcohol is a drug which is largely used by many surgeons as a stimulant or food. Such contradictory opinions have been expressed by great authorities that it is difficult to be at all dogmatic on the subject. On the whole, the use of alcohol in moderation is to be advised, but it must be regarded as a drug, and not be administered indiscriminately. Few cases require more than four ounces of brandy during twenty-four hours. Alcohol may be given in various forms. Champagne is an excellent diffusible stimulant, very valuable in abdominal cases, and it has some effect in checking sickness. Cases

of genito-urinary disease do not as a rule require alcohol, but should its use be considered necessary, whisky or gin is to be preferred to brandy. Alcohol may be given per rectum in saline enemata, but its introduction into the vein, even in small quantities, when saline infusion is undertaken, is not advisable. An excellent stimulant for a child is made up as follows:—

℞ Ammon. Acet.	℥ss	Sp. Ætheris		℥iv
Rum	℥iv	Aq.	ad	℥iij

One teaspoonful every hour.

Oxygen is a very valuable stimulant, and after severe operations upon the abdomen it is good practice to order inhalations for two or three minutes every quarter or half hour. If the pulse is failing, the oxygen should be passed through absolute alcohol. This method was first suggested to us by Drs. Alcock and Collingwood, as the result of their experiments in the Physiological Laboratory, and it has been most successful in reviving a failing circulation. An ordinary wash-bottle is taken, and is connected on the one hand to the oxygen cylinder, on the other to the mouthpiece, and the gas is allowed to bubble through the alcohol, reaching the patient charged with alcohol vapour. This vapour is very pleasant to inhale, and is powerfully stimulating. In very cold weather oxygen should always be passed through warm water before the patient is allowed to inhale it, as the cold gas may irritate the bronchi and lungs. If the alcohol be employed, it can be warmed very easily by allowing the wash-bottle to stand in a bowl of warm water. In cases of emergency a "Junker's" apparatus serves the purpose of a wash-bottle admirably.

Diet.—The diet of ordinary surgical cases presents little difficulty. Only the special diet required in abdominal cases and the details of nasal or œsophageal feeding will be considered.

Abdominal Cases.—No food should be given for the first six hours after the operation. If the patient complains of thirst, small amounts of warm water up to 2 oz. may be given. There is no need to adhere strictly to the old method of treatment, when only teaspoonfuls of warm water were permitted. Rectal salines will also be of service in checking the thirst.

Feeding may begin with small amounts of weak tea, milk, albumen-water, etc., and it is convenient to start with about 2 oz. every two hours, so that in the twenty-four hours the patient takes 24 oz. of nutritive fluid. It may be advisable to diminish or increase these amounts, and such steps must depend upon the patient's condition. If the administration of food by the mouth excites vomiting, it must be discontinued in favour of rectal feeding; but if the patient takes well, at the end of the twenty-four hours the amount may be increased to 3 or 4 oz. With an increase in the amount to 4 oz. or over it is well to increase the intervals between the feeds, so that the patient gets food every three or four hours instead of every two.

POST-OPERATIVE TREATMENT

The best guide as to the way a patient should be fed is the way he takes and digests the nutriment. Even after the operation of gastro-enterostomy a patient will take food readily within twelve hours of the operation.

The various fluid diets suitable for abdominal cases are (1) Milk; (2) Albumen-water; (3) Beef-tea; (4) Plasmon foods; (5) Raisin-tea.

Milk should not be given in its natural state in most abdominal cases, as it is apt to curdle in the stomach. It should be given in the form of peptonized milk, or citrate of soda should be added to it. Many patients cannot take milk, so that other foods must be selected.

Albumen-water is made by adding the whites of four eggs to one pint of water, mixing thoroughly, and adding a little lemon and sugar.

Beef-tea, even if prepared by prolonged soaking of fresh-cut meat in water, probably has little nutritive value. It is, however, very palatable, and many patients prefer it to milk. If the scraping of fresh raw meat (raw meat juice) be added to beef-tea or beef extracts, or to any plain soup, a very nourishing and stimulating food is produced.

Plasmon is a form of albumen which is easily digested. It is obtained in the form of a white powder, which can be added to beef-tea, milk, or cocoa, and is very satisfactory

Raisin-tea is made by pouring half a pint of boiling water on to half a pound of chopped raisins and allowing it to stand. The water, which now contains a solution of grape sugar, is poured off and used as an alternative to the other foods mentioned.

A fluid diet must be continued for at least forty-eight hours in most cases, after which custards, jellies, bread and milk, and beaten-up eggs may be allowed. As a general rule, nothing of a more solid nature should be given until the bowels have acted.

When a severe operation such as gastro-enterostomy or enterectomy has been performed, the diet should be fluid for about a week. No definite rules can be laid down on this point, as many surgeons hold the view that the diet may with advantage be more generous in the early days after operation, and it is better to rely upon the patient's general condition and on the manner in which food is tolerated in an individual case than to keep strictly to a hard and fast rule.

If a patient is fed by nutrient enemata, they should not be discontinued until at least 24 oz. are taken by mouth in the twenty-four hours.

Nasal and Œsophageal Feeding.—Feeding through the nose or the œsophagus is required after severe operations upon the mouth and throat, since the passage of food over the raw surface would be most injurious; it is also required in some cases of tetanus, hysteria, and laryngeal disease in children.

Nasal Feeding.—A rubber tube with a blunt rounded end like a catheter, of sufficient length to pass into the stomach (16 in. for an

adult) is dipped in glycerin and passed along the inferior meatus of the nose into the pharynx and thence into the œsophagus and stomach, if necessary—usually it is sufficient to pass the tube well down the œsophagus. Care must be taken that the tube does not pass into the larynx, an accident which is most likely to happen if the patient is under an anæsthetic, and which is immediately followed by a violent fit of coughing. A glass funnel is connected to the nasal tube by another piece of rubber tubing and a glass joint. The "feed" consists of milk, beaten-up egg, and a little brandy. If preferred, beef tea and raw meat juice may be given. On the first occasion it is advisable to start with a very small amount (2 to 4 oz.), since the sudden introduction of a large quantity (10 oz.) into an empty stomach is likely to cause vomiting, and the very accident is caused which it was intended to avoid, namely, the soiling of the wound with food particles. For the same reason, as this accident may happen in spite of such precautions, the "feed" should be sterile at first, and should consist of boiled milk or beef tea and brandy. The feed should be given slowly, and the tube should be rapidly withdrawn, since by this manœuvre the œsophagus and pharynx are less liable to be stimulated. When the patient has become accustomed to this method, larger amounts (10 to 12 oz.) may be given every four hours (for an adult).

(*Esophageal feeding* is performed in the same way, but the tube is introduced through the mouth, and must be made to impinge on the post-pharyngeal wall and guided past the larynx in the middle line into the œsophagus. Constant nasal feeding may make the nose sore, so it is well to alternate the two methods.

In tongue and mouth cases, as soon as power of swallowing is regained, a rubber tube should be fitted over the end of a feeder, and if the tube is passed well to the back of the mouth the patient may be allowed to swallow his food. It is always advisable to test the patient with a little water before giving him the food, in case he is unable to get it down.

The Management of the Bowels.—On the third evening after the operation an aperient should be given. Castor oil, 1 oz., is the drug usually employed, and it is a most satisfactory purge. It is, however, exceedingly unpleasant on account of its nauseous taste, and calomel 2 to 3 gr., followed by a saline draught in the early morning, may be used instead.

In simple uncomplicated abdominal cases, such as hernia, etc., the above routine treatment may be regarded as satisfactory, but in all cases where there has been much manipulation of the intestine, or where a certain amount of damage has been necessarily inflicted, such as in resection, anastomosis, etc., it is much better to depend upon an enema for obtaining an evacuation, than upon an aperient.

Even when the appendix has been removed in a quiescent state it is better to start the action of the bowels by an enema; as soon as this has acted, mild aperients—salines, cascara (4 gr.), or small

repeated doses of calomel (½ gr.)—may be given by the mouth. Some surgeons go so far as to keep the bowels absolutely quiet after these operations, giving neither aperients nor enemata; but the discomfort of their patients seems a potent argument against this line of treatment.

Distention or meteorism will be considered among the special complications.

Retention of Urine follows and complicates many operations on the abdomen. Sometimes it appears to be a reflex condition, the vesical nerves being temporarily paralyzed, as after operations on the rectum; at other times it seems due to the dorsal decubitus.

This complication must be carefully considered and treated. It is quite unnecessary to have immediate recourse to a catheter; milder domestic remedies should be tried. A hot bottle (rubber) or a fomentation should be applied to the hypogastrium, and a hot sponge to the perineum. Unless there is some special contra-indication, the patient may be turned on to his face, or even on to his hands and knees, a position which will materially assist the act of micturition. A drachm of spirits of juniper with warm water is sometimes of great value.

If these measures fail, a catheter must be passed. Every antiseptic precaution is to be observed, and its use must be discontinued as soon as possible. Women are exceedingly liable to develop cystitis when confined to bed: how far the condition is dependent upon the use of the catheter has not been accurately ascertained, but many cases are due to this cause. The catheter is rarely required after the second or third day, but when it is discontinued it is very necessary to make certain that the bladder is properly emptied.

If a large pelvic tumour, such as a fibroid uterus, has been removed, a considerable cavity is left into which the bladder may prolapse. After the first few days of catheterization, the power of micturating returns, but the patient complains of pain and discomfort in the bladder: these symptoms may signify cystitis, but they also may mean that the bladder is not being properly emptied. A catheter must be passed at once to clear up the doubt.

Thrombosis, or intravascular clotting, concerns us only insomuch as it may affect the veins, not only in the region of the operation, but at some distance from it.

Venous thrombosis in surgery is usually, but not invariably, associated with some degree of bacterial infection. If a patient with a sluggish circulation is placed on a too exclusive milk diet, there is some risk of thrombosis occurring. Sir A. E. Wright advises, that when milk is being given in any large quantity, sodium citrate 10 to 20 gr. to the pint should be added.

If the venous clot is in a state of active suppuration, there is a great chance that embolic particles will be carried into the lungs and general circulation, with the result that septic pulmonary infarcts or pyæmic abscesses develop. In any case of bone suppuration the cardiac and

pulmonary physical signs are to be noted carefully, as the first indication of a deep thrombosis may be a cardiac murmur or a patch of pulmonary dullness, with friction sounds, tubular breathing, and perhaps hæmoptysis. Even when signs of active sepsis are not present, the complication is a serious one. Pulmonary infarction (non-septic) may occur, and the sudden detachment of large particles of clot may cause very urgent dyspnœa, or even a fatal issue from blockage of the pulmonary artery.

In any large series of cases such accidents will be recorded, and they are the more distressing in that they often occur quite unexpectedly, when a patient is apparently getting on quite well.

Curiously enough, it is not the clots which excite the most symptoms that become detached as a rule, but the quiet unsuspected thrombi in the pelvic or ovarian veins, which are suddenly discharged into the circulation with a disastrous result.

In its ordinary form thrombosis usually attacks the veins of the extremities. The patient complains of a pricking or itching in the region of the vein: later of a dull aching pain influenced by movement. The course of the vein is represented by an exquisitely tender cord; possibly some slight reddening of the skin is present. The temperature is raised. If the clotting is extensive there will be swelling of the limb.

TREATMENT.—The development of an active septic clot is a very great source of danger to the patient, and it will be a matter for the visiting surgeon to decide whether any active measures are to be taken. Briefly they are two: (1) The ligature of the main vein to prevent dissemination—this principle is practised in the ligation of the internal jugular vein in cases of lateral sinus thrombosis—the septic clot is cleared out subsequently; or (2) Amputation. In some cases of compound fracture with evidence of extensive thrombosis this treatment may be demanded.

In the simpler forms absolute rest must be enjoined. The patient must lie perfectly quiet, with the limb wrapped up in cotton wool and protected by a cradle.

The best application is a long strip of cotton wool shaped like a trouser leg, kept in position by a many-tailed binder. Glycerin and belladonna should be applied as a local sedative over the inflamed vein. Under no circumstances is the patient to move, as the slightest effort may lead to the detachment of the clot.

Iron, nux vomica, and other tonics should be given when there is marked anæmia; and if the bowels are sluggish, small enemata should be ordered. The patient should be kept rigidly quiet for at least a month.

Pulmonary Complications. — Although any form of pulmonary disease may at times complicate a surgical procedure, we are here concerned only with those which are of more common occurrence: (1) Hypostatic pneumonia; (2) Septic pneumonia; (3) Pulmonary embolism.

1. *Hypostatic Pneumonia* occurs in elderly subjects, especially in those who have any chronic pulmonary or cardiac lesions, such as chronic bronchitis, or a heart hypertrophied from previous circulatory disturbance. It is not due to a bacterial infection, in the first instance at any rate, although it is possible that in the later stages bacteria may reach the clogged and stagnant tissues and terminate matters by producing a microbic inflammation. This form of pneumonia is, in fact, a stasis or congestion of the vessels at the lung bases, with some œdematous effusion into the alveoli, and it occurs among old people who are kept in bed, especially in the supine position after fractures of the femur, so that the free movement of the posterior part of the diaphragm is interfered with.

In many operations upon the upper part of the abdominal cavity a curious pulmonary complication is met with, described by Pasteur as "massive collapse." It appears to be an œdema, partly the result of impaired movement of the diaphragm.

In connection with these pulmonary complications we realize the value of the proverb, "Prevention is better than cure;" and in all conditions where they are likely to supervene, special measures must be taken. Elderly patients, the subjects of chronic bronchitis or weak circulations, should never be placed flat on the back in bed, but should be propped up in a semi-sitting posture, which allows the viscera to fall away from the diaphragm. (*See* "Fractures," p. 102.)

2. *Septic Pneumonia* is a bacterial infection of the lung, either through the upper air-passages or as the result of pyæmic emboli. As a bacterial infection from above it usually follows operations on the mouth, such as the removal of the tongue or upper jaw. It is a very dangerous complication, usually fatal, the most favourable ending being a pulmonary abscess.

The importance of care in preparing the mouth as a preliminary in these cases has been alluded to (*see* p. 522), and it is very important, as a preventive measure, that blood should not trickle down the trachea at the time of operation.

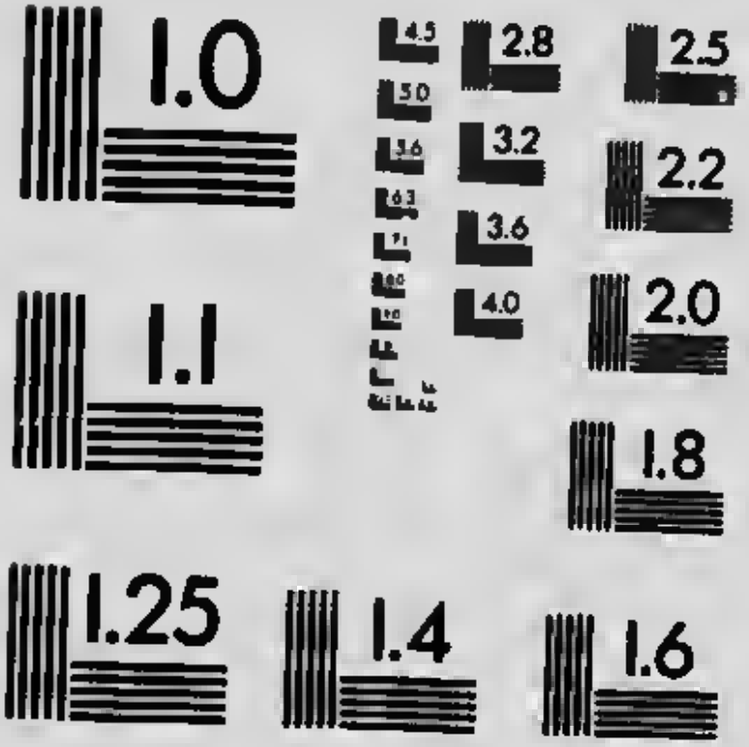
A sloughy condition of the mouth after such an operation as removal of the tongue must have the most careful attention. The mouth should be washed out by the patient every hour during the day (carbolic 1–100, or listerine 3 oz. to the pint); every two hours a nurse should gently wipe the surface with a soft Turkey sponge, so as to remove adherent clot.

Morning and evening the house surgeon should make a thorough inspection of the mouth, removing sloughs and dead particles with care, because the sudden detachment of a slough is often followed by secondary hæmorrhage.

It is only by such attention to detail that septic pneumonia can be prevented. The bronchitis kettle, at one time placed beside every tongue case, is not necessary unless there be bronchitis, but the patient must be kept warm and protected from draughts.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

As a prophylactic measure the patient may be made to inhale some guaiacol carbonate or cyllin inhalant three or four times a day. In any case where the slightest cough is noticed this treatment will be attended with good results. Guaiacol carbonate 1 dr., or cyllin inhalant 2 dr. and tinct. benzoin co. 2 dr., are dropped into an inhaling flask full of boiling water, and the patient sits up and breathes in the medicated steam.

When septic pneumonia has developed, no special treatment can be adopted. The strength must be maintained by salines and stimulants, and if later an abscess becomes localized it may be opened and drained.

3. *Pulmonary embolism* has been already alluded to. For the urgent dyspnœa which attends its onset, inhalations of oxygen and artificial respiration should be employed. Injections of strychnine are of service to tide over the period of immediate cardiac failure. Even in cases when sudden death occurs, artificial respiration should be tried.

Rigors and Suppression of Urine.—Suppression of urine rarely occurs apart from renal disease, and has been dealt with. Rigors are a series of shivering fits which are often the prelude to the more serious complication—suppression.

When a rigor follows any operation on the genito-urinary tract, special care must be taken to keep the patient warm, to supply him with warm diluent and diuretic drinks, and he should be given tinct. opii 10 min., quin. sulph. 5 gr. immediately, to be repeated in six hours. Such treatment may avert suppression; but should it occur it should be treated as suggested.

Poisoning from Antiseptics is of very much rarer occurrence than formerly, though it does occasionally arise from absorption of drugs used in the lotions or dressings. The house surgeon should remember the possibility of this occurring, and be able to recognize the early symptoms. Perchloride of mercury, carbolic acid, and iodoform are the three antiseptics most liable to be followed by toxic effects, and a brief account of the most common symptoms will be here given. The signs are often vague, and a certain diagnosis may be impossible, but in any case of doubt the method of dressing should at once be altered.

Perchloride of Mercury.—Poisoning most frequently occurs after large irregular cavities have been washed out with a strong lotion, some of which is retained and absorbed. The chief symptom is diarrhœa with abdominal pain and distention, and blood may also be passed per rectum. Salivation is rare. There may be at first some rise of temperature. Death occurs either from collapse or the exhausting effect of the diarrhœa. Post mortem, inflammation and ulceration of the intestines will be found, usually most marked in the large gut.

Carbolic Acid.—Under the old Listerian method of dressing it was not unusual for the urine, yellow when first passed, to become of an

olive-green colour on standing; or it might be tinged when first passed, the colour deepening afterwards, until it became almost black. This condition hy itself is not of any great importance, but when poisoning occurs there are other symptoms added, of which severe vomiting is the most important. The temperature usually becomes subnormal, and a condition of collapse supervenes, with a rapid feeble pulse, fixed pupils, and muscular twitchings, ending in death. The sulphates also disappear from the urine, and albumin may be present. Some persons appear to be particularly susceptible to carholic acid, and show symptoms of poisoning when only small quantities have been absorbed.

In carbolic acid poisoning the frequent administration of small doses of sulphate of soda has been recommended, and should be tried.

Iodoform poisoning is rarely seen in England, where the drug is used in much smaller quantities than abroad. The symptoms are very variable, and the diagnosis is often difficult. In some cases there is simply collapse, in others, a high temperature. The pulse is frequent and feeble, and there may be wild delirium, or drowsiness, especially in children. The patient rapidly emaciates, there is loss of appetite, and he complains that everything smells and tastes of the drug.

Treatment.—In all cases of poisoning the first and most obvious treatment is to discontinue the use of the toxic drug, and the wound should be thoroughly cleansed with a non-poisonous lotion, such as boric acid. Saline purges should be administered, and saline infusion practised if the case demands it.

SPECIAL COMPLICATIONS OCCURRING DURING AFTER-TREATMENT.

Shock and hæmorrhage, which may attend any surgical proceeding of importance, have been duly considered; for the present only those complications which are of common occurrence will be discussed.

Vomiting is a common complication, and there are few abdominal cases in which it will fail to occur; but at the outset it is necessary to recognize that there are four distinct varieties: (1) Post-anæsthetic; (2) Gastric and nervous, occasionally renal or uræmic; (3) Peritonitic; (4) Obstructive.

1. *Post-anæsthetic Vomiting* is largely due to the excretion of the anæsthetic by the gastric mucous membrane. In the majority of cases it is slight and soon passes off, and the chief difficulty attending the satisfactory treatment of some post-operative complications which give rise to vomiting, such as regurgitant vomiting after gastro-enterostomy, or that due to intestinal obstruction, is the fact that it is often impossible to discriminate, at any rate at first, between post-anæsthetic sickness and sickness due to some serious disturbance. As a preventive measure before operation the hypodermic injection of morph. sulph. $\frac{1}{8}$ gr., atrop. sulph. $\frac{1}{100}$ gr., is of undoubted value, and it is said that the administration of 4 to 6 ounces of plain

water just before the anæsthetic is begun, has the effect of diluting the drug as it reaches the stomach. Unless the duration of this symptom is protracted—when its consideration falls under the second heading,—no treatment is required beyond stopping all feeding by mouth for six to twelve hours.

2. *Gastric and Nervous Vomiting.*—Unfortunately, cases are now and then encountered where vomiting is a very serious and distressing complication, continuing for days, and apparently little influenced by drugs; indeed, a fatal issue may result from this alone. Instead of the sickness gradually ceasing, as it should do about the second day, it persists, to the extreme discomfort of the patient and the anxiety of the surgeon. Such vomiting may follow operations on other parts of the body than the abdomen, and it is by no means clear whether it is the effect of the anæsthetic upon the stomach or nervous system, or whether it results from some other obscure nervous change.

Treatment should be directed along two definite lines. If the vomited matter contains a large quantity of bile, the stomach is probably in an unhealthy state; there is a certain amount of gastritis, and no good results from the use of gastric sedatives.

The first and most important step is to get the stomach clean. This can be done by giving the patient a tumbler (half a pint) of warm water with a dessertspoonful of bicarbonate of soda dissolved in it. Such a draught provokes prompt emesis, and enables the patient to get rid of a quantity of mucus and bile which are clinging to the walls of the stomach and irritating them.

A weak solution of iodine, 10 to 20 min. of the tincture to the half-pint, may be used instead. This treatment has been found most effective in cases where the ordinary remedies had entirely failed.

If this draught is retained and prompt emesis is not provoked, the stomach must be washed out with warm bicarbonate of soda solution, a teaspoonful to the pint, or warm saline. It is an unpleasant procedure, but of the greatest benefit, and it should not be shirked because of the temporary discomfort to the patient.

Such treatment has given surprisingly successful results in cases of persistent vomiting after gastro-enterostomy and in cases of uræmic sickness. But when it is obvious that there is no accumulation in the stomach, or when, in spite of the above treatment, vomiting persists, we must endeavour to check it by means of drugs.

It can be said at once that no one drug will effect a cure in these cases; it is often necessary to make a trial of a large number before one is found that has a good effect in a particular case, and indeed in some instances the sickness seems gradually to wear itself out uninfluenced by drugs.

First try small repeated doses of cocaine and peppermint:—

℞ Cocainæ Hydrochlor. gr. $\frac{1}{30}$ | Aq. Menth. Pip. ad ℥ss
Tinct. Card. Co. ℥xv |

To be given every hour up to four doses.

Next try hydrocyanic acid or bismuth :—

(1).

℞ Bismuth. Subcarb.	gr. xx	Sp. Chlorof.		℥xv
Sod. Bicarb.	gr. xv	Aq. Menth. Pip.		ad ℥j

4tis horis.

(2).

℞ Sod. Citrat.	gr. xxx	Sp. Chlorof.	℥x
Sod. Bicarb.	gr. xx	Tinct. Card. Co.	℥j
Acid. Hydrocyan. Dil.	℥iij	Aq. Menth. Pip.	℥j
Sp. Ammon. Arom.	℥xx		

4tis horis.

If these fail, chloretone 5 gr. every three hours up to 20 gr., or ammonium bromide 15 to 20 gr. may be tried. Should none of these drugs have any effect, apply a mustard plaster, 4 in. square, to the epigastric region.

As already pointed out, failure will often follow treatment, and two points must specially be borne in mind: (1) It is not always necessary to stop all feeding by the mouth in these cases. Sometimes sips of iced champagne or a little solid food—a piece of bread and butter—will be found to succeed when drugs fail; but if the vomiting occurs strictly in relation to food, and if it is very frequent, the patient must be fed rectally. (2) Constant vomiting is not only distressing, but weakening; therefore saline injections into the bowel must be employed, and if there are great restlessness and exhaustion from disturbed sleep, a small hypodermic injection of morphia should be given.

Warning.—Some patients are susceptible to enemata and morphia, and both may cause an increase of the symptoms; the condition is, however, rare.

Uræmic Vomiting is to be treated mainly by saline injections and by washing out the stomach; the bowels and skin should be made to act freely.

The use of calomel and saline purgatives will be discussed below.

3. *Peritonitic Vomiting.*—Peritonitis, whether present at the time of the operation or resulting from it in a mild or severe form, causes trouble and sickness, and this is the more to be feared since in such a condition the patient wants all his strength and energy to combat a dangerous disease.

The vomiting is due to two separate conditions: (1) To the irritation of the inflamed peritoneum, the vomiting being reflex and of short duration: (2) To distention of the intestines and pressure on the stomach, and in the later stages to actual obstruction.

So long as there is no marked distention of the abdomen, treatment on the lines suggested above should be adopted, but when it is accompanied by distention of the gut, a different and more active line must be attempted (*see* "Meteorism," p. 539).

This mainly consists in giving repeated small doses of calomel ½ gr., or magnesium sulphate 1 dr., every hour up to ten doses, with the idea of getting the bowels to act and so diminishing the meteorism.

In addition to this, fomentations as hot as can be borne should be placed on the abdomen *over* the gauze dressing. This application is very successful in relieving pain and in checking vomiting.

Peritonitic vomiting is distinguished from the other varieties by the fact that it is accompanied by abdominal rigidity, later by distention, and an *increasing pulse-rate*. In the milder varieties of the disease, such as the plastic form which follows any extensive abdominal operation, or in those cases of extensive peritonitis which have been operated upon successfully, the vomiting will gradually subside as the general condition improves.

4. *Obstructive Vomiting.*—An occasional complication following abdominal operations is mechanical obstruction by a band of adhesions, or a kink in the intestine. In the later stages of peritonitis obstruction is present, but it is due to paralysis of the muscular coats of the bowel, and a similar condition may result after an obstruction has been relieved, as in strangulated hernia.

Early recognition of this condition is most difficult, since it is obviously complicated and masked by post-anæsthetic vomiting. The following points may be of assistance: (1) If the post-anæsthetic vomiting has ceased for some time, and the patient subsequently is often sick, this suggests some cause other than the anæsthetic; (2) If the vomit becomes first bile-stained and then sour—duodenal and jejunal contents (it is not necessary to wait until the vomit is stercoraceous)—obstruction is probably present; (3) If severe spasmodic abdominal pain is complained of; (4) If distention comes on in the absence of obvious peritonitis. (5) If no action of the bowels can be obtained, especially if no flatus is passed; (6) If the pulse-rate increases and the general condition of the patient becomes rapidly worse, *organic* obstruction is present, and the abdomen should be opened without delay.

Hiccough or Diaphragmatic Spasm is a complication usually associated with vomiting; in many cases it is a symptom suggestive of a spreading peritonitis, but it is met with after operations in which the peritoneum has not been damaged; it is often a troublesome complication of nephrectomy and prostatectomy.

If hiccough is a symptom of progressive peritonitis, treatment must be directed to this grave condition; otherwise attention must be given to the state of the stomach or the nervous system. If the stomach is dilated it should be washed out as suggested under "Vomiting," after which gastric sedatives and a mustard plaster to the epigastrium should be tried. When, however, hiccough arises as the result of some nerve disturbance—we have seen it in an aggravated form after nephrectomy—the effects of treatment are by no means satisfactory. It is a serious complication if prolonged, and may cause death by exhaustion. If in spite of a severe hiccough a patient is able to get sleep and rest, the prognosis is good; in such cases the hiccough gradually ceases.

TREATMENT when gastric trouble is not present :—

1. First try nitroglycerin $\frac{1}{100}$ gr. three or four times a day.
2. Bromide of potassium, 20 gr. ; chloral hydrate 20 gr. ; aq. chlor. 1 oz. . for three doses ; by mouth or per rectum.
3. Faradization over phrenic nerve.
4. Hypodermic injection of morphia.
5. In severe cases, anæsthesia must be induced.

Meteorism, or distention of the intestines with gas, may occur in straightforward abdominal cases, when no peritonitis has supervened. If the bowel has been imperfectly cleaned out before the operation, fermentative changes may take place in the large intestine and cause a great deal of trouble. But for the most part meteorism is a complication of peritonitis, and is serious because it prevents the intestine from carrying off its contents ; the distention increases, and total paralysis of the bowel and obstruction result.

TREATMENT.—Immediately after operation pass a small tube a few inches into the rectum and leave it there. The abdominal muscles are often incapable of exerting any contractile power after an operation, and as such contraction is of assistance in expelling flatus, something must be done to make its passage easy. The position of the patient is, moreover, one which does not readily permit of relaxation of the sphincter ani. In cases where continuous rectal saline is administered, the saline tube has the same effect. If distention comes on shortly after the operation, say within twenty-four to forty-eight hours, give slowly a turpentine enema (*see* " Enemata," p. 346). If this is retained, give a glycerin enema. Start calomel by the mouth (*vide ante*). Give hypodermic injections of strychnine, atropine, or eserine. Eserine, in doses of $\frac{1}{250}$ gr. by mouth, or $\frac{1}{30}$ gr. hypodermically, is of the greatest possible value in treating distention : it is much more active than strychnine. It is often necessary to work very hard at these cases ; many enemata have to be given before finally the intestine expels its flatus, and it may be necessary to extend their use over several days. It must be borne in mind that the flatus is in both large and small intestine in many cases : it is an easy matter to get an enema into the large, but impossible to introduce it into the small bowel. A certain amount of distention will therefore persist until the bowels act freely from above. It is no use injecting a turpentine enema into the rectum ; it must be introduced into the colon, and the tube must be passed well up into the bowel for this purpose.

In a few cases enemata will fail to effect their object, but let it be made clear once more that some patience and perseverance are needed before giving up the attempt ; in such a case the bowel should be opened and a tube inserted into the cæcum or small intestine. Although a *dernier ressort*, and one which the visiting surgeon will perform if he thinks advisable, it is a method that undoubtedly saves life. A preparation of pituitary extract has been employed frequently for the relief of meteorism ; it is a drug of considerable value in cases of shock

also; it must never be used in patients over 50 or in those with advanced arteriosclerosis. The writer has met with a fatal result from its employment in such a case. The drug is put up in ampoules, and is administered hypodermically.

Sepsis.—An operation may be performed for septic states, in which case the wound treatment will differ from that required in an aseptic condition. Again, septic changes still occur in clean wounds, and will continue to do so until the surgical millennium is reached. All septic wounds require very careful attention, and septic changes introduce a number of additional complications, such as sapræmia, septicæmia, and pyæmia. Wounds that are already septic at the time of operation must be kept freely open, so that the pus has no chance of burrowing along the fascial and muscular planes, and they must be frequently dressed. So long as a destructive process is at work, as shown by the unhealthy sloughy appearance of the wound, weak antiseptic lotions and dressings are preferable, since they at least hinder the development of putrefactive organisms in the dead tissue and diminish the smell which is often present.

As soon as healthy granulations appear, dry dressings should be applied, and the healing assisted by the application of friar's balsam. Rubber and gauze drains should be removed as soon as possible (*vide* "Abscess").

We will take as an example a case of compound fracture which has become septic. The wound must be opened up freely, counter-incisions being made at dependent points to favour drainage, and moist hot dressings should be applied. Carbolic fomentations, 1–100, are most suitable. If preferred, and if the part is accessible, constant irrigation or a continuous bath may be employed. Dressings must be changed every four hours, in milder cases at least twice a day; the wound should be irrigated, and the tubes either removed for cleaning or, if there is likely to be some difficulty in replacing them, syringed out and moved. This latter detail is important, since granulations are apt to grow into the holes in the side of the tube and interfere with their subsequent removal. This treatment must be undertaken until the wound has reacted.

In the case of a wound becoming septic, attention will generally be drawn to the case either by a rise in the temperature or by the patient's complaints. (A rise on the first day after operation does not necessarily denote sepsis, but if the rise is sustained or increased on the second or third day, sepsis is probably present.) The dressings must at once be removed and the part carefully examined. There is not always a pronounced rise of temperature in the milder forms of sepsis, which fortunately are the most common, but there is generally some pain or uneasiness in the wound. A septic wound is not always red and puffy, but large collections of pus will form beneath a skin wound which has healed perfectly. Some fullness will be present, and if in cases of doubt a probe be introduced into the line of incision,

the pus will make its appearance. The stitches must be removed: it is not necessary to remove them all in every case; so long as sufficient drainage is provided and there is no tension—a most important point—a certain number may be left.

The after-treatment will be the same as above detailed. Useful lotions are: Hydrarg. oxycyan. 1–5000; hydrogen peroxide 5 to 10 vols.; and as a local application in septic states, *dioxide* of zinc is most satisfactory. This is a greyish-white powder, which is non-irritant, and which gives off oxygen when brought into contact with the tissues.

The general treatment of the patient in septic states consists in supporting his strength with nourishing foods, stimulants, and salines. Quinine should be given, and the bowels should be made to act freely. According to the severity of the condition, alcohol should be prescribed, and, if required, opium or its derivatives.

Apart from the more immediate dangers associated with sepsis, sinuses are likely to form and give trouble, and there is some danger of an abdominal incision giving way and of the intestines prolapsing. Septic wounds of the abdominal wall must therefore be watched with great care, and it is advisable to strengthen the dressing by broad pieces of strapping.

Sinuses usually persist if a ligature has become infected, but they also may occur in wounds that have apparently run an aseptic course. If a ligature is present, the sinus will not heal until it is removed, and this can often be neatly effected by means of a small metal crochet-hook. Infected sinuses should be swabbed out with a drop or two of pure carbolic acid, or they may be treated by cupping—a test tube heated in a spirit lamp acts admirably for a small sinus. In some cases Wright's solution—

R	Sodium Chloride	4 parts	Water	120 parts
	Sodium Citrate	1 part		

which excites a flow of lymph through the sinus, has succeeded when other methods have failed.

Chapter L.

OF THE MAKING OF POULTICES, FOMENTATIONS, ETC.

POULTICES are rarely required in *surgical* cases. In *medical* cases they are mainly intended to reduce an inflammation of parts at a distance from the skin surface to which the heat and moisture are applied. But in all cases the immediate object to be served by putting on a poultice is to warm and moisten the tissues with which it is in contact. The manner of its action is partly mechanical—for by relaxing the tissues, pain and tension are reduced—and partly physiological, as it affects, primarily, the circulation of the part poulticed, and, secondarily, the tissues or organs at a distance.

A great variety of materials have been used at one time or other for making poultices—carrots, turnips, potatoes, etc., but we shall here consider the following only:—

1. Poultices of crushed linseed meal.
2. " " " " " with mustard flour.

The Linseed Meal Poultice is the one in most general use, and is the easiest to make. The *crushed seed*, not the ground linseed flour, should always be chosen, for the former still retains a good deal of oil, which gives a surface to the poultice mass, and prevents it from sticking to the skin.

All that is necessary to make a good linseed poultice is to see that the water is boiling to begin with, and to waste no time in the mixing. The general plan is to scald out a pudding basin, to put into it the linseed, and to add boiling water gradually, stirring the mass with a warm spoon; or, if it is preferred, the water may be put first into the basin and the meal gradually added; or again (and in this way all cooling of the poultice mass during mixing is avoided), a sufficient quantity of water may be kept boiling in a saucepan upon the fire, and the linseed gradually stirred into it. In any case, when the proper consistence has been reached, the contents of basin or saucepan should be emptied out upon a piece of old linen or cotton stuff, of the shape of, but a little larger every way than, the poultice required, and quickly spread with a spatula, or large knife (an ivory paper knife does well), which must be kept well wetted with boiling water, until it is everywhere about a quarter of an inch thick. This spreading should have distributed the mass evenly over the stuff, up to about an inch of its edges; this inch must now be neatly turned over upon the margins of the poultice, to which it will adhere.

Another good plan is to card out tow and fashion it into a bed for the poultice mass. The manipulation of the tow requires some practice and can hardly be described in words, but it forms a very light non-conducting backing.

If the mean has been hit between sloppiness and dryness, the poultice should now be able to be folded up or handled freely without coming to pieces, and its surface should be smooth and non-adherent to the skin, to which it should be, when first made, still too hot to be applied.

If it be desired to keep a poultice hot for a little time before it is applied, or if one has to be carried for any distance, it is best to fold it up and place it between two hot plates.

Poultices should be applied as hot as they can be borne, and to get their full benefit they should be *changed at least every two hours*, for whatever they are made of they soon get stiff and cold; as a rule, every three or four hours is considered to be the time for changing poultices, and in hospital it is perhaps hardly possible that it should be otherwise. But under no circumstances should eight or ten hours be allowed to pass, for by that time the poultice will have become sour.

Of whatever kind the poultice may be, the surface of the mass must be placed upon the skin itself, without the intervention of any woven stuff, even of the thinnest muslin.

If oiled silk or oiled paper be placed over the back of the poultice it will retain its heat and moisture better. It should overlap the edges at least an inch all round. Wool is often laid over this again an inch larger all round, and will be found to retain the heat still longer.

All old poultices should be burned directly, never allowed to remain in a ward or be thrown into a dust-bin.

For counter-irritation, *mustard flour* may be added to the crushed linseed in varying proportions (generally equal parts of each), and the poultice made as before.

Fomentations.—A fomentation is made by soaking a piece of flannel or lint in boiling water, and wringing it as dry as possible in a warmed towel. Some few people, laundresses especially, are able to perform this wringing with their unaided wrists, but for most it will be necessary to use a set of wringing sticks. These consist of two pieces of stick like rulers, about 2ft 6in. in length, passed through the ends of a round towel, about 2ft 6in. by 10in. When the soaked flannel is picked out of the boiling water it should be allowed to drip for a few seconds, and then it must be placed in the centre of the towelling, and the whole twisted up by the leverage of the sticks until no more water comes away. This should take but a few moments. Another good way is to sew the ends of the flannel together and to pass the sticks through before the boiling water is poured on to it. It can then be lifted and wrung without loss of time, and put into a dry warm towel.

For a simple fomentation the flannel should just be applied to the skin as an application of warmth and moisture, and covered with a piece of oiled silk slightly larger than the fomentation; over this again

a layer of cotton wool should be laid, and the whole fixed with a triangular bandage or a few turns of a roller. Boric lint is frequently substituted for ordinary flannel, and, being antiseptic, is used when there is an open wound.

But these fomentations are often used with some counter-irritant or anodyne; thus laudanum, or the tincture of belladonna, or, more frequently still, turpentine, may be sprinkled over the flannel. This last forms the common turpentine stupe, so often used for lumbago. In all cases, if the fomentation is to produce its proper action, the flannel must be wrung dry out of boiling water, and if the wringing be not effectually performed it is quite likely that some scalding of the skin will take place.

Chapter LI.

ON URINE TESTING.

By WILLIAM HENRY WILCOX, B.Sc., M.D.

Lecturer on Public Health, Pathology, Chemistry, and Forensic Medicine, St. Mary's Hospital Medical School; Physician to Out-Patients, St. Mary's Hospital.

AN examination of the urine of all new cases should be made, whether disease of the kidneys is suspected or not, and therefore a brief account of the most important tests is here given, with their significance.

The urine of a healthy person is perfectly clear or only very faintly clouded when passed. When allowed to stand, that is to say, to cool down to the temperature of the room, a faint cloud appears, due to mucus. The colour is pale lemon or straw, but the intensity of the colour depends a good deal on the amount of water present, or to put it in another way, on the specific gravity. The less the water the greater is the proportion of salts, the higher the specific gravity the deeper the colour, and *vice versa*. Any great change from this colour indicates some pathological condition: red or smoky urine shows the presence of blood, a yellowish-green or brown is associated with jaundice, and when carbolic acid is being absorbed the urine becomes black. The smell of freshly passed urine is well known, the most important departures from the normal being due to turpentine (which gives an odour resembling that of violets), asparagus, and a few other bodies. The ammoniacal smell associated with decomposing urine is readily recognized.

The quantity passed by a healthy adult varies from 45 to 65 ounces or 1250 to 1850 c.c., but considerable physiological variations may occur, depending on the amount of liquids consumed, the state of the bowels, skin, the time of year, etc., and the flow during certain portions of the day varies considerably. To estimate the amount, the total quantity for twenty-four hours must be collected and measured.

Increase in the Amount, if persistent to any great degree, indicates some pathological condition in most cases, but allowance must always be made for temporary nervousness, during which very large amounts are often passed. The conditions in which polyuria are found are in diabetes mellitus, diabetes insipidus, in conditions where the blood-pressure becomes raised, for example in arteriosclerosis, after the administration of drugs which act either as direct or indirect diuretics, at the crisis of certain diseases, in chronic interstitial nephritis, and in certain forms of hysteria occurring in males or females.

Decrease in the Normal Amount is associated with the low blood-pressure seen in some forms of heart disease, and particularly with the low blood-pressure associated with concussion and shock following injuries or temporary heart failure from other causes. It is also observed in all febrile conditions owing to the large amount of water-vapour given off by the skin and lungs. In all forms of acute and subacute nephritis there is a very marked diminution. In cases where some obstruction exists preventing the flow of urine down the ureter, such as the pressure of inflammatory exudation, the presence of a new growth or stone, and also in cases where there is accumulation of fluid in the body, as, for example, in the marked ascites associated with cirrhosis of the liver, tuberculous peritonitis, and other causes, a marked diminution occurs.

Suppression of Urine, a condition known as anuria, is very likely to occur in the early stages of an attack of acute nephritis, or from any source of local irritation in the urogenital tract; thus a direct local cause might be a renal calculus; an indirect or reflex cause might be a wound of the urethra or the irritation caused by too forcible attempts to pass a metal catheter through a stricture.

The Specific Gravity of normal urine lies between 1015 and 1025, but if above or below this may possibly be due to physiological variations, and not to disease. To obtain the specific gravity accurately, the whole amount of urine passed in twenty-four hours should be mixed and a part taken for examination, as it is found that considerable alterations take place during the day, especially if large amounts of fluid are taken at meals or other times. Normal urine is, as a rule, acid, it turns blue litmus paper red, but on standing for some time it becomes alkaline, owing to the development of bacteria; it then deposits a sediment composed of ammonium magnesium phosphate $Mg.NH_4PO_4$, calcium phosphate $Ca_3(PO_4)_2$, and later ammonium urate $C_5H_4(NH_4)_4N_4O_3$, developing a smell of ammonia, not unlike that of a stable.

In the urine several salts are held in solution, the most important being chloride of sodium, sodium and other sulphates, certain phosphates, urates, and also urea, creatinin, etc.

Urea, $CO(NH_2)_2$, is the most important nitrogenous constituent. In febrile diseases the amount excreted is increased, in consequence of the excessive tissue destruction, and this increase is often observed even for some days after the temperature has fallen to normal. A great increase is observed in diabetes mellitus. There is also a great increase in physiological conditions where excessive proteid is being taken in the diet, and in pathological conditions where the patient is on a full diet and marked muscular wasting is resulting. A diminished excretion is observed in association with diseases of the liver, such as acute yellow atrophy, carcinoma and cirrhosis, and in all forms of Bright's disease.

Urea is recognized under the microscope by its fine white needle-like

crystals when rapidly formed, but when allowed to crystallize slowly it forms colourless quadratic rhombic prisms. It is important, however, to remember that urea is *never found as a deposit* in urine, owing to its great solubility. To estimate the amnunt of urea present a ureometer is used. This consists of a hurette (*b*) attached to a

Fig. 311.—UREA CRYSTALS.
(1, 2) Prisms of pure urea; (3) Rhomboidal plates; (4) Hexagonal tablets.

reservoir (*c*). capable of being raised or lowered. From the top a tube leads to a bottle (*a*) containing 25 cc. of a 40 per cent solution of sodium hydrate and 2 cc. of bromine (*Fig.* 312).

To test a urine, 27 cc. of the hypobromite solution is placed in the bottle and 5 cc. of urine in the small tube (*t*). Water is poured into the burette, which must be disconnected from the bottle, so that it appears in the movable limb; the bottle is then connected and the water brought to a level in the tubes. Then a reading should be taken by the markings. By tipping the bottle the urine is mixed with the hypobromite solution and a certain volume of nitrogen is liberated, the water being driven down in the burette. After waiting some time to allow the gas to cool (considerable heat being given off by the reaction), the pressure is again equalized by lowering the reservoir (*a*), and a second reading is taken by the markings. The difference between the two will give the amount of nitrogen liberated from 5 c.c. of urine. The gas liberated is the nitrogen of the urea. In Gerrard's ureometer (*Fig.* 312), the burette is calibrated so that it reads off directly the percentage of urea (in grams per 100 c.c.). For very accurate

Fig. 312.—GERRARD'S UREOMETER.

determinations various allowances have to be made for barometric pressure, the temperature, and the tension of aqueous vapour; but for these details the student must refer to larger works. The normal percentage of urea in urine is 2 per cent, and the daily excretion is 30 grams, or about 1 ounce.

Uric Acid ($C_5H_4N_4O_3$) is present as sodium quadriurate in small quantities in normal urine, being increased in febrile diseases and in persons who suffer from the uric acid diathesis, and by the action of certain drugs. There is an increase in the uric acid excretion in pathological conditions where there is excessive proteid metabolism, e.g., diabetes and other diseases associated with muscular wasting where the patient is on a full diet; also there is a physiological increase where excessive quantities of proteid are being taken, and particularly where excessive amounts of nucleoproteid are being consumed, since this especially leads to the production of uric acid. A pathological example of the latter condition is leucocythæmia, where the uric acid excretion is often doubled. In concentrated urines the quadriurate of sodium (and potassium and ammonium) separates out when the

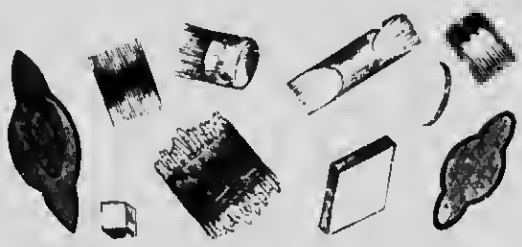


Fig. 313.—Uric Acid Crystals.

urine cools, as a red-brick amorphous deposit; the colour of this deposit is due to urinary pigments carried down with the quadriurates. In urines where there is little pigment, e.g., that of women and children, the quadriurates often form an almost white, or pinkish-white deposit. Where the urine is very acid, the uric acid is deposited in the form of the free acid and not as the quadriurates. Then the uric acid forms the well-known red deposit which has been likened to the colour of cayenne pepper. This colour is due to the urinary pigment carried down with the uric acid crystals (these being in the pure state colourless). The normal daily excretion of uric acid is about $\frac{1}{2}$ gram.

Its presence may be shown by several tests, the most satisfactory being that known as the murexid. To 200 c.c. of urine add 10 c.c. of hydrochloric acid and set aside for twenty-four hours, filter, and dissolve the filtrate in strong nitric acid, evaporate to dryness, and add a drop of ammonia, when a deep purple-red colour will appear. The best method of estimating uric acid is that devised by Hopkins, for details of which see special works on urine analysis.

Oxalic Acid ($C_2H_2O_4$), as the calcium salt, is another constituent of the urine, separating out if the acidity is diminished. The octahedral crystals are easily recognized, and are known as envelope crystals; sometimes the crystals appear as dumb-bells (*vide Fig.* 314).

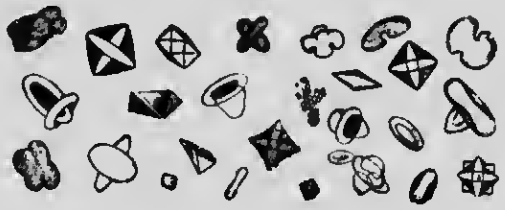


Fig. 314.—Oxalate of Calcium Crystals.

Albumin.—It is not intended to enter deeply into the question of the presence of albumin in health; it will be sufficient to say that it may be present and not justify us in saying that there is any grave organic disease of the kidneys. This condition is known as functional albuminuria; in it the urea, chlorides, and other constituents of the urine are normal, and no casts are present, while in pathological albuminuria there are always abnormal variations in the other constituents. There are several albumins which may be present in the urine, but serum albumin is the most important clinically, and is the only one referred to here.

Albumin is present in the urine in many diseases, the most important being acute and chronic nephritis, amyloid disease of the kidneys, heart disease, febrile conditions, and after taking certain drugs.

Its presence is recognized by the following tests:—

Boiling Test.—This is much the most reliable test. If the urine is acid, place it in a test tube, if not acid make it *slightly acid* by the addition of 2 per cent acetic acid, and then place in the test tube. Boil the upper part of the urine in the tube by heating the upper portion, then notice if a cloud has formed; now add a few drops more of the acetic acid solution, and if albumin is present there will be a distinct precipitate or cloud in the portion of liquid heated. Occasionally a cloud forms in the upper part of the liquid, due to the deposition of earthy phosphates; this, however, instantly dissolves on the addition of acetic acid after boiling.

Nitric Acid Test.—Fill a test tube about a third full of urine, and allow concentrated nitric acid to run slowly down and settle in a layer at the bottom. The presence of albumin is indicated by a cloud forming between the two layers of fluid.

Picric Acid Test.—This is used as a quantitative test, and is known as Esbach's.

The picric acid solution is made as follows: Picric acid 10 grams; citric acid 20 grams; distilled water 1 litre.

Equal parts of this solution and the urine are mixed in a specially

graduated tube, and allowed to stand for twenty-four hours, a stopper being placed in the mouth of the tube. At the end of this time the precipitate—which consists of uric acid, creatin, and other bodies, as well as albumin—will have settled down, and the amount of albumin per mille in grams can be read off by the scale.

Blood may be present in the urine, and when present may tint it red or almost black. It is readily recognized by a microscopic examination, the characteristic appearance of the red corpuscles being seen. The spectroscope forms a most reliable method of quickly recognizing the presence of blood. By looking through the urine in a test tube (filtered if necessary), the spectrum of oxyhæmoglobin or possibly of reduced methæmoglobin is observed, and this can be confirmed by gently warming the urine with about 20 drops of caustic potash solution and 5 drops of ammonium sulphide, when the characteristic spectrum of hæmochromogen becomes at once visible.

The chemical test for blood in urine is as follows: Take a test tube about one quarter full of urine, add about 10 drops of fresh tincture of guaiacum, which should be of a light amber colour and not too strong,

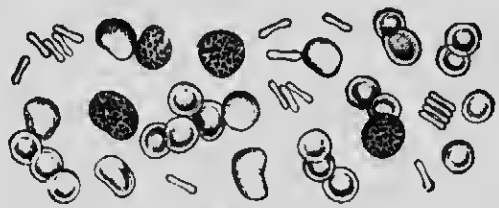


Fig. 315.—Blood Corpuscles.

mix, when a milky liquid results, owing to the deposition of the resin in the tincture of guaiacum. Now pour carefully down the side of the test tube some fresh sensitive ozonic ether. If blood is present, a blue colour will develop almost immediately. It must be remembered that if pus is present, or potassium iodide, then this result may be given in the absence of blood.

Sugar.—Several carbohydrates may be present in the urine, but glucose is the only one of general clinical interest.

It may be present physiologically owing to the excessive consumption of sugar and carbohydrates, that is, its presence does not always indicate disease, though any case in which it is found must be looked on with great suspicion. It also occurs in the urine pathologically in many conditions which are not true diabetes, e.g., in gout, Graves' disease, abdominal tumours, cerebral tumours pressing on the fourth ventricle, etc. This is known as glycosuria. The disease its presence indicates is diabetes mellitus, and persons suffering from this complaint and also from glycosuria bear surgical operations badly. The tests employed to show its presence are many, but only three qualitative and two quantitative are given here.

Fehling's Test.—The two solutions employed are best kept apart till required for use. This composition is as follows :—

1. Crystallized copper sulphate 34·64 grams dissolved in 500 c.c. of distilled water.
2. Sodium and potassium tartrate, 173 grams ; potassium hydrate, 125 grams ; distilled water, 500 c.c.

Equal parts of these two are mixed, brought to the boiling-point, a few drops of the urine added, and the mixture well boiled. If sugar is present a yellow precipitate of suboxide of copper is thrown down. It must be remembered that only the presence of the precipitate indicates that sugar is in solution in the urine, and that a change of colour, such as green, is of no importance. It must be also remembered that sometimes a brownish flocculent precipitate is produced when no sugar is present, owing to the presence of creatinin, uric acid, glycuronic acid, or albuminous bodies.

Where the reaction is not well marked and definite, a confirmatory test should be applied. The following two tests are absolutely conclusive :—

(*a*) *The Fermentation Test.*—Take a test tube, place in it a lump of yeast the size of a nut, fill completely with the urine, place the thumb on the end of test tube, invert, and place the open end of the test tube beneath the surface of some of the urine in a dish, then remove the thumb, when the test tube will be vertical and filled with the urine to be tested and contain the lump of yeast. Now support the tube in this position, and place it with the dish in an incubator or in a warm place. In an hour or so the urine will begin to descend in the tube owing to the production of carbonic acid gas by the fermentation of the sugar in the urine. If no sugar is present, the tube will remain filled up with urine.

(*b*) *The Phenyl Hydrazin Test.* — Dissolve 1 gram of phenyl hydrazin hydrochloride and 3 grams of sodium acetate in 15 c.c. of water, filter, add 5 drops of acetic acid. Now add 5 c.c. of urine, and warm in water bath for half an hour. Then allow to cool slowly. If sugar is present, a light yellow precipitate is seen, and on microscopical examination of this, beautiful yellow sheaves of needle-shaped crystals (phenyl glucosazone) are seen. This test is very reliable and delicate.

To estimate the amount of sugar present, the above solutions are employed, which are so made that 10 c.c. of the mixed solutions will reduce 0·5 gram of glucose.

It is best to dilute the urine ten times, as the test can be then applied more accurately. Place 10 c.c. of the mixed Fehling's solution in a porcelain dish, or glass flask, and continue boiling, adding from a burette the ten-times diluted urine drop by drop. An immediate precipitation of oxide of copper takes place. As long as any blue colour exists in the Fehling solution, the urine is added. When this has entirely disappeared, read off the amount used. To calculate the percentage amount of sugar present :—

If x = number of c.c. of diluted urine used, the percentage of sugar (grams per 100 c.c.) = $\frac{\cdot 5 \times 100}{x}$.

Though this method of estimation sounds easy, it is by no means so in practice, for no inconsiderable difficulty will be found in being exactly sure that all the blue colour has disappeared. To make quite certain that all copper has been reduced, a drop or two of the solution may be filtered off, acidulated with acetic acid, and a drop of potassium ferrocyanide added. If some copper still remains, a brown coloration appears, showing that more urine should be added. It is of course possible that too much may have been added, so it is as well to repeat the test.

Another method of estimating the amount of sugar present is by fermentation. The specific gravity of the urine is taken accurately, and a small quantity of yeast added, the vessel being placed in an incubator at 37° C. After twelve hours the specific gravity is again taken, and the difference between the two readings multiplied by 230 (an empirical factor) will give the percentage of sugar present; e.g., if 1·030 and 1·010 are the respective specific gravities, the percentage of sugar = ·02 × 230 = 4·6 per cent. This method is only approximate.

In the condition of glycosuria apart from diabetes mellitus, if much sugar is present, the patient would be a bad subject for a surgical operation. By appropriate diet and medical treatment the sugar in this condition can usually be rapidly reduced, and then an operation could be safely performed. In true diabetes mellitus there would always be a very grave risk from a surgical operation, especially if a general anæsthetic were given. The urine in this disease is usually very pale, and greatly increased in quantity. In simple glycosuria the quantity is not increased and the urine is normal in colour. In diabetes mellitus the urine usually contains, in addition to sugar, acetone, diacetic acid, and oxybutyric acid. The two former of these can be readily detected, and their presence gives a valuable confirmation of the diagnosis of diabetes. These tests should always be applied whenever sugar is found in the urine. They are as follows:—

Acetone.—Take a test tube one-quarter full of urine, add about 1 c.c. of a 5 per cent solution of sodium nitroprusside, mix, pour very carefully down the side of the slanted tube some strong ammonia solution (s.g. ·880), and allow to stand for five minutes. A beautiful rose-violet colour develops at the junction of the two liquids.

Diacetic Acid.—Take a test tube one-quarter full of urine, and add about half the quantity or a little more of ferric chloride solution; a slight or deep claret colour is produced, according to the quantity of the acid present. If the liquid is well boiled for a few minutes, the colour disappears. (Ferric chloride gives colours with salicylic acid, antipyrin, and carbolic acid which may be present if being given in medicines; these colours are not destroyed by boiling.)

Bile Pigments never occur in health in the urine, and are generally associated with jaundice. Their presence is shown by Gmelin's test—

a piece of blotting-paper is wetted with urine, and a drop of concentrated nitric acid added. A rainbow ring of colours will form if bile pigments be present. A better test for bile pigments is the "iodine test." It is performed thus: Dilute some tincture of iodine with alcohol until it is light red-brown in colour. Place the urine in a test tube, and pour carefully down the side of the slanted tube the iodine solution. Allow the tube to stand for two or three minutes. A green zone forms at the junction of the two liquids.

Pus may be present in the urine, and if in small quantities it can be recognized only by the microscope. If present in any considerable amount, it forms on standing a light-coloured layer which is readily diffused on shaking. It is not soluble in acetic acid, which differentiates it from phosphates, and the addition of caustic potash solution converts it into a gelatinous mass.

Another chemical test for pus is the following: Take some of the deposit by means of a pipette, and place in a test tube. Add fresh

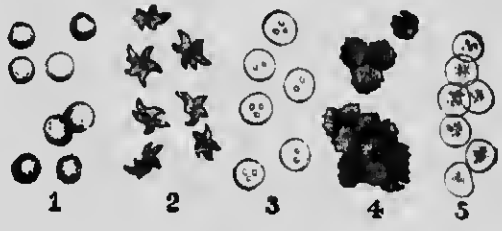


Fig. 316.—Pus Corpuscles.

(1) Normal; (2) With prolongations showing amœboid movements; (3) Showing nuc rendered distinct by acetic acid; (4) Altered by chronic pyelitis; (5) Swollen by ammonic carbonate.

ozonic ether. A brisk effervescence of oxygen soon occurs if pus is present.

There are many other bodies found in health or disease in the urine, but for these the student is referred to works on the urine or manuals of clinical diagnosis.

Microscopic Examination of the urine is of great importance, and should never be omitted if there be any sediment. The centrifugal machine may be used to separate the deposits quickly.

The most commonly observed bodies that form deposits in urine are:—

1. *Uric Acid* may appear in several forms, the most common being those shown in *Fig.* 313. Frequently it separates in large rosettes of crystals of a deep red colour, rhombic prisms—the well-known cayenne-pepper deposit. The test for uric acid has been already mentioned. This deposit occurs only in acid urines.

2. *Amorphous Urates* are commonly seen in the urine of febrile cases, and redissolve on the application of heat. Deposits of urates only

occur in acid urines; they are usually reddish in colour, and form the characteristic brick-red deposit.

3. *Calcium Oxalate* occurs in small, colourless, high-refracting octahedra (*Fig.* 314), not unlike envelopes. It may also appear in dumb-bell-shaped masses. They are not unlike those of ammonium magnesium phosphate, which are, however, larger, and soluble in acetic acid, while the oxalate ones are not. Calcium oxalate crystals are only found as a rule in acid urines.

4. *Ammonium Magnesium Phosphate*, or triple phosphate, appears as large prismatic rhombic crystals, which are numerous in alkaline urine.

5. *Basic Magnesium Phosphate* is seen as highly refracting plates soluble in acetic acid.

Epithelial Cells are frequent constituents of urinary deposits, and their recognition is of considerable importance in some cases. Three kinds are observed: round, conical, and flat cells.

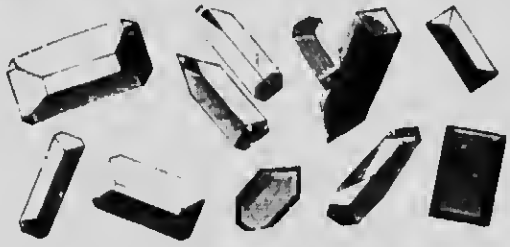


Fig. 317.—Triple Phosphate Crystals.

The round cells are derived from the uriniferous tubules and deep layers of the mucous membrane of the kidneys. They have a nucleus, and by this can be distinguished from pus cells, whose nucleus is only brought out by the addition of acetic acid. Their presence, when associated with albumin and tube casts, generally indicates the existence of pyelitis.

The conical cells come from the superficial layers of the pelvis of the kidney, and occur also in pyelitis.

Flat cells are shed from the bladder and vagina, and are readily recognized.

Leucocytes or Pus Cells of course show inflammatory changes in the urinary tract, but in women care must be taken to exclude the possibility of some vaginal discharge being mixed with the urine. Their appearance varies considerably; in acid urines they are little changed from those seen from other parts, but in alkaline urines they are swollen and opaque. Acetic acid brings out their nucleus.

Red Blood Corpuscles are frequently observed in the urine, but the colour produced by them must be distinguished from that produced by the condition known as hæmoglobinuria, in which the red colouring matter of the blood has been removed from the corpuscles and is free in solution.

The colour of the urine will not be altered materially if only a small quantity of red corpuscles are present, so that it may be impossible to determine their presence except by the use of the microscope. The corpuscles will in many cases be found to have been considerably changed in appearance, depending on the length of time they have been in the urine, and other reasoos. They may be swollen, crenated, almost colourless, or shrunken, and without their biconcave appearance, so that considerable care must be taken in observing them. Blood casts or tube casts containing blood corpuscles may be seen in cases of hæmaturia of renal origin.

Urine contaioing blood is always albuminous, due wholly or partially to the blood. In nephritis, where blood is present, usually there will be a very large quantity of albumin relatively to the blood, e.g., the urine may become solid or nearly solid on boiling, and yet be only light red or brown in colour from the small amount of blood.

Where the blood comes from a traumatic lesion, or from a calculus wounding the kidney or ureter, the amount of albumio present will be relatively much less than with acute or subacute nephritis; thus there will be only a small precipitate on boiling.

Tube Casts may be present in urinary sediments. They come from the uriniferous tubules of the kidney, and may be clear (hyaline casts), granular, epithelial, hlood, or pus. All these varieties may occur in different conditions, and though their presence always indicates some pathological condition, their full significance is often hard to explain. The student is referred to larger works for greater detail.

Micro-organisms.—It is probable that urine in the bladder of a healthy person contains no micro-organisms, but it is certain that when it has been exposed to the air for a short time they can easily be found.

The variety most commonly appeariog is the *Micrococcus ureæ*, to which the ammoniacal fermentation is due. In certain pathological conditions many others may be present, such as the *Staphylococcus pyogenes aureus* and *albus*, the typhoid bacillus, tubercle bacillus, *Bacillus coli communis*, *Diplococcus pneumoniæ*, *Gonococcus*, etc., depending on the various diseases the patient may be suffering from. Their presence is of great importance clinically, especially so in the case of the tubercle bacillus, for the discovery of this micro-organism in the urine may be of great assistance in determioing the state of the kidneys and bladder.

Chapter LII.

OF X-RAYS, AND OF THE TAKING AND INTERPRETATION OF SKIAGRAMS.

By ALLPRESS SIMMONS, M.D., B.S.Lond.
Senior Radiographer St. George's Hospital.

IN the short space that can be given to this subject it is impossible to enter at any length into the physics of the subject, or even to give a detailed account of the apparatus employed; for information on these many important points, reference must be made to the more

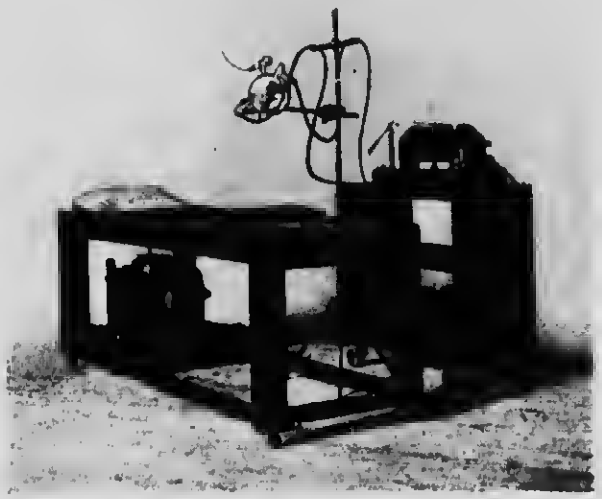


Fig. 318.—A Simple Complete X-Ray Outfit. Consisting of a small coil on a portable stand, with accumulators beneath. It is worked by a platinum brake. Two insulated cables lead from the secondary terminals, over a spreading bar to an x-ray tube. In this position the patient lies on the couch and the plate is placed on a flat board beneath him. A fluorescent screen and a pair of x-ray-proof gloves are lying on the couch. A tube box is beneath the couch, and can of course be used instead of the stand.

recent works on physics or the numerous manuals that have been brought out on this particular subject.

The apparatus required is expensive, but not difficult to manipulate, provided the operator has some knowledge of electricity and of the primary rules of photography; but as some of the electrical machines employed may give an incautious experimenter very serious shocks,

too much caution cannot be exercised when using currents of high voltage.

Fig. 310.—A COMPLETE MODERN X-RAY OUTFIT (except Couch), showing coil mounted up out of the way, interrupter beneath it, and all resistances and contacts mounted on a separate moveable stand. This apparatus (K. Schall & Son, London) uses continuous current from the main.

The beginner, too, must not expect to get the excellent results which a person more experienced in the use of the apparatus obtains.

Much patience, experience, and strict attention to details are required to get good skiagrams.

The practical value of these rays to the surgeon lies in the fact that they have the power of penetrating certain substances which are opaque to ordinary light rays, while they are incapable of passing through others. For instance, they pass readily through soft tissues, such as muscle, but only to a limited extent through bone. They also have another important property, without which their value would be very considerably lessened—a photo-chemical action on ordinary photographic plates. As a result of these properties, a photograph of a shadow of a bone can be taken when a hand, for instance, is interposed between the photographic plate and the source of the rays, the rays acting on the silver salts with more or less intensity on all parts but those where the shadows of the bones fall. When the plate is developed with the usual reagents a negative is obtained, the bones being less deeply coloured than the other parts, and this when printed on paper gives the ordinary positive print.

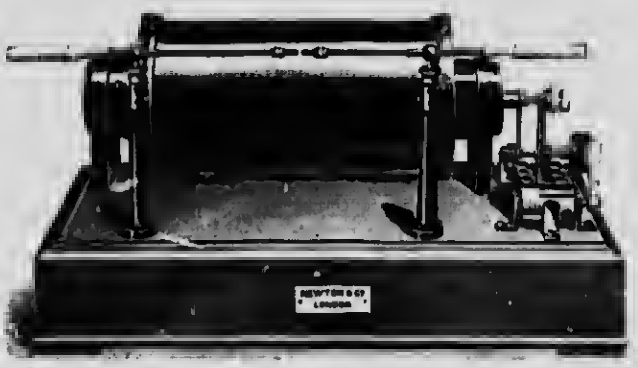


FIG. 320.—AN ORDINARY INDUCTION COIL, showing platinum break and commutator on the right side. The two horizontal handles belong to the adjustable spark-gap or spintermeter. The tops of the two vertical uprights supporting them are connected to the tube by flexible wires.

A long series of experiments, conducted by many investigators, contributed to the discovery of these rays and their physical properties, though the credit of finding them has generally been given to Röntgen. It appears that he was the first to make or suggest any practical use of them, though photographs of metal substances had been taken by these rays through wood and cardboard by other experimenters some time before Röntgen published the results of his work.

The name "*x*" rays was given because the nature of them was at first not fully understood. This name has remained, but they are also called the Röntgen rays, while the picture produced on photographic paper is known as a radiogram or skiagram.

In producing these rays, currents of electricity are employed, and certain apparatus which is described below. It is as well to repeat

the warning here, that unless care is taken very serious shocks may be experienced by a person interposing himself in the circuit, so before handling any part of the apparatus, the operator should always see that the current is turned off.

The Apparatus as used in the *x*-ray department of a hospital, for the purpose of surgical and medical diagnosis and treatment, consists of:—

1. A source of electrical energy.
2. An apparatus for converting the low-tension current from (1) into a high-tension unidirectional current capable of exciting an *x*-ray tube.
3. A number of *x*-ray tubes.
4. Tube-holding apparatus.
5. A fluorescent screen.
6. An *x*-ray couch.
7. Protecting apparatus consisting of *x*-ray-proof gloves, spectacles, aprons, *x*-ray-proof linings to tube boxes, and so forth.

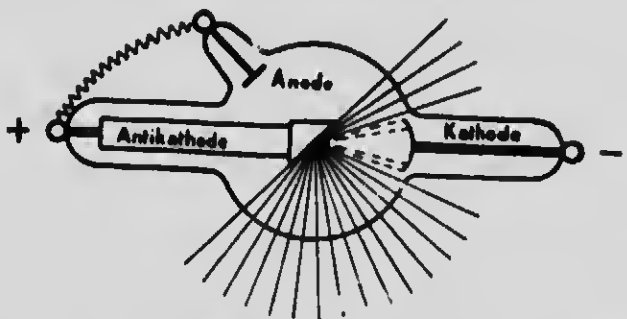


Fig. 321.—Diagram to show the parts and poles of an X-Ray Tube, and the path of the X-Rays.

It will only be necessary here to briefly describe this apparatus, with hints and precautions as to its use, as a preliminary to going into greater detail as to technique in the application of *x*-rays for the purpose of surgical diagnosis.

Should the practitioner be desirous of procuring an outfit for his consulting-room, he should refer to some of the many complete treatises on the subject, and go into the matter with an *x*-ray expert, as so many considerations of local possibilities, expense involved, and the amount of use it is proposed to make of the apparatus, enter into the matter, that a whole treatise might be written on that subject alone.

1.—*The Source of Electric Energy* is either a battery of accumulators giving 24 volts and 20 to 60 ampères, or as is now usually more convenient, a connection with the main which supplies the electric light to the hospital. The current supplied by either of these is not suitable for exciting an *x*-ray tube, and it consequently has to be converted by

2. *An Apparatus for Converting* low-tension electricity into a high-tension unidirectional current. This is usually an induction coil, but

it may be one or other of the different types of transformers. In the remarks that follow it will be taken for granted that it is an induction coil (*Fig.* 320) capable of giving a 12-inch or longer spark in air, and fitted with either a platinum, an electrolytic, or a mercury "break," or interruptor, and with a resistance for regulating the strength of the primary current, and also with the usual terminals and switches. A coil is chosen because its rationale is clear and typical, and because what is called a coil outfit is the only one that is likely to be at the disposal of a house surgeon, or within the means of a general practitioner. The transformer outfits are extremely costly, and their energy

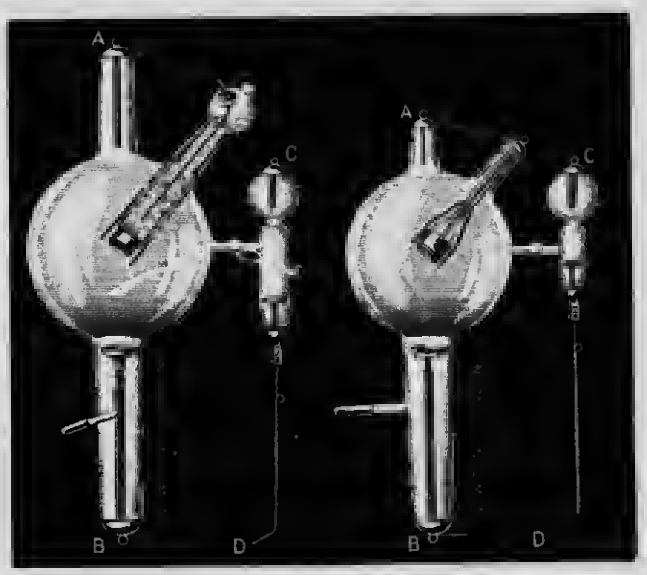


Fig. 322.—Good types of X-Ray Tubes, with heavy antikathodes and vacuum regulating devices.

is so great that any unskilled handling would destroy a tube in a few seconds, and consequently they are never to be safely used except by a skilled and experienced operator.

3.—*The X-ray Tube* (*Fig.* 322) consists of a highly exhausted bulb fitted with two or three electrodes, of which one, the kathode, is cup-shaped, and one of the other two is flat, situated near the centre of the tube, and inclined at an angle of 45° with an imaginary straight line connecting its centre with the centre of the kathode cup.

This is the antikathode or target, and its function is to receive the stream of electrified particles called the kathode stream, which is focussed upon it by the concave kathode. Each of these particles as it hits the target gives rise to an *x*-ray, and the target or antikathode is consequently the source of the *x*-rays.

4.—*Tube-holding Apparatus.* This is an extremely important part of an *x*-ray outfit, and the simple stands furnished with a clip-tube-holder have been superseded by more elaborate apparatus, the same in principle but more convenient and safe to use. With these it is

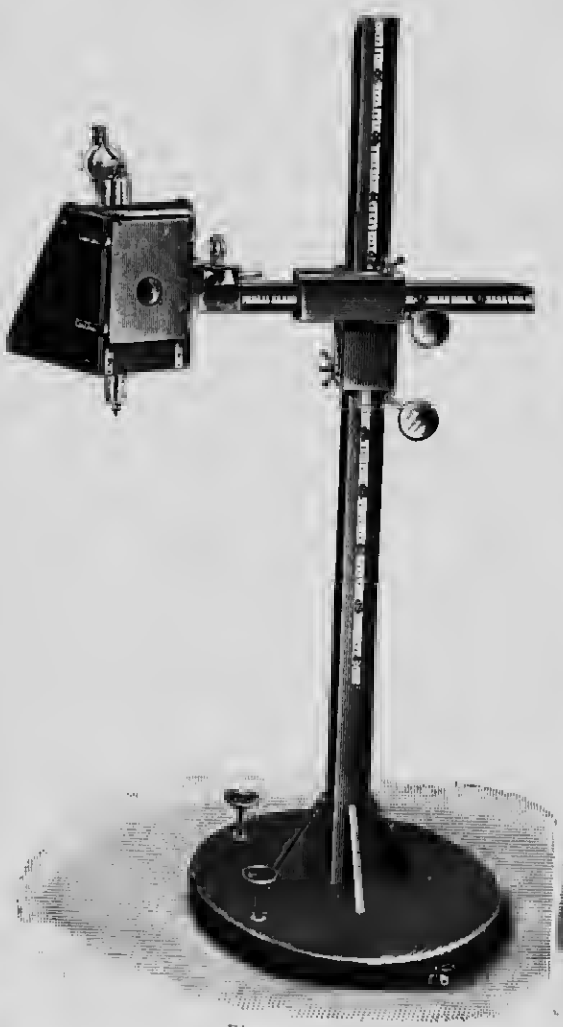


Fig. 323.—TUBE STAND, with diaphragm and *x*-ray-proof box to cover luminous part of tube.

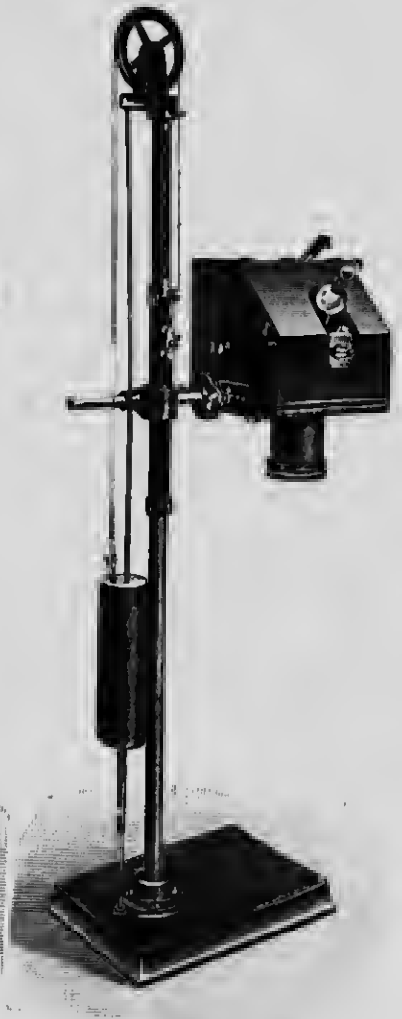


Fig. 324.—X-RAY TUBE-HOLDER, cylinder diaphragm, and compressor.

possible to adjust a tube simply and readily in any position with relation to a patient, whether below or above him as he lies on a couch, or behind or in front of him as he stands or sits. They are provided, as is most essential for the protection of patient, operator, and bystanders

alike, with a box or other device lined with an *x*-ray-proof material to contain the tube, and having an opening only in one side through which the *x*-rays may be directed on to the patient. Two such stands are illustrated in *Figs.* 323 & 324. These are mainly for use above the patient as he lies on a couch, or behind him as he stands or sits.

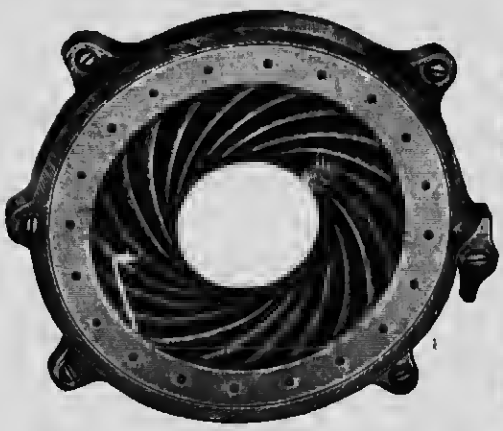


Fig. 325.
IRIS DIAPHRAGM FOR *x*-RAYS.

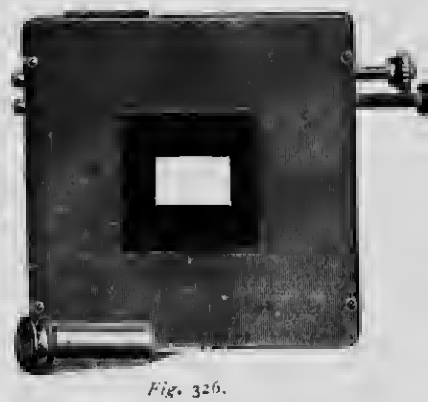


Fig. 326.
RECTANGULAR DIAPHRAGM FOR *x*-RAYS.

Fig. 324 can also be used beneath a couch, but for convenient beneath-couch work it is necessary to have a tube-box working on rails in both directions beneath the couch, and this will be illustrated while describing the couch. Every tube-box should be provided with an adjustable diaphragm on the side whence the *x*-rays emerge, so that

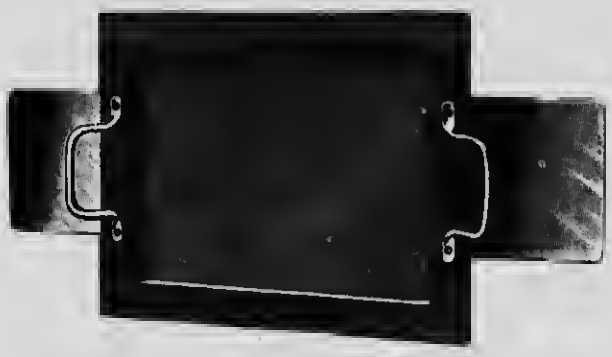


Fig. 327.—LEAD-GLASS SCREEN WITH METAL FINGER-GUARDS.

the area of illumination can be limited to the exact part under examination. Two such diaphragms are illustrated in *Figs.* 325 and 326, by means of which either a circular or rectangular area of any required size can be examined. The circular one is the most generally useful, but the rectangular one is especially serviceable when examining long bones or, say, the œsophagus.

5.—*The Fluorescent Screen* is a frame in which is stretched some thin material spread with a layer of platinocyanide of barium, which has the property of fluorescing brightly to *x*-rays. It should be covered with a lead glass and furnished with metal finger-guards. Such a screen is illustrated in *Fig.* 327.

6.—*The Couch* (*Fig.* 328) is of a convenient height for a patient to lie upon, and has a top of stout canvas, so that the tube can be put beneath the couch, and the screen or photographic plate be used above, as well as *vice versa*. A constituent part of the couch should be, and generally is, an *x*-ray-proof tube-holding box beneath it, running on slides that enable it to be easily shifted beneath any part of the patient

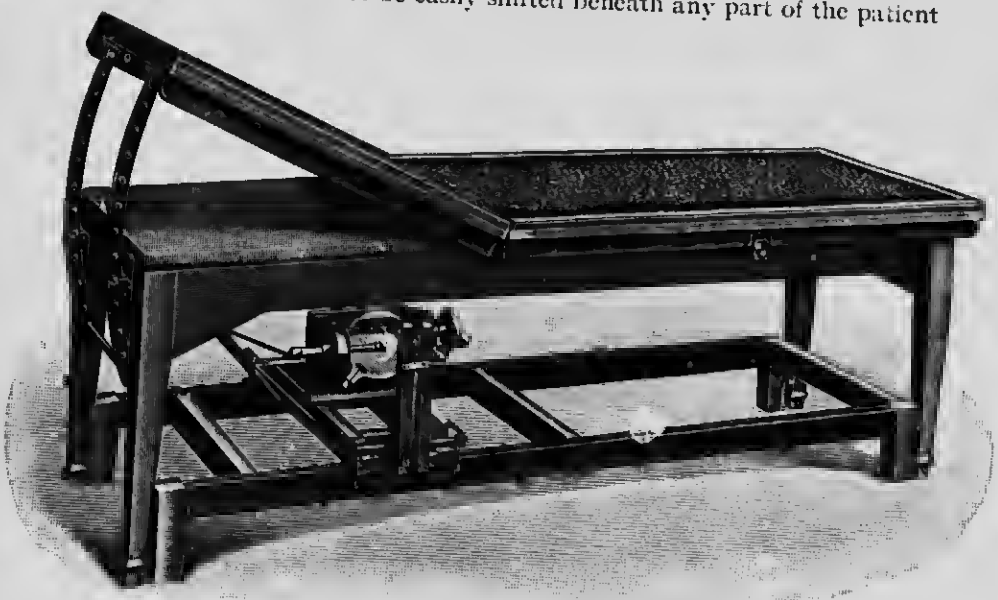


Fig. 328.—A VERY USEFUL COUCH FOR X-RAY WORK, with a canvas-covered top, and in addition with a felt-covered plate, which can be raised at the head end or removed entirely if required. The tube-holder beneath can be moved both longitudinally and transversely. The tube is shown uncovered for the sake of clearness, but it should invariably be enclosed in a box that is opaque to *x*-rays except for an aperture above.

that is to be examined. Such a couch is illustrated in *Fig.* 328, where the frame beneath it is shown provided with an uncovered tube. This is only shown for sake of clearness; the tube should be completely covered in as with the upright tube-holder.

7.—*Protective Apparatus.*—This consists of all the devices in use to confine the *x*-rays to the area under examination, such as *x*-ray-proof lining to boxes, lead-glass spectacles for operator, finger guards, and lead-glass cover to screen. They are referred to again here to emphasize their necessity. In the early days of radiography, before it was known that *x*-rays could produce dangerous results after long exposure, these devices were not in use, and many *x*-ray operators

were badly injured, and some lost their lives. It is absolutely necessary that protective apparatus should be a constituent part of every *x*-ray outfit.

Technique.—Before starting operations, it is necessary to see that the commutator of the coil is in the "off" position, that two lateral terminals of the accumulators or from the main are connected with those marked *battery* on the coil, and where a mercury or electrolytic break is used, that the terminals on the coil marked *break* are connected with those marked *coil* on the break, and finally that the terminals on the mercury break are connected by separate wires, either with 12 or 24 volts, as the case may be, of the accumulator, where an accumulator is used, There are a great variety of breaks in use, and it would occupy too much space to describe them, but the principle is the same in all, of rapidly interrupting the primary circuit through the coil, each interruption giving rise to a spark between the terminals of the secondary circuit.

Having seen that the connections are perfect, let the operator first switch on the motor of the mercury break, where one is used, and then put the commutator of the coil into the "on" position, and immediately, if all is right, a stream of bright, noisy sparks will crackle between the adjustable terminals of the secondary circuit. These will vary in intensity and frequency with the amount of current allowed to pass through the regulating resistance. In doing this it is necessary to be very careful not to touch either of the secondary terminals, as the shock is a very intense one, and might be productive of serious results. Let there be no incautious handling of the coil or source of electric energy at any time. Now switch off again and take an *x*-ray tube; fix it in the holder, and connect the kathode and antikathode terminals to the secondary coil terminals by means of the highly insulated flexible wires that form part of every *x*-ray outfit.

Switch on again, reversing if necessary, when a sort of bowl of greenish-yellow light will be seen to extend over about half the tube: this is caused by fluorescence of the glass of the tube by the *x*-rays, which are shot off in every direction from the centre of the anode where the kathode stream strikes it.

To judge whether the tube is suitable for screen work or for taking *x*-ray photographs, the room should be darkened; the fluorescent screen should then be held up in front of the tube at a distance of about 18 inches, with the hand in close contact with its back. The operator will now see whether the penetration is good, whether the bones stand out clearly and are sharply defined, and at the same time neither very black nor very transparent.

Generally speaking, if the screen fluoresces a brilliant green-yellow colour, and the bones of a normal hand are clearly defined and somewhat transparent, the tube is in satisfactory condition.

It is important in this connection to test the "alternate spark-gap," namely, the distance between the adjustable terminals on the coil

that the spark will prefer to jump rather than pass through the tube. It will be found generally that an alternate spark-gap of from 2½ to 5 inches will do for most cases, the contrast between bone and soft tissues being greater the less the spark gap, and *vice versa*. It follows from this, that for thick parts and dense tissues the alternate spark-gap must be greater than for thin parts, such as a hand or wrist; but generally speaking, for screen examination the alternate spark-gap needs to be longer than for photography, and for good photographic effects the alternate spark-gap should be as short as possible, provided the rays will penetrate the part that is being examined or photographed.

The alternate spark-gap being short is a sign that the tube offers correspondingly less resistance to the passage of the secondary current than when it is long; the shorter it is the lower the vacuum, and *vice versa*. The extremes are found (1) where the tube is so low in vacuum that the current through the tube does not give rise to *x*-rays of any penetrative power, which is seen by the soft tissues showing black on the screen, and by a pencil of bluish light extending from the kathode to the antikathode; and (2) where the tube is so high in vacuum that the current passes with great difficulty and the sparks crackle around the tube rather than pass through it, while the bones of the part examined are extremely transparent, and the soft tissues invisible, the illumination generally being very poor.

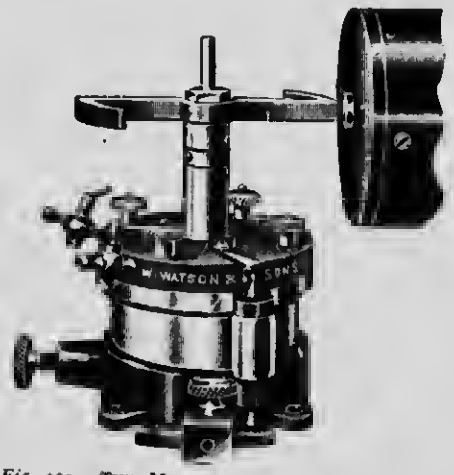


Fig. 329.—THE MOTO-MAGNETIC INTERRUPTER. A very efficient form of mercury break, and one that is extensively used. The make and break take place in an atmosphere of coal-gas, and it is mounted at one end of the coil, and actuated by the magnetic action of the core. It may also be actuated by a small separate motor.

Too low a tube is useless because the rays do not penetrate, and too high a tube because the rays are few in number and do not give sufficient differentiation between soft and hard parts.

Tubes can be regulated within limits, and have various regulating devices attached to them, but it is necessary to have a number of tubes of various degrees of vacuum for different purposes.

The skill of a radiographer very largely consists in judging tubes and using them with discretion. If for example a powerful current is passed through a medium vacuum tube for too long a time, the vacuum will often suddenly fall very low and the tube be ruined for the time being. Such a tube may take months to recover, or may have to be re-exhausted. It is wise with most tubes not to allow the anti-

kathode to remain red-hot. If it begin to glow, the current should be cut off till it is cool again.

With frequent use, tubes gradually rise in vacuum till at last they become so high that they are of no further use.

Where a surgeon makes frequent use of *x*-rays for screen work, he should not examine his own hand or expose himself more than is absolutely necessary to the rays, as they give rise to a particularly dangerous form of dermatitis; but where the use is only occasional there is no danger, and in skilled hands there is never any danger to the patient. Those who have suffered in the past have paid the penalty of being pioneers in a hitherto unknown field.

Application.—After the preliminary account of how to use an *x*-ray apparatus, it is necessary to consider its particular applications. These are so many that *x*-ray examination is now an indispensable factor in surgical diagnosis in many cases, and indeed screen examination is resorted to in hospitals in a very large proportion of the minor surgical cases that come to the casualty or out-patient department, and it is therefore very important that the house surgeon should make himself thoroughly familiar with the hospital *x*-ray outfit, and the screen appearances of fractures, foreign bodies, and so forth.

For **Screen Examination**, by far the most convenient arrangement is the couch as described above, the top of the box being provided with an adjustable diaphragm, as in *Figs.* 325, 326, It is much easier to distinguish differences in density where the area of illumination is restricted to the part to be examined. For the purposes of minor surgery, screen examination is usually sufficient.

For the upper extremity, the patient can be seated in a chair by the couch, which should of course be in a room that can be darkened at will. He can then place the arm on the couch, and the hand, wrist, elbow, and lower arm can be examined by placing the screen above them, the tube in its box being moved into position below as may be required.

A convenient distance for the anode of the tube from the top of the couch is about 14 inches, and most boxes are thus arranged. The part examined should always, where possible, be inspected in two planes, at right angles to each other, as only thus can a correct idea be obtained as to the position of the fracture or foreign body.

Needles in the hand or wrist have frequently to be sought by *x*-rays. The part should be examined both antero-posteriorly and laterally, and the position of the needle marked on the skin surface each time with a skin pencil, the intersection of the two planes giving the exact position of the needle. In difficult cases the needle is frequently extracted in the *x*-ray room, a probe being passed through the incision beneath the screen till it is seen to touch the needle or other foreign body.

For the examination of the rest of the body, the patient lies on the couch, and in this way it is easy to examine the foot, ankle, leg, knee,

and thigh, adopting the same precaution always to examine in two positions by shifting the patient's body so that the part is viewed antero-posteriorly and laterally.

By this means the presence of fracture or foreign body can be excluded or diagnosed, and located with great accuracy for all the thinner parts and in patients who are not obese; but in all doubtful cases an *x*-ray photograph or "skiagram" should be taken. The patient can be "screened" in the vertical position with the help of one or other of the tube stands illustrated (*Figs.* 323, 324).

X-ray Photography.—To take an *x*-ray photograph, the same procedure as for screen-work is adopted, and the same arrangement of couch and tube-box is most convenient, with the exception that, after having localized the part for examination, the operator now places a photographic plate in a light-tight envelope upon the part, and switches the current on for the requisite time for the rays to impress the plate, which is then developed in the same way as an ordinary photograph.

X-ray photography proper, commonly known as skiagraphy, is an art demanding a considerable amount of skill and experience, but a brief description of the method will not be out of place here.

The plates are photographic plates, which are preferably coated with a very thick and rich emulsion, and are especially made for *x*-ray work. Each plate is placed first in an inner red envelope having the film side next the plain side of the envelope, and this again in an outer black envelope, adopting the same precaution. The plate is chosen of a size suitable to cover the part that is to be photographed.

This part is first localized by screen examination, and then immobilized by sand-bags, of which there should be a number of various shapes and sizes available, the most convenient being about a foot long and 3 or 4 inches in diameter, *loosely* filled with sand. They are so disposed as to lie upon and around the limb, so that it cannot move, taking the precaution that they shall not intervene between the rays and the plate as it lies on the limb. The plate is then placed on the part, with another bag on top of it to prevent it from shifting. It is usually necessary to pile bags around the limb to the same height as the limb itself, that the plate may have a firm bed to lie on. The plain side of the envelope, that is the film side of the plate, should always be in contact with the body.

Stereoscopic Photography.—To take a stereoscopic photograph, the part to be photographed is centred in the screen in the usual way, and the plate placed on it. Then, before making the exposure, the tube-box is shifted about 1¼ inches (the rails are usually graduated for that purpose) on the cross-rails. After the exposure is made, the plate is removed and another plate is placed in exactly the same position as the first one, the tube box being displaced 2½ inches in the opposite direction. These two plates or prints from films when viewed in the stereoscope will give the effect of relief.

Exposures vary with every apparatus, with conditions of tube, thickness of part, and so on, but generally vary between ½ to 1 minute for thin parts up to 2½ to 5 minutes for dense parts. After exposure, the plates are developed by ordinary photographic methods, which it is not necessary to describe here.

Special Cases.—*The Shoulder* can be taken either from below or above, and as it cannot be taken in two planes, it is often as well to take it stereoscopically and from below and above.

To take it from above, the tube is adjusted with its anode vertically over it, at about 18 inches, and a flat board is placed below the shoulder with the plate envelope on it plain side uppermost. The board is necessary, so that the weight of the body may not break the plate. It is usually advisable to photograph the shoulder joint as well as screen it, in case of any doubt, as it is not always an easy part to see clearly on the screen in stout patients.

The Hip Joint should always be photographed as well as screened. It is one of the most difficult parts of the body either to screen or photograph, and should be taken both from below and above.

Kidney Region.—Stones in the kidney can sometimes, in thin people, be seen on the screen, but in every case one or more photographs should be taken. This is best done by placing the patient on his face on the couch, with a long sausage-shaped air-bag, sold for that purpose, beneath his abdomen just below the ribs, in order to immobilize the kidney. The screen is now placed on his back, and the current turned on to see that the tube is in a central position. It is well to take two photographs in every kidney case, shifting the tube about 1¼ inches to the right of the mid-line for the first, and the same distance to the left of the mid-line for the second. By this means you have two plates to confirm each other, and if required they can be combined in the stereoscope. It is necessary to ensure that the bowel is empty before examining for stone. The plate when developed should show the lowest two ribs, the transverse processes of the lumbar vertebræ, and the crest of the ilium on each side, and also the edges of the psoas muscle extending obliquely downward and outwards to the iliac crest. If all these are seen clearly on both plates and there is no shadow to suggest a calculus, the presumption is strong that none is present, though even then it is not possible in all cases to exclude the possibility of a small uric acid calculus in a fairly solid subject.

These plates all show the upper ureters. The lower ureters and the bladder region are shown by placing the patient on his back, the anode of the tube being beneath him in the mid-line at the level of the hip joints and a 12-in. × 10-in. plate on the front of the pelvis.

For photographing the *Thorax*, the patient lies on his back on the couch with a flat board beneath his thorax, with a 12-in. × 10-in. plate on it; the tube is adjusted centrally above him at the level of the second costal cartilage.

For screen examination of the thorax, for heart and lungs, the

patient should stand or sit, and the operator should adjust the tube at a convenient height behind his back and hold the screen on the chest when examining from the front, and *vice versa*.

When making screen examinations in a vertical position, the stand should he provided with an *x*-ray-proof tube-box. Where this is not the case, it is necessary to cover the tube with a piece of black velvet to darken it, as its fluorescence is sometimes very brilliant and gives too much light.

A special case of screen examination is that of the *Œsophagus* with bismuth, and it is particularly in this case that the right anterior oblique examination is of service. The patient is given a mouthful of bismuth in suspension, and told not to swallow until directed to do so. He is then placed with the tube behind his left scapula and the screen pressed against his right chest. In this position the heart and aorta are seen in profile. He is then told to swallow, whereupon the bismuth can clearly be seen passing down the œsophagus behind the heart, or arrested at the point of stricture, as the case may be.

Screen examination of the *Stomach and Intestines* is practically invariably done with the help of bismuth. The patient is made to swallow a large quantity (one or two ounces) of bismuth carbonate or oxychloride suspended in milk or water, or mixed with gruel or bread and milk. Subnitrate is not used, because it is poisonous in large doses. He is then screened and skiagraphed from in front and behind, and sometimes laterally in both horizontal and vertical positions, and in this way the shape, size, and position of the stomach can be made out; and hy repeating the examination at intervals afterwards, the rate of progress of the bismuth can be traced through the intestines, as also the size, shape, and position of the latter.

Localization of Foreign Bodies.—This forms only a small proportion of a radiographer's work, and is best done hy taking skiagrams in two planes at right angles to each other. In the case of needles and such small objects in hands, the position can be marked with a skin-pencil on the skir surface. With larger and deep-seated foreign bodies the two skiagrams will show the position with reference to the nearest bony points. In any case a pair of stereoscopic skiagrams can be taken and combined in the stereoscope, and it is very rarely necessary to make use of any special piece of localizing apparatus.

The localizaton of *Foreign Bodies in the Eye* is more a matter for a skilled and experienced radiographer, and it would take too much space to describe the various procedures adopted for such cases; but even the unskilled practitioner can verify the presence of a foreign body in the orbit by placing the patient on the couch with his temple on the suspected side resting on a small plate, and adjusting the anode of the tube above the head just in front of the bridge of the nose and about 7 inches from the plate, having first strapped a small piece of fuse wire on the centre point of the margin of the lower lid. The photograph will then show the shadow of the wire, and also that of the

foreign body if present. The patient should be directed to look straight in front of him during the exposure, and in every case at least two skiagrams should be taken.

Treatment by x-rays should never be undertaken except by skilled and experienced operators.

INTERPRETATION OF SKIAGRAMS.

A house surgeon or medical man in general practice is much more often faced with the problem of examining an *x*-ray plate or print with the object of interpreting it, namely, deciding exactly what it signifies with regard to the condition of the part it depicts, than with that of taking the plate. Ready interpretation of skiagrams can only be acquired by experience, but a few remarks as to how to proceed and what points to look out for are advisable.

A few prints from skiagrams are inserted to illustrate points referred to in the following paragraphs. Those of fractures have been selected from cases where the displacement is so slight that without extremely careful examination on the lines laid down, the fracture might have escaped notice.

When an *x*-ray plate is being examined, it is necessary that it should be viewed by diffused light. A sheet of opal glass forming the front of a box which contains a light is the usual viewing apparatus, but the plate can be almost equally well examined by reflecting the light through it at an angle from a sheet of white paper or by holding it up to a dull grey sky.

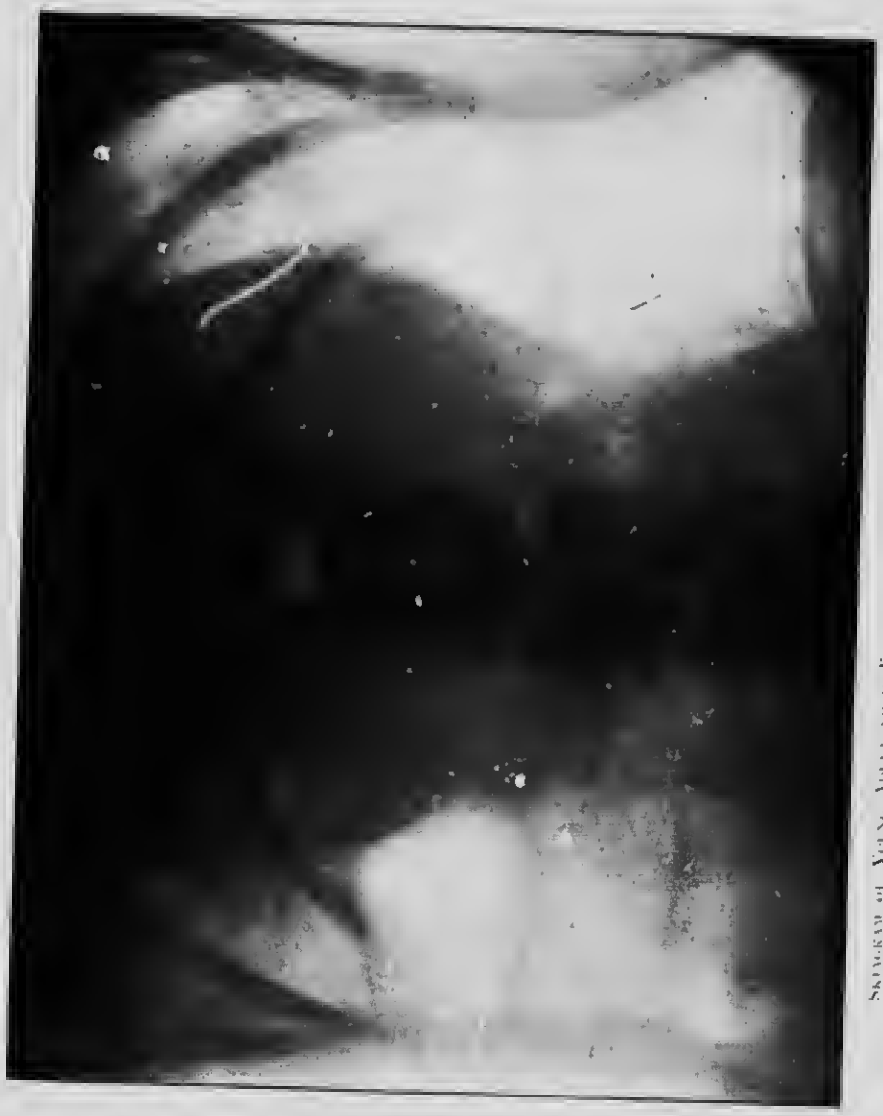
The contrasts between bone and other tissues in *x*-ray plates of thick parts of the body are slight as compared with ordinary photographic negatives. Before deciding as to what may be abnormal conditions, it is necessary to be acquainted with the appearances on the plate or print of normal bones, joints, and so forth, and in cases of doubt it is well to refer to plates or prints of a normal case of the part under examination. A stock of plates of normal cases is usually kept.

In examining a skiagram, first run the eye along the contours of the bones throughout their whole length, and next examine the density of the bone substance. Normal bones and joint surfaces are clean cut and show very definite outlines, while bone tissue has very uniform and regular gradations of density; any departure, therefore, however trifling, from a definite continuous contour, or any irregularity of density, should arouse suspicion.

Generally speaking, as regards the long bones, it is extremely easy to say if there is a fracture and what is the position, *provided* that the skiagrams have been taken in two positions at right angles to each other. Conversely, it is practically impossible in most cases to say what is the position of the fragments from one skiagram only.

In examining joints also, two views are necessary at right angles to each other wherever possible, and no judgment should be passed until both have been carefully examined.

PLATE VIII.



Skiagram of Young Adult Female showing Kidneys of Horse in Situ.
Note ribs and both transverse processes of lumbar vertebræ and edge of psoas muscle.

To face page 570

PLATE XI.

In the cases of hip and shoulder joints two views at right angles cannot be taken, but stereoscopic skiagrams, and views both from behind and in front, enable a very accurnte estimate tn be made of the position of fractures into or near these joints, and checked by re-examination of the patient. The rule that two views at right angles to each other must be taken is fortunately not so important in these two cases where it cannot be fulfilled, because displacements of fragments relative to each other near these joints cannot in the nature of things be so extensive as in the case of fractures in the course of the long bones.

In examining *carpus* and *tarsus* it is necessary to count and tick off the bones mentally by name. Omission to d this will occasionally result in failure to detect a fracture of scaphoid or semilunar in the wrist. A somewhat oblique view of the *tarsus*, the plate having been placed on the outer front of the foot, and the tube beneath the sole somewhat internal to its mid-line, will show the tarsal bones much more spread out and separate from each other than an accurately antero-posterior or lateral view, though of course in doubtful cases these should be taken as well.

In examining skiagrams of suspected *Pott's fracture*, the lateral view is particularly important, as the antero-posterior view may show no displacement whatever, while the lateral view may show a considerable amount of displacement backwards of lower fragments taking the foot with them.

In cases where a fracture is strongly suspected, and the contour of the bones for any reason, say slight tremor or movement of the patient during the exposure, is not absolutely clear cut, another skiagram will sometimes show a crack that was not visible in the first one.

Skiagrams of the kidney region need very careful examination. The differences of contrast may be very slight in stout subjects. If the plate be looked at very obliquely, so that it is viewed partly along from below upwards, and partly through, differences of density can often be made out that cannot at first be seen when the plate is looked straight through. It is important to emphasize that the bowel must have been empty at the time of examination. In every case of apparent calculus in kidney or ureter, however unmistakeable in appearance, it is absolutely necessary to take a confirmatory skiagram at a subsequent date, while with regard to apparent calculi in the course of the upper ureter above the pelvis, it is practically impossible to be certain from *x*-ray appearances alone that a shadow in this position may not be due to the presence of a calcified gland.

In a very large proportion of skiagrams of the pelvis of subjects of middle age and onwards, a number of small shadows are seen on either or both sides, which give rise to suspicion of calculi in the lower ureter, but these are in most cases due to the presence of calcified phleboliths.

Chapter LIII.

UPON SURGICAL CASE-TAKING.

THE art of taking notes of surgical cases well is one not easily acquired, and for the notes to be of much value, something more than vague general notions upon surgical subjects must be presupposed. Yet in many hospitals, dressers who are beginning their work in the surgical wards, or clinical clerks in the medical ones, are expected to be able to write intelligible histories of cases which are themselves very possibly obscure to the last degree; and further, to write these so that their account shall stand for all time as being full, true, and particular, and so that those who may on some future occasion require to look up the case-books of the hospital will find therein a trustworthy account of whatever case, or group of cases, may be under investigation.

Notes which will perfectly fulfil these conditions can hardly be expected, and will only exceptionally be obtained, from dressers, at any rate during the first few months of their hard work; but nevertheless there is hardly any other part of a dresser's work which will be so useful to him educationally, as his case-taking. *Litera scripta manet*, and he will find that every case which he intelligently records (and therefore studies, because he *has* to record) will remain with him a lifelong experience.

What he must aim at in his case-taking must be, first and foremost, *absolute truth*, and it will be found that sometimes there is a strong temptation to make the facts square with a preconceived theory; and secondly, to present a clear story of the case without introducing any personal opinions, letting the facts tell their own tale.

The notes of a case, then, should comprise:—

1. A description of the patient, and of the symptoms, objective and subjective, presented by him (or her, but for shortness we will use the male appellation) when he first comes under the notice of whosoever has to record the case.

2. An account of those facts in his previous life history, and in his family history, which may throw light upon his present condition, and the sources of this information.

3. The previous story of the illness, derived from the patient himself, his parents, or from other people, the source being in all cases stated.

4. A *diary* recording the measures, operative and other, which are adopted for the relief of his complaint, after he has come under observation, and the subsequent course of events.

5. The *result* of such treatment, namely, cured, relieved, unrelieved, or died; and in the last event,

6. Whether or not a post-mortem examination was made, and if so, an account of the results of this examination.

The following scheme will be found a generally convenient and workable plan for recording cases upon the lines we have here laid down.

Ward	No. of Register	Date of Admission	Date of Discharge	Result— Cured / Relieved / Unrelieved / Died
Name	Occupation	Residence		

By whom taken	Name of Surgeon	Date of taking case

The patient's family history.
i.e. (*a*) If the parents are alive or dead: if the latter, at what ages, and how.
(*b*) Brothers and sisters. No. of, whether alive or dead, etc.
(*c*) Place of patient in his family.
(*d*) Results of enquiries about hereditary tendencies, as to gout, insanity, cancer, etc.

The patient's previous history,
including (*a*) Previous illness.
(*b*) Habits of life (state source of information).
(*c*) Other facts bearing on this part of the case.

History of the present illness from its commencement up to the date of taking the case, as derived from the patient, or from his friends or relatives (state the source), given in as nearly as possible the words actually used by them.

The patient's condition at the time of taking the case.
(*a*) General description. Position of patient in bed. State of nutrition, local and general. Indications of a diathesis (i.e., strumous, syphilitic, etc.). The condition of the organs of circulation, respiration, and digestion. The condition of the skin and of the glands. The temperature (noting time when taken). The appearance, sp. gr., and quantity of urine passed, and whether albumin is present or not. The condition of the organs of motion and locomotion. Sleep, its amount and character.
(*b*) Description of actual seat of disease, its locality, its *objective* physical appearances, and the *subjective* abnormal sensations connected with it.
(*c*) Other noteworthy local abnormalities.

The "case" being thus taken, it will be the duty of the dresser, or of whosoever is appointed to continue the record, to preserve a consecutive account of the course of events from the moment the patient comes under treatment.

If an operation be performed, it must be fully described, especial attention being paid to the following points:—

The actual incisions and manipulations, and the condition of the patient at the close of operation. The number and method of insertion of sutures (if any used). The position of the drainage tubes. The plan of dressing the wound, the subsequent position of the patient in bed, and the nature of the anæsthetic.

If the operation be of the nature of a *removal*, either of a growth or of a limb, the notes must always describe fully the part taken away. For example, if the thigh be amputated in its lower third, for disease of the knee, the details of the condition of the joint, and the ligaments, muscles, etc., in its neighbourhood, the cartilages and the bones must all be fully pictured. If the operation be one for the removal of a tumour or new growth, such as epithelioma of the lip, in addition to the naked-eye appearances of the growth, its microscopic structure should also be given.

As the case goes on it will probably be found unnecessary to make daily entries on the case paper, but however chronic the disease in question may be, and however slow the convalescence, it will be found convenient to make some note of the patient's condition at the very least once, and as a rule twice, in the week, upon the occasion of the surgeon going his rounds.

The patient's temperature is now commonly taken night and morning by a ward nurse, and entered upon a chart appended to the case book. This plan is a good one in many ways, inasmuch as the observations are made at every four, six, or twelve hours, and at the most suitable times, but it involves a certain risk that this condition of the patient may be overlooked by the dresser. It should therefore be a rule that the temperature readings should be entered in the notes, as well as placed upon the chart, in all serious cases.

When the notes record a patient's discharge, the extent of recovery should always be noted, and in the case of death, the actual cause should be carefully stated, if it be apparent. In those cases where a post-mortem examination is made, the results must be fully recorded, and the dresser should be especially careful not to lose this opportunity of clearing up obscurities, and verifying and correcting opinions formed during the patient's lifetime.

INDEX.

JOHN WRIGHT AND SONS LTD., PRINTERS, BRISTOL.