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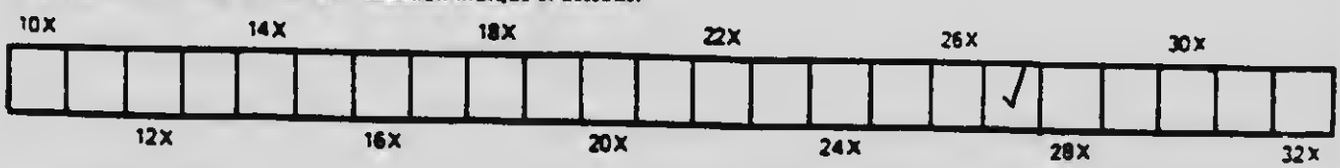

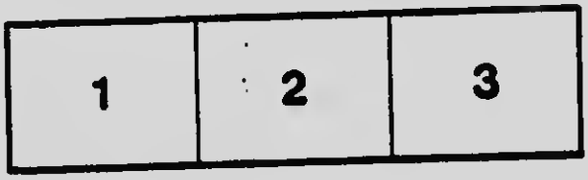

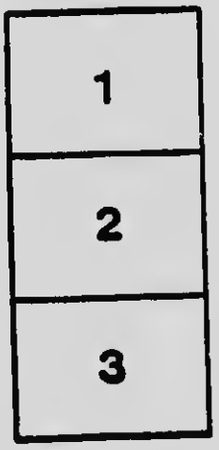

CONTRIBUTIONS

TO THE

REFERENCE HANDBOOK OF THE MEDICAL SCIENCES

ON

ANATOMICAL ANOMALIES,

SURGERY,

AND

SURGICAL ANATOMY.

BY

FRANCIS J. SHEPHERD, M.D., C.M.,

PROFESSOR OF ANATOMY AND LECTURER ON OPERATIVE SURGERY IN McGILL UNIVERSITY, MONTREAL; SURGEON TO THE MONTREAL GENERAL HOSPITAL; CONSULTING SURGEON TO THE MONTREAL DISPENSARY; MEMBER OF THE ROYAL COLLEGE OF SURGEONS, ENGLAND, ETC.

MONTREAL, 1904.

cent. aqueous solution of the salt. This solution may be given in the same dose and manner as Fowler's solution.
Edward Curtis.

[1] Th. Gies: Archiv für experiment. Path., December, 1877, quoted in Phillips's Materia Medica.
[2] Maclagan: Edinburgh Medical Journal, 1864, p. 261.
[3] Ringer: Journal of Physiology, vol. i., p. 253.

ARTERIES, ANOMALIES OF.—Arteries are subject to frequent variations of size, origin, and distribution. Some of these are so common that it is difficult to decide what is the normal condition. Many anomalous arteries are merely a persistence of an early fetal condition, others are reversions to forms of distribution which are natural in the various species of the lower animals, while some are due to an abnormal enlargement or diminution of vessels which naturally exist. I propose in the present article chiefly to describe those anomalies which are important surgically—that is, those which exist in parts liable to diseases which necessitate a surgical operation for their cure or relief. However interesting would be a consideration of anomalies of arteries from a morphological point of view to pure anatomists, I fear the subject is not of sufficient interest to the general profession to justify me in devoting much space to it here.

Aorta.—This vessel is subject to many variations. It may vary in length and position. The summit of the arch has been seen as high as the top of the sternum and as low as the fifth dorsal vertebra. The distance to which it reaches on the spine before dividing into the two common iliacs also varies, the point of division being occasionally as low as the fifth, and as high as the third, or even the second, lumbar vertebra. The aorta has been seen consisting of two closely united tubes, in part or the whole of its course, due to a persistence of the original double aorta of early fetal life (Fig. 288). The aorta is sometimes very tortuous, of large size, and displaced to one side, especially in old people, but this condition is due more to pathological changes than to congenital malformation.

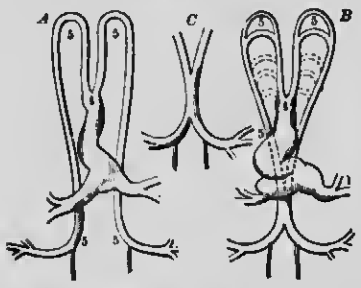

Fig. 288.—Diagrammatic Outlines of Heart and First Arterial Vessels of the Embryo, as Seen from the Abdominal Surface. 4, Aortic bulb; 5, 5, the primitive aortic arches and their continuation as the descending aorta. These vessels are separate in their whole extent in *A* (36 to 38 mm. in thickness), but at a later period, as shown more fully in *C*, have coalesced into one tube in a part of the dorsal region. In *B*, below upper 5, the second aortic arch is formed, and farther down the dotted lines indicate the position of the succeeding arches, numbering five in all. (Quain's "Anatomy.")

The main trunks of the *aorta* and pulmonary artery are (4, Fig. 288) both derived from the arterial bulb of the fetal heart, "and are liable to variations which may be traced to deviations from the natural mode of their septal division and of their union with the left or right ventricles of the heart respectively" (Quain's "Anatomy"). These variations are generally associated with malformations of the heart, and often with patency of the ductus arteriosus. The aortic or pulmonary trunk may be almost obliterated, or the two trunks may communicate freely with each other, owing to the failure of complete septal division; again, their origins may be transposed, the pulmonary artery arising from the left ventricle and the aorta from the right. A very rare anomaly has been reported where the pulmonary artery and aorta form one stem which arises from a simple heart like that seen in fishes. A few cases are reported in which the descending aorta arose from the pulmonary artery and gave off the left subclavian, the left ventricle giving off only the innominate and left carotid. Most of these varieties are incompatible with life, and are fully described in works on pathological anatomy.

Varieties of the Aortic Arch.—The various anomalies of the aortic arch depend on the mode of development of the fourth and fifth fetal branchial arches. In man and nearly all mammalia the arch is a left one, produced by the persistence of the fourth left branchial arch (Fig. 289). In birds the permanent aorta is formed from the right fourth branchial arch; and in reptiles both the right and left fourth branchial arches are persistent. In cases in which there is transposition of the heart, and also, of course, of the arch of the aorta, the aorta is a right one, instead of the usual left, and this is owing to the persistence of the right fourth branchial arch, as in birds. The pulmonary artery in these cases is also transposed and is formed from the right fifth arch in place of from the left. Many of these cases have been reported and have been diagnosed during life, the direction of the apex of the heart being toward the right, the apex beat being felt on the right side between the fifth and sixth ribs. A very good specimen of this anomaly is to be seen in the museum of the Pennsylvania Hospital in Philadelphia.

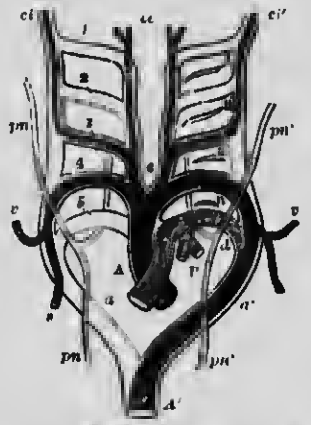

Fig. 289.—Diagram of the Fetal Aortic Arches, Showing Their Transformation into the Permanent Vessels of the Mammal. (After Rathke.) The permanent vessels are represented by the deep shading, the pulmonary arteries lighter, the temporary primitive arches in outline only. A, P, Primitive aortic stem, divided into A, aortic arch, P, pulmonary artery; *a*, right aortic root; *a'* left aortic root; *A'*, descending aorta; 1, 2, 3, 4, 5, primitive vascular arches; *pn*, *pn'*, right and left pneumogastric nerves; *v*, *v'*, right and left vertebrals; *s*, *s'*, right and left subclavians; *cc*, external carotids; *ci*, *ci'*, internal carotids. (From vol. ii., Quain's "Anatomy.")

Occasionally the aortic arch has been observed completely double (Fig. 290), as in reptiles, due to the persistence of both right and left aortic roots (*a*, *a'*, Fig. 289) and the fourth branchial arches of both sides. The double aorta embraces the trachea and œsophagus, and unites below to form a single trunk on the left side of the spinal column, as in early fetal life (*B*, Fig. 288).

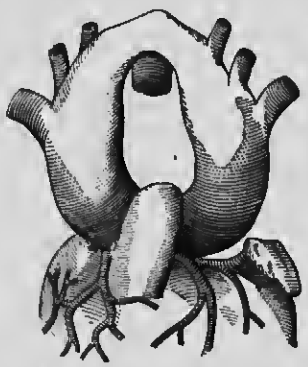

Fig. 290.—Example of a Double Ascending Aorta, from the Arch of Which Arise Six Branches—Two Subclavian and Four Carotid Arteries. (After Malacarne.)

The aorta may pass to the right of the trachea and œsophagus instead of to the left, and this without the transposition of the heart mentioned above. If we study the fetal conditions the explanation of this anomaly is easy. It is a persistence of the right fourth branchial

arch and aortic root instead of the left (Fig. 289). In these cases the recurrent laryngeal nerve of the left side hooks round the subclavian, and that of the right around the arch of the aorta. In some of the cases of right arch that have been observed the left subclavian arose from the back part of the descending aorta, passed behind the trachea, and reached its usual position in the neck between the scalene muscles. In cases of this kind, the first part of the subclavian being absent, owing to the non-development, or rather obliteration, of the fourth left vascular arch, the inferior laryngeal nerve does not hook around it, but goes directly to the larynx, and the vertebral artery may arise directly from the arch.

FIG. 291.—The Right Subclavian Artery Displaced or Proceeding from the Right Aortic Root. A, A', ascending and descending portion of the thoracic aorta; a, right aortic root persisting as the subclavian artery; a', left aortic root; P, pulmonary artery. (Quain's "Anatomy.")

Variations in Number and Position of the Branches of the Arch of the Aorta.—These variations are very numerous; I shall mention only the most common and important. The branches of the aortic arch may be given off from a single trunk, which forms what is called the anterior aorta. This arrangement is seen in the horse. The commonest abnormal arrangement of the branches is that where the left carotid arises from the innominate; thus only two branches are given off from the arch, the left subclavian and the innominate. This is the usual distribution in most of the carnivora. There may be two innominates given off from the arch, each dividing into a carotid and subclavian, as in the bat. Three branches is the normal number arising from the arch in man, apes, and a few other animals. Occasionally we see three branches arising from the arch in a different way from the normal. We may have the two subclavians arising separately, and the two carotids arising from a common stem between them. This is the normal disposition in some cetacea. Sometimes all four vessels arise separately from the arch. Again, the left vertebral may arise from the arch, while the other branches preserve the normal arrangement, or there may be five branches given off separately, viz., the two subclavians, two carotids, and left vertebral. As many as six branches have been seen to come off from the aortic arch. This occurs when, in addition to the above-mentioned five branches, the right vertebral is also given off. A curious anomaly, and one which is interesting from its rarity and manner of development, is that form of arch where the right and left carotids and left subclavian arise separately from the arch, and the right subclavian arises from the back part of the descending aorta, passes behind the trachea and œsophagus and ascending portion of the arch, and reaches its normal place between the scalene muscles (Fig. 291). In this case the right inferior laryngeal nerve, instead of hooking round the subclavian, passes directly to the larynx. The subclavian here represents the persistent right aortic root, and the right fourth branchial arch is obliterated (see Fig. 289). Some years ago I met with a curious anomaly having somewhat this character. I looked upon it as a double subclavian. The right subclavian was given off as usual from the innominate, but was joined in the second part of its course, between the scalene muscles, by a small branch which arose from the back part of the descending aorta. I considered this a case of persistence of the fourth right vascular arch, and also of the right aortic root (Fig. 292). (For a complete description of the very many varieties of the arch of the aorta, see Turner on "Varieties of the Arch of the Aorta," in *Brit. and For. Med.-Chir. Rev.*, 1862; Henle's "Anatomy," vol. iii.; Hyrtl; and Professor Struthers.)

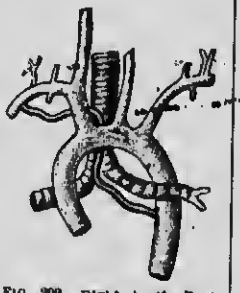

FIG. 292.—Right Aortic Root Persisting as a Small Branch Which Connects the Descending Aorta with the Subclavian. May be regarded as an example of double subclavian.

INNOMINATE, OR BRACHIO CEPHALIC.—This artery occasionally varies as to the point of its division. In some cases it divides above the sterno-clavicular articulation, and in others considerably below it. When there is a high division, there is danger of its being wounded in tracheotomy, especially in those cases in which the artery inclines to the median line. In cases of ligature, however, the operation would be much facilitated by a high division, and rendered much more difficult by a low one.

The *thyroidea ima* or *middle thyroid* (Fig. 293) is not infrequently given off from the innominate, and ascends to its destination in front of the trachea. When present it would complicate the operations of tracheotomy and excision of the thyroid gland. In observations made by myself on 250 subjects, I found that this artery occurred 12 times, or once in 20.83 cases. Richard Quain, in his valuable work on the arteries, found it 9 times in 291 subjects, or once in 32.33. It is sometimes of large size, dividing into two branches, one of which goes to each lobe of the thyroid gland.

This artery sometimes arises from the right common carotid, and rarely from the arch of the aorta between the left carotid and innominate.

COMMON CAROTID ARTERIES.—These vessels may vary in their origin and place of division. The *right carotid* occasionally arises directly from the arch of the aorta either alone or with the left carotid. In the latter case the artery, to reach its usual position on the right side, crosses the trachea above the upper border of the sternum, a fact worth remembering in connection with the operation of tracheotomy. It may arise above or below the sterno clavicular articulation, according as the innominate is longer or shorter than usual. The *left carotid* varies more frequently in origin than the right, as it is derived from the innominate in about one case in nine. It may also arise from the arch in common with the right carotid.

FIG. 293.—Showing a Middle Thyroid Artery (T. t.) Arising from the Innominate and Running up the Front of the Trachea to Supply the Thyroid Gland. (From R. Quain, slightly altered.)

Place of Division.—The common carotid often varies as to its place of division. The normal dividing point is opposite the upper border of the thyroid cartilage, but it sometimes divides as high up as the hyoid bone, and as low down as the cricoid cartilage. Morgagni reports a case in which it divided at the root of the neck. Cases are recorded in which it did not divide at all, one or other of its main branches being absent. I have occasionally seen this artery give off the superior thyroid and ascending pharyngeal before its division, and also a small laryngeal. I also once saw the left carotid giving off the left vertebral.

EXTERNAL CAROTID AND ITS BRANCHES.—As mentioned above, the origin of the external carotid varies considerably. It has in rare cases been noticed arising from the innominate, and even from the arch of the aorta itself. Absence of this artery has been met with, the branches arising at varying intervals from a common trunk, representing both internal and external carotids. The artery sometimes passes between the digastric muscle and stylo-hyoid. I have in one case seen it pass up to the parotid gland superficial to both the posterior belly

of the digastric and the stylo hyoid, instead of behind them.

The origin of the branches varies considerably; they may be crowded together at the commencement of the vessel, or at a point higher up. Sometimes they arise from the main trunk at nearly regular intervals, and occasionally we find several branches arising from a single stem. Accessory arteries may arise from the external carotid, such as the accessory superior thyroid and accessory ascending pharyngeal. The sterno-mastoid, which usually arises from the occipital, occasionally arises from the main trunk, and when this occurs the hypoglossal nerve hooks around this small branch instead of around the occipital. In consequence of the lower origin of the sterno-mastoid, the nerve in such cases passes lower down the neck before crossing the vessels to reach the hypoglossus muscle.

Superior Thyroid.—This vessel may be very small or absent, its place being taken by the artery of the opposite side and the inferior thyroid of the same side. It sometimes arises from the common carotid. The *crico-thyroid* may be of considerable size, and its *superior laryngeal* branch may arise from the main trunk, or pierce the thyroid cartilage instead of the thyro-hyoid membrane, as is the case in many mammals. Mr. Walsham ("St. Bartholomew's Hosp. Rep.," 1880) has several times met with a large branch from the superior thyroid crossing the trachea between the cricoid cartilage and isthmus of the thyroid. He once wounded it in performing tracheotomy.

Lingual.—This artery often arises in common with the facial, and occasionally with the superior thyroid. Instead of passing beneath the hyoglossus muscle it has been seen to pierce it.

In some rare cases it has been absent, and its place has been taken by a branch from the internal maxillary. Its place has been taken also by a branch from the facial, the submental. Its sublingual branch is occasionally derived from the facial. The hyoid branch is often wanting, and in such cases the hyoid branch of the superior thyroid takes its place. The lingual sometimes gives off the submental and ascending palatine artery. In one case of operation on the dead subject, the writer could not find the artery in the usual place, but it was found coming off from the superior thyroid, passing up to the median line of the neck on the thyro-hyoid muscle. It crossed the hyoid bone internal to the lesser cornu, pierced the hyoglossus muscle, and thence onwards its course was normal (*Annals of Surgery*, vol. ix., 1889, p. 33).

Facial.—This artery is very variable in size and also in extent. When the facial is deficient its place is taken by the transverse facial, internal maxillary, or ophthalmic, most frequently the first mentioned.

Occipital.—This artery usually arises opposite the facial, but its place of origin may be above or below this point. Sometimes it is derived from the internal carotid or the ascending cervical branch of the inferior thyroid. It occasionally passes to its destination superficial to the trachelo-mastoid muscle, or it may pierce the sterno-mastoid and splenius capitis muscles. R. Quain mentions a case in which it passed superficial to the sterno-mastoid muscle. It not infrequently gives off the posterior auricular and ascending pharyngeal.

Posterior Auricular.—Often a branch of the occipital; sometimes of small size, ending in the sterno-mastoid muscle.

Ascending Pharyngeal.—Varies greatly in its place of origin; may arise from the internal carotid, occipital, or a lingual-facial branch. It is occasionally double.

Superficial Temporal.—This vessel is very often tortuous, especially in the aged.

The *transverse facial* is occasionally of large size, and takes the place of the facial. It is sometimes double.

Internal Maxillary.—This artery frequently arises in common with the temporal. R. Quain has observed it in two instances arising from the facial, "from which it coursed upward, to pass beneath the ramus of the maxillary bone in the usual situation."

It very frequently (in about 4.5 per cent.) is covered by the external pterygoid muscle, instead of lying superficially to that muscle. It sometimes perforates the external pterygoid, and rarely the internal. It may replace the facial by a branch from the posterior dental, buccal, or infra-orbital artery.

Internal Carotid and Its Branches.—This artery in the neck is occasionally very tortuous. It has been known to be absent, its place being taken by the artery of the opposite side or by a branch from the internal maxillary. It is sometimes very small, smaller than the vertebral (Hyrtl). The ascending pharyngeal, occipital, lingual, or transverse facial may arise from the internal carotid.

A large communicating branch has been seen going from this artery, while in the cavernous sinus, to the basilar artery; in such a case the posterior communicating branch is wanting. The posterior cerebral not infrequently comes off from one of its branches, the posterior communicating.

Ophthalmic Branch.—This has been seen to come off from the middle meningeal artery. Occasionally the middle meningeal comes off from the ophthalmic. The ophthalmic may, by its nasal branch, supply a deficiency in the facial. In fifteen per cent. of cases it crosses beneath instead of over the optic nerve. It has been seen to go through the sphenoidal fissure.

Cerebral Arteries.—The *anterior cerebral* of one side is often much larger than that of the other. In some rare cases the two anterior cerebral arteries are united into a common trunk, like the basilar. The *anterior communicating* artery is sometimes double; I have once seen it treble. It is often very short. The *posterior cerebral* may arise from the internal carotid by a large posterior communicating. It has been seen by Hyrtl to give off the middle cerebral.

The *posterior communicating* artery occasionally comes off from the middle cerebral instead of from the internal carotid.

Subclavian.—The varieties of origin of this artery have already been mentioned in the account of the anomalies of the arch of the aorta and innominate artery. It is generally given off from the innominate on the right side, opposite the sterno-clavicular articulation, but occasionally the innominate reaches nearly as high up as the cricoid cartilage before it divides, and in these cases the artery would be at an unusually high level. The highest part of the artery is the second portion, and it is normally about 1.2 to 2.7 cm. (one-half to three-quarters of an inch) above the clavicle, with the shoulder depressed, but not infrequently it may be below, or on a level with, the clavicle, and sometimes, especially on the right side, it may be placed as high as 3.7 cm. (one inch and a half) above the level of the clavicle. It may, in those rare cases in which a cervical rib is attached to the seventh cervical vertebra, pass over this rib in place of the first dorsal, and be raised fully two inches above the clavicle. I have seen this occur once in two hundred and fifty subjects examined. In the living, when this condition exists, it may be, and has been, mistaken for aneurism. Sir James Paget has diagnosed this anomaly four times during life. It is obvious that the height to which the artery reaches is important in cases in which ligature is necessary. I have seen in one case in which there was an incomplete left first rib the artery pass over the second rib. On the right side there was also a rudimentary first rib completed by fibrous tissue. There was a deep groove in this rib, in which rested the artery; before complete dissection this was taken for a cervical rib. The cases for which ligature is undertaken are chiefly those of aneurism of the axillary artery, in which, in consequence of the condition of the parts, the shoulder is elevated. If the artery should be at an unusually low level, or even just behind the clavicle, the operation, as may be conceived, would be rendered extremely difficult.

The third part of the artery in thin people with small muscles is very superficial, but in stout, muscular individuals it is very deeply placed. Dupuytren says: "The

third part of the subclavian lies near the skin in those who are thin and have slender and long necks, with long and pendent shoulders; it is, on the contrary, deeply hidden in persons who have short, thick necks and muscular shoulders."

Occasionally the subclavian artery pierces the scalenus anticus instead of going behind it, and more rarely passes entirely in front of the muscle; of the first variety I have seen five cases in two hundred and fifty subjects (three on the left and two on the right side); of the second, in the same number of subjects examined, I have seen only one example.

The vein may pass with the artery behind the anterior scalenus, and in very rare cases their normal positions may be reversed. The trapezius may cover the third part of the subclavian, or it may have in front of it the omo-hyoid muscle. These conditions, however, will be more fully described under *Muscles, Anomalies of.*

Variations of Branches.—It is important, surgically speaking, that the position of the various branches given off from the subclavian should be considered.

The branches given off from the first part do not, as a rule, vary much in their arrangement, but several may be transferred to the second or third portions. The left vertebral may arise from the arch of the aorta instead of from the first part of the left subclavian, and the branches of the thyroid axis may be given off separately.

The first part of the right subclavian, having been occasionally ligated, it is necessary to know at what distance from the innominate the branches arise. In the majority of cases this is from 1.25 cm. (half an inch) to 2.4 cm. (one inch) (R. Quain); but it often exceeds this, and is frequently 2.4 cm. (one inch) to 3.8 cm. (one inch and three-quarters). In a small minority of cases the distance is under 1.2 cm. (half an inch).

In the *second portion of the artery*, one branch, as a rule, is given off, the superior intercostal; occasionally no branches are seen here, and again, not infrequently, there are two or three.

The *third portion*, in a little more than half the cases, gives off no branch, in a little less than half, one branch, occasionally two, and in very rare cases three and four.

Vertebral Artery.—Origin: The right vertebral. In those rare cases in which the right subclavian arises from the arch of the aorta, is given off from the common carotid of the right side. The right vertebral has been seen coming from the arch.* The left vertebral not infrequently is given off from the arch of the aorta, generally between the left carotid and left subclavian. I have seen this arrangement twelve times in two hundred and fifty subjects. I have once seen it come off from the left common carotid. The vertebral has been seen with two, and even three roots (R. Quain).

Course: This vessel may fail to enter the transverse process of the sixth cervical vertebra, but continue up the neck between the inferior thyroid artery and vein to enter the transverse process of any of the vertebræ from the fifth to the second. It is not uncommon for it to enter the transverse process of the fourth or fifth vertebra, but it is only very occasionally that it passes up as high as the third and second before entering the foramen. Again, it may enter the transverse process of the seventh cervical vertebra, instead of the sixth.

Size: The left vertebral is frequently much larger than the right, especially in those cases in which it is given off directly from the arch of the aorta. Sometimes the vertebral is nearly as large as the common carotid, at other times as small as the ascending cervical branch of the inferior thyroid.

Branches: The vertebral may, as a very rare occurrence, give off the inferior thyroid or superior intercostal artery. I have seen two examples of the first variety occurring on both sides of same subject. Its inferior cerebellar branch is frequently absent on one side.

The *thyroidea ima* has been observed in rare cases to come off from the right subclavian.

The upper end of the vertebral artery occasionally divides into two branches, which unite a little higher up, thus forming a loop through which pass filaments of the hypoglossal nerve. I have seen this anomaly in two instances.

Thyroid Axis.—This trunk occasionally arises beyond the scalenus anticus muscle (according to R. Quain twice in two hundred and seventy three cases). It not infrequently gives origin to the internal mammary. It is sometimes absent, its branches being given off separately from the subclavian.

Inferior Thyroid.—This artery frequently arises as an independent branch from the subclavian. It has been seen to arise from the common carotid, and not infrequently from the vertebral. It varies considerably in size, and when small its place is taken by the superior thyroid. In cases of enlarged thyroid gland (bronchocele) it is often nearly as large as the carotid. Two inferior thyroids have been found on the same side, one having the normal course beneath the carotid artery, and the other reaching its destination by passing superficially to that vessel (Fig. 294). Its branches of division are closely connected with the recurrent laryngeal nerve, which may pass beneath or above them, a point to be borne in mind in extirpation of the thyroid gland. The inferior thyroid

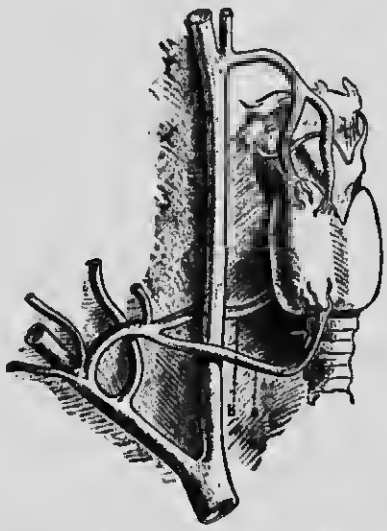

FIG. 294.—Inferior Thyroid Artery Dividing into Two Branches, one of which (a) passes in front of the carotid sheath, the other (b) behind it. (Anderson; *Journ. Anat. and Phys.*, vol. xiv.)

may be wanting altogether, its place being supplied by an enlarged superior thyroid of the same side.

The *ascending cervical* branch of the inferior thyroid may be derived directly from the subclavian or one of its branches. It is occasionally of large size, and may take the place of the occipital.

Suprascapular.—This artery is usually derived from the thyroid axis, but not infrequently has a different origin. It is often given off directly from the subclavian. It may be given off from the internal mammary. I have several times seen it derived from the subscapular and also from the axillary. It is often very small.

Transverse Cervical.—This artery when given off from

* Mr. A. M. Paterson (Jour. Anat. and Phys., April, 1884) records a case of right vertebral arising from the aortic arch beyond the left subclavian, and reaching the vertebro-arterial canal by passing behind the trachea and œsophagus; in fact, following exactly the course of the subclavian when it arises from the back part of the arch, as figured above. Mr. Paterson regards this anomaly as a persistence of the right aortic root, with obliteration of the connection between the subclavian and vertebral arteries where they cross.

the thyroid axis divides into two terminal branches, viz., the superficial cervical and posterior scapular. Very often the superficial cervical only is given off from the thyroid axis, the posterior scapular coming off as a separate branch from the second or third part of the subclavian, rarely from the first part. It is well, when ligaturing the third part of the subclavian, to remember that the posterior scapular comes off from it about once in every three cases. When the posterior scapular artery is given off from the third part of the subclavian I have not infrequently seen it pierce the fibres of the scalenus medius muscle, and occasionally go between the cords of the brachial plexus. The posterior scapular artery may be given off from the axillary, or it may end near the scapula in a small branch, its place being supplied by branches from the suprascapular. The superficial cervical may come off from the subclavian as a separate branch, the posterior scapular alone being derived from the thyroid axis. When the posterior scapular is a branch of the third part of the subclavian it often gives off a large branch to supply the trapezius, which represents the greater part of the superficial cervical, the latter artery in such cases being very small or absent.

The transverse cervical artery is occasionally given off from the subclavian as a separate branch.

Internal Mammary.—This is a large and very regular branch of the subclavian, generally arising from the lower part opposite the vertebral. It may arise from the thyroid axis, axillary, or innominate, or even from the arch of the aorta. It may also form a common trunk with either of the scapular arteries, and be given off from the second or third part of the subclavian. Hyrtl describes a case in which the trunk of this artery crossed in front of the fifth right costal cartilage, coming out of the thorax through the fourth interspace and re-entering it by the fifth. In one case the author saw the phrenic nerve pierced by this artery.

A branch is sometimes given off from the upper part of the internal mammary, called by Henle the *A. mammaria interna lateralis*, which crosses the inner surface of the upper four to six ribs and intercostal spaces at right angles, about midway between the spine and sternum, anastomosing in its course downward and outward with the intercostal arteries. In penetrating wounds of the thorax, fractured ribs, and other injuries, this lateral branch might be wounded and give rise to dangerous hæmorrhage. It might also be wounded in the operation for evacuating an empyema.

Superior Intercostal.—Sometimes arises from the thyroid axis or vertebral. I have seen it arise from the internal mammary. It may be of considerable size, and may supply three or four intercostal spaces. It in some cases passes between the neck of the first or second rib and the corresponding transverse process of the dorsal vertebra. It is very rarely absent.

Deep Cervical.—This artery is generally a branch of the preceding, but occasionally is derived directly from the subclavian, in the proportion of 1 in 20 subjects (R. Quain). In rare cases it arises from the posterior scapular and internal mammary. It is not infrequently of small size, its place being taken by the deep cervical branch of the occipital, a branch of the inferior thyroid, the ascending cervical or a posterior cervical branch of the transverse cervical (Henle).

It may pass between the transverse processes of the fifth and sixth cervical, first and second dorsal, or second and third dorsal instead of between the seventh cervical transverse process and first rib.

There is sometimes an accessory branch accompanying it.

Axillary Artery.—The most important anomaly of this vessel is its early division into two trunks, one of which may give off all or most of the branches, or may be a high origin of the radial, ulnar, or even the interosseous artery (Fig. 295). When one of the trunks gives off all or most of the branches it is nearly always surrounded by the brachial plexus of nerves and embraced by the two heads of the median. The branches given off from this common stem may vary. I have seen it give origin to the acromial thoracic, long thoracic, anterior and posterior circumflex, subscapular, and one or both of the profunda arteries of the arm; the anterior and posterior scapular with the subscapular arteries not infrequently come from a common stem. This arrangement of the branches of the axillary occurs normal in many animals, *e.g.*, the lemur, tapir, peccary, dolphin, etc., and much resembles that which takes place in the lower extremity, viz.: the common femoral dividing into a superficial and a deep branch, the deep giving off all the branches, and the superficial going down the extremity branchless. According to Richard Quain, this variation occurred 28 times in 506 arms examined. I have met with it only 15 times in 500 arms in which the arrangement of the axillary was observed. Quain gives the proportion of cases in which one of the arteries of the forearm is derived from the axillary as 23 in 506; Gruber, 21 in 1,200. I have found this condition to exist 12 times in 500 arms examined.

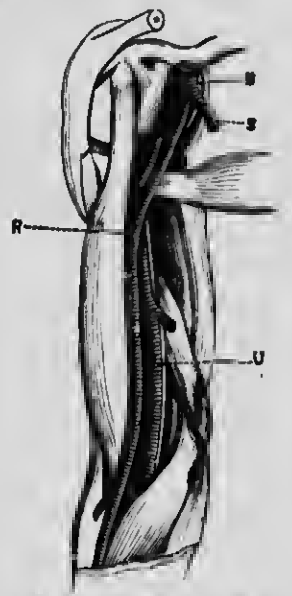

Fig. 295.—Origin of Radial (R) from the Axillary (B). (After Reeves.)

The radial is the branch most frequently given off in these cases, next the ulnar, and very rarely the interosseous. I have only once seen the interosseous arise from the axillary.

An aberrant artery is occasionally found arising from the axillary; it generally courses down the arm alongside the brachial, which it joins near the elbow. Sometimes this aberrant vessel joins the radial, ulnar, or interosseous artery near the wrist. One remarkable case came under my observation some years ago in which this aberrant artery passed down the arm superficial to the fascia, in the forearm followed the course of the median nerve, communicated with the radial by several transverse branches, and finally ended by taking the place of the superficial volar, completing the superficial palmar arch (Fig. 296).

The most constant branch of the axillary is the long thoracic or external mammary; this, or a representative of it, is nearly always seen running along the lower border of the pectoralis minor muscle; it, however, not infrequently arises from the thoracic axis and occasionally from the subscapular. There may also be an accessory external mammary. The subscapular and circumflex branches frequently arise together. The dorsalis scapulæ, instead of being derived from the subscapular, may arise directly from the axillary.

The posterior circumflex occasionally fails to enter the quadrilateral space (formed by the humerus, subscapularis muscle, long head of triceps, and teres major), but reaches the deltoid muscle by winding round the lower border of the tendons of the latissimus dorsi and teres major muscles. It not infrequently arises from the superior profunda, and is sometimes double. In rare cases the internal mammary, posterior scapular, or suprascapular may arise from the axillary.

Brachial Artery.—The variations in the course, re-

lations, and distribution of this artery are very numerous and of special surgical interest.

Course: The brachial artery sometimes, accompanied by the median nerve, courses down the arm to the internal condyle of the humerus, and thence regains its normal position at the bend of the elbow, by passing forward under a fibrous or bony arch. This arch is formed, usually, partly by bone and partly by ligament; the bony process is called the supracondyloid and the foramen, which is completed by a ligament from the tip of the process to the internal condyle, the supracondyloid foramen. In these cases it is usual to have a high origin of the pronator radii teres muscle from the supracondyloid process. This arrangement is said to be more common in dark races, and is the normal one in all the cat tribe and in monkeys, lemurs, and sloths. In these animals the foramen is nearly always completed by bone, and affords protection to the median nerve and artery during flexion of the fore-limb, and also affords them a more direct course to the fore-limb. In man the artery may occasionally take this course without there being present a supracondyloid process; there may be only a high origin of the teres muscle.

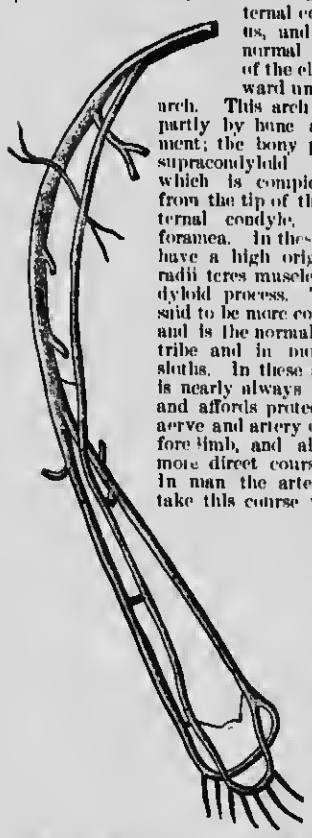

FIG. 296.—Example of an Aberrant Artery from Axillary, Going to Complete the Superficial Palmar Arch, Taking the Place in the Hand of the Superficial Volar.

Division: I have once seen the artery divide near its commencement into two branches which unite to form one trunk near the bend of the elbow, from which the ulnar and radial arteries are given off at the usual place (Fig. 297).

In 481 arms examined by R. Quain a high division was found 64 times, a low division (that is, below usual place) only once. Gruber, in 1,200 arms examined, found a high division in 82. In 500 arms examined by myself, I found a high division in only 27, and in one case the brachial divided below the pronator teres.

Adding to these the cases in which the division takes place in the axilla, in 481 arms examined by Quain two arteries existed in the arm in 94 cases, or 1 in about 5¼. My statistics are quite different from the above, and I cannot account for the great diversity. The same class of people were examined, and they were of the same race. In 500 arms I found that two arteries existed in only 43 cases. This is made up as follows: division of axillary, 12; division of brachial, 27; aberrant arteries, 4—total, 43, or 1 in 11.6 cases. W. Gruber, in 1,200 arms, found a high division in 103, or 1 in 11.6, the same proportion exactly as in my own cases.

The point of division is in most cases in the upper third of the arm. It is also seen in the middle and lower thirds, but much less frequently. The artery which is given off thus prematurely is generally (three cases out of four) the radial; this vessel is most frequently to the ulnar side, and subsequently crosses to the radial. Next in frequency comes the ulnar, which often, in these cases, passes superficially down the forearm and gives off no branches, the interosseous coming from the radial (Fig. 298). In rare cases the interosseous is the branch having the high origin (Fig. 299), and still more rarely it is a vas aberrans.

Three branches have been seen in the arm, viz., the radial, the ulnar, and a vas aberrans.

The *position of the two branches* in the arm when a high division occurs is of surgical importance. They are usually in the ordinary position of the brachial trunk and lie close together, but the radial, as mentioned above, often arises from the inner side, and, after accompanying the large vessel for some distance, crosses over it at the bend of the elbow.

The *ulnar artery*, when having a high origin, may incline toward the internal condyle, this, however, occurs only when it nears the elbow. When there is a high division of the brachial the ulnar-interosseous branch may pass through the supracondyloid foramen mentioned above, and under a high origin of the pronator teres.

The *aberrant arteries*, which are given off occasionally, are long, slender arteries, which are derived from the brachial or axillary, and end by joining the radial most frequently and sometimes the ulnar and interosseous. They are loop lines, so to speak, and in cases of ligature of the brachial their occasional occurrence must be borne in mind by the surgeon (Fig. 300). The two arteries in the arm are in some instances connected together by anastomosing transverse branches. These branches may number two or three, or even four.

A *median artery* has been described as arising from the brachial and passing down over the muscles of the forearm and supplying the fingers to which is distributed the median nerve.

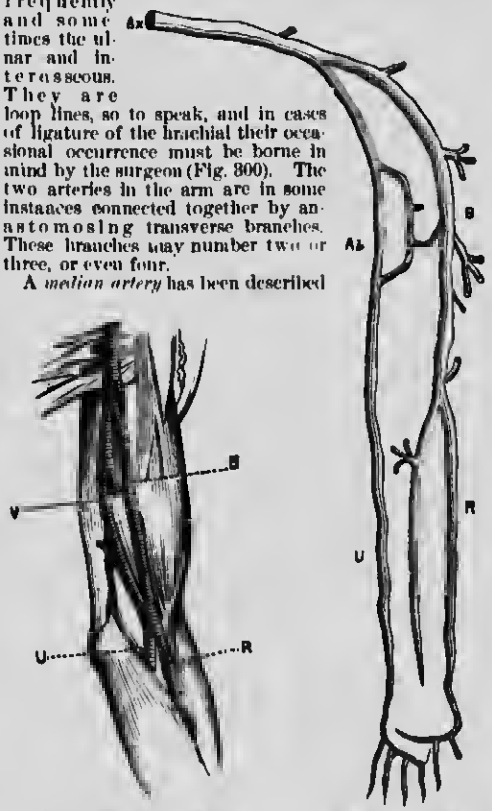

FIG. 298.—High Origin of the Ulnar Artery (U). Ab, aberrant artery; R, radial, giving off the interosseous arteries.

FIG. 297.—Brachial Dividing High up, Reuniting at Elbow, and Then Almost Immediately Dividing into the Radial and Ulnar. V, Vas aberrans. (After Reeves.)

The brachial artery may in some part of its course (more frequently near the elbow) be covered by a muscular slip. The median nerve sometimes passes behind

instead of in front of the artery, especially in those cases in which the two heads embrace a common trunk from which the axillary branches are given off.

Superior Profunda.—This is occasionally derived from a trunk common to it and several of the axillary branches, as mentioned above. It not uncommonly arises with the circumflex, and occasionally gives off the inferior profunda.

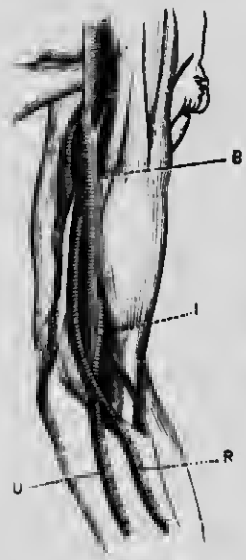

FIG. 299.—Anterior Interosseous (I) Given Off from the Brachial High up. (After Reeves.)

FIG. 300.—Aberrant Artery (3), separating from the brachial (1) at the middle of the arm, passing with the median nerve (*d*) through the internal intermuscular septum, and joining the regular ulnar (4) lower down. (Quain.)

Inferior Profunda.—This is often absent. It is frequently united with the superior profunda.

Anastomotica Magna.—Frequently of small size; its place is sometimes taken by the inferior profunda.

RADIAL ARTERY.—Origin: I have found that the radial has a high origin (Fig. 301) in 1 case in 21, but Quain reports the high origin to occur as often as 1 in 8. Gruber in 440 arms examined found the radial had a high origin in 26, or about 1 in 17 cases.

Course: The radial only very occasionally deviates from its usual course in the forearm. It has been found lying superficial to the fascia of the forearm, and the semilunar fascia of the biceps. It in rare cases runs down the forearm on the surface of the supinator longus instead of along its inner border. It not infrequently is superficial to the tendons of the extensor muscles of the thumb. It is occasionally joined by a vas aberrans. It may leave the front of the forearm near its middle, its place being taken by an enlarged superficial volar. This would cause a weak wrist pulse.

Size: It does not vary often in size. It is, however, sometimes much smaller than usual, its place being, to a considerable extent, taken by some other vessel, as the ulnar and anterior interosseous.

The radial has been described as absent by some anatomists. Quain never saw a case of absence of this artery, but such a case is described by Professor Otto, and I have seen one case.

Branches.—Radial recurrent: This vessel is sometimes of large size, or it may consist of several small branches. When the radial has a high origin the recurrent branch is given off from the ulnar-interosseous trunk.

Superficial volar: Very often of small size, so small that it terminates in the muscles of the thumb, and does not complete the superficial palmar arch. It is occasionally entirely absent. It may be of large size and furnish several digital branches (Fig. 302), and it may arise much higher than usual.

I once saw it arise as high as the middle of the forearm, and it was quite as large as the radial, from which it was derived; this is the normal arrangement in some monkeys. The *first dorsal interosseous* is, in some cases, of large size, and may supply several digits and end by completing the superficial arch.

The *carpal* and *dorsal interosseous* branches are often of very small size, their place being taken by the perforating arteries.

ULNAR ARTERY.—Origin: Quain found that this artery deviated from the usual origin in 1 case in 13, Gruber 1 in 26, myself 1 in 37.

Where the origin of the ulnar is unusual, it most commonly arises from the brachial in the arm, and less commonly from the axillary. In one case out of five hundred I found it coming off from the brachial below the pronator radii teres. In this case there was, of course, a low division of the brachial.

Course: In the forearm this artery is much more subject to variation than the radial. When it has a high origin it nearly always crosses down the forearm superficial to the muscles, but beneath the fascia; but cases occasionally occur in which it is immediately beneath the skin and superficial to the fascia (Fig. 303). When the ulnar is superficial, it, as a rule, gives off no

FIG. 301.—Dissection of Right Arm. Showing an example of high separation of the radial artery (3) from the brachial (2); a large median artery (4) is seen in forearm. (From Quain's "Anatomy," after Tiedemann.)

FIG. 302.—No Distinct Superficial Arch. Large superficial volar supplying thumb and index finger with half middle finger, and rest supplied by ulnar. (Reeves.)

branches in the forearm, these being given off from the radial—interosseous trunk—or the interosseous itself, which is invariably given off from the radial. The ulnar, in rare cases, has this superficial course when it arises in its usual situation.

Interosseous Artery.—This artery, in rare cases, arises from the axillary or brachial artery (Fig. 298), and gives off the recurrent radial and ulnar arteries. The anterior

and posterior interosseous may arise separately from the ulnar.

Median Artery (Fig. 304).—This branch, which accompanies the median nerve, is ordinarily of small size, but occasionally it is developed into quite an important vessel. It is usually derived from the anterior interosseous, but sometimes from the ulnar, and, in rare cases, it has been found coming from the axillary or the brachial. It accompanies the median nerve and reaches the hand beneath the annular ligament, but, according to Tiedemann, sometimes passes over the ligament. It may complete the palmar arch, or be distributed as digital branches to certain of the fingers, generally those supplied by the median nerve, which it accompanies. In

Fig. 303.—Abnormal Superficial Ulnar Artery (3, 3'), Rising Higher than Usual from the Brachial. (Quain's "Anatomy," after R. Quain.)

Fig. 304.—Dissection of Left Arm. Showing an enlarged median artery (5) which replaces the radial (2) and ulnar (3) arteries in the supply of the palmar digital arteries to half the fingers. (From Quain's "Anatomy," after Tiedemann.)

the cases which I have observed, the latter arrangement was the more frequent. I have occasionally seen this artery pierce the median nerve.

Arteries of the Hand.—The arteries of the hand are subject to many variations.

The superficial palmar arch is sometimes entirely wanting. It has been occasionally seen double. In the majority of cases the superficial volar branch does not complete the arch, but it is completed often by a large branch from the radial, which emerges between the thumb and forefinger, and I have sometimes seen it completed by a large branch from the radial, which, after coursing over the back of the hand, emerges on the palm between the index and middle fingers. The arch is also often completed by a transverse branch, which comes from the muscles of the thumb and is derived from the princeps pollicis or radialis indicis branch of the radial (Fig. 305). A median artery may complete the arch (Fig. 306), or it may go to the digits on the radial side, and the ulnar to the digits on the ulnar side, and no regular arch be formed. The superficial volar sometimes has this arrangement (Fig. 306).

Fig. 305.—Superficial Arch Formed Entirely by the Ulnar and Joining the Princeps Pollicis Artery. (Reeves.)

The superficial arch may be very small and some of the digital branches be wanting, or it may be very large, supplying all the digital branches, both superficial and deep.

The deep arch is occasionally formed by the ulnar. It is sometimes so deficient that the digital arteries are derived from the superficial arch. A large metacarpal branch on the back of the hand may give off the digital branches.

Abdominal Aorta.—According to R. Quain, in ten out of every thirteen bodies the division of the great artery took place within half an inch above or below the level of the iliac crest. Eckhard, Bolnet, and Cruveilhier record cases of division as high up as the second lumbar. Two cases are on record (Quain, tenth ed.) of a large pulmonary branch which arose below the diaphragm, passed through the œsophageal opening, and divided into two branches which supplied the lungs near their bases.

Cœliac Axis.—The branches of this artery may arise separately from the aorta. The phrenic arteries may be given off from it, and it may be connected with the superior mesenteric.

Renal Arteries.—Now that the operation of nephrectomy has become so common, the variations of these arteries have been rendered important surgically. Professor Macalister has reported (*Journ. Anat. and Phys.*, vol. xvii.) most of the anomalies of the renal artery.

The renal artery may be replaced by two, three, four, and even six branches. The origin of these arteries is very various: they are usually derived from the aorta, and are separated, at their origin, by a larger or smaller interval; the lowest may arise quite near the bifurcation of the aorta, and the highest just below the cœliac axis. In some rare instances the renal artery has been described as arising from the common iliac, internal iliac, and middle sacral. The right and left renal arteries have been found coming from a common trunk; they may arise from the anterior or lateral part of the aorta. The suprarenal frequently gives off an upper renal, and it less frequently is derived from the upper lumbar, hepatic, and right colic. Frequently when the renal arteries come off from the aorta low down or the iliacs, the kidney on that side is malplaced; it is situated lower down than usual, opposite the bifurcation of the aorta and even between the two common iliacs. In such cases the hilum is usually placed on the anterior surface.

Fig. 306.—Large Median Artery (M), Taking the Place of the Radial in the Formation of the Superficial Arch and Giving Off Outer Digitals. (Reeves.)

Inferior Mesenteric.—It may be absent, its branches being given off from the superior mesenteric.

The branches of the renal artery, instead of entering the hilum, may penetrate the kidney at its upper or lower end. It is not uncommon to see the normal artery entering the hilum, and two or three supernumerary branches piercing the upper and lower end of the gland. In two subjects I found that the kidney was supplied by

two arteries arising from the aorta at some distance apart, one going to the extreme upper end, and the other to the extreme lower end of the kidney; no artery entered the hilum (Fig. 307). The vein and duct were normal. This variation I once met with while performing nephrectomy on the dead body. R. Quain met with a case of absence of the renal artery on one side. Multiple renal arteries occur normally in fishes, lizards, snakes, crocodiles, and birds, and in man are due to a persistent early fetal condition.

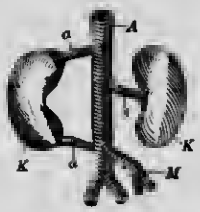

Fig. 307.—Abnormal Right Renal Arteries. An artery distributed to each extremity of the kidney, but none entering the hilum.

Spermatic Artery.—Sometimes double, not infrequently derived from the renal. Three spermatic arteries have been seen.

Common Iliac Arteries.—The place of origin of these arteries depends on the place of division of the abdominal aorta. This may be as high as the upper border of the third, or as low as the lower border of the fifth lumbar vertebra. In three out of four cases the aorta divides opposite the lower border of the fourth lumbar.

The common iliac arteries vary considerably in length. I once saw them only 1.8 cm. (three-fourths inch) long in a negress, and, in another case, 2.5 cm. (one inch). In the large majority of cases, according to R. Quain, the length varies from 3.7 cm. (one inch and a half) to 7.5 cm. (three inches). The greatest length is about 10 cm. (four and a half inches).

The right and left common iliacs differ in length very often, the right, owing to the aorta dividing to the left side of the spinal column, being often the longer; but the left may be the longer, and in about one-third of the cases they are of equal length (R. Quain).

When the left is longer than or equal to the right, it is owing to the left artery descending to a lower level than the right. The artery has been seen dividing into internal and external iliacs as low down as the iliac fossa.

The common iliac on one side has been reported absent by Cruveilhier and Walsham. In this case the aorta divided into three branches, two on the right (external and internal iliac), as is seen in birds, and one on the left (common iliac). Surgically, these variations are of great interest.

Fig. 308.—Obturator Given Off from the Internal Epigastric, and Passing to the Inside of the Crural Ring to Reach the Obturator Foramen. (After Gray.)

Internal Iliac.—The place of division of this vessel varies considerably; it may divide as low as the margin of the sacro-sciatic foramen and as high as the upper margin of the sacrum. The point of division is of importance surgically; when the trunk is short it is more deeply placed in the back part of the pelvis, but when it is of some length, then a part of the artery is likely to lie above the pelvic cavity, and therefore would be much more easily reached by the surgeon (R. Quain). It has been found as short as 1.2 cm. (half an inch), and as long as 8.2 cm. (three and a half inches).

The branches are given off from this artery very variously. In many cases there is no division into anterior and posterior trunks. The artery occasionally gives off one, and sometimes two branches before it divides. The variations of most of the branches of this artery, being of no surgical importance, will not be discussed here.

Obturator.—According to R. Quain, the obturator artery arises from the epigastric in 1 case in 3.5. His conclusions are derived from observations in 361 cases. I have observed 500 cases (250 subjects), and have found this abnormal arrangement much less frequently than Quain. I have found the obturator coming from the epigastric in only 1 case in 9 (55 in 500). Quain found the obturator derived from the external iliac in 6 cases out of 361. I found it only 3 times in 500 cases. Quain found the epigastric giving off the obturator 23 times on both sides. I found this arrangement 11 times.

When the obturator arises from the epigastric or external iliac, it reaches the thyroid foramen by arching either to the inner or to the outer side of the femoral ring. If it arches to the inner side of the femoral ring, along the edge of Gimbernat's ligament, then, in case of strangulated hernia requiring operation, it would be in great danger of being wounded (Fig. 308); in fact, this accident has happened more than once.

Fig. 309.—The Same, Passing to the Outside of the Ring. (After Gray.)

In only 9 out of the 58 cases in which the obturator proceeded from the epigastric and external iliac did I see the artery going to the inner side of the femoral ring. In the remaining 49 cases it either crossed it, in a few cases, or held a position well to the outer side in the majority (Fig. 309), so that in only about 1 case in 50 is there danger of wounding the obturator in the operation for strangulated hernia. The explanation of the origin of the obturator from the epigastric is simple enough. Normally, we have the pubic branch of the obturator anastomosing with the pubic branch of the epigastric; these vessels become enlarged, and the proper obturator branch of the internal iliac either remains undeveloped or becomes obliterated.

In four cases I have seen the obturator, epigastric, and internal circumflex arise together from the external iliac, and once these same arteries were seen to arise by a common trunk from the common femoral 2 cm. below Poupart's ligament. In one case the epigastric and obturator arose together from the femoral, a little below Poupart's ligament. In some cases, in which the obturator arises from the epigastric, there is a small branch, representing the obturator, derived from the internal iliac.

Internal Pudic Artery.—This vessel is occasionally of small size, and fails to supply all the usual branches; in such an event these are given off from an accessory pudic. The branches furnished by the accessory artery are usually those branches which go to the cavernous body and dorsum of the penis, the pudic itself ending as the artery of the bulb. In a few instances the pudic ends as the superficial perineal, the other branches coming from the accessory vessel.

Fig. 310.—Abnormal Internal Pudic Artery, Which Has a Course Midway between the Ischial Tuberosity and the Coccyx. (After Henle.)

The accessory pudic is, as a rule, given off from the deep pudic within the pelvis; it then passes alongside the bladder and prostate, and, after piercing the triangular ligament, supplies the dorsum of the penis and the cavernous body, and, perhaps, the bulb. It may be given off from the obturator in the pelvis, or from the epigastric.

The pudic artery has been seen passing up to the perineum midway between the tuberosity of the ischium and the coccyx, and ending as the superficial perineal and artery of the bulb (Fig. 310).

Artery of the Bulb.—Is sometimes of large size, placed farther back than usual, and ascends obliquely to the

bulb; in such a case it would necessarily be wounded in the operation of lithotomy. It may arise from the accessory pudic; when this happens it would be placed well in front of the usual incision for lithotomy.

The *dorsal artery of the penis* has in some cases been seen to arise from the obturator artery near the thyroid foramen, from the external pudic of the femoral, and from the deep femoral. In the first case it would be in danger of being wounded in lithotomy. The two arteries

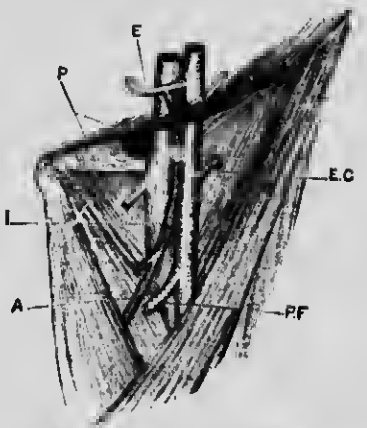

Fig. 311.—Abnormal Origin of the Internal Circumflex Artery (I): E, epigastric artery; PF, profunda femoris.

of the penis sometimes unite to form a single trunk, or are united by transverse branches. Mr. Spencer has described a large prostatic artery which gained the perineal surface of the prostate without dividing into minute branches. Wounds of the prostatic arteries have led to fatal hemorrhage in cases of lateral lithotomy.

The *sciatic artery* is sometimes replaced by a branch from the gluteal. In a few cases this artery has been seen of large size, taking the place of the femoral (see under Variations of Femoral). There is sometimes a large comes nervi ischiatici artery. The gluteal artery has been reported as absent (Roberts), its place being taken by a large branch from the femoral, passing outward and backward to the gluteal region.

External Iliac Arteries.—The length of these arteries varies according to the point at which the common iliacs bifurcate; they usually measure 7.50 cm. (three inches) to 10 cm. (four inches) in length. In those rare cases in which the main artery of the limb is a continuation of the sciatic, it is much reduced in size.

Epigastric Artery.—May arise at a higher point than usual. R. Quain reports it in one case 6.4 cm. (two and a half inches) above Poupart's ligament. It arises from the femoral in about one case in twenty. The usual place of origin is close to or opposite Poupart's ligament. It may, in rare cases, arise from the deep femoral.

The origin of the obturator from the epigastric has already been noticed. In a few cases the epigastric has been seen coming from the obturator when that vessel is a branch of the internal iliac.

I have, in four instances, seen the epigastric arise in common with the internal circumflex artery of the deep femoral. In three of the cases the common stem arose from the femoral 2 cm. below Poupart's ligament; in the fourth, 2 cm. above the ligament. In the last-named case the internal circumflex passed beneath Poupart's ligament in the same compartment of the femoral sheath as the artery, and continued down the thigh about 5 cm., lying between the artery and vein; it ended, after giving off a large branch to the adductor muscles, as the internal circumflex proper (Fig. 311). A similar anomaly has been observed by Mr. A. Thompson (*Journal Anat. and Phys.*, April, 1883), but in the cases described by him the artery passed internal to the femoral vein, and would, he thinks, have been wounded in the operation for relieving strangulated femoral hernia. A similar arrangement of vessels exists normally in the American black bear. I have met with four cases in which the obturator, epigastric, and internal circumflex arose by a common stem, two below Poupart's ligament and two above.

Circumflex Iliac Artery.—The origin of this artery is sometimes from the femoral. It is occasionally double.

Femoral Artery.—The femoral artery has, in some rare cases, been found of small size, and terminating near the knee joint. When such a condition exists, the main artery of the limb is furnished by a branch from the internal iliac, generally the sciatic (Fig. 312), which is much enlarged, and accompanies the sciatic nerve to the popliteal space, whence the course of the artery is the same as if the distribution had been normal. This is the usual arrangement in birds.

Cases have been reported in which the femoral divided into two portions, which united below to form again a single vessel. Sir Charles Bell, when ligaturing the femoral for popliteal aneurism, met with this anomaly.

Fig. 312.—Posterior View of the Right Thigh. The ischiatic artery much enlarged, accompanying the sciatic nerve, and taking the place of the femoral artery. (After Dubreuil.)

Fig. 313.—Bell's Case of Double Femoral Artery. Showing ligature of one of the trunk and the aneurismal tumor below. (After Bell, from *London Medical Gazette.*)

Though the ligation of the femoral did not arrest the pulsation in the aneurism, the cause was not recognized till after the death of the patient, when it was found that the femoral was double, and only one of its divisions had been ligatured (London *Med. and Phys. Jour.*, vol. lvi., 1826). (See Fig. 313.) Tiedemann, Houston, Dubreuil, Tyrrell, and Quain also report cases. Mr. H. A. Kelly (*American Journal of the Medical Sciences*, January, 1882) reports three cases (one of which is doubtful), met with in the dissecting rooms in Philadelphia. In two of these cases the artery divided below the profunda, and reunited just above the opening in the adductor magnus.

The division has been seen above the origin of the profunda.

The two femorals, when this arrangement occurs, run down the thigh, side by side, in separate fibrous sheaths, so that in cutting down on one the other would not be seen.

I have occasionally seen, in cases of high origin of the profunda, the latter artery quite as large as the superficial femoral, and running down the thigh parallel to it, beyond the apex of Scarpa's triangle. In such a case it would be difficult, in the living, to distinguish between the vessels, should ligature of the femoral be necessary. As a rule, the profunda lies to the outer side. The appearance of the above-described condition in Scarpa's triangle is very similar to those cases figured as double femoral, and I imagine that the cases of double femoral reported as seen in amputating the thigh are only cases of large profunda arteries, especially as the disposition of the vessels below the amputated joint is not described.

The *profunda*, or deep femoral artery, may be given off from the inner side of the main trunk, or even in some cases from the back part of the vessel. It may arise above Poupart's ligament, or as much as 10 cm. (four inches) below it. It not uncommonly arises 1.2 cm. (half an inch) below the ligament. When it is given off low down, one or both circumflex arteries arise from the femoral. The deep femoral has been occasionally altogether wanting, its branches arising separately from the main artery.

The *external circumflex artery* not infrequently arises directly from the common femoral. It may be represented by two branches, and even three, which arise from the femoral or profunda—I have seen it arise in common with the internal circumflex. The *internal circumflex artery* also frequently arises directly from the femoral. It occasionally arises in common with the deep epigastric, and passes down to the thigh in the same sheath as the femoral vessel. This variety I have described under the Epigastric. It may arise with the epigastric from the femoral artery before the profunda is given off, and in some cases might be injured in the operation for strangulated femoral hernia. I have twice seen it arise with the obturator and epigastric from a common stem.

Unusual branches are, in rare cases, given off from the femoral. I once saw the dorsal artery of the penis given off from the common femoral, cross the thigh at right angles, and reach the dorsum of the penis by piercing the deeper genital tissue.

A large saphenous artery has been found which accompanied the great saphenous vein. It may arise above or below the profunda, course down the thigh between the adductor magnus and internal vastus, and pierce the deep fascia of the thigh on the inner side of the knee joint, where it reaches the internal saphenous vein and accompanies it to the internal malleolus. This arrangement is the normal one in the rabbit and in some other mammals.

I once saw this branch, after reaching the inner side of the knee, wind round to the front of the joint, below the patella, and divide into a cutaneous branch and a branch which pierced the ligamentum patellæ to supply the interior of the joint.

Popliteal Artery.—This artery is not subject to many variations. The chief deviation from the normal disposition consists in a high division of its terminal branches. I saw this only twice in 250 subjects; in both, the artery divided immediately above the upper edge of the posterior ligament of the knee joint. In 227 subjects Quain found a high division in 10. Portal reports a case of low division of the popliteal, the artery dividing about the middle of the leg into anterior and posterior tibial. In some cases of high division, the peroneal artery arises from the anterior tibial; this was the arrangement in one of my cases. The artery and vein, usually so constant in their relation, may, in rare cases, change places. When there is a third head to the gastrocnemius muscle it usually passes between the artery and the vein. Ward Cousins has seen the popliteal artery dividing in the upper part of the popliteal space into two branches which united again below after a separate course of two inches.

Cases are reported (Otto) of branches from the popliteal proceeding upward along the semimembranosus muscle, and ending in one of the perforating arteries of the profunda. Also an aberrant artery is described as being given off above the knee joint, and joining the popliteal before its division (Hyrtl). A small saphenous artery has been seen which accompanies the short saphenous vein behind the external malleolus and anastomoses with one of the tarsal branches (Hyrtl). The azygos artery may be given off from one of the articular arteries. I once saw a common trunk give off the two superior articular arteries and the azygos. One or other of the articular branches may be absent, their place being supplied by an enlargement of the remaining arteries.

Posterior Tibial.—In cases of high division of the popliteal the tibial is larger than usual. It may be increased or diminished in size. When increased, it partly takes the place of the peroneal or anterior tibial, and when diminished, it may be reinforced by transverse branches from the peroneal near the ankle. The posterior tibial may be of very small size and end near the middle of the leg, its place being taken by a large peroneal artery which furnishes the plantar arteries. In a lesser degree of diminution of the posterior tibial, the anterior tibial, or rather its dorsalis pedis branch, furnishes the arteries which form the plantar arch and its branches. In these cases the external plantar artery ends near the accessorius muscle. I have several times seen a muscular slip (flexor accessorius), which arose from the lower end of the fibula, or more commonly from the tibia, cross the tibial vessels behind the internal malleolus. The nerve is occasionally placed to the inner side of the artery, at the lower part of the leg.

Peroneal Artery.—This artery, as described above, may take the place of the posterior tibial, or it may be of small size, and its place be supplied by a branch of the posterior tibial. The anterior peroneal branch may be of large size, and may take the place of the lower part of the anterior tibial, furnishing the arteries supplying the dorsum of the foot.

In cases of high division of the popliteal, the peroneal artery generally arises from the anterior tibial. It also arises in the same way, occasionally, when no high division takes place. I have seen it furnish a large internal calcaneal branch as well as an external. An accessory peroneal sometimes exists.

The *internal plantar artery* is sometimes of very small size, ending in the flexor brevis pollicis muscle, or it may be of large size, and furnish digital branches to the great and second toes.

The *external plantar* is occasionally very small, ending in the accessorius muscle; when such a condition exists the dorsalis pedis artery furnishes the deep plantar arch and digital branches. I have several times seen this anomaly. The artery is occasionally of large size, and partly takes the place of the dorsalis pedis branch of the anterior tibial. The digital [illegible] of two toes, generally the second and third, not frequently come from a common stem. The deep arch [illegible] in rare cases, double.

Anterior Tibial Artery.—In some cases this artery is given off from the posterior tibial in the middle of the leg. When there is a high division of the popliteal it may give off the peroneal, and may pass beneath the popliteus muscle. In the leg it may be subcutaneous, its pulsations being easily felt under the skin. Velpeau reports a case in which this artery did not pierce the interosseous membrane, but passed to the front of the leg round the fibula with the musculo-cutaneous nerve. It may be altogether wanting, its place being supplied by perforating branches from the posterior tibial, or it may end in the muscles about the middle of the leg. When there is such a distribution the deficiency is made up by an enlarged anterior peroneal or plantar artery. It not infrequently fails to furnish digital branches, which, in

this event, come from the plantar arteries. The artery may be of larger size than usual, and may take the place of the peroneal artery in some cases, and of the plantar branches of the posterior tibial in others; the dorsalis pedis branch being of very large size, as mentioned in the description of the varieties of the posterior tibial. The dorsalis pedis artery sometimes ends in the neighborhood of the cuneiform bone. The anterior tibial, in some rare cases, gives off an anterior tibial recurrent to the knee joint. *Francis J. Shepherd.*

ARTERIES, COMPRESSION OF. — INDICATIONS. — Compression of arteries for the arrest and prevention of hemorrhage and for the cure of aneurism is a very old procedure, and one which, although in many instances superseded by ligation, made safe by the introduction of antiseptic surgery, is still employed to a considerable extent, particularly in the prevention of hemorrhage. Compression of the carotids, thereby lessening the blood supply to the brain, has been recommended and practised at different periods in the treatment of epileptic convulsions, maniacal excitement, congestive headache, and for the purpose of producing sleep. Dr. Corning, of New York, in 1882, strongly urged the advantages of this procedure and devised a special instrument for the compression of the carotids.

MEANS.—Compression is accomplished either by means of the hand or by some mechanical device. Digital compression may be either direct or indirect, that is, in the wound or over the vessel of supply, and may be employed for the immediate arrest of existing hemorrhage or for the prevention of hemorrhage during an operation. This means is occasionally still used in the treatment of aneurism, but has largely been superseded by the ligature, and by the combined use of gold or silver wire and electricity. For the instant arrest of bleeding nothing is more readily and satisfactorily employed than the fingers, placed either directly in the wound or over the arterial trunk supplying it. The greatest disadvantage of the method is that it is impossible to keep it up for a great length of time without the help of a number of intelligent assistants. There are two ways of applying digital compression, one by pressing the vessel between the fingers and a bone, the other by compressing it between the forefinger and the thumb. The former method is more satisfactory, because it can be kept up for a much longer period of time. When a change of hands is made the fresh hand should always be placed above the point of former compression before the first hand is removed. Digital compression can much more readily be employed when a wound has been made, thus exposing the vessel, than when it is attempted with considerable tissue intervening between the finger and the vessel, as, for instance, in compression of the abdominal aorta.

Innumerable forms of compression apparatus have been invented for compressing blood-vessels, one of the oldest and most universally used being the tourniquet of

FIG. 314.—Esmarch's Elastic Compressor.

Petit (Fig. 120), which consists of two metal plates, connected by a spiral screw, whereby they may be separated, and a strap which buckles around the limb. In the use of this tourniquet many surgeons apply a roller bandage over the vessel to be compressed and buckle the strap over this. The separation of the plates by the screw tightens the strap and increases the pressure. In order to prevent the strap from cutting the skin it is well to apply first a turn or two of muslin bandage about the part. In an emergency, when a tourniquet cannot be had, a fillet may be employed by passing a handkerchief or piece of cloth or cord about the limb and then tightening it by twisting it with a piece of wooden stick. The most generally used means of compression to-day is the Esmarch bandage and tube (Fig. 314). The bandage is an ordinary rubber roller applied from the tip of the extremity up to the point where it is desired to place the tube, and its object is the saving of the blood in the extremity, in case of amputation, and the freeing of the limb of blood when any operation is to be done upon it. The tube is of rubber, flat, and about one inch wide. This is passed tightly about the limb and fastened by a hook at one end of the tube and a chain at the other. Certain precautions must be observed in the use of this form of compression. One is to move the part as little as possible after the tube is applied, as tearing of the tightly bound down muscles may occur, and another is to see that each turn of the bandage and tube overlaps the preceding, else pinching of the skin occurs. When a limb is diseased, compression with the bandage is not to be made over the diseased area, but it is to be applied above and below it, or else it is not to be used at all, but the limb is simply to be elevated for a time, after which the tube alone is to be used. This method of elastic constriction has the great advantages of simplicity and cleanliness over other forms of mechanical compression.

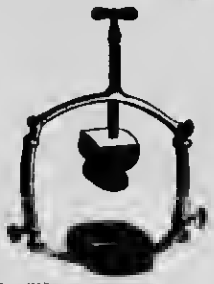

FIG. 315.—Skey's Arterial Compressor.

Other forms of compression apparatus are so constructed that the pressure is exerted only on the main artery without constricting the surrounding tissue. These forms are specially advantageous in the treatment of aneurism, for they are much less likely to cause gangrene, which is so apt to follow the prolonged use of the two forms of compression above described. Esmarch's elastic compressorium for the aorta and Skey's compressor (Fig. 315) illustrate this point.

About ten years ago Dr. Wyeth, of New York, introduced a new method of compressing the vessels of the thigh in hip-joint amputation. This method (see Figs. 191, 192, on page 265), which is a combination of the older methods of Trendelenberg and Dieffenbach, consists in passing through the muscular tissue and skin above the point of amputation two long steel mattress needles, and then applying above them the constricting band of Esmarch. This method is also used in amputation at the shoulder joint and has done a great deal to reduce the mortality of these operations, in which the loss of blood had formerly been so great. It must not be forgotten that all forms of compression, if kept up for a great length of time or if the pressure is too great, may be productive of destruction of tissue at the point of application or of gangrene in parts below. Also it must be remembered that after circular constriction of an extremity reactionary hemorrhage may occur, and hence it is necessary to tie all bleeding points before closure of the wound.

SPECIAL ARTERIES.—The *aorta* cannot be compressed until it has passed through the diaphragm into the abdomen, and then only with difficulty, unless the abdomen be opened. Compression of the abdominal aorta is resorted to as a means of preventing severe hemorrhage from its distributing branches or for the purpose of temporarily arresting the circulation in them; for example, in a hip-joint amputation, or in an attempt to cure an aneurism. It can be satisfactorily accomplished without abdominal section in thin persons, but in those with thick abdominal walls it is very difficult of accomplishment. As to the precise mode of effecting the desired pressure, one may employ an Esmarch's elastic compressor or that of Skey,

While any of the veins of the lower extremity may be affected, the trouble is most often found in some of the radicles of the internal saphenous vein. The tortuous and dilated vessels are easily recognized on inspection, and if they lie near the surface their bluish color is visible through the skin. If they are not or have not been inflamed, they collapse under moderate pressure and disappear almost entirely when the foot is elevated. In some places their channels through the skin feel like a break in its continuity; while here and there they lie so near the surface that they seem to be covered with little more than epithelium. The deep veins of the leg may be affected as well as the superficial ones. If the dilatation goes to a still greater degree a distinct thin-walled sac filled with fluid blood is formed. Such a large varix is shown in Fig. 4992.

As a result of the dilatation many of the valves become insufficient. This can be tested in the following manner: After the veins of the lower extremities have been emptied by elevation of the foot and stroking of the limb toward the body, the thumb is placed upon the main saphenous trunk and the patient is directed to stand. The varicose veins will fill slowly and only to a moderate degree. The moment the thumb is removed the column of venous blood falling into them from above instantly distends them to their fullest capacity if the valves are incompetent. Such are the conditions of simple varicosity. Sooner or later one or more complications are likely to arise, such as thrombosis, rupture, periphlebitis, œdema, eczema, and ulcer.

Complications.—Thrombosis may occur in dilated veins of the leg exactly as it may occur in the dilated vein of an external hæmorrhoid. It is accompanied by a good deal of pain and tenderness, by slight redness and by œdema plainly limited to the immediate vicinity of the vein involved. Thus if a not very tortuous vein be affected for a distance of five or six inches its course can be accurately mapped out as an infiltrated strip about three-fourths of an inch wide. If the vein is tortuous, the infiltrated area will have an irregular outline.

The nutrition of the parts drained by varicose veins is often seriously affected, so that a wound may become infected. The result may be erysipelas, cellulitis, abscess, or suppurative thrombophlebitis, although the last-mentioned condition is by no means common.

When the vein lies near the surface it is easily ruptured by a blow from a sharp object, and as there is little elastic tissue about the opening, the hemorrhage is profuse and may be serious if it is not stopped by pressure or ligation.

A fourth complication, more often seen in older individuals, is an extensive ulcer. At first this is of the usual type, revealing itself by pitting on pressure; but after it has existed for many months the production of fibrous tissue may be sufficient to prevent much indentation on pressure. This condition may be due to other causes than varicosity of the veins, and it greatly interferes with the nutrition of the parts, and especially with the repair of a chronic ulcer, whether varicose or not.

Eczema is another complication due to an imperfect nutrition which is apt to lead to ulcers starting in the small scratches made by the patient in the vain attempt to relieve himself from the intolerable itching.

Not every ulcer occurring in a patient whose veins are varicose is to be attributed to such varicosity. A long-standing ulcer of the leg of a non-malignant, non-syphilitic, non-tuberculous character is better spoken of as a chronic ulcer. It may be the direct or indirect result of varicose veins, but it may also be due to traumatism or eczema, or œdema, or anæmia. It is misleading to call all such ulcers varicose ulcers. They are all due to poor local nutrition, of which varicosity of the veins is simply one cause.

When varicose veins have existed for a considerable time there will often be noted a brown pigmentation of the skin, occurring more or less in patches, and due either to small subcutaneous ruptures of the venous radicles or to transudation of red blood cells through the dilated venous walls. In either case the blood pigment becomes permanently fixed in the fibrous tissue of the skin, giving it a characteristic yellow-brown color.

Symptoms.—Varicose veins often give rise to no symptoms whatever. Such is apt to be the case in young and

Fig. 4992.—Varicose Veins of Both Legs with a Large Varicose Vein below the Left Knee and a Varicose Ulcer just above the Right Ankle. (Von Bruns.)

healthy persons, and also when the veins are dilated throughout a small area—for example, over one half of the vulva, or around the saphenous opening.

The symptoms in uncomplicated cases are: A sense of weight and more or less dull aching relieved by elevation of the affected extremity.

The symptoms of thrombosis are: Marked tenderness on pressure, acute local pain, which is considerably but not wholly relieved by a recumbent position, and a rise of temperature of one, two, or three degrees.

The symptoms of the inflammatory complications mentioned above are such as accompany these processes wherever they occur in the body.

The diagnosis of varicose veins and of the different complications above enumerated is easy for any one who is able to recognize the different forms of inflammation and ulceration. The inflamed strip of a varicose vein is broader than that of infection in a lymph vessel, and the overlying skin is not so red. A sharply localized varix can hardly be mistaken for any sort of a cystic growth, as it is collapsible on pressure, refills slowly, and has less tension than most cysts. It does not pulsate like an aneurism.

Treatment.—Palliative treatment of uncomplicated varicose veins consists in attention to the general health; in the avoidance of such occupations and such clothing as tend to interfere with the venous flow; in the elevation of the feet as much as possible when the patient is sitting down, and in the wearing, during the daytime, of an elastic bandage or stocking reaching from the toes to the knee. Even though the varicose veins extend well into the thigh, firm compression of the leg will usually relieve the symptoms, and it is difficult to apply a stocking or bandage with comfort above the knee-joint.

A woven elastic, cotton or silk-web stocking costs from $2.50 to $8. Its advantages are the ease with which it may be applied and the firm pressure which it exerts when new. A thin white lisle thread stocking should be

worn next the skin to protect the elastic stocking from perspiration. With the best of care an elastic stocking loses its tone in a few months, so that the expense is no inconsiderable item to a poor person. Various kinds of elastic bandages have been devised, such as pure rubber, rubber webbing, cloth webbing, stockinette, etc., but nothing is more satisfactory than pure coarse white flannel cut on the bias in strips about three inches wide, a sufficient number of which are sewed together to make a bandage six or eight yards long. Such bandages can be washed and ironed as often as they become soiled, and they will last a long time. They should be applied before the patient gets up in the morning. In the beginning this is a considerable trouble, as it is by no means easy to bandage one's own leg. But most patients soon learn to apply them in five or ten minutes, and many put them on as neatly as a professional could hope to do. No one who has once become accustomed to apply such bandages would willingly exchange them for an elastic stocking, since he can always regulate the pressure according to his own comfort, aside from the fact that they are cleaner and cheaper.

The radical treatment of varicose veins may be (1) their multiple ligation, either subcutaneously or through short incisions, (2) the excision of portions or of the whole of the dilated veins, or (3) the double ligation of the saphenous vein at its entrance into the femoral. The injection of substances to produce clots in the veins is no longer in vogue.

The subcutaneous ligation of the vein consists in the passage of a needle threaded with catgut first beneath the vein and then between the vein and the skin (Fig. 4993).

The ligation of the main trunk of a saphenous vein was recommended by Trendelenburg in an article published in 1891. The good results then reported and those which have since been obtained by others, have given this operation a considerable renown. It is worth remembering, however, that a thrombus may form in the proximal portion of the vein and that it may reach up into the femoral and cause embolism. For this reason a patient ought to remain in bed for at least ten days after the operation. The vein can be exposed under the influence of cocaine at its termination in the femoral vein, or, in case its higher branches are not varicose, it may be exposed just below the centre of the thigh. It should be ligated in two places and divided between the ligatures.

The excision of a considerable length of a varicose vein is an operation which usually requires some little time

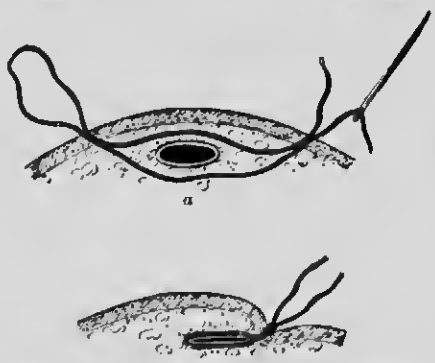

FIG. 4993.—Subcutaneous Ligation of a Vein (Trendelenburg's Method). *a*, Shows how the ligature is to be applied; *b*, shows the condition of the parts after the ligature has been drawn taut and tied.

and which can best be performed under a general anæsthetic. The limb should be allowed to hang over the edge of the operating table for a minute or two for the purpose of distending the veins, and then a constricting band or rubber tube is placed around the thigh, not tight enough, however, to obstruct the arterial flow. The dissection of the veins should be made from above downward, since in this manner they will remain full of blood and will thus be easily found. As long as the vein is not cut into it is clearly visible and the dissection is easily performed; but often, in spite of his resolve not to do so, the operator will cut a hidden branch which extends from the superficial vein to some deeper one, and the wound will then become filled with a flow of blood which is sometimes stopped with difficulty. When the tissues are once stained with blood the veins are less easily recognized. When the affected veins have been removed the wounds in the skin are sutured, and if they heal primarily the patient should be able to go about in ten days or two weeks. The ultimate recovery is not hastened by getting the patient out of bed before there is firm union of the skin.

These operations are of service not only in relieving the patient of his troublesome varicose veins, but in tending to cure such complications as eczema and ulcer.

Excision may also be applied to a thrombosed vein. The time of recovery will not be much greater than that required for excision of an uncomplicated varicose vein, while the non-operative method of treatment of thrombosis often requires four or five weeks for effecting a cure. The risk is said to be no greater than that following excision of simple varicose veins.

The non-operative treatment of a thrombosed varicose vein consists in rest in bed and the application of moist wet dressings or an ice-bag to relieve the pain. In from two to four weeks the acute symptoms will have subsided, and the patient may again go about. It is better to apply, for a time at least, a firm bandage from the toes upward, so as to relieve the veins from the strain of a column of blood to which they have grown unaccustomed during the rest in bed. An annoying feature of thrombosis is its tendency to spread in spite of treatment. An extension upward along the vein may occur at any time, and the course of the trouble in the new situation will be exactly like that of the original thrombosis. Excision has been lately advised as a method of curing thrombosed veins, as stated above.

In regard to complications which may occur in connection with varicose veins, see articles on *Blood-Vessels, Pathological Anatomy of, Erysipelas, Phlegmon*, and *Ulcer and Ulceration*. *Edward Milton Foote.*

VARIX. See *Veins, Diseases of.*

VAS DEFERENS. See *Genital Organs, Male.*

VASO-MOTOR NERVES. See *Circulation of the Blood.*

VEINS, ANOMALIES OF.—The anomalies of veins, though of great morphological interest, are, with a few exceptions, of no great surgical importance. The most important variations of the venous system are found in the great veins entering the heart, and in their large tributary branches in the thorax and abdomen.

Although variations of veins are more frequent than those of arteries, they have been much less studied, one reason being that veins are rarely injected with paint for purposes of dissection. Their variations also are of much less surgical importance than those of arteries. When arteries are anomalous, so are their accompanying veins; an exception to this rule is seen in the obturator vein which empties into the internal iliac vein, even when the artery is abnormal.

Abnormal communications by aberrant vessels are much more common in the venous than in the arterial system. Many veins which are normal in the lower animals occur as anomalies in man. Many varieties which occur in man are really persistent fœtal conditions, and these are permanent conditions in animals lower in the scale. An example of this is seen in the occurrence of a double vena cava, the supernumerary vessel (the left cava) being merely a persistent left duct of Cavier.

The following account of the anomalies of veins is nec-

essarily incomplete; the reader who is interested in the subject is referred for further information to W. Krause's "Varietäten der Körpervenen" in vol. III. of Henle's "Anatomie des Menschen," the various articles in the *Journal*

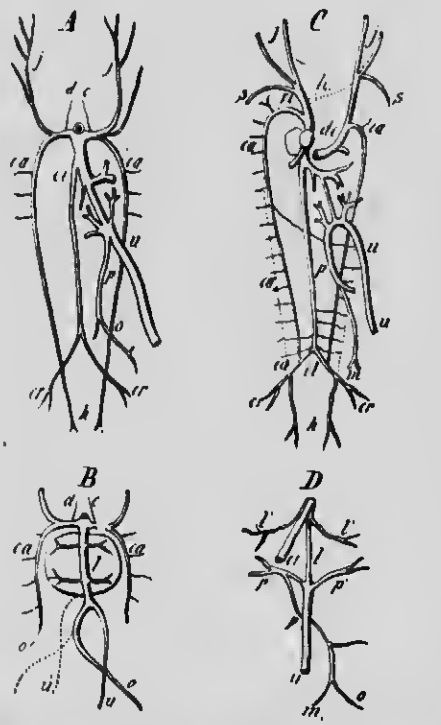

Fig. 4994.—Diagram illustrating the Development of the Great Veins. (After Kölliker.) *A*, Plan of the principal veins of the fœtus of about four weeks or over, after the first formation of the vessels of the liver and the vena cava inferior; *B*, veins of the liver at a somewhat earlier period; *C*, principal veins of the fœtus at the time of the first establishment of the placental circulation; *D*, veins of the liver at the same period; *dc*, the right and left ducts of Cuvier; *cu*, the right and left cardinal veins; *jj*, jugular veins; *s*, subclavian; *az*, azygos; *u*, umbilical; *o*, omphalo-mesenteric vein; *p*, portal vein; *p' p''*, venæ advehentes; *l*, ductus venosus; *h*, hypogastric or internal iliac veins in the line of continuation of the primitive cardinal veins; *it*, transverse innominate.

of Anatomy and Physiology, and R. Quain's "Commentaries on the Arteries," 1844; and, for an excellent account of the development of the veins, to vol. I., Part I., of Quain's "Anatomy," 1890.

Cardiac Veins.—*Coronary Sinus.*—The coronary sinus and the small oblique vein connected with it must be regarded as the persistence of a fœtal condition which will be described in connection with the superior cava; it is really the termination of the left duct of Cuvier, or left superior cava. The vena azygos minor has been seen emptying into the coronary sinus; in this case the left superior cava was persistent as a small branch.

It is not uncommon for one or more of the cardiac veins to be absent. When the left superior cava persists, it may receive veins which normally enter the coronary sinus. The *great coronary vein* may end in the auricle itself, as may also the *middle cardiac vein*; this is the normal condition in the horse, camel, etc.

Pulmonary Veins.—The pulmonary veins occasionally communicate with other veins, as the innominate (Hyrtl); the right upper pulmonary has been seen to empty into the superior cava, and the left upper into the innominate. The two pulmonary veins of one side may unite into a single trunk (more commonly on the left side) before emptying into the left auricle.

There may be three pulmonary veins on the right side, the third coming from the middle lobe of the right lung. Hepburn[1] records a case of double vena cava in which there were three right pulmonary veins, the upper opening into the superior cava of the right side, and the two lower into the *right* auricle; there was also a separate foramen (quite distinct from the foramen ovale) between the right and left auricles. Peacock[2] records a similar case in a child six years of age.

I have on two occasions seen the upper pulmonary vein of the right side emptying into the superior vena cava. The left vein may open into the innominate. Shepherd[3] reports a case of a single right pulmonary vein opening into the vena azygos major.

Development of the Great Veins.—In order to understand more thoroughly the variations of the great veins which return the blood to the heart, the following description, abridged from Quain's "Anatomy," 9th edition, vol. ii., will be of service:

"At the time of the commencement of the placental circulation two short transverse venous trunks, *ducts of Cuvier*, one on each side, open into the auricle of the heart; each is formed by the union of a superior and an inferior vein named the *primitive jugular* and the *cardinal vein*. The *primitive jugular* receives the blood from the cranial cavity by channels in front of the ear, which are subsequently obliterated; in the greater part of its extent it becomes the external jugular vein, and near its lower end it receives small branches which grow to be the internal jugular and subclavian veins."

The *cardinal veins* are primitive vessels which return the blood from the Wolffian bodies, the vertebral column, and the parietes of the trunk. The inferior cava is a vessel of later development, which opens into the trunk of the umbilical and omphalo-mesenteric veins above the *venæ hepaticæ revehentes* (Fig. 4994).

The iliac veins, which unite to form the inferior cava, communicate with the cardinal veins. The inferior extremities of the cardinal veins are persistent as the internal iliac veins; above the iliac veins the cardinal veins are obliterated in a considerable part of their course; their upper portions then become continuous with two new vessels, the *posterior vertebral veins* of Rathke, which receive the lumbar and intercostal twigs.

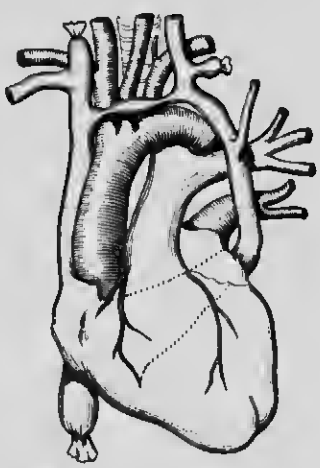

Fig. 4995.—Double Vena Cava seen from the Front, with Small Transverse Innominate Veins. (R. Quain.)

As development proceeds, the direction of the ducts of Cuvier is altered by the descent of the heart to the thoracic region, and then it becomes continuous with that of the primitive jugular veins. A communicating branch makes its appearance between the two jugulars, directed obliquely downward from left to right; further down in the dorsal region, between the posterior vertebral veins, another communicating branch is developed.

The communicating branch between the jugulars is converted into the left innominate vein (see Fig. 4996). The portion of the primitive jugular below the commu-

ascending vein, together with the right duct of Cuvier, forms the superior vena cava, while the cardinal vein opening into it (*az*, Fig. 4994) is the extremity of the great azygos vein. On the left side, the portion of the primitive jugular placed below the communicating branch, and the cardinal and posterior vertebral veins, together with the cross branch between the two posterior vertebral veins, are converted into the left superior intercostal and left superior and inferior azygos veins. The left duct of Cuvier is obliterated, except at its lower end, which always remains pervious as the coronary sinus. Traces of this vein are recognized in the adult as a fibrous band or a small vein (see Fig. 4996, *A*). The variability in the adult arrangement of these vessels depends on the various extent to which the originally continuous vessels are developed or atrophied at one point or another.

Varieties of the Superior Cava and Innominate Veins.—*Double Vena Cava.*—This anomaly is rather a rare one, and is due to the persistence of the left duct of Cuvier. When the left duct of Cuvier persists, the transverse innominate vein is absent or of a very small size, and the vein formed by the junction of the left internal jugular and subclavian is continued down in front of the arch of the aorta and root of the left lung to the heart (see Fig. 4995), where it receives the great cardiac vein, and then passes outward to become continuous with the coronary sinus, and thus opens into the right auricle (see Fig. 4996, *B*).

The explanation of this anomaly is simple, if the description of the development of the great veins, given above, be referred to. It is merely a persistence of the fœtal condition. The left duct of Cuvier is not obliterated, and in consequence the transverse branch between the two primitive jugulars has been developed but slightly or not at all. The persistent left cava has been seen in a few cases to open into the left auricle (Hyrtl, Gruber, and others).

In birds and some mammals, as the rabbit, etc., the left duct of Cuvier persists normally as well as the right.

R. Howden[4] reports a case of double vena cava in which the left vein was joined by a large left azygos vein; the right azygos was broken up into several veins; the most inferior one joined the left azygos, and the superior the vena cava. This is a reversal of the usual condition, and the left azygos in this case must be looked upon as a persistence of the left cardinal vein.

The writer has met with no less than six cases of persistence of the left duct of Cuvier. They all occurred in adults (four males and two females), and were of the usual form; in four the transverse innominate was of considerable size. In the third and fourth cases it was very small, and formed chiefly by the inferior thyroid veins. Instances have been recorded in which the right superior cava was absent and the left persisted; in such cases there was a right transverse innominate vein. This variation occurred without transposition of the arch of the aorta or any of the viscera. In cases of transposition of the viscera this is the normal arrangement.

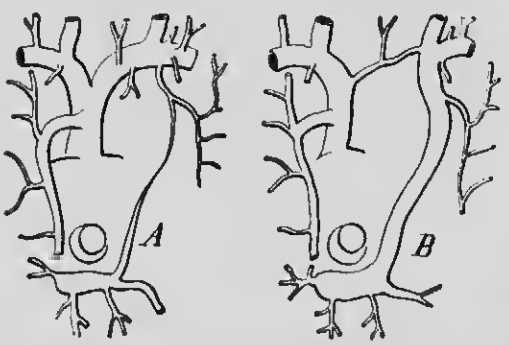

Fig. 4995.—*A*, Diagram showing Vestige of the Left Superior Cava with Brachiocephalic, Superior Intercostal, Azygos, and Cardiac Veins. *B*, Diagram showing persistence of left superior cava and its communication with the coronary sinus. (After Marshall.)

In some cases the transverse innominate vein is of normal size, and yet there is a persistence of the left duct of Cuvier in its whole length, either as a good-sized canal or as a very small, but patent, vein.

In some cases in which two superior cavæ are present, the left has been seen to enter the left auricle instead of the coronary sinus.

Gruber reports a case in which the principal veins of the heart terminated in a trunk which opened into the left innominate vein, the opening of the coronary sinus into the right auricle being occluded (*Virchow's Archiv*, xclx.).

Connection between the Vena Cava and Pulmonary Veins.—Cases are on record of the upper right pulmonary vein emptying into the superior cava (Meckel, Gegenbauer); of the left pulmonary vein joining the innominate (Buchdaucher); and also of the right pulmonary vein opening into the vena azygos major (Shepherd). Hyrtl reports a case in which there was a communication between a rudimentary left cava and the left inferior pulmonary vein.

Transverse Innominate.—This vein may be placed higher up than usual—so high, in fact, that in children with short necks it might be accidentally wounded in the low operation for tracheotomy.

Cooper[5] reports it as passing through the thymus. Gruber examined many embryos of children, and found that in certain cases the vein passed behind the left and in front of the right lobe of the gland, and in others in front of the left and behind the right lobe (quoted by Krause).

Coronary Sinus.—This has been seen to open into the left auricle. Gruber reports a case in which the opening into the right auricle was occluded, and the principal veins of the heart ended in a trunk which passed up to join the left innominate vein.

Vertebral.—This vein not infrequently passes behind the subclavian to reach the innominate, or it may embrace the subclavian by dividing above and reuniting below. It occasionally passes through the transverse process of the seventh cervical vertebra, or sends a branch through the foramen to join the deep cervical vein.

Internal Mammary.—This may be double, and may anastomose with the upper intercostal. The writer has seen it empty into the superior cava. It may empty into the azygos major on the right side (Portal).

Superficial Veins of the Head and Neck.—The arrangement of the superficial veins of the neck often varies greatly from that described in text-books of anatomy.

The two divisions of the *temporo-maxillary* vein are frequently very unequal in size; the branch joining the facial may be of large size, and that going to the external jugular very much diminished, or *vice versa*. In some cases the branch joining the facial returns all the blood into the internal jugular, and in other cases the internal jugular receives no branch from the temporo-maxillary. When the latter arrangement exists all the blood empties into the external jugular.

The *facial vein* sometimes passes back over the sterno-mastoid muscle to join the external jugular. It may pass across the sterno-mastoid to its posterior border, and then join the internal jugular beneath that muscle. It sometimes joins the internal jugular behind the posterior belly of the digastric and stylohyoid muscle, or it may be continued downward to the anterior jugular (see Fig. 4998).

External Jugular.—This vein may be double. In those cases in which the posterior division of the temporo-maxillary trunk is wanting, and all the blood goes to the internal jugular, the external jugular is very small, being formed altogether by the posterior auricular.

When the posterior auricular joins the temporo-maxillary trunk, the external jugular is wanting altogether in the upper part of the neck. Gruber describes a case in which a loop was formed in this vein through which passed the transverse cervical nerve. The lower end of

FIG. 4997.—External Jugular passing over the Clavicle and going up between that Bone and the Subclavius Muscle to join the Subclavian. (Richard Quain.)

the external jugular may divide into two branches, one of which joins the subclavian vein or transversus colli, and the other the anterior jugular, subclavian, or internal jugular.

Occasionally the vein may pass over the clavicle and join the cephalic vein, or the cephalic may join the external jugular beneath the clavicle, and communicate with it at the same time by a loop line above the clavicle (Nuhn). (See Fig. 4999.)

The writer has seen several cases in which the external jugular passed over the clavicle and then turned up between that bone and the subclavius muscle to join the subclavian (see Fig. 4997). A knowledge of these anomalies is important in operations on the clavicle and subclavian artery.

According to Hallett, the external jugular is absent once in ninety-three subjects.

Anterior Jugular Veins.—These veins are not constant. One may be much larger than the other. Occasionally the two join to form a single median trunk. The two veins may be united by a large trunk over the trachea, which may give rise to troublesome hemorrhage if wounded in the operation of tracheotomy.

Pilcher says that when one of the veins is absent it is compensated for by a large obliquely transverse branch which comes from the external jugular and crosses the neck at its lower third to join the anterior jugular which persists.[8]

Pilcher also describes a deep anterior jugular of large size which is occasionally seen. It has its origin in the suprahyoid region, passes down directly in the median line, deeply seated beneath the muscles; it passes over the cricothyroid space, and, going down the middle of the neck over the trachea, receives the superior and inferior thyroid veins, and finally empties into the transverse innominate vein.

The anterior jugular may in rare cases pass outward over the sternomastoid muscle.

Transverse cervical and suprascapular veins not infrequently empty into the subclavian vein independently. Occasionally they join the internal jugular (R. Quain).

Internal Jugular.—This vein frequently covers the common carotid artery to such an extent that the artery cannot be seen until the vein is drawn aside (see Fig. 4998). According to R. Quain[1] this occurs most frequently in the left side. The left vein is occasionally of very small size, its place being taken by the external jugular (W. Krause). This is a persistence of an early fœtal condition, for in early fœtal life the primitive or external jugular returns all the blood from the heart. This is the normal adult condition in many mammals, as rabbits, squirrels, etc. The internal jugular is altogether absent in fishes, many amphibia, birds, and some mammals, as the horse and ruminants.

A case is reported by J. W. Williams[2] in which the right omohyoid muscle, instead of passing over the vein, "played by means of its intermediary tendon through a slit in the vessel."

In some cases the temporo-facial trunk fails to empty into the internal jugular, the external receiving all its blood.

R. Quain reports a case in which a very large anterior jugular vein communicated with the internal jugular over the carotid artery (see Fig. 4998).

The internal jugular may receive the vertebral, the transverse cervical, and the suprascapular veins. A superior intercostal has been seen to empty into it (Lauth);

FIG. 4998.—Facial Vein, continuous with the Anterior Jugular, which is Joined by the Internal Jugular by a large Communicating Branch over the Carotid. The Internal Jugular is seen covering the upper part of the carotid artery. (R. Quain.)

or a large bronchial vein (Weber). The external jugular has been seen to empty into the internal about the middle of the neck (Führer).

VARIETIES OF CEREBRAL SINUSES.*—The sinuses about the *torcular Herophili* are subject to considerable variation. A true confluence of the sinuses is not always found at this point. The torcular may be placed to one side or other of the median line. The connecting branch

* J. F. Knott has given an excellent account of the variations of the sinuses in the Journal of Anatomy and Physiology, vol. xvi.

between the torcular and straight sinus may be of large size and convey the blood from the superior longitudinal sinus.

Superior Longitudinal Sinus.—This sinus may be completely absent (Portal). Knott describes it as being occasionally so small as hardly to represent a normal sinus. It may join the straight sinus; it may bifurcate posteriorly a little behind the coronal suture, and reunite about an inch posteriorly (Knott and Vieq d'Azyr). Malacarne reports a case of bifurcation of the sinus near the apex of the occipital bone, each branch following the lambdoidal suture of its own side and joining the lateral sinus.

Lateral Sinus.—The right is often very diminutive. Lieutaud has recorded a case of complete absence of the left lateral sinus. Both lateral sinuses may be of small size; in such cases the occipital sinuses are much enlarged, and empty their blood into the internal jugular.

Sometimes one or both sinuses are divided into two by a septum (Hallett). Verga describes an aberrant vein going from the cavernous sinus or ophthalmic vein to the left lateral sinus. One sinus may be of large size and the other small. The left is usually the larger. A case is reported [9] in which both lateral sinuses were small, especially the right, which became quite minute after the exit of a large vein through the mastoid foramen. In this case three large emissary veins were present at the anterior extremity of the superior longitudinal sinus, also three others opening into the torcular, one into the commencement of the right lateral sinus, and one into the posterior extremity of the superior longitudinal.

Inferior Longitudinal.—Knott [9] reports a case in which this sinus, instead of joining the straight, turned up between the layers of the falx and ended in the superior longitudinal sinus, one quarter of an inch above the internal occipital protuberance.

Straight Sinus.—Sometimes absent. In a case reported by Knott the vein of Galen and the inferior longitudinal sinus met at the anterior edge of the tentorium, formed a trunk three quarters of an inch long, and then divided into three veins, one of which passed up between the layers of the falx to join the superior longitudinal, and the other two passed between the layers of the tentorium to the left side to join the lateral sinus.

Cavernous Sinus.—Complete absence of this sinus is reported by Santorini. There is sometimes a vein from

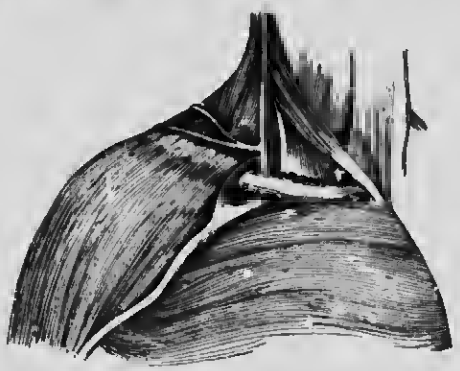

Fig. 4999.—Cephalic Vein passing up under the Clavicle to Join the Subclavian. The cephalic is connected with the external jugular by a loop line which passes over the clavicle. (Nuhn.)

it going through the foramen rotundum with the superior maxillary division of the fifth cranial nerve (Nuhn).

Superior Petrosal.—Sometimes absent; may communicate with the ophthalmic vein (Verga).

Inferior Petrosal.—Sometimes terminates within the skull above the margin of the jugular foramen.

Circular Sinus.—May receive the ophthalmic vein.

Occipital Sinuses.—Sometimes wanting, occasionally of large size. In such cases the lateral sinuses are small; they may be very small. The sinus is often much larger than its fellow, and may groove the occipital bone as it passes forward to join the lateral sinus.

Petrosquamous Sinus (Luschka, W. Krause).—This additional sinus is sometimes present, lying in a small groove along the junction of the petrous and squamous portions of the temporal bone, and opening behind into the lateral sinus. In rare cases it is found passing through an aperture (*foramen jugulum spinosum*) in the squamous portion of the temporal bone, between the orifice of the external auditory meatus and the glenoid cavity, and joins the temporal vein. In the dog and many other animals a similar vessel forms the principal outlet for the intracranial blood. In the human subject also, at an early period of fœtal life, the lateral sinus is continued forward in this course, and opens into the primitive (afterward the external) jugular vein; the occurrence of the petrosquamous sinus is due to the persistence of this channel, which usually becomes obliterated after the development of the internal jugular."

Veins of the Upper Limb.—The superficial veins of the forearm are subject to considerable variation, both as to arrangement and as to size. At the bend of the elbow the arrangement varies greatly.

The *radial* vein may be very small or absent, and in such cases the cephalic vein is wanting, the outer branches from the radial side being collected into the median vein, which goes directly to form the *median basilic*. This latter is occasionally double.

The *cephalic* vein may be absent (Hallett found it absent in two out of ninety-three cases). It may be double. It sometimes empties near the insertion of the deltoid into the brachial vein. Sometimes it anastomoses with the brachial vein by an aberrant branch. It may pass up over the clavicle to join the external jugular, or it may be connected with it by a branch called the jugulo-cephalic (see Fig. 4999). In two cases this branch has been seen to perforate the clavicle (Allen Thompson). This vein may pass up between the clavicle and subclavius muscle to join the subclavian vein; the writer has seen several examples of this anomaly (see Fig. 4999).

The *median cephalic* vein is not infrequently absent.

Basilic Vein.—May be double in its whole course. May anastomose with the ulnar vein. May be separated from the brachial artery by only a very thin fascia; this fact should be kept in mind in bleeding from this vessel. The basilic may anastomose by a large branch with the cephalic vein (Thelle).

Axillary Vein.—This vein may be double, from a failure of the venæ comites to unite with the basilic. R. Quain has repeatedly seen the axillary vein perforated by a branch of the internal cutaneous nerve.

Subclavian Vein.—This vein may be placed at a higher level than usual, overlapping the artery at the outer edge of the scalenus anticus. In rare cases the vein passes *behind* the scalenus anticus muscle with the artery, or, in cases in which the artery passes in front of the muscle, the vein may pass behind. Luschka has several times seen the subclavian vein passing between the clavicle and the subclavius muscle. The same anatomist also reports having seen the vein divided and embrace the scalenus anticus muscle, and reunite and follow its usual course. The two venæ comites have been seen to empty into the subclavian; also a left bronchial vein (Weber.)

Double Subclavian.—Morgagni (quoted by R. Quain, p. 182) in one instance found on both sides of the same body two venous trunks placed side by side, instead of the usual single subclavian vein. On the right side the two veins were of equal size, about five inches long, and reached to a point where the internal jugular ends. On the left side one of the veins was of very small size.

The *anterior jugular, supramscapular,* or *transverse cervical* may empty into the subclavian separately. Weber reports the subclavian receiving a large bronchial vein. The *cephalic* vein may empty into the subclavian above

or below the clavicle. An aberrant vein may unite the upper end of the cephalic vein with the subclavian by passing behind the clavicular portion of the pectoralis major (W. Krause).

Azygos Veins.—The variations of the azygos veins are considerable, the veins on the left side being especially liable to variation. Two or three of the middle intercostal veins of the left side not uncommonly unite into a single trunk which passes directly into the azygos major. The left superior (hemi-) azygos vein may be absent, the intercostal veins emptying separately into the main trunk. The hemiazygos may empty into the subclavian (Wrisberg) or into the left innominate, joining with the superior intercostal. A case has been reported (Cerutti) in which the hemiazygos joined the internal jugular vein. All the intercostal veins on the left side may be collected into a single trunk which empties into the left innominate, a distribution somewhat similar to that on the right side. The writer has reported an example of this arrangement.[12] By referring to the short account given above of the development of the great veins it will be seen that this anomaly is due to a persistence of the left cardinal vein. A case is recorded by Gruber in which the left azygos opened into the coronary sinus, and was met by a small vein descending from the union of the subclavian and jugular. In this case the jugular vein had been developed in the usual way, while the left vena azygos continued to pour its blood into the left duct of Cuvier (Quain).

FIG. 5000.—The Inferior Cava continued into the Thorax as the Vena Azygos, and the Blood from it Entering the Heart through the Superior Cava. In this case the hepatic veins opened into the right auricle in the usual situation of the inferior cava. (R. Quain.)

The azygos veins may be transposed, the larger vessel being placed on the left side and being joined by the right azygos; the trunk formed by these veins then arches over the root of the right lung and opens into the left coronary sinus (Gruber). This is the normal arrangement in the sheep and some other animals.

R. Howden[14] reports a case of double vena cava in which a single large left azygos, after being joined by some of the right intercostal veins, emptied into the left cava near the coronary sinus. The upper right intercostals, formed a trunk which emptied into the right cava.

There may be a single azygos vein ascending in front of the spinal column and receiving the intercostal veins of both sides (Wagner). The azygos major may empty into the right innominate (Meckel) or higher up than usual into the superior cava. Wrisberg has described a case in which the azygos major passed through a canal by grooving the upper lobe of the right lung. Most of the varieties mentioned above may be easily explained by studying the development of the veins, for they are all persistent fœtal conditions. The vena cava inferior has been seen continuous with the azygos major. (See Fig. 5000. This will be more fully described with the vena cava inferior.)

The right spermatic has been noted as emptying into the azygos vein, also the left renal and suprarenal veins (Quain).

An aberrant branch has been seen going from the angle of junction of the left renal and inferior vena cava to the right azygos (W. Krause). The right pulmonary vein has been seen to join the vena azygos major (Shepherd, in *Journal of Anatomy*, vol. xxiv.).

Inferior Vena Cava.—R. Quain[15] divides the peculiarities of this vein into two classes: (*a*) Where the vein has the usual mode of termination in the heart; (*b*) where it terminates in the superior vena cava.

The common iliac veins may not join at the usual place; the left common iliac, after sending a branch across to join the right, may pass up on the left side of the aorta and join the left renal. This is not a very uncommon anomaly, and has been seen several times by the writer. It is sometimes called an example of double vena cava inferior. A case is reported by William Osler[16] of occlusion of the vena cava as it entered the liver. There was in this case a double cava arranged as above described (see Fig. 5001); the circulation was carried on by a large branch from the left renal, which probably joined the splenic.

FIG. 5001.—Case of Double Inferior Vena Cava, the Two Common Iliacs being Joined by a Transverse Branch. *A*, Occluded vena cava; *e*, right renal; *f*, right spermatic; *d*, large branch, probably joining the splenic, through which circulation was carried on. View taken from behind. (W. Osler.)

In some cases there is no transverse branch below between the two common iliacs (see Fig. 5002). These cases are examples of the persistence of the lower part of the cardinal veins.

Another somewhat similar anomaly is that in which the two common iliac veins join to form a common vein which passes up on the left side of the aorta, but, after receiving the left renal, crosses over (rarely under) the aorta and from there on takes its usual position.

FIG. 5002.—Example of Double Inferior Vena Cava. The left cava is joined by the left renal and then crosses the aorta to join its fellow, and below, the inferior cava proper. Each cava is really a continuation upward of the common iliac vein of that side. (R. Quain.)

The explanation of this anomaly is that the right cardinal vein has been obliterated while the left persists. In cases of transposition of the viscera the vena cava inferior passes up the whole distance on the left side of the aorta, grooves the transposed liver, and joins the right auricle of the heart in its transposed position on the left side. A case of transposition of the viscera is recorded (Hernhohlt) in which the inferior cava passed up on the right of the aorta, pierced the diaphragm,

and then crossed over to join the transposed superior cava.

In some rare cases the inferior cava passes up normally to the diaphragm without receiving the hepatic veins, it then pierces the diaphragm, and goes over the root of the right lung to join the superior cava, thus taking the place of the vena azygos major; the hepatic veins in these cases form a trunk, which opens into the right auricle at the usual place of termination of the inferior cava (Fig. 5000). Again, the inferior cava may pass up on the left side of the aorta and, after piercing the diaphragm on that side, go behind the aorta and thoracic duct to join the superior vena cava, thus following the course of the left azygos vein. The hepatic veins, as in the former case, open into the right auricle (see Fig. 5003). These cases are explained on the supposition that the normal inferior cava has never been developed, and that the blood is returned from the lower part of the body by a persistent cardinal vein.

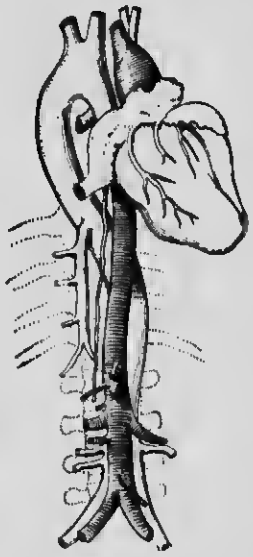

Fig. 5003. Vena Cava to Left Side of Aorta; below, but crossing behind that vessel above, and, passing up the thorax on the right side; it empties its blood into the superior cava. (R. Quain.)

W. Gruber[17] reports a case in which the inferior cava was formed by the junction of three trunks —right and left external iliacs and a common iliac formed by the junction of the two internal iliacs; this arrangement is seen in some of the lower animals, as the bear, etc. The vena cava inferior is occasionally formed by a common iliac vein and the veins of the other side, not opening by a common trunk, but separately.

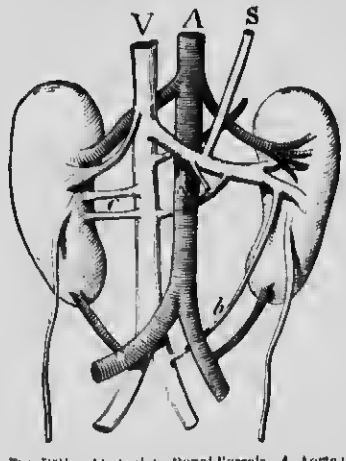

Fig. 5004. Abnormalities Renal Vessels. *A*, Aorta; *V*, vena cava; *b*, communication between the left renal and the left common iliac; *S*, vein from left renal going to join the splenic; *c*, supernumerary renal veins. (Shepherd.)

Renal Veins.—The left renal vein, in order to reach the inferior cava, may pass *behind* instead of in front of the aorta. Supernumerary renal veins are not so common as supernumerary renal arteries, but they not infrequently occur. One of these supernumerary vessels of the left side may open into the azygos of that side.

Walshum[18] reports a case of double left renal vein enfolding the aorta, one passing in front and the other behind. The posterior branch received the spermatic and also the third lumbar vein. The writer has seen a somewhat similar case, referred to below. When the kidney is placed lower than normal, a vein from it usually empties into the common iliac.

In the museum of McGill University is a beautiful specimen of abnormal renal veins obtained by the writer. Both kidneys were placed lower down than normal, reaching to the intervertebral substance between the fourth and fifth lumbar vertebræ, and each received a supernumerary artery from the common iliac artery. On the right there were two renal veins, on the left one large vein proceeded from the hilus of the kidney in front of the aorta, and a smaller one passed behind the aorta to join the inferior cava lower down. This communicated below, by a large branch which passed beneath the left common iliac artery, with the left common iliac vein, and above, by another large branch, with the splenic vein (see Fig. 5004). This case is probably one of persistence of the left cardinal vein in its lower part.

Fig. 5005. Example of Popliteal passing up the Thigh to Join the Profunda. In this case the lower end of the femoral artery is accompanied by a very small vein. (R. Quain.)

Spermatic and Suprarenal Veins.—These may empty by a common trunk into the azygos. The right spermatic may empty into the right renal and the left spermatic into the inferior cava. The spermatic vein may empty into the suprarenal. It may be double in the upper parts of its course or may be altogether absent.

Common Iliac Veins.—A perforation is occasionally seen through which passes a small artery. Sometimes the vein divides and reunites farther on, thus making it double in part of its course (R. Quain). The left common iliac vein has been seen passing in front of the right common iliac artery (Zaaijer). Absence of the common iliac vein of one or both sides has been met with by Gruber; the left external and internal iliac veins in one instance being continued upward to enter the commencement of the inferior cava, and in another the two internal iliac veins were joined into a common trunk which united with the right and left external iliac veins to form the vena cava.[19]

Obturator Vein.—Often double, one accompanying the artery and the other coursing around the inner side of the femoral ring. It may open by two mouths into the external iliac.

Internal iliac vein of the *right* side has been seen to empty into the *left* common iliac vein. The internal iliac may be double (Quain).

Veins of the Lower Limb; Superficial Veins.—*External Saphenous.*—This vein may empty into the long saphenous or femoral instead of the popliteal. It may communicate with the gluteal veins beneath the gluteus maximus muscle.

A case is reported[70] in which the external saphenous, after piercing the deep fascia in the popliteal space, ran

Fig. 5006.—Case of Double Popliteal Vein. (R. Quain.)

up on the posterior surface of the adductor magnus, perforating it near the second perforating artery, and then joined the profunda vein. In the same paper another case is mentioned in which the venæ comites of the posterior tibial, instead of uniting to form the popliteal, continued up as two veins, being joined by the external saphenous, and going up on the adductor magnus to open into the profunda vein near the first perforating artery. The writer has seen the external saphenous empty about the middle of the thigh into an abnormal popliteal vein which passed up the back of the thigh to join the profunda. The external saphenous may empty into muscular branches to the adductor magnus. Branches of communication have been seen between the perforating and ischiatic veins and the external saphenous.

Internal Saphenous Vein.—This vein may pierce the fascia lata higher or lower than usual. It may be doubled, or may form an island. It may receive the superficial epigastric, circumflex iliac, an accessory saphenous, or the external saphenous. It is in some cases very large, and in others of no great size. There is frequently an accessory internal saphenous.

Deep Veins of the Lower Limb.—*Popliteal Vein.*—The veins which form the popliteal occasionally unite farther up than usual, so that the lower part of the artery is accompanied by two veins. In some rare cases the vein is double in its entire length. It may be double as high up as the profunda vein. Sometimes the popliteal vein passes up the thigh and joins the profunda; in such cases the external saphenous empties into this vein high up on the thigh. When the popliteal vein does not accompany the artery to become the femoral, a small vein is occasionally seen with the artery (see Fig. 5005).

The popliteal vein may lie deeper and more internal than the artery and next the bone.[71]

Femoral Vein.—Occasionally double in part and, more rarely, in the whole of its course. When double, the femoral artery lies between the two veins (see Fig. 5007). In some cases one of the veins may cross the artery. Small veins are occasionally observed passing over the artery in various directions, sometimes in transverse loops (see Fig. 5008), or obliquely; these transverse branches usually connect various parts of the double vein. The femoral vein may be much diminished in size when the popliteal vein empties into the deep femoral and pierces the adductor magnus at a higher point than usual. In these cases the femoral vein proper first comes in contact with the artery in the groin. R. Quain mentions a case in which he could find no femoral vein accompanying the lower end of the artery; the writer has seen one such case.

Portal System of Veins.—*Hepatic Veins.*—Rolfe, a German surgeon, reported many years ago (1787) a case in which one of the large hepatic trunks from the right lobe of the liver terminated, not in the inferior cava or right auricle, but in the base of the right ventricle. Its entrance was guarded by three valves (noted by W. Krause). In cases in which the inferior cava, as already described, joins the superior cava, the hepatic veins may open separately (Horner) or by a single trunk (Abernethy) into the right auricle. This arrangement is normal in some animals. The writer has described[72] a case in which the vena cava inferior, after piercing the liver and being joined there by a few small hepatic veins (principally from the left side), passed as usual to the dia-

Fig. 5007. Case of Double Femoral Vein. (R. Quain.)

phragm, and as it pierced that muscle it was joined by a large vein, the size of one's finger, and with walls as thick as those of an artery. This vein, when traced back, proved to be a common trunk formed by two large hepatic veins which came from the right lobe; the common trunk measured one inch in length (see Fig. 5009).

Morgagni reports a case of the hepatic veins joining the vena cava inferior after it had pierced the diaphragm (quoted by W. Krause). Hyrtl has seen the hepatic veins empty by a common trunk into the right auricle

FIG. 5008. — Small Looped Veins passing Over the Femoral Artery, forming a Double Femoral Vein. (R. Quain.)

to the inner side and separately from the inferior cava; this, as mentioned above, is the normal course when the vena cava is absent or its place is taken by a persistent cardinal vein.

Umbilical Vein.—This vein has occasionally been found patent for a variable distance below the liver. It may communicate with the epigastric, and thus establish a collateral circulation; this is much more evident when a diseased condition of the liver obstructs the venous circulation.

J. A. Russel[22] reports two cases of persistent communication between the umbilical and portal veins in the

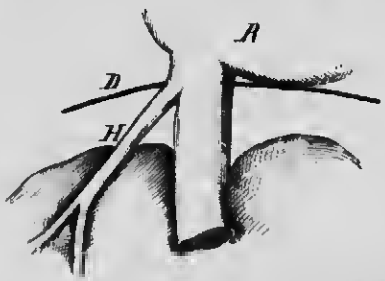

FIG. 5009. Hepatic Veins from Right Lobe of the Liver Opening by a Common Trunk near the Entrance of the Inferior Vena Cava through the Diaphragm. *R*, Right auricle; *D*, line of diaphragm; *L*, liver; *V*, vena cava; *H*, abnormal hepatic veins. (Shepherd.)

human subject. F. Champneys[24] describes a communication between the external iliac and portal veins through the epigastric and umbilical veins.

This was due, probably, to fusion of Luschka's *par umbilicalis* (which, according to him, always exists normally as a communication between the portal and epigastric veins), and the channel was afterward increased in size by obstruction, due to enlarged liver. A communication of large size between the umbilical and epigastric veins is the normal arrangement in many of the lower animals, as the rorqual, seal, sheep, pig, etc., and in man is an early fœtal condition. Numerous examples have been recorded of communication between the veins of the abdominal parietes, as the phrenic (azygos, etc.) and the portal vein. The writer has already described, in connection with the renal vein, a case in which a large branch of communication existed between the left renal vein and the splenic.

Menière has described a case in which a large vein, as thick as a finger, went from the portal vein to the right iliac. And Brigidi[25] has reported a case of free communication between the umbilical vein, which was patent, and the right iliac by means of a branch of large size in a case of cirrhosis of the liver.

W. Krause[26] mentions a number of cases of communication between the portal vein and the iliac veins by means of a patent umbilical, connected directly by a branch or through an epigastric vein.* These communications are all due to persistent fœtal conditions, and are much more apparent when there is any obstruction to the portal circulation. *Francis J. Shepherd.*

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23 *Ibid.*, vol. vi.
24 Lo Sperimentale, April, 1888.
25 Henle's Anatomie des Menschen, vol. iii.
26 *Ibid.*, vol. xvi.

VEINS, PATHOLOGY OF.—In general, the same pathological processes are found in the veins as in the arteries, though varying in degree and importance in the two sets of vessels, some conditions being more pronounced in the arteries, others in the veins. Thus, for example, inflammatory changes are of much more frequent occurrence in the veins; sclerosis and calcification in the arteries. Thrombosis of veins and thrombophlebitis are among the most common and important of pathological conditions; while, on the other hand, from the nature of things, arterial embolism holds a like important place in pathology. In addition to the pathological processes common to both sets of vessels there is a number of morbid conditions peculiar to the veins, among the most important of which may be mentioned varices and phlebectasias.

ANOMALIES.—*Congenital anomalies* in the number, branching, course, and distribution of veins are very common. They are rarely of clinical importance, though at times causing temporary embarrassment during surgi-

* Sappey is of opinion that all recorded cases of free communication between the umbilical and epigastric veins rest on errors of observation; he holds that the dilated vein is not the umbilical vein, but one of the accessory portal veins. Professor Biacconini is also of the same opinion, saying that the umbilical vein, in its course from the umbilicus to the portal vein, neither gives nor receives any branch normally. Professors Bordoni and Bonfil, however, have investigated the subject afresh, and find that the umbilical vein anastomoses with the epigastric, not only in infants a few days old, but in those five and six months of age. In bodies of infants several days or months old they never failed to demonstrate the anastomoses between the branches of the epigastric and umbilical veins by means of Richardson's injecting medium (see London Medical Recorder, July, 1888, p. 274).

these tumors usually originates from pre-existing muscle tissue, either of blood-vessels or of the organ involved, or from embryonal germs of such tissue which have re-

Fig. 3430.—Showing Irregular Contour of Muscle Fibres and Irregular Arrangement of Striation. (Fujimaki.)

mained latent until some cause excited them to growth or removed the inhibition which was preventing their development.

Among the less important, because less frequent tumors arising in muscle are lipomas, angiomas, fibromas, chondromas, osteomas and myxomas. The structure of these tumors when found in muscle does not differ materially from their structure in other localities.

Carcinoma in muscle is a result of lymphogenous metastasis or of the infiltration of the muscle by the carcinomatous nodules in the neighborhood. The muscle fibres take no part in the formation of the tumor, although they undergo various degenerative changes, and the tumor cells may even penetrate the broken sarcolemma and fill the muscle fibre, as shown in Fig. 3427. From this fact it has been said that the carcinoma cells arise from the muscle cells, but although we recognize the atypical character of origin and growth of tumors, yet it seems unnecessary to assume in this case a mode of origin so remote from the normal type. Inflammatory processes may also be seen in the neighborhood of these tumors. *Sarcoma* is, however, the most common malignant tumor occurring in non-striated muscle. These may be very large and either consist of round cells or of spindle-shaped cells. The sarcoma may be mixed with fat, fibrous tissue, mucoid tissue, etc., forming the lipo-sarcomas, fibro-sarcomas, and myxo-sarcomas. As in carcinoma, sarcoma cells may penetrate the broken sarcolemma, giving the impression of being formed from the muscle cells. The structure of these tumors does not differ materially from that of analogous tumors in other regions. We are therefore far more concerned at this place with the pathological changes produced in the muscle by the ingrowth of the tumors than with the structure of the tumors themselves, which will be fully treated in another place. Schmeller, Fujimaki, Anzinger, and others have investigated the changes which occur in voluntary striated muscle in the neighborhood of malignant tumors, and have found nearly every possible form of degenerative change. Fujimaki asserts that the alterations in the muscle are essentially the same in sarcoma as in carcinoma, while Anzinger believes that degenerative changes are more marked in the neighborhood of carcinomas, while the so-called regenerative changes are seen in greater abundance near sarcomas. All agree that the distinctness of the striation may be greater or less than normal, varying much in different portions of the same preparation.

Atrophy is the most frequent and constant change, due probably, at least in part, to a disturbance in the nutrition of the muscle, but partly also to the diminished functional activity of the muscle, and possibly also to nervous and trophic influences. Peculiar depressions, containing large numbers of muscle nuclei, are often found at the sides and ends of the fibres, giving an irregular contour to the fibre; this is known as lacunar erosion. The muscle fibres may also break up, either longitudinally into slender fibrils containing rows of nuclei, or transversely into segments containing groups of nuclei. Fujimaki also notes a peculiar twisting of the muscle fibrils within the sarcolemma. Zenker's necrosis, cloudy swelling, vacuolation, proliferation of nuclei, both by mitotic and by amitotic processes, with marked alterations in the nuclear form, are frequently observed in the neighborhood of these tumors. Fujimaki regards all these changes as essentially degenerative in character, in spite of the fact that certain multinuclear forms resembling the myoblasts of regenerating muscle are frequently seen. Anzinger and others regard these giant-cell forms as abortive attempts at regeneration. While more work is needed on this point, there seems little doubt that at certain stages of the process degenerative forms occur which closely resemble the regenerative forms of voluntary muscle, although the conditions are such that no attempt at regeneration is to be expected.

Fig. 3431. This Figure Shows the Atrophy, Irregular Contour, Faint Striation, and other Degenerative Changes in the Muscle and the Inflammatory Process in the Intermuscular Connective Tissue in the Neighborhood of a Malignant Tumor. (Anzinger.)

The perimysium of the voluntary muscle in the neighborhood of these malignant growths is often hyperplastic and shows leucocytic infiltration, hemorrhage, edema, fat infiltration. Endarteritis and periarteritis are frequent occurrences.

The penetration of muscle cells and leucocytes and even of tumor cells into the muscle cells is one of the most interesting points mentioned in the study of these cases. Fujinami has figured a number of muscle cells containing a larger or smaller number of tumor cells and states that the tumor cells may be derived from the degenerating muscle cells. This idea is refuted by Schaeffer, although supported by Schrœder, Neumann, Bardeleben, and others. Schaeffer states that there may be a great similarity between the tumor tissue and the muscle tissue, which makes confusion possible, and that the tumor cells may penetrate the muscle fibres. The origin and etiology of these tumors in muscle, as in other tissues, are still obscure; but it seems more reasonable to regard the appearance of the tumor cells within the sarcolemma as a result of the passage of these cells through a broken sarcolemma, especially as they are accompanied in this position by leucocytes and giant cells, than to believe that the tumor cells are formed from the contractile substance of the muscle fibre by its degeneration.

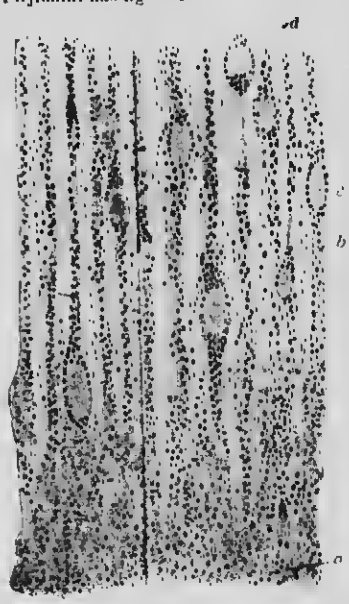

Fig. 3432.—Atrophied Muscle with Circumscribed Dilatations and Nuclear Proliferation in the Neighborhood of the Tumor Mass. (Fujinami.) *a*, Carcinomatous cells; *b*, atrophied muscle; *c*, angular portion, beginning of giant cell formation; *d*, giant cells.

Lydia M. DeWitt.

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MUSCLES, ANOMALIES OF.—The muscular system of man is subject to many variations, all of which are interesting from a morphological point of view, and many are important surgically. Not only do muscles vary as to form and attachment, but supernumerary and rudimentary muscles are not infrequent. Again, some may be absent in a certain number of individuals, *e.g.*, the pyramidalis, palmaris longus, etc.

Many muscles are mere rudiments of those which exist in a well-developed condition in the lower animals, and there is, in fact, no muscular variation in man which has not a corresponding normal condition in some animal lower in the scale.

In the present article space forbids the giving of any extended account of muscular variations, for it is a subject on which volumes have been written. It is intended to describe only the commoner and more important anomalies, especially mentioning those whose rebirth to arteries renders them of surgical interest. The reader who wishes to obtain a fuller knowledge of the subject is referred to Wood, Turner, and others, in the *Journal of Anatomy and Physiology*; J. Wood, "Proceedings of the Royal Society," 1864–69; "Guy's Hospital Reports"; "St. Thomas' Hospital Reports"; Macalister's "Catalogue of Muscular Anomalies," in Trans. Royal Irish Academy, 1874; W. Gruber, in the *Mem. of Acad.*, St. Petersburg, and Virchow's *Archiv f. klin. Med.*; Henle, "Handbuch, Muskellehre"; Hallett, *Edin. Med. Jour.*, 1845; Krause, "Handbuch," 1880; Testut, "Les Anomalies Musculaires chez l'Homme," Paris, 1884; also various papers in the *Journal of Anatomy and Physiology*.

MUSCLES OF THE HEAD AND NECK.—*Occipito-Frontalis* varies much as to size and position. The *occipitalis* occasionally approaches the median line, and may be divided into several portions. Some of its fibres may be continuous with the posterior auricular muscle.

The *Frontalis* may send slips to the nasal and superior maxillary bones. Theile says that it generally sends a bundle of fibres to the external angular process of the frontal bone. Its fibres have been described as normally continuous with the levator labii superioris alæque nasi.

Auricular Muscles.—Very various as to their development. The retrahens is very often of large size, and its tendon frequently arises from the occipital bone or the external occipital protuberance; in such cases its belly is

very fleshy, and may be divided into two portions. It is sometimes connected with the transversus nuchæ. Cruveilhier has described a deep *musculus auricularis anticus*, which goes beneath the superior from the zygoma to the outer surface of the tragus. The anterior auricular muscle is often very much diminished in size, and its fibres may be very indistinct.

Muscles of the Nose.—Absence of the pyramidalis has been observed. The compressors and dilators are often so feebly developed as to be seen only with a magnifying glass.

The *Musculus Anomalus* (Albinus) is a slip described as being frequently present, lying beneath the levator labii superioris alæque nasi, and arising with it from the nasal process of the superior maxillary bone, it is inserted into the same bone near the origin of the compressor naris.

Muscles of the Face.—*Zygomaticus Major.* Frequently double. The second head may arise in the neighbourhood of the infra-orbital foramen or from the masseteric fascia below the zygoma. It is sometimes absent.

Zygomaticus Minor. Frequently absent. It may be inserted into the fascia of the cheek. It may be fused with the levator labii superioris proprius, zygomaticus major, or frontalis. It is not infrequently double; the second head may arise in common with the levator labii superioris proprius. Sometimes it arises from the orbicularis palpebrarum, and it may be inserted into the levator labii superioris proprius or levator labii superioris alæque nasi, or both.

Levator Labii Superioris Proprius occasionally sends a slip to the zygomaticus minor. The writer has twice seen this muscle arise by two heads, the extra head arising from the malar bone. In both these cases the zygomaticus minor was present.

Risorius (Santorini). Often absent. Santorini describes it as double, and even triple. It has been seen to arise from the zygoma, external ear, fascia over the mastoid process, and the skin over the upper portion of the sterno-mastoid.

Depressor Anguli Oris (triangularis menti). Santorini described a muscle, the *transversus menti*, which is sometimes found arising from the inner border of the depressor, and passing downward and inward across the mesial line below the chin to the corresponding part of the opposite side.

Muscles of the Orbit.—*Levator Palpebræ.* Sometimes absent or fused with the superior rectus. Budge describes the *tensor trochleæ*, which is a muscular slip given off from the levator to the trochlea.

The muscles of the eyeball are very constant. The two heads of the *rectus externus* have been seen separate to their insertion, forming a double muscle. Absence of the outer head has been noted by Macalister, and Curnow describes it as giving slips to the outer wall of the orbit and lower eyelid.

Transversus Orbitæ (Bochdalek). This is an arched slip of muscular fibres passing from the orbital plate of the ethmoid across the upper surface of the eyeball to the outer wall of the orbit (Quain). Macalister suggests that it is a deep, displaced slip of the palpebral fibres of the orbicularis.

Obliquus Inferior. *Accessorius* is a slip going from the inferior rectus to the inferior oblique. The writer has seen a slip going from the inferior oblique to the superior rectus.

Muscles of Mastication.—*Masseter.* Monro has described a bursa as occasionally occurring between the two portions of this muscle, and Hyrtl has once seen a bursa between the masseter and the capsule of the inferior maxillary articulation.

Temporal. Henke says that sometimes the temporal muscle, and sometimes the deep portion of the masseter, is attached to the fore and back part of the interarticular fibro-cartilages of the lower jaw, or from the borders muscular fibres arise which are inserted into one or other of the afore-mentioned muscles. In many cases these fibres form a well-developed muscular belly, the *musculus temporalis minor*, which is inserted into the bottom of the sigmoid notch of the lower jaw (Henke). The writer has occasionally seen a deep slip from the temporal muscle attached to the pterygo-maxillary ligament. This slip is sometimes pierced by the internal maxillary artery.

Pterygoideus Externus. A considerable portion may be inserted into the capsule of the inferior maxillary articulation. When the pterygoideus proprius is present the upper head is of small size.

Pterygoideus Proprius. This is a muscle which is not infrequently seen arising from the infratemporal crest of the sphenoid and part of the great wing itself; it then passes over the external pterygoid to the lower part of the external pterygoid plate, or to the tuberosity of the palate and superior maxillary bones. It sometimes receives a slip from the upper head of the external pterygoid, and a portion of the upper head of the muscle may arise from it. The writer has occasionally seen the pterygoideus proprius inserted into the pterygo-maxillary ligament and alveolar process of the upper jaw (see Fig. 3433). In one case it sent a slip over the internal pterygoid to be inserted into the inferior maxilla near its angle. Externally this muscle is tendinous, and deep down, muscular; sometimes it is tendinous along the inner border only. When the pterygoideus proprius is present, the upper head of the external pterygoid is generally much diminished.

Pterygospinosus (Thane). This name is given to a muscular slip occasionally seen springing from the spine of the sphenoid and inserted into the hinder margin of the outer pterygoid plate, between the external and internal pterygoid muscles; the parts are frequently connected by fibrous tissue, and sometimes by bone.

Muscles of the Neck.—*Platysma Myoides.* This muscle varies considerably in its development. It is sometimes well developed, thick and red, and at other times its fibres are pale, thin, and hardly to be seen. It has been reported absent by Macalister. The platysma may reach over the clavicle as far as the fourth rib. It sometimes fails to reach as far as the clavicle; in such cases it is reduced in extent at other parts as well. It may have an insertion into the thyroid cartilage or the sternum. When well developed it has been seen attached to the lower jaw above and to the clavicle below. The upper part of the platysma is occasionally joined by a slip from the mastoid process, or from the occipital bone. The two muscles not infrequently cross each other in

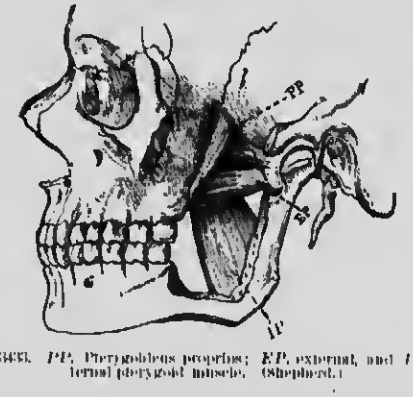

Fig. 3433. *PP*, Pterygoideus proprius; *EP*, external, and *IP*, internal pterygoid muscle. (Shepherd.)

the median line. The writer has seen the lower fibres continuous with some fibres of the musculus sternalis. Fasciculi in connection with this muscle have been traced to the axilla. The platysma is the principal representative in man of the skin muscle (*panniculus carnosus*) of the lower animals. In most mammals with loose skins these trigonometry muscles are well developed; *e.g.*, in the hedgehog, porcupine, porpoise, etc.

Occipitalis Minor. This is the name given to a bundle of muscular fibres arising from the fascia over the upper

end of the trapezius and ending in the fascia over the upper end of the sterno-mastoid. It is probably a modification of the slip which occasionally joins the platysma from the mastoid process or occipital bone.

Sternocleidomastoideus. This muscle is usually considered to be made up of two muscles, the sterno-mastoid

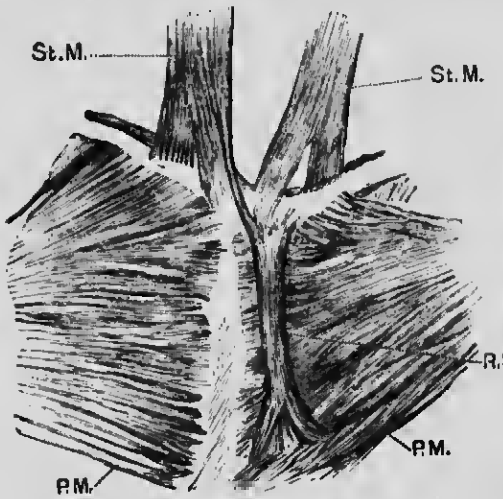

Fig. 3431. *R.S.*, Rectus sternalis continuous with (*St.M.*) sterno-mastoid of the opposite side. (Shepherd.)

and cleido-mastoid. Krause, however, regards it as consisting of four muscles, viz.: (1) Sterno-mastoid, (2) sterno-occipital, (3) cleido-occipital, (4) cleido-mastoid. The spinal accessory nerve pierces the cleido-mastoid, or runs between the cleido-occipital and cleido-mastoid. Krause suggests the name *sternocleidomastoideoccipitalis*, or the *musculus quadriparticus capitis*. He says that the ordinary varieties in man are readily explained by the isolation or absence of particular parts, or by the extension of the cleidooccipitalis to the occipital protuberance. Both the cleidooccipitalis and sternooccipitalis may be feebly developed, or both may be absent, as, indeed, may be the sterno-mastoid. Again, the cleido occipital or cleido mastoid may be developed as separate muscles. The views of Krause are supported both by human and comparative anatomy. However, for ordinary purposes it is sufficient to regard the sterno-mastoid as consisting of two muscles. These two portions may be completely separate, or may join together at a much higher point than usual. This separation of the muscles into two is the normal condition in the greater number of mammals; *e.g.*, ruminants, solipeds, the majority of carnivora, and many of the anthropoid apes.

The sterno-mastoid and cleido-mastoid muscles may be completely fused—a condition which is not of great rarity.

Sternal attachment of the muscle may vary; the two sternal tendons may unite on the sternum or cross each other. The writer has seen the sternal tendon of one side continuous with a musculus sternalis of the opposite side (see Fig. 3434).

The sternal tendon may in rare cases be divided into two portions, inserted separately into the sternum. The sternal portion has been noted absent by Macalister. A sesamoid bone is sometimes seen in the tendon of the sterno-mastoid; this is looked upon as a rudiment of the episternal bone of monotremes and lizards.

The clavicular portion varies considerably as to the extent of its attachment to the clavicle; it not infrequently covers the space called the subclavian triangle, and this should be borne in mind when performing the operation of ligature of the subclavian artery in its third part. The writer once, when operating on the neck, found the clavicular portion absent. In animals without clavicles the cleido-mastoid forms part of the cephalo-humeral muscle, being continuous with the outer portion of the pectoralis major or deltoid.

Cleido-occipital (Cephalo-humeral of Flower). This is a muscle described by Wood and others as arising from the clavicle outside the cleido-mastoid and inserted into the superior curved line of the occipital bone close to the origin of the trapezius. It is usually separated by a distinct areolar interval from both the sternal and clavicular fibres of the sterno-cleido-mastoid (see Fig. 3435).

This muscle corresponds to the cleidooccipitalis of Krause. It exists as a separate muscle in the guinea-pig, hedgehog, etc. In apes and monkeys it is always present, but is in them continuous with the hinder border of the true sterno-cleido-mastoid. In many of the carnivora, as the dog and cat, it forms part of the cephalo-humeral muscle. Wood found this muscle thirty-seven times in one hundred and two subjects.

The sterno-mastoid has been described as sending slips to the angle of the lower jaw and hyoid bone (Gruber). The sterno-hyoid and omo-hyoid, and in rare cases the trapezius, may unite with the sterno mastoid.

A tendinous intersection is sometimes seen near the lower end of the muscle; the same intersection is seen in the sterno-hyoid and sterno-thyroid muscles; it is probably the remains of one of the transverse septa of the primitive ventral muscle plate. These intersections are seen normally in the rectus abdominis.

Levator Claviculæ arises from the clavicle, and is inserted into the cervical vertebræ. A fuller description of this muscle will be given further on, under Muscles of the Upper Limb.

Supraclavicularis is a small muscle behind the sterno-mastoid, which arises by a slender tendon from the first piece of the sternum, crosses above the sterno clavicular articulation, and is inserted into the upper surface of the clavicle. When present on both sides the muscles may be continuous in the middle line.

Transversus Nuchæ. This is described by many anatomists as a normal muscle, which is always represented when absent by tendinous fibres. It arises from the external occipital protuberance, and is inserted into the aponeurosis of the sterno-mastoid (see Fig. 3436).

Sternohyoideus occasionally arises only from the clavicle. In such cases there is a wide interspace at the root of the neck devoid of muscle. The writer in one case saw, on both sides, the sterno-thyroid and sterno-hyoid arise altogether from the clavicle an inch outside the sterno-clavicular articulation. On removing the skin and fascia the trachea and thyroid gland immediately came into view.

This muscle is occasionally double. There is sometimes an accessory muscle seen going from the clavicle to the hyoid bone (cleido-hyoid). The sterno-hyoid has been described as occasionally arising from the sterno-clavicular ligament and first costal cartilage. It is sometimes fused with the muscle of the opposite side, as in the horse.

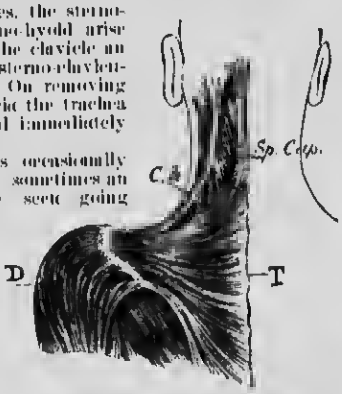

Fig. 3435. *C.h.*, Cephalo-humeral muscle; *Sp. Cerv.*, splenius capitis; *D*, deltoid; *T*, trapezius. (After Flower, from the dissection of a Bushwoman, *Journ. of Anat. and Phys.*, vol. i.)

The muscular fibres are not infrequently interrupted by a tendinous intersection, which is generally on a line with the tendon separating the two bellies of the omo-hyoid. This intersection is seen

normally in some animals, as the chimpanzee, horse, etc. The muscle has been noted as absent on one side. It may be united by slips with the omo-hyoid, myo-hyoid, or sterno-thyroid. All the anomalies above mentioned have their corresponding normal condition in the lower animals.

Fig. 3436.—*TX*, Transversus nuchæ. (After Henle.)

Sternothyroideus. Occasionally some of the fibres of this muscle continue on upward and are inserted into hyoid bone with the omo-hyoid, or are continuous with the hyo-glossus muscle. A few fibres may be continued into the thyro-hyoid or inferior constrictor of the pharynx. In one case the writer saw it, on both sides, arise, with the sterno-hyoid, entirely from the clavicle. Wallum reports a case ("St. Barth. Hosp. Rep.," 1880) in which the right sterno-thyroid arose from the left as well as the right side of the sternum and crossed the trachea. The left muscle was rudimentary. This muscle would be a source of embarrassment in performing tracheotomy.

In the gorilla and chimpanzee some fibres usually arise from the clavicle. The two sterno-thyroid muscles are often united at their origins across the middle line. Doubling of the muscle, as well as absence, has been observed. A tendinous intersection is sometimes seen opposite the tendon of the omo-hyoid. It may exist in both the sterno-hyoid and sterno-thyroid in the same line.

Costofascialis. Wood describes a slip arising with the sterno-thyroid from the lower part of the first rib, which crosses the carotid vessels to be inserted into the cervical fascia as high as the thyroid cartilage.

Sternofascialis. This is a slip described by Gruber as arising from the first piece of the sternum behind the sterno-mastoid and passing upward to be inserted into the fascia of the subclavian triangle. It might be called the tensor fasciæ colli.

Thyrohyoideus. This muscle is often fused with the sterno-thyroid, and in such cases the sterno-thyroid is inserted into the hyoid bone. Absence of this muscle has been reported; this is generally due to a fusion of the sterno-thyroid and thyro-hyoid, so that they form one muscle, which is inserted into the hyoid bone. The muscle may be divided into two distinct slips.

Cricohyoid. Wulshun first described this muscle as arising from the lower border of one side of the cricoid cartilage and inserted into the lower border of the hyoid bone. Gruber also mentions its occurrence.

Depressor Thyroidæ. A small muscle described by Bradley as arising from the first tracheal ring, passing over the cricoid cartilage and inserted into the lower border of the thyroid cartilage.

Omohyoideus. This muscle is frequently abnormal. In 250 subjects examined the writer found anomalies of the omo-hyoid in 39, or about 1 in 6. The muscle may be completely absent, and in rare cases it has been noted double. Again, one or other of its bellies may be wanting. When the anterior is absent, the posterior belly ends in the cervical fascia beneath the sterno-mastoid. In 250 subjects the writer has seen this arrangement twice. Sometimes the anterior belly arises from the clavicle and ascends the neck directly to its insertion into the hyoid bone without having any intermediate tendon or intersection. This has been regarded by some as absence of the posterior belly. The writer has only in one subject seen this anomaly; it occurred on both sides. This muscle has been called the *rhizo-hyoid*. In some rare cases, however, the posterior belly is altogether absent, the anterior arising from the fascia covering the subclavian triangle (*hyofascialis*).

The posterior belly not infrequently arises from the clavicle solely. In 120 subjects examined, the writer has seen this arrangement 8 times (1 in 15). The posterior belly may be double, the supernumerary portion arising from the clavicle. The writer has seen this occur 9 times in 120 subjects. In these cases the origin from the clavicle is generally extensive, and is from the middle third of the posterior border for a distance of two and sometimes three inches. In rare cases it may arise from the sternal end. The posterior belly of the omo-hyoid may be so bound down by fascia to the clavicle that the subclavian triangle is obliterated. In ligaturing the subclavian, it would be well for surgeons to bear in mind this occasional arrangement. This condition is present more frequently when the posterior belly arises from the clavicle.

The omo-hyoid being originally fused with the sterno-hyoid, it would be natural to see the lower portion occasionally displaced and have its origin from any of the osseous joints between the scapula and sternum, or to receive supernumerary heads from the various points.

The scapular head of the omo-hyoid, besides having an accession from the clavicle, may receive one from the coracoid process, the acromio-clavicular joint, the acromion process, and even the first rib.

The anterior belly of the omo-hyoid is occasionally double. The writer has seen this anomaly three times. In the first case the supernumerary belly was inserted into the superior cornu of the thyroid cartilage; in the second, into the great cornu of the hyoid; and in the third it blended with the sterno-hyoid.

The anterior belly not infrequently blends with the sterno-hyoid so as to form one broad muscle, which is occasionally bounded below by an arched tendon, as in the seal. This fusion is due to the non-differentiation of the primitive brachiocephalic sheet from which these two muscles are developed.

The writer has twice seen a portion of the omo-hyoid muscle pass over the hyoid bone and go up between the anterior bellies of the digastrics to be inserted into the lower jaw near the symphysis (see Fig. 3437).

The omo-hyoid may send slips to muscles in the neighborhood; *e.g.*, sterno-mastoid, sterno-hyoid, and the various muscles of the submaxillary region. A slip has been seen going from the posterior belly to the transverse process of the sixth cervical vertebra.

Fig. 3437.—Shows the Omo-Hyoid Muscle Continuing up over the Hyoid Bone to be Inserted into the Inferior Maxilla; also, the Muscular Belly going from the Tendon of the Digastric to be Inserted into the Body of the Hyoid Bone. (Step-mot.)

The intermediate tendon of the omo-hyoid may be absent or represented by a tendinous intersection.

Comparative Anatomy. The omo-hyoid is completely wanting in many animals, as the rat, dog, peccary, mole, and also in rodents without clavicles. The anterior belly is absent in the orang outang. The muscle arises from the clavicle in the sciuk and in some of the bats and the iguana. The intermuscular tendon is absent in many mammals as the echidna, ornithorhynchus, the American black bear, and some of the quadrumana. In the seal

the anterior belly is fused with the sterno-hyoid and is bounded below by an arched tendon.

Levator Glandulæ Thyroideæ. This is a fibrous or muscular band which goes from the body of the hyoid bone to the isthmus or one of the lateral lobes of the thyroid gland. There may be two or three slips. The writer, in one subject, on both sides, saw this slip proceed from the oblique line of the thyroid cartilage and go to each lateral lobe of the gland. The levator thyroideæ is looked upon as an aberrant portion of the muscles between the sternum and hyoid bone (see Fig. 3438).

Fig. 3438.—*L.T.*, Levator thyroideæ, going from Hyoid Bone to Left Lateral Lobe of Thyroid Body. (Quain.)

Digastricus. The digastric muscle is subject to many variations. Occasionally its tendon fails to pierce the stylo-hyoid. The *anterior belly* is very often abnormal; not infrequently the two anterior bellies unite in the median line and completely shut out from view the mylo-hyoid muscles. The two bellies often decussate, as in the Norway rat and ruminants. It is not uncommon to find the anterior belly divided into two or more parts, one of which may cross the middle line of the neck and join the anterior belly of the opposite side. A slip from the anterior belly may join the mylo-hyoid, or decussate in the middle line with a similar slip from the opposite muscle. These slips may be looked upon as varieties of the mento-hyoid muscle, described below. In one subject the writer saw a well-marked muscular slip given off from the intermediate tendon and inserted into the body of the hyoid bone (see Fig. 3437). Also, in another subject there was complete absence of the anterior belly on the left side; the posterior belly ended in the deep cervical fascia attached between the hyoid bone and angle of the jaw. This might be regarded as a form of the monogastric muscle, which is well seen in the lower animals, as the carnivora. MacWinnie describes a case in which the muscle was monogastric and was inserted into the middle of the body of the lower jaw. In rare cases a muscular slip from the angle of the jaw joins the anterior or posterior belly. The writer once saw a well-marked tendinous slip going from the angle of the jaw to the posterior belly.

The *posterior belly* occasionally receives accessory slips from the styloid process. It has been seen arising entirely from the styloid process. It is sometimes connected by a muscular slip with one of the constrictors of the pharynx. Wolfsohn describes a tendinous intersection, and in one case a distinct tendon, occurring in the posterior belly. The posterior belly has been seen to pass behind instead of in front of the carotid artery.

Occipito-hyoid. Perrin (*Journ. Anat. and Phys.*, vol. v.) first described this muscle as an additional digastric; he regarded it as homologous with the stylo-hyoid of birds. The muscle is double-bellied; its posterior belly arises from fascia covering the occipital bone, and its anterior belly is inserted into the hyoid bone beneath the hyoglossus. Humphry looks upon it as a superficial appendage to the stylo-hyoid and digastric muscles. There is a similar muscle in the seal.

Mento-hyoid (Macalister). This is the name given to a slip of muscle of variable size, and sometimes double, which is not infrequently seen passing, superficial to the mylo-hyoid, from the lower jaw near the symphysis to the body of the hyoid bone. Occasionally the muscle does not reach the hyoid bone, but ends in a fascia which covers the mylo-hyoid and is attached to the bone. It is sometimes triangular in shape. Macalister looks upon the mento-hyoid as a differentiated portion of platysma; but it is probably more closely related to the anterior belly of the digastric and the sterno-hyoid group, which are formed from the superficial brachiocephalic stratum of muscle (see Fig. 3430). The mento-hyoid exists normally in many animals, as the bat, hippopotamus, etc.

Stylohyoideus. Occasionally absent. Testut suggests that in cases of supposed absence of this muscle it is fused with the posterior belly of the digastric. A division of the muscle into three has been noticed. It may sometimes pass behind the carotid artery. It is occasionally inserted into the tendon of the digastric or lesser cornu of the hyoid bone. Its fibres may be continuous with the mylo-hyoid, thyro-hyoid, omo-hyoid, or, as in the ant-eater, with the muscles of the tongue. It sometimes arises from the lower jaw and goes to the hyoid bone (hyomaxillaris); again, it may not reach the hyoid bone, but go from the styloid process to the angle of the lower jaw, as in birds (stylomaxillaris). The writer has seen this muscle absent in two subjects, once on both sides.

Stylochondrohyoideus (Douglass); *Stylohyoideus alter* (Albinus). This is an additional muscle which occasionally replaces the normal stylo-hyoid and has the course of the stylo-hyoid ligament; in other words, it is the stylo-hyoid ligament become muscular. It is inserted into the lesser cornu of the hyoid bone and passes behind the carotid artery. In one case, noted by the writer, in which this muscle existed the normal muscle was represented by a thin tendinous slip. The normal stylo-hyoid and this muscle frequently are present together. The

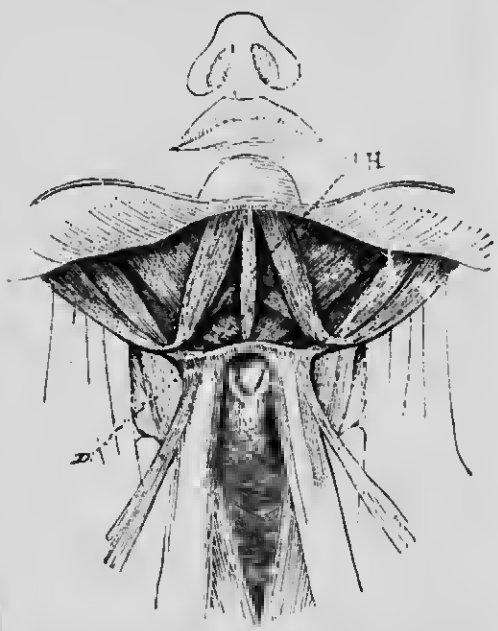

Fig. 3439.—Showing Mento-Hyoid Muscle (*MH*); also, the Anterior Bellies of the Digastric Muscles United in the Middle Line by Muscular Fibres (*D*). (Shepherd.)

stylo-hyoideus alter may receive a slip from the lower jaw. In one hundred and twenty subjects the writer has seen this muscle nine times; three times it occurred on both sides of the same subject.

Stylohyothyroideus. This is the name given by the

writer to a muscle seen by him in a female subject in the anatomical rooms of McGill University during the winter session 1885–86. On both sides of a thin female subject, in addition to the usual stylo-hyoid, a stylo-chondro-hyoid was present. On the left side this muscle gave off a slip to the middle constrictor of the pharynx. On the same side, arising in common with the stylo-chondro-hyoid, was another muscle of the same size, this had a well-developed belly, and passed down posterior but parallel to the above-mentioned muscle to a little above the hyoid bone; here it left its companion and developed a well-formed round tendon, which passed under the middle constrictor and was inserted into the tip of the superior cornu of the thyroid cartilage. The stylopharyngeus was of normal size and insertion.

Mylo-hyoid. The median raphe between the two muscles is sometimes absent. The mylo-hyoid is often closely united to the anterior belly of the digastric, and may be partially replaced by it. The sterno-hyoid, omo-hyoid, or stylo-hyoid may send slips to it. The muscle may be divided into two portions, an anterior and a posterior, separated by a considerable interval. This is the arrangement in some of the rodents. A deficiency of the fore part is of common occurrence, the origin not reaching further than the canine teeth (Quain).

Genio-hyoideus. The two muscles may be fused in the middle line. It occasionally receives a slip from the great cornu of the hyoid bone. It may be closely united with the geniohyoglossus or hyoglossus.

Genio-hyoglossus. This muscle has been found united with the genio-hyoid. The two muscles may be fused together, no cellular interval separating them. Slips have been seen going from the geniohyoglossus to the epiglottis, stylo-hyoid ligament, and lesser cornu of the hyoid bone. An accessory muscle has been described by Henle, Luschka, and Bochdalek, going from the mental spine to the hyoid bone between the two geniohyoglossi muscles.

Hyoglossus. Sometimes pierced by the lingual artery. The middle portion of the muscle is occasionally absent, leaving a larger or smaller interval between the outer and inner portions, and exposing the lingual artery (see Fig. 3440). The lingual artery may lie on the muscle instead of beneath it.

Triticeoglossus (Bochdalek). This is a small muscular slip which arises from a cartilaginous nodule in the thyro-hyoid ligament, and passes upward and outward to join the posterior part of the hyoglossus.

Chondroglossus. This has been described as a distinct muscle, occurring normally, separated from the hyoglossus by the pharyngeal fibres of the genioglossus. It arises from the base of the lesser cornu and, spreading out, is inserted into the dorsum of the tongue near the middle line.

Styloglossus. The styloglossus is occasionally absent. The writer once saw it absent on both sides of the same subject. There is sometimes an additional origin, from the angle of the lower jaw or the stylo-maxillary ligament. The whole muscle may arise from these points, the styloid origin being absent. When it arises from the angle of the jaw it is called the *mylohyoideus*. Gruber has described a rare origin of this muscle, from the external ear (*auricularis*). The muscle may be divided into two portions; one of which is inserted normally, the other into the pharynx (Sandifort). Macalister has reported this muscle as double. Henle has described a slip going from the styloglossus to the genioglossus near its origin.

Muscles of the Pharynx.—Constrictor Superior. The second portion may be distinct. Meckel describes an accessory slip, arising from the pharyngeal spine and becoming lost in the middle line of the posterior wall of the pharynx. The writer once, on both sides of the same subject, saw this muscle receive a slip from the Eustachian cartilage.

Constrictor Medius occasionally receives fibres from the stylo-hyoid ligament or hyoid bone; also from the tongue and hinder part of the mylo-hyoidean ridge. It is common to see a slip from the thyro-hyoid ligament (*cyatho-pharyngeus*, Douglass). The upper fibres of the muscle may reach the occipital bone.

Constrictor Inferior. A few fibres of origin may come from the trachea. It is occasionally connected by muscular slips with the crico-thyroid, sterno-hyoid, or sterno-thyroid muscles.

Stylopharyngeus. Cleavage of this muscle into two or even three parts has been noted. Gruber has described a double-headed stylopharyngeus. The accessory head in his case arose from the mastoid process.

Supernumerary Muscles of the Pharynx are not infrequently present, proceeding from the lower part of the

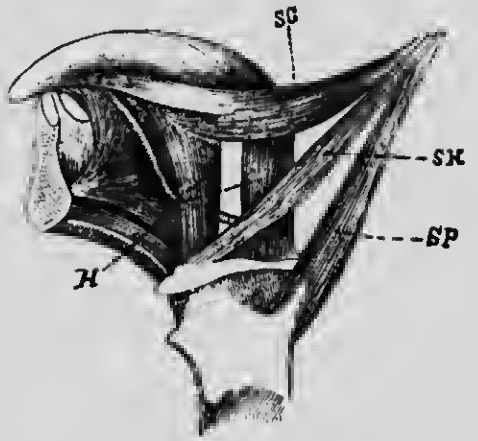

FIG. 3440.—*H*, Hyoglossus muscle deflected at its central portion; *St*, styloglossus; *SH*, stylo-hyoid; *SP*, stylo-pharyngeus. (Walsham.)

base of the skull and going to one of the constrictors or passing between these muscles and the fibrous layer of the pharynx. They may arise from the petrous portion of the temporal (*petro-pharyngeus*), spine of the sphenoid (*sphenopharyngeus*), lamular process (*pterygopharyngeus*), basilar process (*occipitopharyngeus*), or from the pharyngeal tubercle of the occipital bone (*occipito-pharyngeus*).

PREVERTEBRAL MUSCLES.—*Scalenus Anticus.* Absence of the muscle has been reported by Macalister. In this case the subclavian vein was in direct contact with the artery. The attachment to the cervical vertebræ may vary in extent. The muscle may be divided into several distinct portions. It is sometimes pierced by the subclavian artery, and in rare cases lies behind the artery, or, more properly speaking, the artery passes in front of it.

Scalenus Medius and Posticus. These two muscles are so intimately united that French anatomists regard them as one muscle. They vary considerably as to the extent of their attachments to the transverse processes of the cervical vertebræ; frequently the slips from the upper cervical are absent. In rare cases the posterior scalenus may be attached as far down as the third and even the fourth rib, as in many of the lower animals. In some animals, as the bear, it reaches as far as the seventh and eighth ribs. In man it is not infrequently absent. The scalenus medius is perforated by branches of the brachial plexus and frequently by the posterior scapular artery.

Scalenus Minimus (Albinus). This is a small slip of muscle, normal in apes, which is seen in non-carnivorous. It passes from the transverse processes of the lower cervical vertebræ to the first rib, behind the subclavian artery, and in front of the brachial plexus.

Transversalis Cervicis Medius (Theile). Under this name a muscle has been described as arising from the transverse processes of the second, third, and fourth cervical vertebræ, and inserted into the sixth and seventh cervical transverse processes.

Rectus Capitis Anticus Major. Varies occasionally in the extent of its attachment to the cervical vertebræ. It is sometimes strengthened by a fasciculus from the transverse process of the axis, and has been noted as having

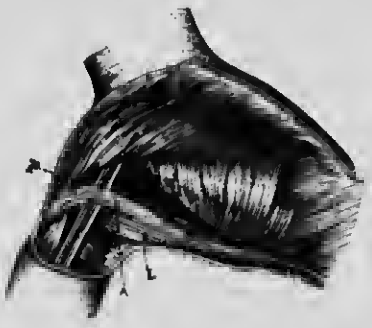

Fig. 3441.—*A*, Axillary band, between the latissimus dorsi (*L*) and the great pectoral (*P*).

no origin from the sixth cervical. It is frequently united with neighboring muscles, as the anterior scaleni, transversalis cervicis, etc.

Rectus Capitis Anticus Minor. Occasionally has a slip from the axis. Macalister has described a supernumerary muscle attached to the anterior portion of the atlas (*M. rectus anterior medius* of Gruber).

Longus Colli. The longus colli is subject to some variations in the number of its attachments and in the degree of separation of its constituent parts.

The lower oblique portion may send a slip to the head of the first rib. It is also sometimes prolonged to the rectus capitis anticus major, and has been seen sending a slip of insertion to the basilar portion of the occipital bone. A supernumerary longus colli (*M. transversalis cervicis anterior* Luschka) may arise by thin, tendinous slips from the anterior tubercles of the transverse processes of the lower four cervical vertebræ and be inserted by two tendons into the base of the transverse process of the atlas and the body of the axis (Henle).

Muscles of the Upper Limb.—*Trapezius* (Cucullaris). The attachments of this muscle are subject to considerable variation. The muscle may be much smaller than usual, and have no occipital origin or be attached to as few as six instead of twelve dorsal spines; it may be divided into a cervical and a dorsal portion. Again, its spinal attachments may be confined to the upper three or four dorsal, or lower three or four cervical spines, the other portions being absent. It is sometimes inserted into more of the clavicle than normal, being continuous with the insertion of the sterno-mastoid. Occasionally there is a slip passing forward across the subclavian triangle to reach the sterno-mastoid; this would be in front of the third part of the subclavian artery, and interferes somewhat with the operation of ligature of that artery. Again, it may be continuous with the deltoid, as is the case in animals without clavicles. In rare cases the portion attached to the clavicle is absent or very small. This arrangement is seen in some of the lower animals. A slip has been described going from the anterior border of the muscle near the clavicle to the sternum; this is a variety of the sterno-scapular muscle. Not infrequently slips of attachment unite the trapezius to the levator anguli scapulæ.

Latissimus Dorsi. The number of dorsal vertebræ to which this muscle is attached may vary considerably. It may be attached to as many as nine, and as few as four. The writer has seen it attached to all the dorsal vertebræ. Its attachments to the ribs also vary, the number being sometimes increased, sometimes diminished. It is occasionally attached to the lower angle of the scapula; the writer has twice seen it send slips to the spine of the scapula.

Axillary Band (Achselbogen). This is a muscular band which crosses the lower part of the axilla from the latissimus dorsi to the great pectoral muscle near its insertion (see Fig. 3441).

It may, instead of uniting with the great pectoral, be inserted into the coracobrachialis or fascia covering the biceps. In its course it usually crosses the axillary vessels, and hence it is well to bear this in mind in ligaturing the axillary artery in its third part. It is sometimes of large size, being as broad as 6.2 cm., and so may cover a considerable extent of the axillary vessels. More frequently it is a small slip, from 1 to 3 cm. broad. It occurs in about five per cent. of all subjects, and is frequently on both sides of the same subject. The writer has seen it in eleven subjects out of two hundred and fifty noted. This muscular band exists normally in many animals, as deer, etc., and is the remains of the continuity which previously existed between the latissimus dorsi and the pectoralis major.

Dorsoepitrochlearis. This is a muscle which is occasionally seen in man in a rudimentary form, but in many of the lower animals, as apes, lemurs, seals, bears, etc., is a well-developed muscle, and is the normal arrangement. It is a muscular slip which is given off from the lower border of the tendon of the latissimus dorsi, and is attached to various points in the arm. It may end in the long head of the triceps, some portion of the internal intermuscular septum, the epitrochlear process of the internal condyle, or the olecranon process (see Fig. 3442). In man the muscle is occasionally represented merely by a fibrous band, sometimes by a small, muscular slip ending in a fibrous cord, which is inserted into the internal condyle, or is continuous with the internal intermuscular septum.

Rhomboideus Minor and Major. Both these muscles are subject to variation as to extent of origin and insertion. They may be divided into two fasciculi, as in some animals.

Rhombo-occipital (occipito-scapular of Wood). This is a slip not infrequently seen in man, and occurs normally in many of the lower animals, *e.g.*, the deer, rat, tiger, etc., as a well-developed muscle immediately beneath the trapezius, and reaching from the occiput to the base of the spine of the scapula. In man it generally exists in an incomplete form, and varies considerably as to its upper and lower attachments. Instead of reaching the scapula it may be connected with either of the rhomboid muscles, serratus posticus superior, or levator anguli scapulæ. Its superior attachment may not reach the occiput, but be connected with the spines of the upper cervical vertebræ. Again, in man, this muscle may be represented by a slip from the aponeurosis covering the splenius capitis to the spine of the scapula, or by a slip from the levator anguli scapulæ to one of the rhomboids. In one case recorded by the writer it consisted of a well-developed muscular slip reaching from the transverse process of the atlas to the aponeurosis over the greater rhomboid (*rhombo-atloid* of Macalister). The many varieties of this muscle in man have been carefully described by Prof. J. Wood (Proceed. Roy. Soc., 1870—see Fig. 3443).

Fig. 3442.—*B*, Dorsoepitrochlearis muscle; *L*, latissimus dorsi. (Perrin.)

Levator Anguli Scapulæ. This muscle varies considerably in the extent of its attachments to the vertebræ and scapula. It is often seen attached to as many as six vertebræ and to as few as two. It has been seen arising from the mastoid process and occipital bone in addition to its spinal origin. It may have an attachment to the spine of the

scapula, and it sometimes sends slips of insertion to the first or second rib. Occasionally it is seen divided into two or more slips, the portions connected with the different vertebræ remaining separate. It is often connected with neighboring muscles by muscular slips. The writer has seen it thus connected with the serratus posticus superior, serratus magnus, deep surface of the trapezius, complexus, splenius capitis, rhomboideus minor, and scalenus posticus. These slips are regarded by Wood as varieties and modifications of the occipito-scapular muscle of the lower animals. In many of the lower animals the levator anguli scapulæ is merely the upper portion of the serratus magnus, forming with it a single muscle.

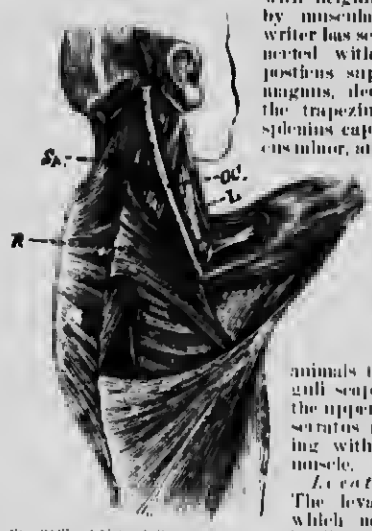

Fig. 3443. Oc, Occipito-scapular muscle; L, levator anguli scapulæ; R, rhomboid muscles; Sp, splenius. (Wood.)

Levator Claviculæ. The levator clavicule, which normally exists in all mammals with the exception of man, is occasionally seen in him. It appears as a separate muscular slip arising from the transverse processes of one or two upper cervical vertebræ, and inserted into the outer end of the clavicle. Slips of muscle from the levator anguli scapulæ, or from the upper cervical spines, to the scalene muscles, serratus magnus, and ribs, are regarded as modifications of the levator clavicule.

Cleido-cervicalis (Gruber). This is a form of the above muscle arising from the transverse process of the sixth cervical and inserted into the outer end of the clavicle. Gruber looks upon it as a supernumerary scalene muscle attached to the clavicle.

Pectoralis Major. Many variations of this muscle have been observed. The more common varieties consist of a greater or less extent of attachment to ribs and sternum, and the separation of its clavicular from its costal attachment.

M. Testut divides the anomalies of this muscle into eight groups, viz.:

1. Fusion of the clavicular portion with the deltoid.
2. Fusion with the great pectoral of the opposite side.
3. Union with the rectus abdominis.
4. Union with the biceps brachii (see Fig. 3450).
5. Separation of the clavicular and sterno-costal portions by an interspace.
6. Division of the costo-sternal portion into two strata or layers.
7. Anomalies in the mode of insertion into the arm.
8. Complete or partial absence of the muscle.

Testut divides the anomalies of the brachial insertion into: (*a*) Insertion into the coracoid process and aponeurosis of the coracobrachialis. (*b*) Insertion into the capsule of the shoulder-joint. (*c*) Prolongation of the tendon of insertion into the capsule of the shoulder-joint. (*d*) Supernumerary insertion into the humerus. (*e*) Insertion into the brachial aponeurosis. (*f*) Insertion into the two lips of the bicipital groove.

Chondrepitrochlearis (Duvernoy). This is the name given by Duvernoy to a muscular slip which is sometimes seen arising from the cartilage of one or two ribs, the aponeurosis of the external abdominal oblique, the lower border of the great pectoral itself, or its tendon; from one of these origins it passes down and out, and is inserted in a variable way into the arm. It is often inserted into the internal intermuscular septum and occasionally reaches as far as the internal condyle of the humerus.

Mr. J. B. Perrin (*Journ. Anat. and Phys.*, vol. v.) has described under the name of epigastric slips a number of muscles connected with the lower border of the pectoralis major, or arising separately from the sixth or seventh rib and inserted into the tendon of the great pectoral, or into the fascia covering the coracobrachialis muscle (see Fig. 3444). They may also be connected with the latissimus dorsi. These muscles are developed to a high degree in many mammals, and are well seen in pigeons and fowls.


Fig. 3444. Example of the Chondrepitrochlearis Muscle (C). (Perrin.)

Musculus sternalis. Syn. Rectus sternalis, sternalis brutorum (Albinus), prästernal (Testut). The musculus sternalis is a supernumerary muscle which has always excited a great deal of interest among anatomists; even yet its proper morphological significance is not fully determined. It is seen in about three or four per cent. of ordinary individuals, but in anencephalous monsters is nearly always present. Its fibres are generally at right angles, and superficial, to the great pectoral; it is often bilateral, but more frequently unilateral, and is subject to many variations. Frequently it has no attachment to bone but rests on the great pectoral, attached above and below to fascia (see Fig. 3445). It is often attached to the sternum and costal cartilages of one side or both, and is occasionally continuous above with the sternal origin of the sterno-mastoid, and below, with the external abdominal oblique (see Fig. 3433).

It usually arises from the first piece of the sternum, and is inserted into some of the ribs and costal cartilages, generally the fifth and sixth. It may be continuous in

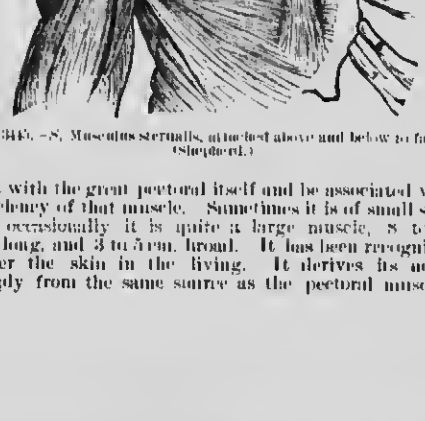
Fig. 3445.—S, Musculus sternalis, attached above and below to fascia. (Shepherd.)

part with the great pectoral itself and be associated with deficiency of that muscle. Sometimes it is of small size, but occasionally it is quite a large muscle, 8 to 10 cm. long, and 3 to 5 cm. broad. It has been recognized under the skin in the living. It derives its nerve supply from the same source as the pectoral muscles,

viz., the anterior thoracic. The muscle is regarded by Sir William Turner, Dr. Dobson, and others as a remnant of a skin muscle. Henle, Theile, Bourrienne, and others look upon it as a prolongation downward of the sterno-mastoid. Halbertsma thought it a muscle *sui generis* peculiar to man, and having no animal representative. D. J. Cunningham thinks it a new inspiratory muscle appearing in man, and is of opinion that

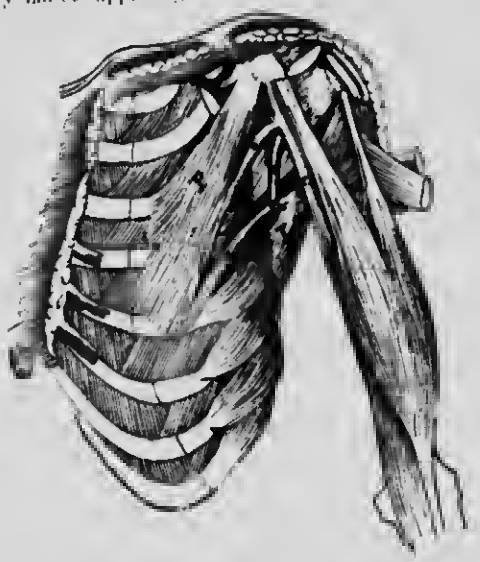

Fig. 3446. *a, a, a*, Muscular slips connecting the pectoralis minor (*P*) with the coracobrachialis (*CB*) and the latissimus dorsi (*L*). (Shepherd.)

it occurs more commonly in females, costal inspiration being more pronounced in them. In dissections of anencephalous monsters made by the writer the nerve supply was traced, in nearly all the specimens examined, to the anterior thoracic. These dissections convinced him that this muscle belongs to the pectoral and not the panniculus group (see *Journ. Anat. and Phys.*, vol. xix.).

Pectoralis Minor. The origin of this muscle varies considerably. It may arise from the second, third, and fourth ribs, instead of the third, fourth, and fifth. Not infrequently it arises from four ribs, and the writer has occasionally seen it arise by five digitations from the five upper ribs. It has been described as attached to only two ribs, and Testut, in his work on "Muscular Anomalies," describes a case in which it arose by a single digitation from the fourth rib, in this case the subclavius muscle was of large size. Sometimes the pectoralis minor is divided into a number of slips corresponding with the ribs from which it arises. It is occasionally connected with the great pectoral. In one case the writer saw it connected by muscular slips with the latissimus dorsi and coracobrachialis, and these two slips were connected together by a third (see Fig. 3446).

The variations of insertion of the pectoralis minor are numerous. The muscle not infrequently passes over the coracoid process and is inserted into the capsule of the shoulder joint and great tuberosity of the humerus. It very frequently is united at its insertion to the coracobrachialis. In one case the writer saw it inserted into the coracobrachialis by a tendinous expansion, 5 cm. broad; in this case the coracoid process received no fibres of insertion. In many of the carnivora and quadrumana this muscle is normally inserted into the humerus. In rare cases the pectoralis minor is divided into two layers which have distinct insertions, and sometimes it is absent.

Pectoralis Minimus. Gruber has described a slip, to which he gives the above name, arising from the first piece of the sternum and cartilage of the first rib; from this origin it passes outward between the subclavius and lesser pectoral to be inserted into the coracoid process. Some regard it as a variety of the chondro-scapular muscle of Wood.

Subclavius. The subclavius is not infrequently inserted into the coracoid process as well as the clavicle; occasionally it has no clavicular attachment, but is wholly inserted into the root of the coracoid process. It has been described as double by some anatomists, but the supernumerary muscle will be described below as the sterno-scapular. Walshom describes a case in which the subclavius had an insertion into the humerus, as is normally seen in birds. The subclavius is sometimes absent, its place being taken by the sterno-scapular.

Sterno-chondro-scapular (Wood). Syn.: Scapulocostalis minor (Macalister), subclavius posticus (Rosenmüller). This is a supernumerary muscle of a somewhat cylindrical shape, which is attached externally to the root of the coracoid process or upper border of the scapula, passes inward over the subclavian artery and brachial plexus of nerves, beneath the clavicle and subclavius muscle, to be attached by a round tendon to the costal cartilage of the first rib, first piece of the sternum, or both (see Fig. 3447).

Sometimes this muscle passes over the clavicle in place of beneath it, and occasionally it does not reach as far as the coracoid, but may be inserted into the anterior

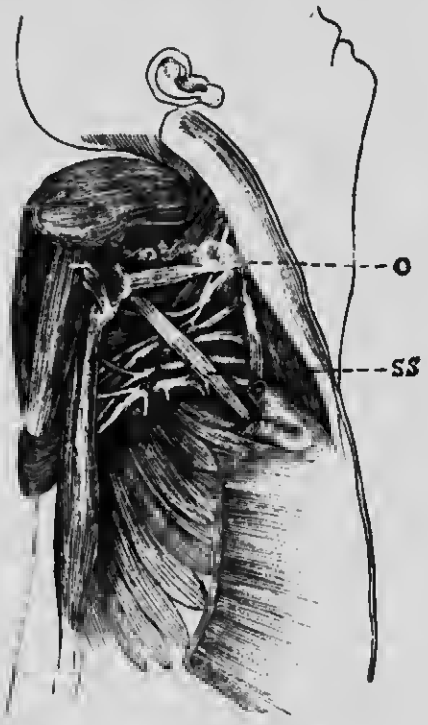

Fig. 3447. *SS*, sterno-scapular muscle; *O*, omo-hyoid. (Wood.)

border of the clavicle (sterno-clavicular anterior). A variety of the sterno-clavicular muscle which the writer has seen is one which reaches from the sterno-clavicular articulation to the anterior border of the trapezius. In its course it passes over the clavicle and across the subclavian triangle, covering the third portion of the subclavian artery (see Trapezius). In ligature of the subclavian it is

well to bear this anomaly in mind. When the sterno-scapular muscle exists there is sometimes absence of the subclavius muscle; the writer has seen this occur once only out of seven cases; in three cases, however, the subclavius was much reduced in size. W. Gruber saw absence of the subclavius in seven out of eleven cases of sterno scapular muscle.

Comparative anatomy.—In the Norway rat, guinea-pig, woodchuck, etc., the sterno-scapular muscle is normally present. In the horse it is a well developed muscle. In animals without clavicles having a sterno scapular muscle it is regarded as the homologue of the subclavius.

Chondro-coracoid is a small muscle described by Wood as arising from the first costal cartilage by a round tendon, and, passing outward below the subclavius, is inserted into the coracoid process superficial to the coracobrachialis.

Many other supernumerary clavicular muscles have been described, such as the scapulo-clavicular, coracoclavicular, supraclavicular, infraclavicular, etc., but they are so rare that it is only necessary to mention them and refer readers wishing to learn more about them to the special works on muscular anomalies mentioned in the introduction to this article.

Serratus Magnus.—The serratus magnus may arise from nine ribs instead of eight, and occasionally it receives a slip from the tenth. Again, some of the highest or lowest digitations may be wanting, the muscle thus being attached to only six or seven ribs. Occasionally some of the central digitations are absent, and the muscle is then divided into two portions. Wood has described two large muscular bands, distinct from the serratus, arising from the ninth and tenth ribs, and inserted into the inferior angle of the scapula. He regards these bands as homologues of the depressor scapulæ of birds. Sometimes there is more or less complete fusion of the serratus with the levator anguli scapulæ. In many mammals it forms one muscle with the levator.

MUSCLES OF THE SHOULDER.—*Deltoid.*—This muscle is not subject to many variations. It is sometimes divided into several distinct portions, viz., the clavicular, acromial, and spinal, as in carnivora. The clavicular and acromial portions are often separated by an interspace; not infrequently the clavicular portion is intimately connected with the contiguous part of the great pectoral, the division between them being determined only by the cephalic vein. The clavicular portion may also, in some cases, be continuous with the fibres of the trapezius, as in animals without clavicles.

The insertion of the deltoid varies in position and extent; in some cases it is inserted much lower than usual. Macalister has described a rare anomaly of this muscle, viz., the prolongation of its tendon as far as the lower end of the radius; he considers this to be the homologue of the extensor plicæ ulnaris of birds.

Testut has described a slip going from the clavicular portion of the deltoid to the internal condyle, crossing in its course the brachial vessels; he calls it the *cleido-epitrochlearis.* The deltoid not infrequently receives accessory slips from the axillary or vertebral borders of the scapula, and also from the spine and subspinous aponeurosis.

Supraspinatus.—Variations of this muscle are extremely rare. It is very constant both as to its size and attachments. Occasionally fibres of the great pectoral are inserted into it. The writer once saw its tendon pass over the capsule of the shoulder-joint in a pulley-like depression, and become continuous with the deep portion of the insertion of the pectoralis major (see Fig. 3448).

Infraspinatus is occasionally fused with the teres minor. It may be connected with the deltoid by a strong fasciculus, and, again, it may be divided into several slips.

FIG. 3448.—*S.S.* Tendon of the supraspinatus, continuous with the deep portion of the insertion of the pectoralis major (*P.M.*). (Sheppard.)

Teres minor is occasionally divided into two portions, the lower being called the teres minimus.

Teres major may be reduced to the size of the teres minor. It is sometimes inseparably connected with the latissimus dorsi, as in some of the lower animals. A fasciculus has been described descending on the fascia of the arm externally. It is analogous to the tensor fasciæ of the leg.

Subscapularis.—Varies but little. A small accessory muscle (subscapulo-capsularis, subscapularis minor) has been described by W. Gruber, Macalister, and others, which goes from the axillary border of the scapula to the capsule of the shoulder-joint or humerus. Knott describes some fibres given off from the lower border of the subscapularis and inserted into the aponeurosis and skin of the axilla. These are regarded as remnants of the panniculus carnosus muscle of the lower animals.

Curnow, Walsham, and others have described a muscle arising from the inner bicipital ridge, or the groove itself, and passing up to be inserted into the capsule of the shoulder-joint near the insertion of the coracobrachialis. Testut describes this muscle under the name of *humero-capsularis.*

Coracobrachialis.—Professor Wood (*Jour. of Anat.*, vol. i.) considers that this muscle consists typically of three portions—superior, middle, and inferior. In man the middle and part of the inferior portion exist most constantly, the two portions being separated by the musculo-cutaneous nerve. Both the superior and inferior divisions are, however, occasionally seen in addition to the middle division (*coracobrachialis proprius.* The superior (*coracobrachialis superior vel brevis*), when it exists in man, arises from the coracoid process, passes over the subscapularis muscle, and is inserted below the lesser tuberosity, or more rarely into the capsule of the shoulder-joint (*coracocapsularis*). This is the normal arrangement in many animals, as the dog, rat, etc.

The inferior division (*coracobrachialis longus*) is also occasionally seen. It may be of large size and be in-

serted into the internal condyle or into a supracondyloid process when that anomaly exists. It is sometimes represented at its lower portion by a fibrous band; this is the internal brachial ligament of Struthers. As a rule, the inferior portion, when present, passes over the axillary artery, and must be kept in mind when ligaturing that vessel (see Fig. 3449).

Fig. 3449. *A*, Coracobrachialis longus passing over the brachial vessels (*A*) to reach the internal condyle; *C*, normal coracobrachialis. (After Wood.)

The coracobrachialis occasionally is not pierced by the musculocutaneous nerve.

Comparative Anatomy: In animals which swim or climb, as the beaver, bear, etc., the *coracobrachialis longus* is well developed. In most of the quadrumana there is a double insertion of the coracobrachialis, and, in the guinea-pig, the median variety only is present, as in man. In some animals, as the kangaroo, the muscle is absent altogether. It has once been found absent in a human monster. The *coracoscapularis* is present normally in many animals, *e.g.*, the dog, rat, etc.

Biceps Brachii. This muscle is rich in varieties. The most common is the presence of a third head, which arises near the insertion of the coracobrachialis, and in close connection with the brachialis anticus. The proportion of subjects having a third head is, in the writer's experience, one in seven; Theile makes it one in nine; Halbert, one in fifteen; Wood and Macalister, one in ten. In two hundred and fifty subjects examined the writer found it five times on both sides of the same subject. The third head generally soon joins the coracoid head about its middle, but it is occasionally seen quite separate as far as the bicipital fascia, into which it is inserted. The third head usually lies outside the vessels, but sometimes is seen covering them. It may arise from the bicipital groove, one of the ridges, or even from the great tuberosity. The writer has seen it arise from the lower edge of the great pectoral near its insertion (see Fig. 3450).

The third head is regarded by some as an offshoot from the brachialis anticus. Struthers has described a muscular slip which comes off from the inner border of the biceps, passes over the brachial vessels, and is inserted into the internal intermuscular septum or internal condyle.

The biceps has been seen with as many as four and even five heads. The supernumerary heads, as a rule, have their origin from the bicipital groove, body of humerus, coracoid process, capsule of shoulder joint, or tendon of the pectoralis major. The coracoid and glenoid portions of the biceps muscle may fail to unite, being completely separate to their insertion. The long head is occasionally absent, the muscle being triceps instead of biceps, as in some animals. The *long* or *glenoid head* may not pierce the capsule, but arise from the capsule itself, the humerus, or the great pectoral tendon. The tendon of the biceps sometimes pierces the tendon of the pectoral (see Fig. 3450). This is a very rare anomaly. It is not uncommon in old joints that have become dry from rheumatic disease to find the long tendon worn through, and perhaps attached in the groove outside the capsule, or to the head of the humerus, or absent altogether. This pathological condition must not be confounded with the anomaly above described.

The *short* or *coracoid head* may also in rare cases be absent.

The biceps may send a slip of insertion to the coronoid process, capsule of the elbow-joint, or fascia of the forearm. It is sometimes connected with the pronator teres, supinator longus, brachialis anticus, and palmaris longus, by muscular slips. In one case, in which the muscular slip crossed the artery and went to the pronator teres, the bicipital fascia was given off from it.

The semilunar fascia is often of larger extent than usual, and may have a high origin. It may be developed into an almost true tendon. It not infrequently sends offshoots to neighboring parts.

Brachioradialis (Wood). The writer once saw this muscle. It arose from the supracondyloid ridge above the supinator longus, and between it and the deltoid; it coursed down the arm between the long supinator and biceps, and was inserted into the oblique line of the radius immediately above the insertion of the teres. Wood looks upon this muscle as a variety of a fourth head to the biceps.

Comparative Anatomy: A third head is the normal arrangement in many animals, *e.g.*, the, seal, rhinoceros, etc. The long or glenoid head is absent in many animals, especially birds. The short or coracoid head is not present in many animals, as the seal, porcupine, puma, and the carnivora, as the dog, cat, bear, hyena, etc. The glenoid head in these comprises the whole muscle. In some, as the American bear, the coracoid head is represented by a very thin tendinous strand.

Fig. 3450. *AB*, Third head of biceps, arising from the pectoralis major (*PM*), which is perforated by the long tendon of the biceps; *CB*, coracobrachialis. (Halbert.)

Brachialis Anticus. Subject to frequent variations. It may be divided into two or three portions. On one occasion the writer saw a slip arise in common with the outer head of the triceps, and after ending in a round tendon, join the brachialis anticus near the coronoid process. The muscle may be inserted into the capsule of the elbow-joint, radius, bicipital fascia, or fascia of the forearm; it may be connected with neighboring muscles as the biceps, deltoid, coracobrachialis, pronator teres, or supinator longus. All these varieties have been seen by the writer. When there is a continuity of this muscle with the supinator longus it simulates a normal condition which exists in apes and monkeys, assisting them in twisting their bodies when hanging by their inferior extremities.

Triceps Extensor Cubiti. This is one of the most constant muscles in the body as to its insertion. One of the most common varieties is a fourth head arising from the inner side of the humerus. This fourth head may come from the axillary border of the scapula. The scapular head may have a more extensive origin, a strong muscular slip, continuous with the deltoid and separated by a bursa from the teres minor, have a tendinous insertion into the scapular head near its origin,

In some animals, as the American black bear, the scapular head is of huge size, and arises from the whole axillary border of the scapula.

Gruber, Macalister, and Testut each report a case of a slip going from the coracoid process and capsule of the shoulder-joint to the triceps. In one instance the writer saw a fleshy slip between the triceps and teres major.

Dorsoepitrochlearis (accessorius tricipitis). Occasionally the muscle to which the above name is given, and which is common in quadrumana and other animals, is seen in man. It has already been described with the latissimus dorsi.

Epitrochleoanconæus or *Exilis* frequently in man. Gruber found it in one in four, Macalister, one in four, and Wood, one in seventeen. It is triangular in shape, the apex being attached to the back of the internal condyle and the base to the olecranon process. The ulnar nerve passes beneath it and supplies it (see Fig. 3451). This muscle is exceedingly common in mammals. According to Galton, it is extensively present in the edentata, less frequent among the primates, disappears among the anthropoid apes, and emerges again occasionally in man as an anomaly. Mr. Galton considers that it, like the supracondyloid process, is now "an almost functionally useless heirloom, which has descended to us from remote ancestors." Mr. J. B. Sutton (*Journ. of Anat. and Phys.*, April, 1885) says that when the epitrochleoanconæus is not represented as a muscle, its place is occupied by a collection of fibrous tissue having the exact shape and attachments of the muscle, and forming a bridge under which goes the ulnar nerve.

Subanconæus. This consists of a few muscular fibres, which are seen on removing the triceps from the lower part of the humerus; they extend from the lower end of the humerus to the capsule of the elbow-joint. It is homologous with the subcrureus muscle found in the lower limb beneath the quadriceps extensor. It is looked upon by many anatomists as a dependent of the triceps.

Anconæus. May vary as to the closeness of its connection with the triceps or extensor carpi ulnaris.

Pronator Radii Teres. The coronoid head is sometimes wanting, in most animals it does not exist. Occasionally there is a third head which arises from the internal intermuscular septum, or from a supracondyloid process when that variation is present; in such cases the direction of the brachial artery is often changed.

Sometimes the third, or supernumerary, head arises from the tendon of the biceps or brachialis anticus. The pronator teres may have its insertion lower down the radius than usual. It may also be divided into two portions, as in birds. The coronoid portion may be separated entirely from the condyloid, or there may be a doubling of each of these portions.

The pronator teres may be connected with the palmaris longus, carpi radialis flexor, or sublimis digitorum in the forearm and the biceps, brachialis anticus, and coracobrachialis in the arm.

Flexor Carpi Radialis. It may receive an additional slip of origin from the biceps tendon and fascia, the coronoid process, or the radius. It may have an insertion partly into the annular ligament, trapezium, scaphoid, or fourth metacarpal bone.

Palmaris Longus. This is one of the most variable muscles in the body. It is absent in about ten per cent of individuals, and in rare cases is represented only by a tendinous band. It does not exist in the solipeds, ruminants, or pachyderms. The form varies considerably. There may be a central fleshy portion, with a long, slender tendon at each end; the muscular portion may be at the distal end. It has been seen muscular throughout, and again has been seen to consist of two bellies united by tendon. The palmaris longus is occasionally double, when a second muscle exists it generally arises by tendon, or is connected with the carpi ulnaris, or sublimis digitorum muscle. It may arise from the intermuscular septum between the two last mentioned muscles, by a tendinous origin, and continue as part of the ulnaris as far as the middle of the forearm, then form a large belly which ends in a tendon near the wrist. The writer has seen it furnish the origin of the flexor brevis minimi digiti; a somewhat similar arrangement exists in the cebus and ungat. Occasionally it receives an additional slip of origin from the coronoid process or radius. It sometimes terminates variously in the fascia of the forearm, muscles of the little finger, annular ligament, scaphoid, and pisiform bones, and tendon of the flexor carpi ulnaris.

Fig. 3451. *E.A.* Epitrochleoanconæus covering the ulnar nerve. (Sutton.)

Flexor Sublimis Digitorum. The radial origin of this muscle is sometimes wanting. The muscle is occasionally subdivided, each of the tendons being connected with a separate fleshy belly. This is more common with the index and little fingers, and may be classed among the anomalies called progressive. The tendon to the little finger may be absent, or the superficial flexor may be connected by slips with the deep flexor and the long flexor of the thumb. This is the arrangement in most mammals, and in man, and his order only, is seen the marked differentiation of the flexors. One of the lumbrical muscles occasionally arises from the sublimis digitorum. This muscle may send a muscular slip to the annular ligament and palmar fascia; this is the arrangement in the bear, and is supposed to represent the palmaris longus.

Flexor Profundus Digitorum. In many animals this muscle is intimately blended with the foregoing, but in man is generally quite distinct; not infrequently, however, it is connected with the sublimis digitorum and also with the flexor pollicis. It occasionally has an additional origin from the internal condyle and coronoid process (the *accessorius ad flexorem profundum* of Gantzer), which may join any one of the perforating tendons, commonly those going to the index and middle fingers (Wood). This is the normal arrangement in many mammals. The writer saw this coronoid slip very well developed on both sides of a negro subject. He also, some years ago, found a strange variety of the *accessorius* muscle occurring on both sides of the same subject. The muscle arose from both the internal condyle and inner side of the coronoid by fleshy fibres, developed into a large muscular belly which divided into two portions, each ending in a tendon, the innermost going to the terminal phalanx of the little finger, and the outermost to the terminal phalanx of the index, superficial to the tendon of the sublimis. On both sides, near the origin of this accessory muscle, a large slip went to the profundus digitorum.

The profundus digitorum may have an origin from the radius; when this occurs it joins the indicial portion of the muscle.

Flexor Indicis. The indicial portion of the profundus

may be quite distinct from the rest of the muscle. In one case the writer saw it connected with the flexor longus pollicis by a tendinous intersection. A flexor indicis is found in the gorilla and chimpanzee.

The tendon to the little and middle fingers may also be quite separate and distinct from the rest of the profundus. Accessory slips are not infrequently found going to join the various tendons of the muscle.

Fig. 3452. — The Pronator Quadratus, *PQ*, consisting of two triangular portions with bases reversed. (Fenwick.)

Lumbricales. Varieties of these muscles are common; they may be diminished in number to three, or increased to five or six. Two may be inserted into one finger, or one into two by the bifurcation of a muscle. Occasionally the perforating tendons of the fourth and fifth fingers are furnished by lumbrical muscles. The third muscle is more frequently abnormal than the others. The writer has seen the lumbrical muscle of the little finger arise in the middle of the forearm from the sublimis digitorum by a round tendon, this, after passing under the annular ligament, developed a large fleshy belly which was inserted into the fifth finger. This might be regarded as a case of absence of the fourth lumbrical muscle, its place being taken by a slip from the sublimis.

Flexor Longus Pollicis. Has frequently a slip of origin from the coronoid process and internal condyle. This slip has been seen to pierce the radial nerve. The muscle may be connected by a slip with the superficial and deep flexors, and also with the pronator teres. It is sometimes fused with the profundus digitorum so as to form a single muscle, as is the case in nearly all mammals. It is sometimes fused with the indicial portion of the profundus, when that part forms a distinct flexor indicis, as in the gorilla. It has been observed sending a slip to the index finger and also to the first lumbricalis.

Pronator Quadratus. The pronator quadratus is sometimes entirely wanting; it may consist of two, three, and even four layers crossing each other. The attachment to the bones of the forearm may be greater than usual. It occasionally sends a muscular slip from its ulnar or radial attachment to the carpus. It may consist of two distinct triangular portions with the bases reversed; the anterior arising from the ulna by aponeurotic fibres and inserted into the radius by fleshy fibres, the deeper and inferior portion inserted into the ulna by fleshy fibres, and arising by aponeurosis from the radius (Fenwick, Seguey, and Macalister). (See Fig. 3452.)

The muscle may consist of a single triangle, as in some animals, *e.g.*, the macaque, seal, etc.

Flexor Carpi Radialis Brevis (Wood) (Radio-carpeus of Fano). This is a small muscle occasionally seen. It arises from the anterior surface of the radius below the oblique line, and is inserted into the annular ligament, trapezium, os magnum, or other part of the carpus. It may also be inserted into one of the metacarpal bones. A variety of this muscle is, in rare cases, seen arising from the ulna (ulno-carpeus).

Supinator Longus. The varieties of this muscle are few in number. It sometimes has a higher attachment to the humerus than usual, and its insertion into the styloid process may be extended upward along the radius. It may have no attachment directly to the external condyle of the humerus, and in such a case it is closely connected with brachialis anticus. The writer once saw a slip from the supinator attached to the middle of the outer border of the shaft of the radius.

The tendon of the supinator may be divided into two or three slips. In cases of absence of the radius this muscle is wanting.

Occasionally it is double, the accessory portion (*brachio-radialis*) arising with it and being inserted into the radius in the neighborhood of the oblique line. It not infrequently is connected with neighboring muscles viz., the deltoid, brachialis anticus (as in monkeys), flexor carpi radialis longior, and the abductor pollicis. The tendon may be pierced by the radial nerve.

Extensor Carpi Radialis Longior et Brevior. These muscles are sometimes completely fused. In many mammals (horse, pig, etc.) they form a single muscle, which ends in two tendons. In man the fusion may be only partial. The tendons of one or other of the muscles may be subdivided. The *ex. radialis longior* may have an additional insertion into the second or third metacarpal bone. Wood has described a muscle which he calls the *extensor carpi radialis accessorius*. It arises from the humerus below the *radialis longior*, and is inserted into the first metacarpal bone, first dorsal interosseous muscle, abductor, or short flexor of the thumb. The writer has seen a digastric slip given off from the extensor carpi radialis longior, which joined the abductor pollicis. Testut has described an *abducteur huméral du pouce*, arising from the external condyle, and inserted into the first phalanx of the thumb. The long extensor is occasionally united with the supinator longus. Macalister has recorded absence of the short extensor.

Extensor Communis Digitorum. The varieties of this muscle relate chiefly to the increase or diminution of the tendons of insertion. The tendon going to the little finger may be absent, and also that going to the index finger. It is more common to have an increase than a diminution of tendons. Any one of the tendons may be subdivided, and as many as eleven have been observed by Perrin and Rüdinger, due to doubling of some tendons and tripling of others. Curnow in one case saw twelve tendons go to the inner four digits and five to the thumb, making seventeen in all. Five and six are commonly seen, the tendons of the little and index fingers being most often duplicated. The extensor communis occasionally sends a slip to the thumb.

The indicial portion of the muscle may be completely separated from the rest, and the extensor minimi digiti may be inseparably connected with the larger muscle.

Extensor Minimi Digiti. Sometimes fused with the common extensor or carpi ulnaris. It may be double, the additional tendon being inserted into the ring finger. It may have no ulnar attachment, and may be inserted into the annular ligament. Complete absence of the muscle has been observed.

Extensor Carpi Ulnaris. An accessory or short extensor, going from the lower end of the fourth and fifth metacarpal bone, has been described. The tendon is not infrequently prolonged downward to the first phalanx of the little finger (*ulnaris quinti*). It is also frequently connected with the abductor minimi digiti. Sir William Turner has lately reported a case of absence of this muscle; its place was taken by a slender band of fibrous tissue. Curnow has also recorded absence of this muscle.

Supinator Brevis. An accessory supinator brevis has been observed going from the external condyle of the humerus to the radius or ulna. The extent of attachment to the radius may be much greater than usual. A sesamoid bone is sometimes found in the tendon of the muscle. This occurs normally in some animals, and is also seen in the papillens, of which the short supinator is supposed to be the homologue.

Extensor Ossis Metacarpi Pollicis. The tendon of this muscle is frequently double, and sometimes is triple. When double, usually both are inserted into the meta-

carpal bone, or one into this bone and the other into the trapezium, as is the normal arrangement in apes. The supernumerary tendon may be inserted into one of the short muscles of the thumb. The muscle may be double throughout, and Curnow has in one case seen it triple.

Extensor Primi Internodii Pollicis. Is sometimes absent, or is not differentiated from the extensor ossis metacarpi. Curnow describes a case of doubling of this muscle. It is found only in man.

Extensor Secundi Internodii Pollicis. Doubling of the muscles is not uncommon. Additional muscles are occasionally present, and have been described by Curnow (*Journ. Anat. and Phys.*, vol. x., p. 506).

Extensor Primi Internodii Pollicis et Indicis. In some rare cases there is an accessory extensor present, which arises between the extensor indicis and the extensor secundi internodii pollicis; it divides into two tendons, one of which goes to the first phalanx of the thumb, and the other to the index finger. This muscle exists normally in the dog and many other carnivora.

Extensor Indicis. The tendon of this muscle is frequently divided into two portions, one going to each side of the index finger; sometimes one of the tendons goes to the middle finger. This latter is occasionally seen as a distinct muscle (*extensor propriodigiti medii*). It arises from the lower part of the ulna or posterior ligament of the wrist-joint, and is inserted into the base of the first phalanx of the middle finger. It exists normally in apes.

A short *extensor indicis* is occasionally seen taking its origin below the long extensor, from the back of the wrist or a carpal bone; it is inserted with the long extensor into the index finger. The writer has seen this accessory muscle arise from the radius, and pass through a separate compartment in the annular ligament to be inserted into the index finger. The extensor indicis may have a more extensive attachment to the radius than usual. The writer has seen it connected by a tendinous slip with the extensor secundi pollicis. Curnow describes one case in which the muscle divided into three tendons—one inserted normally, one with the secundi internodii, and one with the aponeurosis over the middle finger. A somewhat similar arrangement is seen in the hedgehog, kangaroo, and manis. It is rarely absent.

Extensor Pollicis and Indicis (see above).

Extensor Brevis Digitorum. Very rarely met with. It arises from the back of the wrist, post-annular ligament, from the carpus itself, or the bases of some of the metacarpal bones by fleshy fibres; it sends tendinous slips to one, two, or three fingers. The writer has seen them going to the ring and index fingers and to the middle finger. It is probable that the extensor brevis indicis and extensor medii digiti are varieties of this muscle. (See Fig. 3453.)

This muscle is common in reptiles, and survives only in a few anomalous mammals of the order Edentata (Curnow).

Muscles of the Hand.—*Palmaris Brevis.* Varies considerably as to its degree of development. It is occasionally altogether wanting.

Adductor Pollicis. Some anatomists describe the muscle as normally consisting of two portions—an outer and inner. It may receive a third belly from the opponens pollicis, or be connected with it by a muscular slip. It may also receive an accessory slip from the extensor carpi radialis longior, ossis metacarpi pollicis, palmaris longus, or from the radius. Not infrequently a thin, muscular slip is seen going from the skin of the ball of the thumb opposite the tuberosity of the trapezium to the adductor pollicis. Some regard this latter as a skin-muscle.

Flexor Brevis Pollicis. The deeper belly of the muscle is often with difficulty differentiated from the adductor pollicis.

Abductor Pollicis. This muscle is frequently blended with the deep portion of the short flexor of the thumb.

Abductor Minimi Digiti. Sometimes divided into two or even three slips. It is often united with the flexor brevis minimi digiti. It may have an accessory slip arising from the tendon of the ulnar flexor, the annular ligament, fascia of the forearm, and tendon of the palmaris longus. The writer has seen an accessory head arise from the intermuscular fascia beneath the flexor radialis and ulnaris. The accessory slip may pass down and cover the ulnar artery.

Flexor Brevis Minimi Digiti. May be absent or replaced by a slip from the abductor minimi digiti or opponens. An accessory head may spring from the lower third of the inner border of the ulna, from the carpi ulnaris, or fascia of the forearm. A doubling of the muscle has been observed.

Opponens Minimi Digiti. May be closely connected with neighbouring muscles, or receive a second head from the fascia of the forearm (Henle.)

M. Pisiuncinatus. This is a muscle described by Calori, and stretches between the pisiform bone and unciform process of the uniform bone.

Interossei. These muscles do not vary to any great extent. They may be double in one or two interosseous spaces. Henle describes a *palmar interosseous* muscle of the thumb as normal. It arises from the metacarpal bone of the thumb, and joins the inner head of the flexor brevis pollicis. The arrangement of the interosseous muscles of the hand has been observed, in rare cases, to be similar to that of the foot.

Accessory Palmar Abductor Indicis. The writer once saw a small muscle arising from the third metacarpal bone, beneath the adductor pollicis and inner head of the flexor brevis pollicis. After ending in a round tendon, it was inserted into the base of the first phalanx of the index finger.

Muscles of the Lower Limb.—*Gluteus Maximus.* The great size of this muscle is peculiar to man, principally on account of his erect position. In the human species the muscle always covers the ischial tuberosity; in apes, this is uncovered. The variations are important. The muscle may be considerably reduced in size. Macalister reports a case in which the muscle was attached above to the last two sacral vertebræ only. The superficial portion of the muscle is often separated from the deep by a layer of cellular tissue. The lower edge of the muscle is sometimes quite distinct, and represents the *sphincter ani* of the lower animals; it may be inserted into the femur or the femoral aponeurosis. The gluteus maximus is occasionally blended with the tensor fasciæ, as in the elephant and some monkeys.

Fig. 3453. *EBD*, Extensor brevis digitorum. (After Wood.

Ischio-femoral. The writer has only once seen this muscle. It arose from the inner edge of the great tuberosity by a round tendon, which soon developed into a triangular shaped muscle of considerable size; it was separated from the gluteus maximus by the great tuberosity, and joined it near the femur. It was inserted into the lower end of the gluteal ridge of the femur. The *ischio-femoral* muscle exists normally in the gorilla, certain apes, and other animals.

Gluteus Medius. The deeper fibres of this muscle may

end in a separate tendon, which is attached to the upper border of the great trochanter. Its upper or lower border may be separated from the rest of the muscle. Occasionally a bursa is interposed between the tendon of the gluteus medius and the pyriformis. Some of its fibres may be inserted into the pyriformis, or its posterior border may be completely fused with that muscle.

Gluteus Minimus. Occasionally divided into anterior and posterior portions; may send slips to the hip-joint, to the pyriformis, gemelli, or vastus externus muscles.

Accessory Gluteus Minimus (fourth gluteal; scansorius). The fibres of the anterior border are in some cases separated from the muscle, and inserted variously into the anterior border of the great trochanter, into the capsule, or near the lesser trochanter, where it is connected with the iliacus tendon. It represents the scansorius muscle of apes. Testut looks upon it as representing the extra-pelvic portion of the iliacus muscle.

Tensor Vaginæ Femoris (tensor fasciæ). Varies but little. May have a supernumerary origin from the abdominal fascia, iliac crest, and Poupart's ligament. It

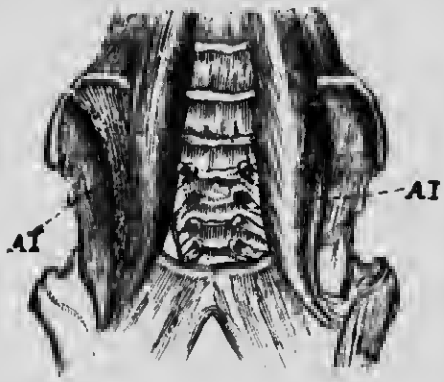

Fig. 3454. *AI, AI.* Examples of double superficial iliacus muscles.

is sometimes fused with the gluteus maximus. A duplication of the muscle has been observed by Macalister and Testut.

Pyriformis. The most common variation of this muscle is its division into two portions by the great sciatic nerve or its external popliteal branch. It is occasionally fused with the gluteus medius more or less completely. It may be connected with the gluteus minimus by a few fibres. Its tendon is sometimes united with that of the obturator internus, or receives the gemellus superior. It may have its origin from as many as five sacral vertebræ, or as few as one. It frequently has no attachment to the first sacral vertebra. It may be inserted into the capsule of the hip-joint. Its complete absence has been noted by several observers.

Obturator Internus. The variations of this muscle are unimportant. It may receive supernumerary fasciculi from various parts in the pelvis, as the psoas minor muscle, ischial tuberosity, sacro-sciatic ligaments, third sacral vertebra, pubes, etc. A pubic portion is sometimes separated by the obturator nerve.

Obturator Externus. Wood has described a large fleshy slip going from the adductor brevis to join the tendon of this muscle, and Macalister has noted a separation of a pubic fasciculus by the obturator nerve.

Gemelli. The *superior gemellus* is not infrequently absent, or very small in size. The *inferior gemellus* has also been observed absent, but more rarely. Doubling of the *superior* has been noticed; it has also been seen fused with the pyriformis and gluteus minimus. The gemellus inferior and quadratus femoris are frequently inseparably united to the obturator internus.

Quadratus Femoris. This muscle may be much reduced in size, or absent altogether; in such a case, the inferior gemellus is larger. It has been described as sometimes double. It may be united above with the gemellus inferior, and below with the adductor magnus.

Biceps Flexor Cruris. The two heads may be quite separate, as in the orang and chimpanzee. The short head may be divided into several fasciculi, or, in rare cases, absent altogether. This latter arrangement is the usual one in a large number of mammals. There is sometimes a third head, which may arise from the femur, from the ischial tuberosity, coccyx, sacrum, fascia lata, or gluteal fascia. The third head generally joins the long head, though when it arises from the linea aspera, or inner condyloid ridge, it joins the short head. The third head has been looked upon as homologous with the caudal origin of the biceps in the lower animals. In rare cases a slip (*ischiocalcaneus*) has been seen going from the long head to the gastrocnemius, external tuberosity of the tibia, femoral aponeurosis, and even to the tendo Achillis. This arrangement is a modification of that seen in the lower animals, especially the bear.

I have seen a muscular slip arising from the biceps near its insertion and inserted by a tendinous expansion into the fascia covering the lower third of leg.

Semitendinosus and *Semimembranosus.* These two muscles may be fused into one. The *semimembranosus* may be absent altogether. It has been seen double. Occasionally, it derives its origin for the most part from the great sacro-sciatic ligament.

The *semitendinosus* may have a supernumerary origin from the coccyx, and sometimes gives off a muscular slip about its middle, which is inserted into the fascia of the leg. This arrangement is normal in some of the lower animals.

Psoas Magnus. Varies somewhat in volume, according as its origin is more or less extensive. It occasionally forms a muscle quite distinct from the iliacus. It may be divided into two portions, between which passes the anterior crural nerve. This is merely an exaggeration of the normal condition. An accessory psoas is sometimes seen arising from the transverse processes of some of the lumbar vertebræ. The writer, in a male subject, saw this accessory psoas of considerable size; it arose from the transverse process of the fourth lumbar, and as it descended widened out into a fusal muscle, which joined the magnus in the middle of the iliac fossa.

Psoas Parvus. Frequently absent and occasionally fused with the magnus. It usually arises from the bodies of the last dorsal and first lumbar vertebræ, and soon becomes tendinous; it then passes down to the inner side of the magnus, and ends by being inserted into the ilio-pectineal line and pectineal eminence. It has been noted as having an insertion into the lesser trochanter, as in the seal, guinea-pig, etc.

Although inconstant in man, it is a large, well-developed, and constant muscle in the lower animals. Gruber in 450 subjects found absence of this muscle on both sides in 183, and on one side in 60; Perrin in 112 subjects found it present in only 32; Theile found it in only 1 out of 20 subjects examined; and Testut, 6 out of 32.

It is occasionally double.

Iliacus. May be divided into several distinct portions. The deep portion is not infrequently separated from the superficial by a well-marked cellular interval, and thus constitutes a separate muscle.

Superficial Iliacus. Sometimes seen arising from the crest of the ilium, last lumbar vertebra, or upper border of the sacrum. In one subject, the writer saw this muscle on both sides: on the right side it was a broad, flat muscle, arising from the posterior third of the crest of the ilium, and on the left a fusiform muscle, which arose from the body of the last lumbar vertebra and upper border of the sacrum. Both muscles ended in strong tendons, which were pierced by the anterior crural nerve, and joined the iliacus below Poupart's ligament (Fig. 3454).

Iliacus Minor. Arises from the anterior inferior spine of the ilium and capsule of the hip-joint; it may be inserted into the lower part of the

anterior intertrochanteric line, lesser trochanter, or iliofemoral ligament. In one subject the writer saw a well-marked fascia separating it from the iliacus.

Sartorius. A case of absence of this muscle has been reported by Meckel. It is occasionally double in its whole course. An accessory portion has been seen having an insertion into the femur, patella, or tendon of the normal muscle.

The sartorius, in addition to its tibial attachment, may have an insertion into the femoral aponeurosis, the capsule of the knee-joint, or the femur itself in the neighborhood of the internal condyle. All these various insertions are seen normally in mammalia. A tendinous inscription in rare cases is seen in this muscle. The writer has only once met with this anomaly.

Quadriceps Extensor Cruris. Not subject to many variations. Occasionally the acetabular origin of the *rectus* is wanting, or it may be reinforced by an additional origin from the anterior superior spine. The *vasti* muscles may be divided into two portions, superficial and deep; this bilaminar arrangement is the normal one in many birds. The two vasti muscles are often closely united.

The *subcrureus* is a muscle which is very variable in volume. It is often divided into two or more separate muscular bundles.

Accessory Head to Quadriceps. The writer once saw, on the left side of a male subject, a supernumerary muscle which arose by a double tendinous origin from the anterior portion of the capsule of the hip-joint and the anterior border of the great trochanter. The two tendons soon united to form one strong tendon, which passed down the thigh between the iliacus and tensor fasciæ, lying on the vastus externus; about the middle of the thigh it developed into a strong muscular belly three inches long. After passing beneath the rectus it joined the common tendon of the quadriceps.

Gracilis. The variations are unimportant and consist chiefly of a greater or less extent of origin and insertion. An accessory head is sometimes seen.

Pectineus. May be occasionally divided into two portions, as in some of the lower animals, each portion supplied by a different nerve—the inner by the obturator, and the outer by the anterior crural. In one case the writer saw it divided into a superficial and a deep portion; the superficial arose from the pectineal line, two inches outside the pubic spine, and was inserted into the linea aspera, with the adductor magnus. The deep portion was the normal muscle.

The pectineus is not infrequently united with the adductor longus; this occurs normally among the Rodentia Carnivora, and Quadrumana. It may be sometimes inserted into the capsule of the hip-joint.

Adductor Longus. May be divided into two portions by the passage of blood-vessels. It is often inserted low down on the femur, and its tendon is inseparable from the magnus. It is sometimes fused with the pectineus.

Adductor Brevis. Occasionally divided into two or three portions—may be continuous with the magnus. It has been reported as united to the tendon of the obturator externus.

Adductor Magnus. The upper part of this muscle is so often separated from the main portion that Henle, Macalister, and other anatomists describe it under the name *adductor minimus* or *quadratus*. Its upper border is occasionally completely united with the quadratus femoris. The different parts of the muscle are not infrequently separated: the portion inserted into the internal condyle is frequently quite distinct (*ischio-condyloid*).

Tibialis Anticus. This muscle has been seen arising from the femur, as occurs so generally in the higher mammals. In the case referred to the leg was congenitally deformed. The tendon is occasionally double, the extra tendon being inserted into the astragalus or base of the first metatarsal, as in apes. The tendon has been seen divided into three portions, and occasionally a sesamoid bone is formed in it.

I have seen a muscular slip from the tibialis anticus end in a tendon which was inserted into the proximal phalanx of the fourth toe. I have also seen this slip inserted into the first phalanx of the great toe.

Tibiofascialis Anticus. A small muscle described by Wood, Macalister, and Humphry, which arises from the lower third of the anterior edge of the tibia, over the tibialis anticus, and is inserted into the annular ligament and deep fascia. It is sometimes represented by a tendinous slip from the tibialis anticus, which is inserted into the fascia of the dorsum of the foot. Gruber describes a *tibio-astragalus anticus* arising from the tibia and interosseous ligament behind the tibialis anticus, and inserted in the neck of the astragalus.

Extensor Proprius Hallucis. Is occasionally united with the extensor communis digitorum, or short extensor of the toes. The muscle or its tendons may be double, and have a supernumerary insertion into the metatarsal bone or first phalanx of great toe. It is sometimes inserted into the second toe. Its tendon may be divided into three portions (*extensor hallucis longus tricaudatus*).

Extensor Ossis Metatarsi Hallucis is a small muscle arising from the extensor hallucis, tibialis anticus, extensor communis digitorum, or as a separate muscle close to the extensor hallucis, going through the same compartment in the annular ligament as the hallucis; it is inserted into the metatarsal bone of the great toe.

Extensor Primi Internodii Hallucis. In one-half the subjects examined Professor Wood found this muscle; it is generally an offshoot from the extensor hallucis, but sometimes arises separately.

Extensor Longus Digitorum Pedis. Varies considerably in the mode of origin and the arrangement of its tendons. The number of tendons may be increased by the doubling of any one. It is not uncommon for the tendon going to one toe to give slips to adjacent toes. It may have an additional insertion into the metatarsus. Occasionally a supernumerary tendon is seen going to the great toe. The tendons may be united on the dorsum by slips, as in the hand. It may be united to a greater or less extent with the extensor proprius hallucis, or extensor brevis digitorum. Each of the tendons may have a separate muscular belly in connection with it. Wood reports a case in which the four tendons had each a separate muscular belly. All these abnormal arrangements have their corresponding normal conditions in the lower animals.

Peroneus Tertius. Sometimes of large size, and occasionally inserted entirely into the fourth metatarsal bone. Its tendon may unite with that of the extensor going to the fourth or fifth toe, or it may unite with the fourth dorsal interosseous. The muscle may be absent altogether or be double.

Peroneus Longus. Occasionally fused with the brevis. In one case it has been noted as arising from the femur, as in many lower animals, *e.g.* the bear, hyæna, etc. It may have a supernumerary insertion into one of the metatarsal or cuneiform bones, as occurs in some animals. The tendon sometimes gives origin to the flexor brevis minimi digiti and outermost plantar interosseous (Wood).

Peroneus Accessorius. This is a small muscle which arises from the fibula between the peroneus longus and peroneus brevis, and ends in a tendon which joins the long peroneal.

Peroneus Brevis. The tendon of this muscle is occasionally divided into two portions, the supernumerary one going to the fourth metatarsal or cuboid bone, or to the proximal phalanx of the fifth toe, joining the extensor tendon of that toe. It may also be inserted into the adductor minimi digiti.

Peroneus Quinti Digiti. It arises from the fibula beneath the peroneus brevis, and is inserted into the extensor aponeurosis of the little toe. It is seldom seen as a distinct muscle, being generally united with the peroneus brevis. It is seen normally in some animals, as the bear and the cat.

Peroneus Quartus. A muscle which is not infrequently seen arising from the back of the fibula, between the peroneus brevis and flexor hallucis, or from the fascia of the deep muscles of the calf; it is inserted into the external malleolus, peroneal tubercle of the os calcis, or the

ridges of the cuboid groove. This is looked upon by Testut as a variety of the peroneus quinti digiti.

In a male subject the writer saw, on both sides, the peroneus longus divided into two portions: the outer and larger passed down in the usual course of the long muscle, but the inner and smaller portion, which arose principally from the intermuscular septum, ended in a tendon which passed through the same compartment in the annular ligament as the outer portion, and immediately before it reached the peroneal tubercle it divided into two parts, one of which spread out and was inserted into the tubercle; the other crossed over the tendon of the peroneus brevis and was lost in the fascia covering the dorsum of the foot; between these two tendons passed the tendon of the peroneus brevis. This was probably a variety of the peroneus quinti digiti and peroneus quartus muscles.

Fig. 3455. A, Example of a third head to the gastrocnemius. (Wood.)

Extensor Brevis Digitorum. The number and arrangement of the tendons vary considerably. Very frequently one or more of the tendons are doubled. A slip not infrequently goes to the little toe. The number of tendons may be reduced to two; occasionally a single tendon may have two muscular heads in connection with it. The innermost portion going to the great toe is often separated from the rest of the muscles, and is called the *extensor brevis hallucis*. Wood describes cases in which slips from the tendons of the extensor brevis joined the dorsal interossei. There may be a special slip going to the second metatarsal bone or long extensor tendon of the second toe. This would be the homologue of the extensor indicis of the hand.

Gastrocnemius. The two bellies are sometimes more or less completely separated from each other, as in the marmot, mani, ronti, etc. The most common anomaly is the existence of a third head (see Fig. 3455). This consists of a band of muscular fibres, which may arise from either condyloid ridge, the popliteal surface of the femur, or the posterior ligament of the knee-joint; passing down, it most frequently joins on the united muscle. This third head may pass between the popliteal artery and vein, or over both vessels and nerves. It is sometimes divided into two portions.

The writer has seen a third head arising from the inner side of the tendon of the biceps femoris, about three inches above the condyles. It passed down, and joined the external head about one inch above its junction with the internal one. This is the normal arrangement in the lion and some other animals.


Fig. 3456. Absence of the external head of gastrocnemius. (Shepherd.)

A slip may be given off from the biceps, semitendinosus, or adductor magnus to the gastrocnemius. The writer, in one female subject, saw complete absence of the external head. On removing the skin and fat, the first structure which came into view was the plantaris muscle (see Fig. 3456). Absence of the whole muscle has been observed.

Occasionally a sesamoid bone is developed in the tendon of the external head. A similar arrangement exists in many animals.

Soleus. An accessory soleus is occasionally seen which arises from the oblique line of the tibia and joins the inner side of the soleus; it covers the posterior tibial artery, and is often of large size.

The soleus has been observed of very small size, the fibular portion alone existing.

It is sometimes inserted into the os calcis separately from the gastrocnemius, an arrangement which is common in many animals. A muscular slip going from the tibia to the tendinous arch over the popliteal vessels has been occasionally seen.

Plantaris. The plantaris, which is rudimentary in man and gradually disappearing, is of large size in some animals, and in them is continuous with the plantar fascia or flexor brevis digitorum. In man it is frequently absent. It sometimes arises by two heads, the supernumerary one coming from the posterior ligament of the knee joint or from one of the condyles. The writer has seen this supernumerary head arise from the outer head of the gastrocnemius and the middle of the outer surface of the soleus by a tendinous origin.

The plantaris has been seen to arise from the popliteal fascia and tibia. The writer on one occasion saw it arise solely from the posterior ligament of the knee joint. The mode of its insertion varies, its tendon sometimes joins the tendo Achillis or internal annular ligament, or ends in the deep fascia of the leg. It may send a slip to the plantar fascia (*tensor fasciæ plantaris*). Its tendon may be enclosed in the lower part of the tendo Achillis.

Fig. 3456a. *A P*, Accessory popliteus arising from a sesamoid bone; *S*; *P*, normal popliteus. (Wagstaffe.)

Popliteus. A sesamoid bone is sometimes developed in its tendon of origin. The muscle in rare cases is absent altogether.

Popliteus Minor. Is a small muscle, rarely seen, which arises from the femur internal to the plantaris and is inserted into the posterior ligament of the knee joint. Wagstaffe has described an accessory popliteus which arose from a sesamoid bone developed in the external head of the gastrocnemius, and was inserted into the oblique line of the tibia superficial to the normal muscle (see Fig. 3457).

Peroneotibialis. This is a muscle described by Gruber, who met with it in one in seven subjects. It arises from the inner side of the head of the fibula, and is inserted into the upper end of the oblique line of the tibia. It is placed beneath the popliteus, and is looked upon as the homologue of the pronator teres in the arm. It is seen in many of the lower animals.

Flexor Longus Digitorum Pedis. This muscle varies somewhat as to its origin. It frequently receives extra slips of origin from the deep fascia and aponeurosis of the leg, the tibia, fibula, or flexor hallucis. The writer has several times seen muscular fibres originating extensively from the deep aponeurosis and flexor hallucis, and crossing the tibialis posticus to reach the flexor digitorum. In some cases the tibialis posticus was completely hidden from view by muscular fibres. A similar arrangement is seen in a great many of the apes. The tendon going to the second toe is sometimes absent; in these cases the second toe receives a slip from the flexor hallucis.

Flexor Accessorius Longus Digitorum Pedis. This muscle and its varieties have been described under various names, as *tibiocalcaneus, accessorius ad accessorium* (Turner); *peronæocalcaneus internus* (Macalister); *pronator pedis* (Humphry). It may arise from the tibia or

fibula by a fleshy belly and in a well-marked tendon, which passes through a separate compartment in the annular ligament, either in front of or behind the flexor hallucis, and finally ending by joining the flexor accessorius or the tendon of the long flexor before it divides. It has been seen to replace the proper accessorius. In its course down to the foot, its fleshy fibres generally cover over the posterior tibial vessels and nerves. When it arises from the fibula and is inserted into the tubercle of the os calcis, it is called the *peronæocalcaneus internus*, and is looked upon as the homologue of the pronator quadratus of the forearm. The writer has several times seen this muscle arising from the tibia, and only once from the fibula. In one case it arose by two fleshy heads, one from the flexor hallucis, and the other for two inches from the inner border of the tibia immediately below the soleus; the two heads united to form a single belly which, after covering the posterior tibial vessels, ended in a tendon. This tendon passed beneath the annular ligament posterior to the vessels, and in the sole of the foot joined the tendon of the long flexor; the normal accessorius was inserted into this tendon instead of into that of the flexor.

A *flexor proprius digiti secundi*, arising from the tibia and going to the second toe, has been described by Bahnsen.

Flexor accessorius. The outer head is not infrequently absent. The muscle is sometimes much reduced in size and may even be absent. Its accessory long head has already been described under the name flexor accessorius longus digitorum pedis.

The number of digital tendons to which this muscle can be traced varies considerably. Offsets may be sent to the second, third, and fourth toes, and sometimes to the fifth. In rare cases it can be traced to only two tendons. The muscle has been observed going to the flexor hallucis tendon instead of the digitorum. It sometimes gives off a slip to the fifth toe (as in monkeys), when the slip to that toe from the brevis digitorum is absent.

Lumbricales. Absence of one or more of these muscles occasionally occurs. The writer once saw, on both sides of the same subject, the two outer ones absent. Two are sometimes seen going to one toe. The tendons are frequently inserted into the first phalanges of the toes.

Flexor Hallucis Longus. Seldom varies. The tendons of the digitorum longus and hallucis are seldom completely separated; they are generally united by a slip from the hallucis to the digitorum, and sometimes by one from the digitorum to the hallucis. The slip from the hallucis may generally be traced to the second or third toes, sometimes to all, and sometimes to the second only. In a subject dissected in 1879 by the writer, the tendon of this muscle divided into three tendons, which went to the great, second, and third toes. The longus digitorum divided into four tendons as usual; but those going to the second and third toes were of small size, and joined the ones from the hallucis. The lumbrical muscles were in connection with the digitorum tendons. In this case there was no connection between the tendons of the muscles before division. A slip may be given off from the flexor hallucis in the leg, and after passing under the annular ligament, may join the accessorius. This is a variety of the muscle described above—*flexor accessorius longus digitorum pedis*. In rare cases the tendons of the two long flexors are fused into one, as is seen in the lower animals. The writer once saw a sesamoid bone developed in the tendon of this muscle as it passed over the astragalus and os calcis.

Tibialis Posticus. Very seldom varies. Is occasionally blended more or less intimately with the flexor hallucis. A sesamoid bone is frequently developed in its tendon. It has been described as being inserted into the peroneus longus tendon, second, third, and fourth metatarsal bones, and cuboid. Wood has seen it combine with the flexor brevis hallucis muscles. It has been reported absent by Budge.

Tibialis Secundus. This is a muscle described by Bahnsen, Henle, and Linhart. Henle calls it the tensor of the capsule of the ankle-joint. It arises from the back of the tibia below the flexor digitorum longus, and is inserted into the posterior part of the capsule of the ankle-joint or annular ligament. A similar muscle has been described as being inserted into the anterior part of the capsule of the ankle-joint.

FIG. 3458.—AQ. Example of the abductor ossis metatarsi quinti arising from os calcis. (Bradley.

Flexor Brevis Digitorum. The slip going to the fifth toe, which is usually of small size, and very often not perforated by the deep flexor, is sometimes absent altogether. Five tendons have been observed, two going to the second toe. The slip to the little toe, when absent, is occasionally replaced by a small muscle arising from the outer side of the long flexor tendon or flexor accessorius. This arrangement is seen in many of the apes.

The tendons of the short flexor may be united to those of the long flexor, and have a common insertion. Some portion of the short flexor may arise from the long flexor tendon. The writer, a few years ago, saw a very good example of this, an arrangement which is like that which exists in apes. The muscle consisted of two portions, superficial and deep; the superficial arose from the inner tuberosity of the os calcis, and divided into two tendons which went to the second and third toes; the deep portion, however, arose by a fleshy origin from the deep flexor tendon before it was joined by the accessorius; its tendons were distributed to the fourth and fifth toes.

Wood mentions a case in which the slip to the fifth toe was augmented by another from the long flexor tendon; they formed a single tendon, which was not perforated but blended with the tendon of the long flexor going to that toe.

Abductor Hallucis. Its tendon is sometimes joined by a muscular slip which comes from the skin in front of the inner ankle. Wood describes a muscular slip from the abductor to the base of the first phalanx of the second toe.

Abductor Minimi Digiti. The tendon is sometimes double.

Abductor Ossis Metatarsi Quinti. A portion of the above has been described, by Wood and Bradley, as a separate muscle arising from the outer tubercle of the os calcis, and inserted into the base of the fifth metatarsal bone; it occurs in about every other subject. Most anatomists look upon this as merely an insertion of the abductor minimi digiti, which fails to exist in about half the subjects examined. Occasionally it exists as quite a separate muscle (see Fig. 3458), having an extensive origin from under the surface of the os calcis. The interest attaching to this muscle lies in the fact that it is the true homologue of a muscle always present in the anthropoid apes.

Flexor Brevis Hallucis. A slip may be sent to the base of the first phalanx of the second toe (Wood). It sometimes receives fibres of origin from the os calcis or long plantar ligament. Occasionally it fails to be attached to the cuboid.

Abductor Hallucis. Occasionally a slip is seen going to the base of the first phalanx of the second toe; this may arise from the second metatarsal bone, or sheath of the tendon of the peroneus longus. Henle thinks it represents the *interosseus tertius primus* of the hand.

Opponens Hallucis (Macalister). Given off from the preceding muscle and inserted into the base of the metatarsal bone of the great toe, as in apes.

Abductor Indicis. The writer once saw a large muscle arise from the cuboid and sheath of the peroneus longus tendon, outside the adductor hallucis, and go to be inserted into the base of the first phalanx of the second toe. This, no doubt, is the homologue of the adductor indicis of quadrumana and other animals, as the sloth elephant, etc.

Transversus Pedis. The slip from the fifth toe is often wanting, and others may also be absent. The whole muscle is occasionally absent.

Superficial Transversus Pedis. In 1879 the writer saw, in the right foot of a male subject, immediately beneath the skin, a muscle which arose from the bases of the first phalanges of the second, third, and fifth toes, and was inserted into the base of the first phalanx of the great toe; deeper down the normal transversus pedis existed and was of the usual size.

Flexor Brevis Minimi Digiti. A slip of muscle is very frequently seen given off from the inner border of this muscle, and inserted separately into the anterior half of the lateral border of the fifth metatarsal bone. In some cases it is almost a distinct muscle. Henle calls it the *opponens minimi digiti*, and looks upon it as the normal arrangement. It is well developed in the orang-outang.

Interossei. Seldom abnormal. May vary sometimes in size, according to the size and use of corresponding digit (Wood). A slip is occasionally seen arising from the base of the second metatarsal bone and sheath of the peroneus longus, and inserted into the base of the first phalanx of the second toe. Henle regards this as the homologue of the interosseus volaris primus of the hand.

Muscles of the Trunk.—*Rectus Capitis Posticus Minor.* The writer has once seen this muscle absent on the right side. The left was of large size.

Serratus Posticus Inferior. Macalister has observed absence of this muscle. It may consist of only three slips, or in rare cases there may be as many as five or six from the first to the sixth rib. Slips may be received from the levator anguli scapulæ. I have, in two cases, seen a well-developed muscular slip arising from the mastoid process, beneath the sterno-mastoid, and inserted into the upper border of the serratus posticus superior. Once I noted a slip passing from the fifth cervical transverse process to this muscle.

Serratus Posticus Superior. In rare cases the whole muscle has been absent. Absence of one or more digitations is not infrequent. It is occasionally of larger size than normal. The writer once saw it arise from the four lower dorsal spines, and two upper lumbar, and go to be inserted into the five lower ribs.

Splenius. The extent of origin of the splenius varies. It not infrequently reaches as high as the middle of the ligamentum nuchæ; it may even be attached to the occipital protuberance (as in the bear). In one subject, on both sides, the writer saw the splenii attached to the whole length of the ligamentum nuchæ, the occipital protuberance, the superior curved line of the occipital bone, and the mastoid process. The two muscles presented the appearance of an inverted triangle.

The splenius colli may have a slip of attachment to the third cervical transverse process. The writer has seen it send slips to the second and third cervical, and in one case to the cervicalis ascendens. The splenius capitis may be quite distinct from the splenius colli, or these two portions may be fused together. The colli portion has been reported absent.

Rhomboideus Capitis (Macalister). Splenius accessorius, adjutor splenii (Walther). This muscle has already been described with the rhomboid. It is a muscular slip going from the transverse process of the atlas to the serratus magnus, rhomboid or serratus posticus superior, and is looked on by Wood as indicating the first degree of differentiation in man toward the formation of the occipito-scapular muscle of the lower animals.

Ligamentum Nuchæ Replaced by Muscle. The writer, in one case, saw the upper part of this ligament replaced by strong muscular fibres, which were attached to the external occipital protuberance, the whole length of the occipital crest, and the posterior tubercle of the atlas and axis. The external border of this muscle consisted of a thick, round tendon, continuous below with the ligamentum nuchæ, which was normal from the spine of the third cervical vertebra.

Sacrolumbalis. The inferior and superior accessory origins of the sacrolumbalis are infrequently absent. The *cervicalis ascendens* may arise as low as the tenth rib, and be inserted as high as the third cervical.

Spinalis Cervicis. This is described by Henle as a normal muscle. It is very inconstant, and arises from the spines of the fifth, sixth, and seventh cervical and upper two dorsal vertebræ, and is inserted into the spine of the axis, and sometimes the spines of the third and fourth cervical vertebræ.

Extensor Coccygis (sacrococcygeus posticus). This is the name given to some slender muscular fibres occasionally seen going from the lower end of the sacrum or the posterior inferior iliac spine to the coccyx. It is the homologue of the great caudal extensor of the lower animals.

Longissimus Dorsi. May vary somewhat as to the number and extent of its attachments. The writer once saw it receive accessory fibres from the spines of the third, fourth, fifth, and sixth dorsal vertebræ.

Spinalis Dorsi. The number of tendons of insertion may be reduced to three; one spine may receive two tendons.

Complexus. The biventer cervicis may be completely fused with this muscle. It may be fused with the trachelo-mastoid or longissimus dorsi. The number of vertebræ to which it is attached may vary from two to seven. A supernumerary fascia sometimes arises from the transverse process of the second dorsal vertebra, and is inserted into the occipital bone beneath the normal muscle. The biventer frequently receives accessory slips from some of the lower cervical or upper dorsal vertebral spines, or from the ligamentum nuchæ. Slips have been seen going to join it from the seventh cervical transverse process.

Multifidus Spinæ. The origin from the seventh cervical vertebra may fail. Muscular slips may run from the necks of the first and second ribs to the fifth and sixth cervical vertebræ, as well as between other ribs and vertebræ.

Interspinales. Longer interspinous bundles are sometimes found passing over one or two vertebræ. In the neck the bundles are broader.

The short *Rotatory* muscles of the neck may be occasionally doubled.

External Intercostals. The last ones are sometimes wanting. Not infrequently they extend as far as the sternum between the costal cartilages. The lower intercostals occasionally are continuous with the external abdominal oblique.

Internal Intercostals. These frequently extend to the vertebral column. The last two are sometimes absent, or so small that it requires a very careful dissection to discover them.

Supracostalis (Wood); *Rectus Thoracis* (Turner). This is a muscle which lies on the upper ribs in the antero-lateral part of the thorax, and generally extends from the first to the fourth rib.

It has been looked upon: (1) as the homologue of the thoracic extension of the rectus abdominis to the first rib, as is seen so often in mammalia, *e.g.*, cat, otter, beaver; (2) as a reproduction in man of the sterno-costal muscles of the lower animals, *e.g.*, dog, badger, etc.; (3) as belonging essentially to the scalene system of muscles, and corresponding to the condition seen in many animals. In the bear the scalene muscles extend back as far as the seventh or eighth ribs. The last view is probably the correct one.

Triangularis Sterni. This muscle varies much as to its extent and points of attachment. Absence of one or both muscles has been noticed. Theile reports a case

in which it extended to the clavicle. It is sometimes continuous with the transversalis abdominis, of which it is supposed to be a remnant or appendage.

Diaphragm. The sternal portion of the muscle is not infrequently wanting (Quain). Carruthers (*Lancet*, 1879) reports a case of absence of the left half of the diaphragm in a child which lived ten days. In this case there was hernia of the small and part of the large intestine into the thorax. Absence of portions of the diaphragm is occasionally seen, and in these cases there is nearly always hernia of some of the contents of the abdomen into the thorax. At a post-mortem held at the Montreal General Hospital in 1885 on a man aged forty, a portion of the left half of the diaphragm was absent, and through the opening the greater portion of the stomach protruded into the thorax.

A fleshy fasciculus has been seen passing from the border of the œsophageal opening to the œsophagus. Knox has described a *musculus hepatico-diaphragmaticus* arising from the left side of the central tendon and passing over the œsophagus to the right, dividing into two slips, one of which went to the under surface of the liver and, becoming tendinous, joined the obliterated ductus venosus and umbilical vein; the other crossed the right crus and was lost in the peritoneum.

Henle and Bourgery describe a muscular slip going from the costal cartilage of the seventh rib partly to the costal cartilage of the ninth, and partly across the middle line of the diaphragm to the opposite border of the sternal portion.

Accessorius Muscle of the Thorax, Connected with the Diaphragm (Subvertebral Rectus of Humphry.) In a well-developed male subject in removing the lung and pleura the writer found a long, flat, ribbon-shaped muscle running down the left side of the bodies of the dorsal vertebræ. It arose from the anterior surface of the head of the sixth and seventh ribs. Becoming broader as it descended, it ended in two slips, one blending with the left arcuate ligament, and the other, which remained muscular with a tendinous intersection, united, by a blending of the two muscles, with the left crus of the diaphragm (*Journ. of Anat. and Phys.*, vol. xxx.).

External Abdominal Oblique (obliquus externus abdominis). According to Macalister, the number of attachments to the ribs varies from six to nine, and one or more slips may be doubled, generally those arising from the eighth and ninth ribs. It is not uncommon to see absence of the highest and lowest digitations. The two lowest may be rudimentary, and an additional fasciculus may come from the lumbar aponeurosis. This muscle may be connected with the serratus magnus, as well as with the pectoralis major, by continuous fibres. The musculus sternalis, when present, may be intimately associated with the external oblique.

A fasciculus has been described going from the ninth rib to the skin over that region (Flesch). This is no doubt a remnant of the dorso-abdominal skin muscle of mammals. Poland ("Guy's Hospital Reports," 1841) reports a case in which the external abdominal oblique became tendinous at a horizontal line on a level with the umbilicus. It was inserted as usual into the ilium and pubis, but had no connection with the linea alba or linea semilunaris; the internal edge of the muscle being external to the semilunar line, and leaving exposed the internal oblique. In this case the external oblique received a special fleshy fasciculus from the eighth rib, near its cartilage.

Internal Abdominal Oblique (obliquus internus abdominis). This muscle, like the preceding, is subject to variations in the extent of its attachments. Its upper or lower attachments may be reduced; it may have an additional slip of insertion into the ninth costal cartilage. A tendinous inscription in the upper part of this muscle has been described as not uncommon; it generally proceeds from the tenth or eleventh rib. Henle describes once finding in the anterior portion of this inscription a short, thin cartilage.

Accessory Abdominal Oblique (M. lateralis abdominis). This is a muscle situated between the two oblique muscles, which arises from the ninth, tenth, or eleventh rib, and passes down to be inserted into the crest of the ilium. The writer once saw this muscle on both sides of the same subject; on the right it arose from the tip of the twelfth, and on the left from the lower border of the eleventh rib; this latter muscle was not inserted into the iliac crest directly, but blended with the aponeurosis of the external oblique behind and above the anterior superior spine of the ilium. Both muscles became broader as they reached their iliac attachment.

In some cases this muscle is attached to Poupart's ligament or to the sheath of the rectus.

Transversalis Abdominis. The extent of its attachments may vary. Cases are reported in which it was attached to the whole length of Poupart's ligament. The spermatic cord may sometimes pierce its lower border,

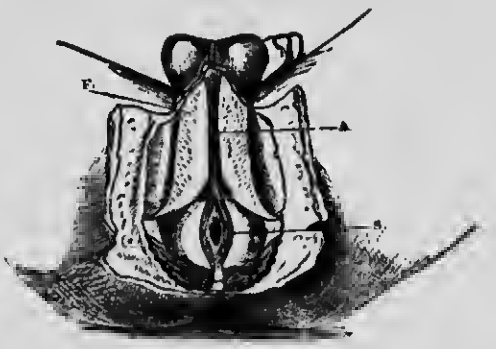

FIG. 3434.—A, Sphincter ani continued upward in the middle line and blending with the raphe of the scrotum; F, perineal fascia; S, sphincter ani. (Shepherd.)

especially in those cases in which the attachment to Poupart's ligament is more extensive than usual. Fusion of the muscle with the internal oblique has been observed, and total absence has been noticed by Macalister. A tendinous intersection has also been seen.

Rectus Abdominis. In some cases this muscle has been seen extending as high as the third, and even the second, rib. It is not uncommon to see a supernumerary slip going to the fourth rib. In most animals the rectus abdominis extends higher than it does in man; in many it reaches as far as the first rib, *e.g.*, in the bear, otter, beaver, cat, porcupine, etc. The writer once saw a slip go from the upper part of the rectus to the middle of the lower border of the pectoralis major. The number of tendinous intersections may vary; as many as six have been noticed in the negro.

Pyramidalis. This muscle varies much as to size. It is very frequently absent, and is occasionally double. When absent the lower part of the rectus is increased in size. It is a muscle which is of no use in man, and is a mere rudiment of the larger muscle which exists in marsupials. It is absent in many of the lower animals, *e.g.*, solipeds, ruminants, and many of the carnivora, as the dog, cat, bear, etc.

Quadratus Lumborum. Is sometimes attached to the eleventh rib, and to the bodies and transverse processes of the tenth and eleventh dorsal vertebræ. Lange (*Journ. of Anat. and Phys.*, vol. ii., p. 289) figures a quadratus muscle sending a slip to the fascia covering the pleura between the twelfth dorsal and first lumbar rib.

Muscles of the Perinæum and Pelvis.—Sphincter Ani. The writer once saw the superficial fibres of this muscle continued up past the tendinous point of the perinæum, as a flat muscular slip 8 mm. broad and 5 cm. long. This slip blended above in the middle line with the darlos of the scrotum (see Fig. 3459). Occasionally fibres of the transversus perinei are inserted into this muscle.

Coccygeus. Is sometimes inserted wholly into the side of the sacrum (Quain).

Sacrococcygeus Anticus (curvator coccygis). This is the name given to a few fleshy and tendinous fibres passing from the lower part of the anterior portion of the sacrum and coccyx. It is well developed in animals with tails.

Transversus Perinæi. This muscle is a very variable one. It is occasionally absent, or so small as to be with difficulty dissected out. It is sometimes inserted either partly or wholly into the accelerator urinæ (bulbocavernosus) muscle or sphincter ani. This muscle is not infrequently fan-shaped, covering the triangular space formed by the three perineal muscles. In these cases the ischiocavernosus forms one edge of the fan. The fibres are inserted into the accelerator urinæ, central tendinous point, and sphincter ani. The muscle is occasionally double, the extra slip joining the accelerator urinæ or levator ani. Henle describes a muscular slip springing from the fascia at the lower border of the gluteus maximus, and inserted into the lower surface of the triangular ligament. In one case of absence of this muscle, the writer found the deep transverse muscle of large size.

Ischiocavernosus (erector penis). Houston has described a variety of this muscle under the name *compressor venæ dorsalis penis.* It is a slip arising in front of the ischiocavernosus and crus penis, which passes upward and forward, and is inserted with its fellow into an aponeurosis above the dorsal vein. The writer once saw this extremely well developed. In the dog and some other animals it is quite a strong muscle.

Bulbocavernosus (accelerator urinæ). This muscle is occasionally joined by the transversus perinæi. Kobelt describes the fibres which cover the most prominent part of the bulb, and which are separated from the others by a more or less distinct interspace, as the *compressor hemisphæricum bulbi.*
Frank J. Shepherd.

MUSCULAR ATROPHIES, PROGRESSIVE.—The presence of muscular atrophy at once suggests to the clinician one of two possibilities, namely:

1. The atrophy is a *symptom.* As such it may indicate injury, hemorrhage, inflammation, or new growth, affecting more or less acutely the oblongata, the spinal cord, or a peripheral nerve; or it may be one expression of joint disease and then due to reflex trophic disturbance in the cord.

2. The atrophy is a *disease.* In other words, it is sufficiently regular in its evolution and constant in its associated symptoms to merit a definite place of its own in our nosology. The scope of the present article is limited to this second group of muscular atrophies, those of the first group being treated under appropriate headings elsewhere in this work.

Our knowledge of muscular atrophy as a clinical entity dates from 1850, when Aran[1] published the first account of what we now recognize as progressive spinal muscular atrophy, although he considered it a disease of the muscles primarily. The disease was elaborated upon by Duchenne a few years later, whence the name "Aran-Duchenne Disease."[10]

The muscular atrophies which are classed as distinct diseases are divisible pathologically into two types, namely:

1. The myopathies or progressive muscular dystrophies; also known as "idiopathic" muscular atrophies, which are characterized by slow premature dissolution of muscle fibres from inherent vital defect. This is a long-recognized tissue condition for which Gowers has recently given us the convenient and expressive term "abiotrophy."[2]

Abiotrophy of the myon would be a concise statement of the pathologico-anatomic status of this group.

2. The myelopathies or "spinal muscular atrophies," characterized pathologically by the same process (premature dissolution) in the spinal motor nerve elements (anterior horn cells or lower motor neurons). Since, however, these same changes often occur also in the cerebral motor neurons (pyramidal motor cells) or in other cases are apparently limited to the peripheral nerves a more comprehensive designation would be *neuronic muscular atrophy. Abiotrophy of the motor neurons,* therefore, would express the pathologico-anatomic nature of this group.

While this classification serves to define the great majority of cases, a series of mixed forms or so-called "connecting links" between the two main groups is becoming numerous in the literature as experience in their recognition increases, *e.g.,* cases which present symptoms of myopathy and myelopathy combined. These serve to illustrate the anatomical and physiological fact now well recognized, that the entire motor tract from the cortex cerebri to cord and from cord to muscle fibre constitutes a continuous functionating unit, and cannot suffer long in one part without in some degree impairing others.

There seems no good reason, however, to the writer for the use of the term "connecting link" for these cases. The coincident or consecutive involvement of one more segment of the motor tract is all that is necessary to the evolution of these mixed forms, and this may be reasonably postulated in any given case.

Accepting the pathological grouping into myopathic and neuronic, therefore, as the best at present available, we proceed in the order mentioned to consider the individual diseases in each group. The accompanying diagram shows at a glance the anatomical location of the pathological process in the several clinical types (Fig. 3160).

The myopathies or primary atrophies are divided clinically into several "types," somewhat arbitrarily perhaps, since there are good reasons for the view held by many that they are all due to the same pathological processes, differing mainly in location. An exception to this statement, however, must be made in the case of the "pseudo-hypertrophy," which is a prominent feature in one form.

They are all characterized, moreover, by certain clinical features in common, of which the chief are:

1. Hereditary or familial tendency.
2. Onset before puberty.
3. Preponderance in the male sex.
4. Loss of myotatic irritability, and in consequence loss of "tendon reflexes."
5. Electrical changes of reaction of *quantitative* character (diminished response to galvanism and faradism), and absence of typical R. D.

The recognized types of myopathy are:

A. Pseudo-hypertrophic Muscular Atrophy.—*Causation.* The disease begins in childhood; in two-thirds of the cases before the sixth year (Gowers). Heredity is traceable in three-fifths of the cases (Dana). The hereditary influence is strongest through the mother's side, though the *male members* of the family are more frequently affected. Church explains the transmission by the female members of affected families by the fact that the disease renders the males impotent.

The disease is frequently preceded by some acute infection—diphtheria for instance, which probably favors its onset in those already predisposed.

Symptoms.—Weakness in the legs of gradual onset, accompanied by a "waddling" gait and frequent stumbling without evident cause are the earliest symptoms. These are usually noticed about the fifth year and are often attributed to carelessness or stupidity on the part of the child. Later, a noticeable enlargement (pseudo-hypertrophy) of the leg muscles, especially of those of the calves, appears. This may extend to the thighs and gluteal muscles; and the infraspinati are also frequently enlarged. The enlargement of muscles may be slight in some cases, but even in these an undue firmness with lack of elasticity is noticeable on palpation. The shoulder girdle muscles are affected later, while those of the face, forearms, hands, and feet escape for a long time, but are probably affected eventually in most cases that survive a sufficient length of time. Thus in two cases, brothers, aged four-

surgically clean aspirating needle. While this method does not act as quickly as the intravenous infusion, it acts promptly enough for ordinary cases and is extremely simple. In cases in which the blood pressure is lowered in consequence of exhaustion of the nervous system from gross injury this treatment may still to a certain extent be advantageous, in that it produces some slight vascular stimulation and also adds to the volume of fluid circulating, and thus assists to a certain extent in compensating for the dilatation of the peripheral vessels. It is, however,

Fig. 4279.

a matter of frequent observation in cases of profound shock with great weakness of the pulse that the introduction into a vein of a quart of normal salt solution does not materially improve the patient's condition. The volume of the pulse in these cases may be restored for a few minutes, but this volume is without tension and soon disappears. This is in consequence of the fact that the vaso-motor system has become partially or completely exhausted. What is desired in these cases is the strengthening of the heart and the restoration of the functions of the vaso-motor system, and of the cerebral cortex. It is,

Fig. 4280.

nevertheless, true in some cases of gross injury or of prolonged operation that the exhaustion of the nervous system is so complete that no treatment which we are able to institute will be effectual.

In my experience with shock there is nothing which meets the condition and which sustains the nervous system and holds the ground gained so well as strychnine. Kymographic tracings show that strychnine increases the blood pressure in practically every instance. This pressure is often increased by a single hypodermic injection from 0.5 to 1 or even 1.5 cm. In the administration of strychnine for a serious condition of shock one-fourth of

Fig. 4281.—Before Whiskey.

a grain may be given in divided doses during the course of one hour, and, following this, one-thirtieth of a grain administered every two hours for one or two days, or until the muscles show the influence of the drug.

Nitroglycerin.—The use of nitroglycerin in shock has been criticised by many writers upon the ground that it dilated the superficial capillaries and thereby reduced blood pressure. In my experimental and clinical work nitroglycerin has always increased the height of the stroke and lessened the frequency of a rapid pulse. Gr. $\frac{1}{150}$–$\frac{1}{75}$ of nitroglycerin, injected subcutaneously, has always increased the blood pressure from 0.5 to 1 cm. Its effect, although manifested almost at once and reaching perhaps the same height as that from strychnine, is not so long sustained. The tracing in Fig. 4279 was taken from the femoral artery of a dog where the pulse was scarcely perceptible in consequence of numerous sections of both sciatic nerves, resection of a considerable portion of the small intestine, and of the entire stomach. The tracing in Fig. 4280 was taken one-half a minute after the injection of gr. $\frac{1}{75}$ of nitroglycerin. In four and one-half minutes the blood pressure had risen 1.8 cm.

Caffeine.—Caffeine acts almost as promptly and effectually in restoring blood pressure as does strychnine. Five grains injected subcutaneously in a dog raised the blood pressure from 12.6 cm. to 13.6 cm. This effect is also well sustained.

Adrenalin.—In the writer's experience adrenalin in gr. $\frac{1}{150}$–$\frac{1}{75}$ acts promptly in increasing blood pressure.

Fig. 4282.—Twenty Minutes after Whiskey.

This action accordingly, however, is not well sustained. Adrenalin is certainly deserving of further consideration in the treatment of shock.

Digitalis and Strophanthus.—Both of these substances were used repeatedly. Their immediate action, however, upon blood pressure is not pronounced. With a rapid pulse their use is indicated, as they will assist in controlling this factor and in maintaining blood pressure.

Whiskey.—The advocacy of whiskey or brandy in shock has occasioned more dispute and acrimonious de-

Fig. 4283.—Three-quarters of an Hour after Whiskey.

bate than that of all the other remedies combined. That they are capable of raising the blood pressure when injected subcutaneously or taken into the stomach there can be absolutely no doubt. A dog whose sciatic had been sectioned half a dozen times was subjected to an intestinal anastomosis and then to a complete resection of the stomach. During these procedures, which occupied one hour and twenty minutes, the blood pressure fell from 14.2 cm. to 12 cm. At 10:25, 25 c.c. of whiskey in water was injected subcutaneously, and in twelve minutes the blood pressure had risen to 13.3 cm., at 10:39 to

Fig. 4284.—One Hour after Whiskey.

13.6 cm., and at 10:40 to 13.8 cm., at which point it remained until 10:44, when it fell to 13.1 cm., where it stood for a very considerable time. The sphygmographic tracing in Fig. 4281 was taken from a weak patient's radial before giving whiskey, the tracing in Fig.

4282 twenty minutes after one ounce by stomach, that in Fig. 4283 forty-five minutes after, that in Fig. 4284 one hour after, that in Fig. 4285 one and one-half hours after, and that in Fig. 4286 two and one-half hours after.

In the treatment of shock there are conditions to be met besides those of blood pressure. One of these is the loss of muscular tone, and another the practical suspension of the mental faculties. It is probably true that anything which assists in restoring blood pressure will

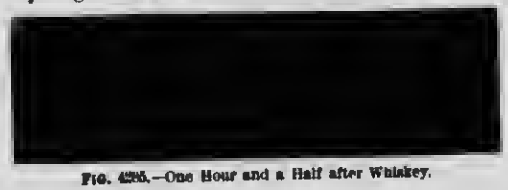

Fig. 4285.—One Hour and a Half after Whiskey.

also assist in re-establishing muscular tone and the vigor of the mental faculties. The normal salt solution, when infused into a vein, acts only mechanically, and is often without decided effect upon the profound depression of the vital functions. Remedies are wanted in shock which will restore not only blood pressure but also all of the vital functions. These conditions are met more perfectly in shock without hemorrhage by the use of strychnine, caffeine, nitroglycerin, whiskey, adrenalin, and normal salt solution than by any other remedies. In

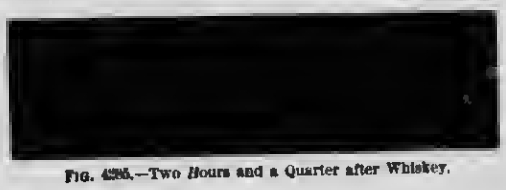

Fig. 4286.—Two Hours and a Quarter after Whiskey.

cases in which hemorrhage has been a prominent factor the normal salt solution should take precedence of all other remedies.

A. H. Levings.

SHOULDER, THE SURGICAL ANATOMY OF.—The region of the shoulder comprises the bones forming the joint, viz., the scapula and the upper part of the humerus, the clavicle and acromio-clavicular articulation, also the upper and outer part of the thorax, which takes part in forming the axilla. These bony structures, with the soft tissues enveloping them, would be included in the term *shoulder*.

Surface Anatomy.—Beneath the skin can be easily felt the outer end of the clavicle, the acromion process, and the coracoid. Where the clavicle joins the acromion there is a distinct elevation which can be without difficulty detected by running the finger nail over it. The line of this articulation would correspond to a vertical line running up the middle of the front part of the arm. The acromion in the stoutest person may easily be made out by following the spine of the scapula, and the coracoid process is just inside the shoulder joint and below the clavicle. Between the coracoid and the acromion processes is the rounded prominence of the shoulder; this is formed partly by the thick deltoid muscle, but also in part by the upper end of the humerus which lies below it. As the arm is rotated the tuberosities can easily be felt beneath the muscles. In dislocation of the humerus, instead of a prominence there is a flattening, and in pressing with the fingers a well-marked depression is found where the head of the bone is normally felt. If in suspected dislocation the thumb be placed on the coracoid process and one of the fingers of the same hand on the acromion, the space will be found wanting in roundness and the finger can be easily pushed into a hollow; the upper end of the bone can be no more felt on rotation. The portion of the humerus which in normal joints is felt beneath the deltoid is not the head, but the tuberosities. The head can be felt through the axilla if the fingers be well pushed up and the arm be strongly abducted. The head of the humerus faces in the direc-

Fig. 4287.—*A*, Clavicle; *B*, *C*, acromion; *D*, coraco-acromial ligament; *E*, coracoid; *F*, coraco-humeral ligament; *G*, great tuberosity of humerus; *H*, capsular ligament; *I*, lesser tuberosity; *J*, scapular neck; *K*, long tendon of biceps; *L*, humerus.

tion of the internal condyle, this latter being always a good guide to the position of the upper end of the humerus.

The adjacent margins of the deltoid and pectoralis muscles cannot be felt below, but above there is a considerable triangular interval which forms the infraclavicular fossa below the clavicle. This fossa is well seen in thin persons, but is obliterated in subcoracoid dislocations, in fracture of the clavicle, and by inflammatory tumors and new growths. In subclavicular dislocations the depression is replaced by an eminence. The space between the two muscles lodges the cephalic vein (Fig. 4288).

Fig. 4288.—Skin and fascia have been removed. 1, Pectoralis major; 2, deltoid; between these muscles is seen the cephalic vein; 3, biceps; 4, coracobrachialis, close to which lies the brachial artery and the median nerve drawn to one side. (After Roser.)

The back of the shoulder is comparatively flat; here the deltoid muscle is thinner. By abducting the arm the deltoid becomes prominent and various vertical elevations appear which correspond to the muscular tissue between the various tendinous intersections which run down from the acromion through the muscle. The axillary border of the scapula and inferior angle may be brought out by placing the forearm behind the back; to bring the vertebral border and superior angle into evidence, the hand should be placed over the opposite shoulder.

Surface Marking of Axillary Artery.—At a point internal to the coracoid process and below the most convex portion of the clavicle the axillary artery may be com-

pressed against the second rib. The course of this artery can be easily marked out by drawing a line from the most convex portion of the clavicle to the inner border of the elevation formed by the coracobrachialis muscle.

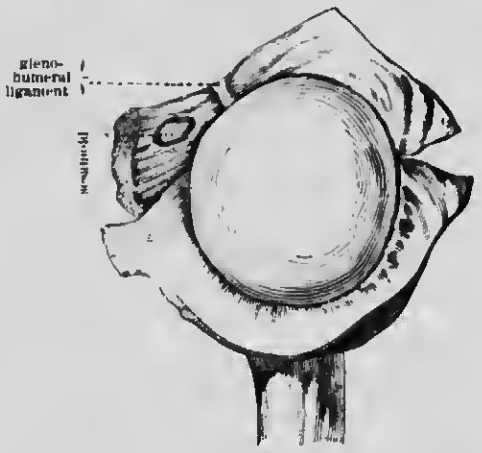

Fig. 428.—Head of Humerus, with Part of Capsule Attached. (Morris.)

If the arm be raised from the side, the third part of the axillary artery may be felt pulsating as it passes into the arm beneath the anterior fold of the axilla, and in a line corresponding to the outer border of the axillary hair, that is, at the junction of the anterior with the middle third of the space between the axillary folds. At the junction of the upper with the middle third of the deltoid muscle the posterior circumflex vessels and nerves wind round to the back of the humerus under the muscle.

The *deltoid region* comprises the point of the shoulder and is confined to the limits of the deltoid muscles which cover the shoulder-joint and upper end of the humerus. Between the deltoid muscle and the joint is a large bursa, the subdeltoid or subacromion bursa. Owing to the exposed position of the shoulder-joint it is liable to

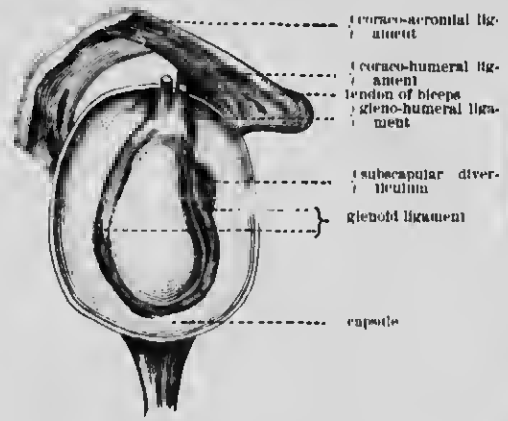

Fig. 429.—Glenoid Fossa of Scapula, with Part of Capsule Attached.

many injuries and diseases; fatty tumors are not infrequently seen here and may attain to a large size.

The shoulder-joint is of the ball-and-socket variety (enarthrodial), and so is very freely movable; the socket in the scapula is very shallow but is deepened by the glenoid ligament, to which the long head of the biceps is attached. It is small in size compared with the large articular surface of the head of the humerus. This disparity gives greater freedom of movement with lessened security and more liability to displacement in extreme movements.

The circumflex nerve supplies the deltoid, shoulder-joint, and skin over the lower two-thirds of the shoulder and upper part of the triceps. In injuries to the shoulder this nerve is frequently damaged, and paralysis with atrophy of the deltoid may result; marked flattening of the shoulder may as a consequence ensue.

Relations of the Joint.—Muscles of great strength surround the shoulder except inferiorly; above we have the deltoid and supraspinatus, internally and in front the subscapularis, and externally and behind the infraspinatus, both these latter separated from the capsule by a bursa. The capsule of the joint, though strengthened by these muscles, is very loose, so that when the muscles are either paralyzed or cut the humerus may be drawn from the scapula for nearly an inch. The capsule is thicker above than below and is strengthened by various accessory ligaments in addition to the muscles mentioned above as being in relation with it, such as the coracohumeral, inferior humeral, glenohumeral, etc.

Fig. 429. Abnormal Arrangement of the Biceps. *a*, Coracoid head; *b*, glenoid head; *c*, humeral head; *d*, capsular head.

There are three perforations of the capsule, the most important being that for the long head of the biceps at its lower part; it is also perforated by the supraspinatus and not infrequently by the infraspinatus. *The tendon of the long head of the biceps* has synovial membrane prolonged along it and surrounding it. This tendon keeps the head of the humerus against the glenoid cavity and prevents the bone rising up toward the acromion. This tendon is sometimes ruptured, thus causing weakening of the upper limb and a drawing up of the humerus forward and inward against the coraco-acromial arch. The tendon may be dislocated—that is, it may slip out of its groove to one side or the other. In such cases the head is prominent and drawn up under the acromion; owing to the higher position of the greater tuberosity, abduction is not so free.

Rupture of the tendon is more apt to occur in persons the subjects of rheumatic disease; in them the joint is dry and perhaps the tendon is partially worn. In old cases

it is not uncommon to see the long tendon of the biceps attached to the upper end of the humerus, the head of the bone having worn through the tendon and the capsule, and entered the subacromion bursæ. In very old cases

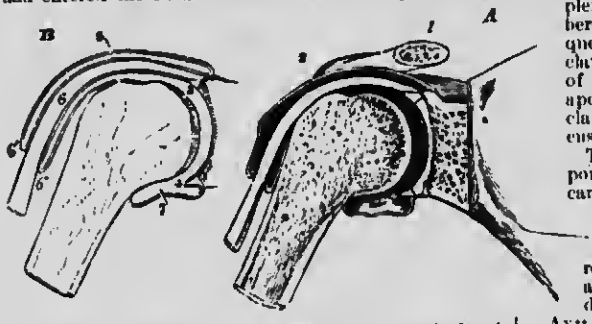

FIG. 4282.—*A*, Section showing the Relation of the Long Tendon of the Biceps to the Shoulder-joint. *B* is an outline showing the arrangement of the synovial membrane. (Allen Thomson in "Quain's Anatomy.")

the under surface of the acromion process will be eburnated as well as the surface of the humerus which has been in contact with it. As a rule the joint is well protected above by the acromion and coracoid processes, and the ligaments between these.

THE EPIPHYSES.—There are a number of epiphyses about the shoulder-joint, some of which are of importance. It is of importance to know that the epiphyseal end of the acromion, which articulates with the clavicle, may sometimes remain separated throughout life and may be mistaken for a fracture; in fact, Sir Astley Cooper described it as such. The coracoid process is also formed by a separate ossific centre, and the head of the humerus forms a single epiphysis in the fifth year; this is composed of no less than three fused secondary centres and it is limited by the surgical neck. Separation of the upper epiphysis of the humerus may be mistaken for dislocation, but the easy reduction and the fact that the glenoid cavity is always full should prevent one from falling into this error.

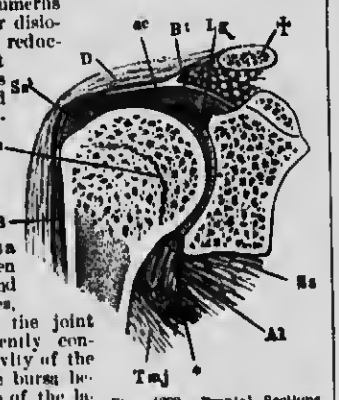

FIG. 4283.—Frontal Sections of the Shoulder-joint while the Arm is Hanging. (Henle.) †, Clavicle; *ac*, acromio-coracoid ligament; *D*, deltoid muscle; *B*, tendon of long head of biceps; *Ss*, subscapularis; *Sst*, supraspinatus; *Al*, triceps; *Taj*, teres major; *, posterior circumflex artery; **, trace of epiphysial union.

BURSÆ.—The bursæ about the shoulder are many, for besides the subdeltoid or subacromion bursa and the ones between the subscapularis and infraspinatus muscles, and the capsule of the joint (which was frequently continuous with the cavity of the joint), we have the bursa between the insertion of the latissimus dorsi and teres major muscles and between the teres muscle and the bone. Any one of these may become inflamed and distended with fluid as the results of strain or direct injury. Very often the inflammation is tuberculous; the subacromion is most often the seat of disease, for it is more exposed than the other neighboring bursæ.

THE CLAVICLE.—The skin over this bone is very loose and easily rolled on the bone. Cutting down on the subclavian artery and pulling the skin firmly over the clavicle, the surgeon cuts freely on the bone, and when the skin is released the incision is well above the clavicle, and the external jugular vein, which it was intended to avoid, comes into view. Passing over the clavicle are seen the clavicular branches of the superficial cervical plexus, and these nerves may be easily injured here. In disease of the cervical spine there is frequently pain over the collar bone. Beneath the clavicle and subclavian artery, the vein and cords of the brachial plexus rest on the first rib. The apex of the lung passes up into the neck behind the clavicle, encircled by the first rib, and can be percussed in the supraclavicular fossa.

The sternal end of the clavicle is near very important structures, such as the innominate and left carotid artery, the pneumogastric and recurrent nerves, and the large venous trunks. The acromio-clavicular joint is sometimes dislocated and is hard to retain in place when reduced; the sternal end also may be displaced and this joint may be attacked by tuberculous disease.

AXILLA.—The axilla (*ala*, a wing) is the space which exists between the upper arm and side of the thorax. It is of a pyramidal shape, and is bounded in front by the pectoral muscles, behind by the subscapularis, teres major, and latissimus dorsi, on the inner side by the serratus magnus, intercostal muscles and ribs, and on the outer side by the upper part of the arm and shoulder-joint. The base is formed by the skin stretching between the anterior and posterior boundaries. The hollow between the anterior and posterior folds is commonly known as the armpit, but anatomically we imply more by the term axilla than this depression; we include all the deeper space which reaches up to between the scalenus muscles, and contains the axillary vessels, brachial plexus of nerves, and lymphatics. This deeper space is surgically continuous with the neck.

Superficial Anatomy.—The skin of the armpit proper, which is very thin, sensitive, attached to the fascia beneath, and of a darkish color, is supplied with glands which secrete an odorous sweat. In some cases this sweat is of a peculiar color, and stains the linen; it may be large in amount and cause great discomfort to the individual and his friends from the disagreeable odor emitted.

The skin of the armpit is abundantly provided with hairs which never grow to any great length; their limit

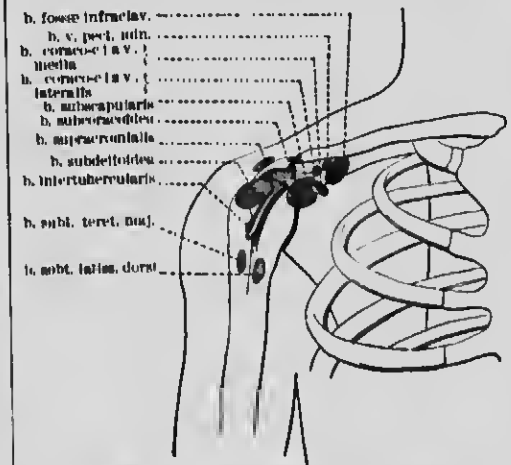

FIG. 4284.—The Principal Bursæ about the Shoulder.

is generally well defined, the outer border furnishing a good surface mark for the axillary artery in the third

part of its course.* The armpit is of different depths in different individuals; in women and children it is not so well marked as in men, chiefly because in them we have less muscular development and more adipose tissue. When the arm is lifted above the head the depression almost disappears and the skin is put so much on the stretch that nothing can be felt of the deeper part; the depression deepens as the arm is lowered to the side, the skin being relaxed and thrown into folds. The fingers can now be pushed high enough to feel the head of the humerus. When it is necessary to examine the deeper structures, the arm ought only to be slightly drawn away from the side. In operations on the axilla the arm should always be abducted and raised to lessen the depression.

It is not uncommon to see suppuration of the follicles in this region; these small follicular abscesses, owing to the sensitiveness of the skin, are very painful and should be opened early.

The skin covering the anterior fold is thick, not closely adherent to the deeper structures, and free from hairs. Close below the clavicle and internal to the shoulder, the coracoid process can be felt.

The lower border of the great pectoral muscle follows the line of the fifth rib; the first visible serration of the serratus magnus on the inner side of the space is the sixth. The posterior fold is thicker than the anterior on account of the great thickness of the teres major muscle. When the arm is raised from the side the axillary artery can be felt pulsating as it passes into the arm, and may be easily compressed.

Fascia.—On removing the skin from the axilla we come upon a strong fascia, the disposition of which it is important to know because of its influence on the course of abscesses, which not infrequently form in the neighborhood. The strong fascia which covers the great pectoral muscle and is attached to all the subcutaneous bony prominences, winds round its lower border and splits into two portions, one of which continues to ensheath the pectoralis muscle on its inner surface, while the other forms the floor of the axilla and, after covering the latissimus dorsi and teres major muscles, passes upward and backward and is lost in the strong deltoid aponeurosis. The portion of this fascia which covers the pectoralis major muscle externally sends a process between it and the deltoid muscle, and this process becomes continuous with the costo-coracoid membrane.

The costo-coracoid membrane (Fig. 4295) is a strong aponeurosis which is continuous with the deep cervical fascia; it splits to enclose the subclavius muscle, is attached to the clavicle and to the coracoid process, and is continued to the capsule of the shoulder. It is also attached to the cartilages of the first and second ribs, and is continuous with the aponeurosis over the serratus magnus muscle. This fascia is the costo-coracoid membrane proper, and covers the first part of the axillary vessels and nerves. When it reaches the edge of the small pectoral muscle it again divides to enclose it; reuniting again, it passes down to the base of the axilla, and becomes attached to the skin and the fascia covering the great pectoral; externally it is continuous with the brachial aponeurosis. Gerdy calls this process the *ligamentum suspensorium*, because he says it is the ligament of the skin of the armpit, which it pulls upward. This suspensory ligament, then, divides the axilla into an anterior and a posterior compartment, the posterior containing blood-vessels and nerves, and the anterior the loose cellular tissue which separates the two pectoral muscles and intervenes between the lower part of the fascia and the great pectoral. Now, when an abscess forms in front of the suspensory ligament—that is, below the small pectoral or between the two pectoralis—it would tend to point at the lower border of the anterior axillary fold, or in the interspace between the deltoid and the great pectoral muscle; but if pus forms behind the suspensory ligament and is not evacuated early, it may burrow into the neck and thence find its way, through the upper opening of the thorax, into the mediastina; it may also find its way beneath the latissimus dorsi and point in the back, or it may burrow into the subscapular fossa and thence get into the shoulder-joint.

FIG. 4295.—Brachial Plexus and Axillary Artery. 2, Costo-coracoid membrane; 3, superior thoracic and ulnar arteries; 5, long thoracic artery; 6, axillary artery; 8, musculocutaneous nerve; 10, median nerve; 15, subscapular artery; 16, ulnar nerve; 18, internal cutaneous nerve; 19, circumflex nerve; 20, nerve of Wrisberg, joined by intercosto-humeral.

Abscesses in the axilla should be opened early and after the manner of the late Mr. Hilton. He advised that the skin alone should be cut with a knife, that a grooved director should then be pushed into the deeper structures till pus wells out. The deeper parts may be still further opened up by introducing a pair of dressing forceps, opening them widely in the abscess and withdrawing them open. If axillary abscesses are opened in this way, there is no danger of wounding any of the displaced vessels in the neighborhood, as they are pushed aside by the director. The finger answers often quite as well as a director.

Boundaries of the Axilla.—The *anterior boundary* (Fig. 4288) is formed by the two pectoral muscles, the great pectoral alone forming the lower border of the anterior fold. It is important, surgically, to remember that the fibres of the large pectoral go downward and outward, and those of the lesser upward and outward. The interspace between the great pectoral and the deltoid may be often very small or wanting, and the division between the two muscles can be made out only by the position of the cephalic vein and a branch of the acromial thoracic artery.

Owing to the pectoralis major muscle having an origin from the clavicle, it is necessary, in fracture of that bone, that the arm should be placed close to the side to prevent the muscle pulling down the inner fragment, and so delaying union. In females the lower edge of the anterior border of the axilla, owing to the presence of the mammary gland, is not so easily seen as in the male. In the female the mammary gland moves freely on the great pectoral muscle, there being an abundance of cellular tissue between the muscle and the gland; but in advanced cases of cancerous disease of the breast every movement of the pectoral muscle is painful because of the gluing together of the breast and the muscle by infiltrated tissue.

The acromial thoracic vessels and the internal and external thoracic nerves are seen on the inner surface of

* According to Mr. A. W. Martin (Edin. Med. Journal, June, 1884): "The presence of hair in the pubic region is sufficient, by the law of correlation of growth, to account for the presence of hair in the corresponding part of the fore-limb, the axilla." He also says that the hair of the axilla has a fixed ratio to that of the pubes and also corresponds closely in color; he regards sexual selection as sufficient to account for it on the pubes, and also remarks that its quantity in both sexes will be in proportion to the sexual passion. With this last statement I certainly am not prepared to agree.

the pectoral muscle. The long thoracic artery generally runs along the lower border of the lesser pectoral.

In rare cases the great pectoral muscle is wanting altogether, or the clavicular portion alone may be wanting. The lesser pectoral may be attached to as many as five

FIG. 4296.—Dissection of Axilla, showing the Axillary Vein (2, 2) and Parts in Relation with it. 1, 1, Axillary artery; 2, 2, axillary vein; 3, 3, basilic vein; 4, cephalic vein; 5, 5, pectoralis minor; 6, axillary glands.

ribs or as few as one. Its insertion may be transferred from the coracoid process to the coracobrachialis muscle or humerus itself.

The *posterior boundary* of the axilla is formed by three muscles which are supplied by the same set of nerves, viz., the three subscapular, and all three muscles are internal rotators of the humerus. The tendon of the latissimus dorsi, with the teres major, forms the lower edge of the posterior fold, the posterior wall of the deeper portion being principally formed by the subscapularis. The axillary vessels rest on this posterior wall, held together by a dense cellular sheath, and separated from the rest of the axilla by the above-described suspensory fascia.

The *internal boundary* of the axilla is formed by the ribs, intercostal muscles, and the upper digitations of the serratus magnus. On this wall, which is somewhat convex, a large nerve is seen running down in a vertical direction, to be distributed to the serratus magnus muscle. This nerve is a branch of the brachial plexus, and is called the long thoracic. We also find here branches of the posterior and long thoracic vessels. Abscesses and tumors, as a rule, lie along this wall, and are fortunately well away from the axillary vessels; in removing tumors we always dissect toward the inner wall.

The *external boundary* of the axilla is formed by the upper part of the humerus and coracobrachialis muscle; along this boundary, and on the inner side of the coracobrachialis are seen the axillary vessels and nerves closely bound down by their fascial covering.

The *inferior boundary* or *base* of the axilla, which is formed by the skin and fascia stretching between the anterior and posterior folds, has already been described.

The apex of this cone-shaped space may be said to be continuous with the posterior triangle of the neck, as vessels, nerves, lymphatics, cellular tissue, and fascia reach the axilla from the neck through this apex. It is the space between the upper edge of the scapula, clavicle, and first rib. Abscesses of the neck have been seen passing through this opening and pointing in the axilla.

Contents of the Axilla.—The axillary vessels, with the lymphatic glands, fat, and loose cellular tissue, are the principal contents of the axilla. The loose cellular tissue permits of free movements of the arm to and from the body, but it also permits of the collection of large quantities of blood and pus. The vessels and nerves are bound together by a sheath of thick cellular tissue; they lie on the outer wall of the space internal to the coracobrachialis.

Axillary Vein (Fig. 4296).—This is the most superficial of the contents of the axilla. In the upper part of its course it is so fixed by fascia connecting it with the coracoid process and pectoralis minor muscle, that if wounded it tends to gape, and air is apt to enter. The vein is formed by the junction of the venæ comites with the basilic vein. This union may occur low down or high up; the normal point of union is at the lower edge of the subscapularis muscle, though the junction not infrequently takes place higher up, sometimes as high as the clavicle. It is always shorter than the artery, measuring about 7.5 cm. (3 in.) in length. Union occurring high up complicates operations upon the artery, owing to the numerous transverse communicating branches which cross the artery. The vein lies to the inner side of the artery, and generally overlaps it. When the arm is drawn away from the side it almost altogether covers the artery. In the course through the axilla, this vein receives many tributary branches, the largest of which is the subscapular. It receives the cephalic vein immediately above the lesser pectoral muscle. In operations on the axilla, the vein and its branches are frequently wounded—more often than the artery—but it is rarely injured by external violence. In reducing dislocations of the shoulder, and using extreme traction, the artery is much more frequently injured than the vein, owing to its proximity to the heart and its fixed position; the vein, when wounded, bleeds freely, and there is great danger of air entering it. This accident has many times occurred, especially in operations for removing diseased glands, and not a few fatal cases are on record. It is always well before dividing the veins, especially about the neck and axilla, to tie them with a double ligature and cut between.

In almost all diseases of the axilla there is swelling of the arm caused by pressure on the veins and absorbents.

Axillary Artery (Fig. 4295).—This vessel, which is the continuation of the subclavian, extends from the lower border of the first rib to the lower border of the teres major muscle; it measures about 15 cm. (6 in.) in length, and its direction is altered with the position of the arm. When the arm is close to the side, it forms a curve having its convexity upward and outward; when the arm is held at right angles to the body, the artery is in almost a straight line; and again, when the arm is held above the head, the slight curve thus formed has its concavity upward. Its upper portion lies close to the chest and rests on the upper serrations of the serratus magnus; the long thoracic nerve is behind it, and in front is the costo-coracoid membrane. Its lower part lies principally on the subscapular muscle. The vein is superficial to the artery above, and the nerves of the brachial plexus lie to its upper and outer side; lower down the vein becomes more internal and the nerves surround the vessel, the two heads of the median embracing it. For convenience of description the axillary artery is divided surgically into three portions—the part above,

FIG. 4297.—Portion of Clavicle and Acromion Process removed with Pectoralis Major and Deltoid Muscles. Pectoralis minor muscle (*R*) crossing the space; relation of axilla to the shoulder shown, and also contents of axilla; *M*, axillary vein; *N*, axillary artery; *O*, brachial plexus; *P*, subclavius muscle. (From Auger's "Anatomie Chirurgicale.")

that beneath, and that below the pectoralis minor muscle, it lies deepest above this muscle and is most superficial below it. The large thoracico-acromial branch is given off immediately above the pectoralis minor, and might be wounded in the operation of tying the axillary in its first part. A number of small branches are given off which are not surgically important. The subscapular artery, given off near the lower edge of the subscapular muscle, is a large branch, which runs to the side of the chest and near its origin gives off the dorsalis scapulæ. The external mammary is given off below the lesser pectoral, and is sometimes of large size; it is always cut in the operation of excision of the breast, and may give rise to slight hemorrhage. The circumflex arteries closely embrace the neck of the humerus, and should be looked for and avoided in excision of the head of the humerus. In wounds of the first part of the axillary artery the vein is so closely in relation with it that it rarely escapes; lower down the artery may be wounded and the vein remain intact. Wounds of the axillary artery may result from stabs, fracture of the neck of the humerus (Fenwick), violence during the reduction of old dislocations. Hemorrhages may be slight or severe, according to the size of the wound. The loose tissues of the axilla admit of great and rapid distention by bleeding from either vein or artery. The treatment is first to compress or temporarily ligature the third part of the subclavian and then cut down on the artery in the axilla, turn out the clots, and ligature above and below the wound in the vessels. It is well to remember that in reduction of an old dislocation the artery has been torn when simple manipulation was practised, owing to the adhesions which had formed between the capsule and the vessel. The artery is usually tied in the third part of its course, where it is most superficial. It has been tied on the first part, but owing to its depth and the thick covering of muscle, and also its close connection with the vein, ligature of the third part of the subclavian is preferred, as being the safer and simpler operation. The third part of the subclavian is more easily compressed than the first part of the axillary.

Aneurism not infrequently affects the axillary artery; this is, perhaps, owing to its nearness to the heart and to the curve the artery makes at its upper part. It has been occasionally ruptured in reducing dislocation of the shoulder.

Nerves of the Brachial Plexus (Fig. 4295).—These nerves are derived from the lower four cervical and first dorsal. They are to the outer side of the artery in the first part of its course, but lower down they surround it. When the axillary artery divides into two trunks, one of which gives off all the branches, this latter is, as a rule, embraced by the two heads of the median. The axillary nerves are rarely torn by traction on the limb; when forcibly stretched they may be torn away from their attachment to the cord in the cervical region, as in a case recorded by Flaubert, where this accident happened in endeavoring to reduce a dislocated shoulder. The median is the nerve most frequently injured in wounds of the axilla, the musculospiral, from its very deep and protected position, always escaping. The axillary nerves are occasionally injured in fracture of the neck of the humerus, and may be compressed in dislocation of the shoulder.

Lymphatics (Fig. 4298).—The axilla is richly supplied with lymphatic vessels and glands. The glands, which are ten or twelve in number, are mostly placed along the axillary vessels and form a continuous chain with the cervical glands. They receive the lymphatics of the arm, and are often much enlarged in inflammatory affections of the hand and arm. A few glands are situated on the serratus magnus muscle and near the lower edge of the pectoral muscles. When enlarged these glands may be felt under the axillary border of the pectoralis major. The lymphatics from the pectoral group of glands drain into the axillary glands as do the lymphatics from the subscapular group. They receive most of the lymphatics from the side of the chest and mamma, and also the superficial lymphatics of the abdomen as low down as the umbilicus (Treves). These are the glands which are first enlarged in certain affections of the breast, *e.g.*, cancer, and also when the chest or abdomen is inflamed superficially, as from blistering, etc. Their efferent vessels join the axillary glands. There are some glands situated at the back of the axilla along the subscapular vessels; these receive the lymphatics from the back. In the interspace between the great pectoral and deltoid muscles near the clavicle, one or two small glands are found; they receive the lymphatics of the shoulder and outer side of the arm; above, they are connected with the lower cervical, and below with the axillary glands. The efferent vessels of the axillary glands pass up with the subclavian vein and join the thoracic duct on the left side, and on the right the lymphatic duct of that side. Sometimes they open separately into the subclavian vein. The axillary lymphatics which pass upward under the clavicle anastomose freely with the subclavian lymphatics and the lymphatics of the deep cervical glands.

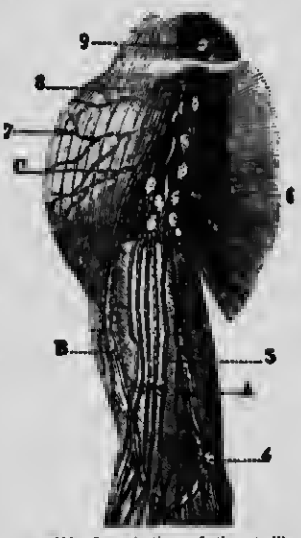

FIG. 4298.—Lymphatics of the Axilla. (From Testut.) 4, Epitrochlear gland; 5, superficial lymphatics of arm; 6, axillary glands; 7, lymphatic of shoulder; 8, lymphatic trunk accompanying the cephalic vein; 9, glands of neck; *A*, basilic vein; *B*, cephalic vein; *C*, axillary vein.

The glands of the axilla are frequently enlarged from sympathy with disease or inflammation of neighboring parts, and not infrequently run on to suppuration. They may be the subject of cancerous infiltration when the breast is affected with malignant disease; occasionally, malignant disease first affects these glands. Scrofulous enlargement of the axillary glands is not uncommon, and their removal is sometimes called for. Professor Verneuil (*Gazette des Hôpitaux*, October 10th, 1879) recommends linear division of the pectoral muscles previous to excision of deeply seated glands. As these glands lie chiefly along the vessels, there is great danger of hemorrhage, and even if the main vein itself is not wounded, some of the large veins going to it may be easily nicked and give rise to free hemorrhage.

In excision of the breast, when the axillary glands are affected they must always be removed, and this is often a difficult operation. The glands are very apt to become adherent to the vessels, especially the vein, which has often been wounded during removal of glandular tumors. When clearing the axilla of diseased glands the fingers will be found more serviceable than any cutting instrument, and infinitely safer. The deep lymphatics of the breast anastomose freely with the lymphatics of the fascia covering the great pectoral muscle and unite with the trunk of the deep lymphatics which go to the axilla. The lymphatics of the pectoral fascia do not anastomose freely with those of the muscle beneath, for the direction of the lymphatic flow is from the muscle to the fascia. Abscess of the axilla, originating in the glands, is not uncommon, the glands most liable to suppurative inflammation being those under the edge of the great pectoral muscle. The course which pus takes when it forms in the axilla has already been described with the fascia. Strumous glands in the axilla frequently break down

and suppurate, leaving sinuses which are very difficult to heal.

Supernumerary mammæ have been frequently reported as occurring in the axilla. Dr. Oarland (*Edin. Med. Jour.*, 1877) reports cases in which there were swellings in the axilla during pregnancy and suckling; and Dr. Sharpe (*Med. Times and Gazette*, 1855) mentions a case in which a supplementary mamma, which enlarged greatly during pregnancy, occurred in each axilla, and milk could be squeezed out apparently through pores in the skin; there was no appearance of nipples.

Mr. Birkett (*Med. Times and Gazette*, vol. ii., 1868) describes several cases of cystic tumors occurring in early life in the axilla and extending into the neck. He strongly advocates excision in these cases.

Fatty tumors frequently develop in this region; they can be removed without much difficulty.

Francis J. Shepherd.

SIALAGOGUES.—This term is applied to remedies that increase the secretion of saliva. In the normal state of the organism the secretion of saliva is a reflex process excited by chemical and mechanical stimuli. These affect the gustatory nerves and the sensory filaments of the trigeminal and glossopharyngeal nerves of the whole buccal cavity. Such stimuli are all foods and drinks that have a perceptible taste and the mechanical movements necessary in masticating. The stimulating impressions upon the sensory nerves are conveyed by them to the salivary centres, especially to the centre in the medulla oblongata; from these centres impulses are transmitted through the efferent nerves to the salivary glands, and as a result of these impulses there are an increased flow of blood to the glands and an abundant secretion of saliva. Hence it is observed that the saliva is most abundant when food has a very decided and agreeable taste and the process of mastication is slowly and thoroughly performed. In abnormal states of the buccal cavity, especially in the various forms of stomatitis, in consequence of the irritation of the sensory nerves, a more or less abundant flow of saliva takes place reflexly. (See also the article on *Saliva*.)

Most sialagogues act in the same manner as the normal stimuli of the secretion, that is, reflexly; by notably impressing the sensory nerves of the buccal cavity they excite the salivary centres and these transmit impulses to the salivary glands. Hence the greater the stimulating effect of sialagogues upon the sensory nerves of the mouth, the more abundant the salivary secretion. Very pungent substances, such as pellitory, mezereum, cubeb, capsicum, mustard, and ginger, if kept in contact with the buccal mucous membranes for some time, cause a free flow of saliva. Numerous other remedies having a decided action upon the sensory nerves of the buccal cavity, such as vegetable and mineral acids, alkalies, simple bitters and aromatics, ether, chloroform, and alcoholics, reflexly increase the flow of saliva.

Some sialagogues, however, do not act reflexly; they cause a very free flow of saliva when they are injected into the subcutaneous tissue or when they enter the blood by other routes. They act directly upon the peripheral ends of the secretory nerves of the salivary glands, and hence are called remote or specific sialagogues. The principal one of them, and the only one used therapeutically, is pilocarpine; others are physostigmine, muscarine, and nicotine. The preparations of mercury also act specifically; but when they have produced stomatitis the local irritation is necessarily followed by reflex salivation. The preparations of iodine and chlorate of potassium also increase the secretion of saliva by acting upon the secretory nerves.

Sialagogues are used when the salivary secretion is insufficient. This occurs in some persons who eat very rapidly; it is also frequently observed in prolonged febrile diseases, and it is one of the results of poisoning with certain alkaloids and ptomaines.

In the dyspepsia of persons eating too hastily sialagogues are probably of little or no benefit; but the adoption of correct habits in eating is generally soon followed by normal digestion. Such patients should be advised to masticate very slowly and at each meal to eat a sufficient amount of hard and dry food, such as stale bread, dry toast, crackers, to excite an abundant flow of saliva. When the teeth have become so defective that food cannot be thoroughly masticated, the patient should be advised to consult a dentist.

The salivary secretion is always diminished in high fevers, and it is sometimes almost completely arrested. When the patient constantly breathes through his mouth, the buccal mucous membrane sometimes becomes so dry that the movements of the tongue, articulation, and deglutition become difficult. In consequence of the dryness, the mucous membrane becomes fissured and abraded, thus presenting numerous openings for the entrance of micro-organisms. Various annoying and dangerous morbid conditions may result, such as soreness, ulceration, and bleeding of the gums, caries of the teeth, fetor of the breath, glossitis, inflammation of the glands of the neck, of the Eustachian tube and the middle ear. Hence, while sialagogues are used to maintain the secretion of the saliva, all other appropriate means should be employed to prevent the dryness of the mucous membrane. The air of the patient's apartment should be kept moist; the patient should frequently drink water, at least every hour; a piece of wet wide-meshed fabric should be laid over his open mouth; and every three or four hours the entire buccal cavity should be moistened by means of a large camel-hair brush with a mixture of one part of glycerin and two parts of peppermint water. The only sialagogues appropriate in fevers are the acids; of these the most agreeable one is citric acid as contained in lemonade, which has been used from time immemorial as a pleasant drink to quench thirst in high fevers. The other acids that may be used are tartaric, acetic, phosphoric, and hydrochloric, very much diluted and given at short intervals. Some authors hold that only vegetable acids should be given, because they do not, like the mineral acids, diminish the alkalinity of the blood, which, according to some researches, always becomes diminished in prolonged fevers; others are of the opinion that the mineral acids deserve preferance because they do not increase oxidation.

The buccal mucous membrane becomes intensely dry from arrested secretion of saliva and mucus in poisoning with belladonna, hyoscyamus, and stramonium, and to a somewhat less degree in poisoning with decayed meat, fish, and cheese. The arrested salivary secretion is, of course, only one of the symptoms; but it may be abated and some of the other symptoms allayed by the cautious administration of pilocarpine.

Pungent sialagogues have been used to allay toothache, earache, and other congestive and inflammatory affections of the nose, ear, and other parts of the head. During the profuse flow of saliva excited by their mastication, the salivary glands are very abundantly supplied with blood, and doubtless this hyperæmia may lessen the flow of blood to adjacent parts of the head and be of some benefit. For this purpose pyrothrum was generally preferred.

Samuel Nickles.

SIDE-CHAIN THEORY OF PAUL EHRLICH.—(Synonyms: Lateral-chain theory; Receptor theory. German, *Seitenkettentheorie*; French *Théorie des chaines latérales*.)

DEFINITION.—An hypothesis which attempts to explain according to chemical laws the mechanism of the processes of infection and immunity.

The side-chain theory first appeared as an explanation of the mechanism of the assimilation of foods (Ehrlich, Paul; "Das Sauerstoffbedürfniss des Organismus," 1885). According to this hypothesis a food must become chemically bound to a cell in order to be assimilated. Union of food and cell depends upon chemical structure. No matter what may be the chemical structure of a food, it must at least contain a chemical group which allows it to unite with a cell. This chemical group in a food is its "binding group" or "haptophorous group" (from the

Objections urged against this stretcher are, that it would be injurious in case of thigh fracture, and that it cannot be availed of for landing parties. Medical Inspector Gravatt, U. S. N., reports that he has used Mahan's device in cases of thigh fracture without detriment.

There are many other forms of stretcher available for the purpose under consideration. Wells' ambulance cot is in use in the United States naval service, but, as is true of other devices of this kind, men cannot be sent below upon it conveniently without the slide. This is an excellent form of stretcher for landing parties. "The improved cot" of Gorgas, or the "ambulance lift" of McDonald are seldom used. Gihon's "naval ambulance cot" is a secure and excellent device (Fig. 3513) and adapted to any ordinary need of transportation. Most of the stretchers devised for the old type of ship contemplate the suspension of the wounded, with hoisting or lowering; but, as hitherto remarked, this is a rare procedure. During an action at sea, if a hatchway is cleared, it will, as a rule, be used for militant purposes, and it is only where the ladder is taken away that suspension can be practised. If the ladder remain, one of the forms of stretcher already described, and with a slide, will be found the simplest and best procedure when hand-portage is not desirable.

For an improvised stretcher Lieutenant Mason, U. S. N., suggested the use of a ship's hammock, which is stretched and laced to a wooden frame, made of poles and cross-bars.

John C. Wise.

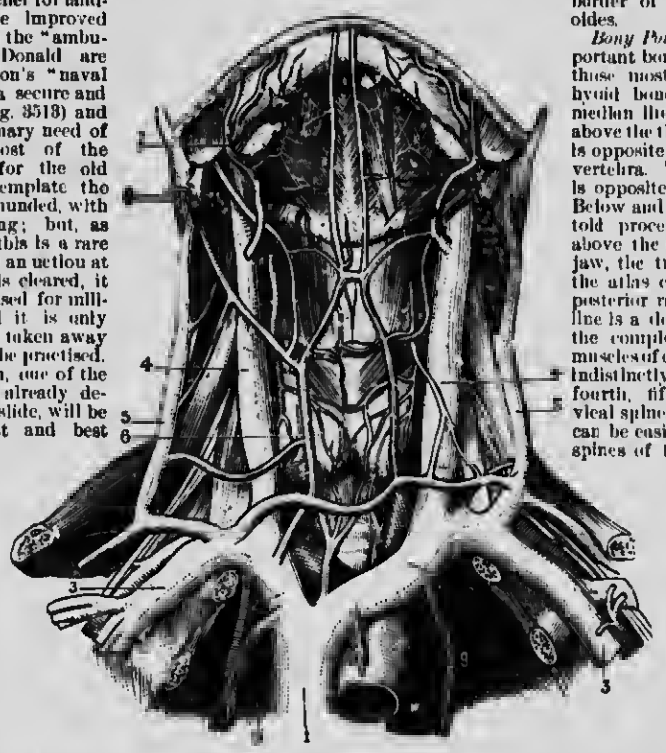

FIG. 3514.—Superior Vena Cava and Its Affluents. (From Testut.) 1, Superior vena cava; 2, trunk formed by the union of the brachial and cephalic veins on the right side; 2', the corresponding venous trunk on the left side; 3, 3, subclavian veins; 4, internal jugular vein; 5, external jugular vein; 6, anterior jugular vein; 7, facial vein; 8, thyroid veins; 9, internal mammary vein.

NECK, SURGICAL ANATOMY OF THE.—By the neck we usually mean the space between the occipital bone and lower jaw, above, and the upper aperture of the thorax, below. For convenience of description it is advisable to divide the neck into regions, viz., two lateral, an anterior median, and a posterior.

The *lateral* region represents a quadrilateral which is divided diagonally by the great sterno-mastoid muscle into two triangles, the anterior (carotid) and the posterior. Each of these is again subdivided into two by the omohyoid muscle. The anterior triangle is subdivided into a superior and an inferior carotid triangle, and the posterior into an occipital and a subclavian triangle.

The *anterior median* region is divided into two spaces by the hyoid bone, the upper being called the suprahyoid or submaxillary, and the lower the infrahyoid or hyosternal region.

The *submaxillary* region is bounded posteriorly by the posterior belly of the digastric and stylohyoid muscles, and contains the submaxillary gland.

The *posterior region* includes the portion commonly known as the nape of the neck.

SURFACE ANATOMY.—The outline of the neck varies much in different people; in stout individuals it is round and full, and the various landmarks are not easily distinguished; in thin people, on the other hand, every landmark stands out prominently, and can be made out by even the most inexperienced. The neck is, as a rule, fuller and rounder in women and children, and the *pomum Adami* is less marked. In muscular males the prominences are well seen; in old people who are thin the sterno-mastoid muscles and superficial veins stand out well, as does also the internal border of the platysma myoides.

Bony Points.—The most important bony point, and one of those most easily felt, is the hyoid bone, which is in the median line, a finger's breadth above the thyroid cartilage. It is opposite the fourth cervical vertebra. The cricoid cartilage is opposite the sixth cervical. Below and in front of the mastoid process, and behind and above the angle of the lower jaw, the transverse process of the atlas can be felt. In the posterior region in the middle line is a depression formed by the complexus and trapezius muscles of each side; here can be indistinctly made out the third, fourth, fifth, and sixth cervical spines, while the seventh can be easily felt, and also the spines of the first two dorsal vertebræ. These become more prominent when the head is bent forward; occasionally, when the spine of the sixth cervical vertebra is well developed, it is quite as prominent as the seventh. The transverse process of the sixth cervical vertebra can be felt on deep pressure opposite the cricoid cartilage, in the course of the carotid vessels. This is called the "carotid tubercle," and here the carotid may be easily compressed against it.

Anterior or Median Region.—In the receding angle below the chin is the hyoid bone, which can be easily felt in the fattest necks, it divides the anterior part of the neck into the suprahyoid and infrahyoid regions. In the median line of the suprahyoid region the anterior bellies and the digastric muscles cause a slight convexity; on the outer side of each anterior belly of the digastric muscle is felt the submaxillary gland lying on the mylohyoid muscle, which helps to form the floor of the mouth. This region is commonly cut into in self-inflicted wounds of the throat. About half an inch below the hyoid bone is the prominent thyroid cartilage (*pomum Adami*). This cartilage is prominent in deep-voiced men and people with thin necks, but in women and children it is not so distinctly seen; the notch at its upper border can be easily felt, and is commonly situated to one side of the median line. The superior cornua of the thyroid cartilage can be traced with the finger.

The space between the thyroid cartilage and the hyoid bone is called the thyrohyoid space, a membrane connecting these two structures; this membrane is covered by the muscles going to the hyoid bone from below, and is pierced by the superior laryngeal nerve and artery of each side. A cut made through the thyrohyoidean space would sever the lower part of the epiglottis. The rima glottidis is opposite the middle of the thyroid cartilage. Below this cartilage the finger sinks into a slight depression, the cricothyroid space; this is the space in which the operation of laryngotomy is performed, the opening here being well below the vocal cords. Across this space ramify two small vessels, the cricothyroid branches of the superior thyroid arteries. The next landmark of interest is the cricoid cartilage; it is a guide to many operations on the neck and air passages, and can be distinguished in the youngest and fattest neck. The cricoid cartilage is opposite the sixth cervical vertebra, and the narrowest part of the gullet is behind it; at this point foreign bodies are most likely to be arrested. The omohyoid muscle crosses the carotid vessels on a line with the cricoid cartilage, immediately above which line is the point usually selected for tying the common carotid artery. The middle cervical ganglion of the sympathetic is also on a line with this cartilage, and a little below and outside of it is the point where the vertebral artery enters the transverse process of the sixth cervical vertebra.

Below the cricoid cartilage the finger passes on to the trachea, the separate rings of which cannot be easily felt, because they are covered by the isthmus of the thyroid gland above, and below the trachea recedes from the surface. At the upper border of the sternum the trachea is one inch and a half from the surface. The isthmus of the thyroid crosses the second and third rings of the trachea.

In front of the trachea, below the isthmus, lie the inferior thyroid veins, which give so much trouble in tracheotomy. Occasionally an artery is found lying upon

Fig. 3515. Dissection of the Neck, showing the Triangles and their Contents. (Testut.)

the trachea, on its way to the thyroid gland; it is called the thyroidea ima and generally arises from the innominate. The episternal notch is felt at the top of the sternum, and is opposite the second dorsal vertebra.

Lateral Region.—The sternomastoid muscle is the prominent landmark in this region; in thin subjects, especially, it is well seen, and stands out distinctly when the face is turned to the opposite shoulder. The inner border, which covers the carotid artery, is more strongly marked than the posterior, which is thin, only the lower portion

Fig. 3516.—Vertical Median Section of the Head and Neck. 1, Ligamentum nuchæ; 2, cricoid cartilage; 3, trachea; 4, hyoid bone; 5, musculus arytenoideus; 6, ventricle of larynx; 7, thyroid cartilage; 8, cricoid cartilage; 9, thyroid body; 10, sternum. (After Braune.)

showing through the skin. The sternal tendons are well seen in nearly everybody, the depression between them being named the suprasternal fossa. In some necks this fossa is absent, owing to the space being filled with fat. The space between the sternal and clavicular portions of the sternomastoid can usually be made out; in thin necks it is well marked. The internal jugular vein and carotid artery lie behind this space; deeper down still, we have the apex of the lung, which sometimes rises an inch and a half above the clavicle.

The sternoclavicular articulation is an important landmark; immediately behind it, on the left side, is the common carotid artery and the division of the innominate; on the right, it is opposite the point where the internal jugular joins the subclavian vein to form the innominate. The division of the innominate artery in children is higher up than the articulation; in some cases it divides in front of the trachea (see *Arteries, Anomalies of*).

The depression above the clavicle, between the trapezius and the clavicular origin of the sternomastoid, is called the supraclavicular fossa. In this fossa the external jugular vein terminates in the subclavian, after piercing the deep cervical fascia. Here also may be felt, in thin persons, the brachial plexus of nerves and the omohyoid muscle, and in the angle formed by the sternomastoid and clavicle the third part of the subclavian artery may be felt pulsating. At this point it can be compressed against the first rib. The central point of the greatest convexity of the clavicle is opposite the third portion of

the subclavian artery. This is a more certain landmark than the muscle, the extent of attachment of which to the clavicle varies considerably.

The posterior border of the sternomastoid corresponds pretty closely to the outer border of the scalenus anticus muscle; this point should be borne in mind in tying the subclavian artery.

Behind the sternomastoid the chain of lymphatic glands, when enlarged, can be easily felt.

The posterior belly of the digastric muscle corresponds to a line drawn from the mastoid process to the body of the hyoid bone. When the chin is extended a prominent fold of cervical fascia can be felt going from the angle of the lower jaw, downward and outward.

The position of the tonsil corresponds externally to the angle of the jaw.

Veins (Surface Marking of).—The most important of these is the *external jugular*, which can always be seen. Its course is marked out by a line drawn from the angle of the jaw to the middle of the clavicle, at which point it pierces the deep cervical fascia to join the subclavian vein. It is occasionally joined by a vein which runs over the clavicle (see *Veins, Anomalies of*). By pressing above the clavicle, the vein is distended, and its course is easily traced.

The *anterior jugular* vein lies on the sternohyoid muscle and in front of the inner border of the sternomastoid. When the external jugular is small this vein attains considerable size.

The surface marking of the *internal jugular* corresponds to a line drawn immediately external to the line of the artery. The *facial vein* runs from the anterior border of the masseter muscle downward and backward, and joins the internal jugular opposite the upper border of the thyroid cartilage.

The *middle thyroid vein* crosses the carotid artery opposite the cricoid cartilage.

Arteries (Surface Marking of).—The *carotid* artery corresponds to a line drawn from the sternoclavicular articulation to a point midway between the mastoid process and the angle of the jaw. The *common carotid* reaches as high as the upper border of the thyroid cartilage. It can be compressed against the sixth cervical transverse process ("carotid tubercle"), which is opposite the cricoid cartilage. The *superior thyroid* artery comes off from the external carotid a little above the upper border of the thyroid cartilage. The *lingual* artery runs forward from the external carotid to the upper border of the great cornu of the hyoid bone, to which it is parallel. The hypoglossal nerve lies above the artery. The course of the *facial* artery in the neck corresponds to a line drawn from the tip of the great cornu of the hyoid bone to the inner border of the masseter muscle.

The *occipital* arteries can be felt pulsating immediately below and a little in front of the tip of the mastoid process.

Nerves (Surface Marking of).—The *spinal accessory* nerve passes beneath the anterior border of the sternomastoid muscle an inch below the tip of the mastoid process, and emerges from the posterior border at a point on a level with the upper border of the thyroid cartilage; it then crosses the posterior triangle obliquely and enters the trapezius muscle on a level with the sixth or seventh cervical spines.

The *phrenic* nerve commences in the neck about the level of the hyoid bone, and runs obliquely downward over the scalenus anticus to its inner edge. In the neck the phrenic nerve is covered by the sternomastoid.

The *superficial cervical* nerves all emerge at a point corresponding to the middle of the posterior border of the sternomastoid. The *great auricular* crosses the sternomastoid on its way up to the ear; the *lesser occipital* runs along the posterior border of the sternomastoid; the *superficial cervical* crosses the sternomastoid at right angles and reaches the middle of the neck, and lines drawn from the point of emergence to the sternum, middle of the clavicle, and the acromion would mark the course of the *supraxternal*, *supraclavicular*, and *supra-acromial* nerves.

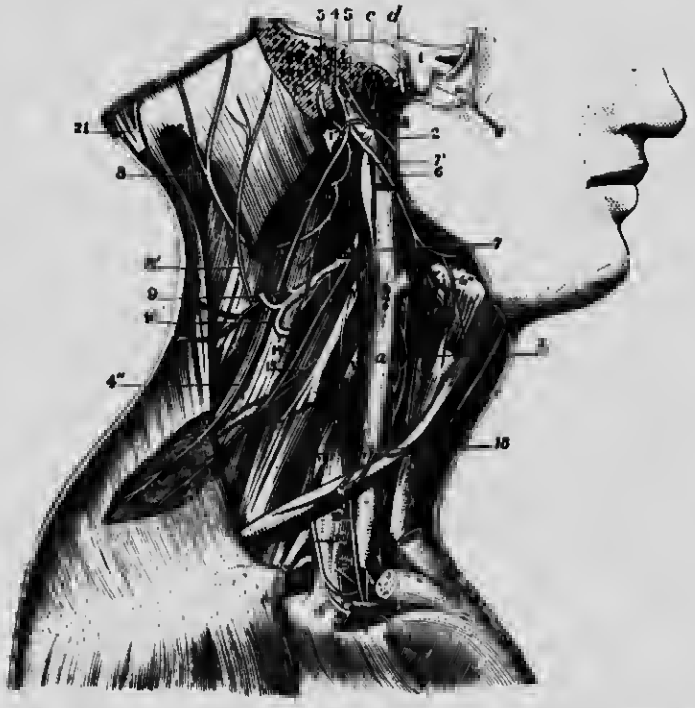

Fig. 3317.—Deep Cervical Plexus of Nerves. (From Testut.) *I, II, . . . VIII*, Anterior branches of the eight cervical nerves.—1, trigeminal nerve, with its three branches; 2, glossopharyngeal; 3, pneumogastric, with, 3', its branch, the superior laryngeal; 4, spinal accessory, with its two branches—4', that which supplies the sterno-cleido-mastoid muscle, and, 4', that which goes to the trapezius; 5, facial nerve; 6, the main trunk of the hypoglossal, with its two branches—6', the descending ramus, and, 6', that which supplies the thyrohyoid muscle; 7, the great sympathetic, with, 7', its superior cervical ganglion; 8, the larger mastoid branch of the cervical plexus; 8', the little mastoid branch; 9, the auricular branch; 10, the transverse cervical branch; 11, the subclavian and anterior thoracic branches; 12, point of anastomosis with the great sympathetic; 13, nerve of the large anterior rectus muscle; 14, trapezian branch of the cervical plexus; 15, nerve of the levator ang. scap.; 16, nerve of the rhomboideus; 17, internal descending branch; 18, bend of the hypoglossal, with its efferent branches that supply the subhyoidean muscles; 19, phrenic nerve, with, 19', its anastomosis with the great sympathetic, and, 19'', its anastomosis with the nerve that supplies the subclavius muscle; 20, the nerve of the subclavius muscle; 21, great occipital nerve.

a, internal jugular vein; *b*, the common carotid artery; *c*, the internal carotid; *d*, the middle meningeal; *e*, the subclavian artery.

The cutaneous branches of the cervical plexus are widely distributed, supplying the ear, back of scalp, cheek, parotid gland, side and front of neck, and upper part of chest and shoulder.

The facial nerve sends a branch to the neck, which supplies the platysma myoides muscle.

Topographical Anatomy.—The skin over the anterior and lateral regions of the neck is thin and lax, and in

Fig. 3518. Superficial Dissection of the Neck, showing the Distribution of the Branches of the Superficial Cervical Plexus of Nerves. (Heath.)

plastic operations is of great value in making flaps. The platysma is closely connected with the skin of this part of the neck. There is frequently some transverse wrinkling of the skin above the hyoid bone, and in this region in fat people there is much fat, giving rise to what is called a double chin; here also the sebaceous follicles are very abundant. In adult males this part is covered with beard.

The skin of the posterior region is very thick and adheres closely to the deeper structures; this is due to the large number of short fibrous connections between the skin and fascia. Carbuncles and boils frequently occur here and cause great pain, owing to the density of the parts and their free nerve supply.

The *nape* of the neck is often the seat of pustular and vesicular eruptions, which are due almost invariably, when localized in this part, to the presence of pediculi, these parasites finding a safe habitat in the thick hair under the prominent portion of the occipital bone. The glands in this region are frequently enlarged in sympathy with eruptions of the hairy scalp. The nape of the neck was the favorite site, in old times, for the application of setons and issues.

Fatty tumors are often seen at the lower part of this region.

Cervical Fascia.—It is the custom to divide the deep fascia of the neck into *superficial* and *deep* processes. The superficial fascia invests all the muscles, with the exception of the platysma; and some of the veins, as the external jugular, are also superficial to it. It is attached posteriorly to the spinous processes of the cervical vertebræ and ligamentum nuchæ; passing forward it splits to enclose the trapezius and then crosses the posterior triangle; at the posterior border of the sternomastoid the fascia divides into two layers which enclose that muscle, these layers unite at the anterior border of the muscle, and the fascia passes on to the middle line of the neck, where it is continuous with that of the opposite side. It covers the anterior triangle, being attached above to the lower jaw. In the posterior triangle the fascia is attached below to the clavicle and above to the mastoid process and the superior curved line of the occipital bone; in this triangle it is pierced by the external jugular vein and some of the superficial cervical nerves. In the anterior triangle the fascia is attached above to the body of the lower jaw, and continues backward and upward over the parotid gland to be attached to the zygoma. It sends a process (the stylomaxillary ligament) between the parotid and the submaxillary glands. In front the fascia is attached to the hyoid bone and covers the thyroid gland, below which it splits into two layers; the deeper covers the sternohyoid and sternothyroid muscles, and is attached below to the posterior edge of the first piece of the sternum, behind the sternoclavicular joint; the superficial and thinner layer passes down over the sternomastoid muscles, and is attached to the anterior edge of the manubrium and interclavicular ligament. The space between these two layers is filled with cellular tissue and fat, and sometimes a small gland is found here. In this compartment are also found the sternal head of the sternomastoid and the anterior jugular vein. In tenotomy of the sternomastoid this space must be opened, and the vein is avoided by keeping the knife close to the tendon of the muscle.

This space is also cut through in performing the operation of tracheotomy, and air is sometimes driven at every inspiration into the cellular tissue beneath the deep layer, an occurrence which complicates the operation exceedingly. The process of fascia covering the posterior belly of the omohyoid and binding it down to the clavicle and first rib, is continuous with the fascia covering the depressors of the hyoid bone.

The deeper processes of cervical fascia are important; one comes off from the anterior border of the sternomastoid and forms a sheath which encloses the carotid artery, jugular vein, and pneumogastric nerve. The vein is separated from the artery by a thin septum of fascia.

A process of fascia also invests the thyroid body, passes behind the depressors of the hyoid bone, and lies in front of the trachea and deep vessels of the neck; below, this layer is continuous with the fibrous pericardium.

The *prevertebral* fascia is a layer which descends on the prevertebral muscles, separating them from the pharynx and œsophagus; laterally it joins the carotid sheath and then proceeds outward covering the scalene muscles, brachial plexus of nerves, and subclavian vessels, becoming continuous with the axillary sheath. It is also connected with the coracoacromial membrane.

Although the cervical fascia influences to a certain extent the growth of tumors and collections of matter, this influence has been much exaggerated, and tumors grow and matter collects and distributes itself often quite irrespective of this fascia.

Pus in front of the trachea would tend to gravitate into the anterior mediastinum and on the side of the neck

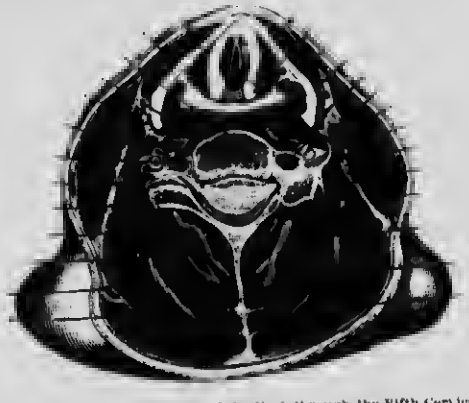

Fig. 3519.—Transverse Section of the Neck through the Fifth Cervical Vertebra, showing Cervical Fascia. (Braune.)

might perforate the apex of the pleural sac. An abscess in front of the vertebræ would lie beneath the prevertebral fascia, and if it did not burst into the gullet, might extend laterally and present itself outside the sternomastoid, or descend to the posterior mediastinum. In some cases these collections of pus have been known, after reaching

the posterior triangle of the neck, to follow the course of the brachial plexus and present themselves in the axilla. Pus pent up between the layers of the cervical fascia has destroyed portions of not only the jugular vein, but also the carotid artery, and when the abscess cavity was opened the patient has died of hemorrhage from these vessels. Dr. S. W. Gross (*American Jour. of the Medical Sciences*, April, 1871) has collected twelve cases of ulceration of the jugular veins, with hemorrhage into the sacs of closed abscesses, or into abscesses several days after their contents have been evacuated, or into acute or chronic ulcers. The majority of cases were in children who had cellulitis of the neck following scarlet fever—all the cases proved fatal.

Dr. Erichsen (*St. Petersburg. med. Woch.*, December, 1877) reports a case of suppurative angina which broke of itself, and several days afterward a profuse and fatal hemorrhage occurred. The autopsy revealed ulceration of the internal carotid artery. In such cases the lesson to be learned is to prevent the destructive effects of diffuse cellulitis by early and free incision, and, if hemorrhage does occur, not to rely exclusively on packing, but to ligature the affected vessel.

In opening abscesses in the neck, there is some danger of wounding some of the great vessels if a too free incision be made with the knife, the vessels being pushed out of their normal position by the abscess; their exact course is difficult to determine. In such cases at first the skin only should be incised; after this the knife should be laid aside and a director should be pushed through the fascia; and when pus runs along the groove of the director, a pair of dressing forceps should be introduced, opened in the abscess cavity, and withdrawn open. This method has the advantage of being perfectly safe, and is especially adapted for opening deep-seated abscesses. It is known as Hilton's method.

Arteries of the Neck.—The two large arterial trunks which are seen in the neck are the *carotid*, which lies in the anterior triangle, and the *subclavian*, which lies in the lower part of the posterior triangle (subclavian triangle).

The *carotid* is included in a sheath of deep cervical fascia with the internal jugular vein and pneumogastric nerve. The vein lies to its outer side, and in the living subject overlaps the artery at the lower end and especially on the left side. To the inner side of the artery lie the trachea and œsophagus, larynx, and pharynx, and low down the recurrent laryngeal nerve. The thyroid gland also lies to its inner side. The vagus nerve lies to the outer side and posteriorly above, and rather more in front below.

Lying on or in the sheath of the vessels is the descendens noni nerve. The great sternomastoid muscle covers not only the common, but also the internal and external carotid arteries. In the undissected subject it is impossible to puncture the common carotid from the side of the neck without piercing the sternomastoid muscle (Richet). This fact is not sufficiently dwelt on in anatomical works, the descriptions given being applicable to dissected subjects only. The omohyoid muscle crosses the artery and vein obliquely and on a line with the cricoid cartilage. The most important structures behind the artery are the sympathetic trunk, the inferior thyroid artery, and the recurrent laryngeal nerve. The common carotid normally gives off no branches in its course. It divides into external and internal carotid opposite the upper border of the thyroid cartilage. The right and left common carotid arteries are so similar in their course in the neck that one description will answer for both. The left, however, it is well to bear in mind, arises from the arch of the aorta, and is somewhat longer than the right, which arises from the innominate opposite the right sternoclavicular articulation. The right common carotid is generally larger and not so deeply placed in the neck as the left; it is also further away from the trachea.

As the vessels ascend the neck they become more superficial, and, having a direction somewhat backward, get further apart as they reach their termination. The surface-marking of the carotid has already been described.

The artery may be easily compressed against the transverse process of the sixth cervical vertebra.

Ligature of the Common Carotid.—A ligature may be applied to any part of the artery, except near its origin or termination. The usual point of ligature is either immediately above or below the omohyoid muscle. It is usually ligatured above the omohyoid, as here the artery is more superficial, and the operation is, in consequence, easier. An incision should be made along the inner border of the sternomastoid muscle, and the parts carefully divided until the sheath of the vessels is reached. The operation is much facilitated by drawing the sternomastoid outward and (if the superior operation be chosen) pulling inward the omohyoid. Should any veins or small branches of the superior thyroid artery come in the way, they should be divided between two ligatures. The sheath of the vessels should be opened on its inner side, so as to avoid the jugular vein, and the descendens noni nerve should be held aside to avoid injury. The aneurism needle with the ligature should be passed from without inward; in this way the vein and vagus nerve are most easily avoided.

Fig. 3320.—View of the Common Carotid and Subclavian Arteries, with the Origin of their Branches and their Relations. (R. Quain.)

The lower operation is the more difficult one, for, to expose the sheath of the vessels it is often necessary to divide some fibres of the muscles covering it. Again, the vein, if large, overlaps the artery; this renders the passing of the aneurism needle a proceeding of some difficulty. On the left side the internal jugular vein is much closer to the artery than on the right, and so the difficulty of passing a ligature around the artery is much increased. Ligature of the carotid is performed for wounds of the vessel or some of its branches, also for aneurism. It has been ligatured for pulsating orbital tumor. Mr. W. Rivington (*British Medical Journal*, October, 1885) records an interesting case of a boy, aged nine years, who swallowed a fish bone; this was followed

by pyrexia, stiff neck, salivation, and a tender lump on the left side of the neck opposite the cricoid cartilage. Three days later, the boy had two severe attacks of hemorrhage from the mouth. Wound of the carotid was diagnosed, and the artery cut down upon and ligatured. The fish bone was found in the centre of a clot, and it had ulcerated into the artery. The patient died of abscess of the brain ten days after the operation. A common site of carotid aneurism is at the bifurcation of the common carotid, and the treatment is ligature of the vessel below. In aneurism at the root of the neck the carotid has been ligatured with success above the tumor. Ligature at the distal side of an aneurism was first proposed by Brasdor, and practised by Wardrop. The treatment of aneurism of the arch of the aorta or innominate artery by simultaneous ligature of the carotid and subclavian arteries has been attended in a few cases with benefit.

Aneurism at the root of the neck frequently gives rise to "pressure symptoms." When the great venous trunks are compressed there is œdema and lividity, not only of the side of the face and neck, but also of the upper extremity of the same side. Not infrequently cough is produced by pressure on the recurrent laryngeal nerve, and if the pressure be great, then paralysis of the vocal cords of that side will ensue and cause a marked alteration of the voice. Dilatation of the pupil may also occur from pressure on the sympathetic trunk.

When the common carotid reaches the upper part of the larynx, it divides into two trunks, one of which, the

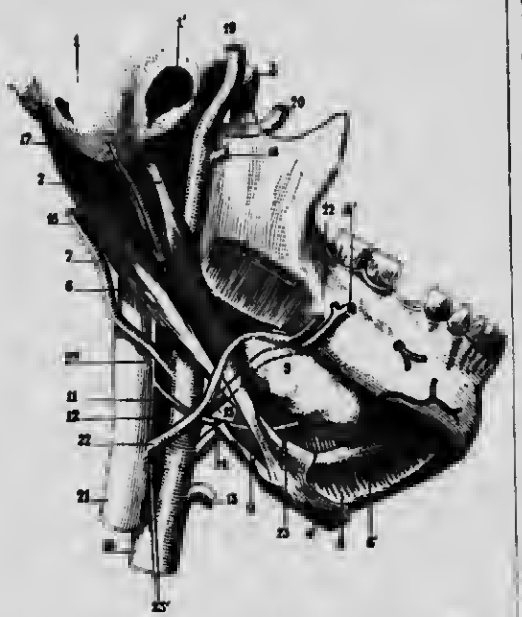

FIG. 321.—Relations of the Two Carotids to the Styloid and Digastric Muscles. (From Testut.) 1, Mastoid process; 1', orifice of the external auditory canal; 2, styloid process; 3, condyle of the inferior maxilla; 4, hyoid bone; 5, submaxillary gland; 6, 6', the anterior and posterior bellies of the digastric muscle; 7, stylohyoid muscle; 8, mylohyoid muscle; 9, hyoglossus muscle; 10, common carotid; 11, internal carotid; 12, external carotid; 13, superior thyroid artery; 14, lingual artery; 15, 15', facial artery; 16, occipital artery; 17, posterior auricular artery; 18, transverse artery of the face; 19, superficial temporal artery; 20, internal maxillary artery; 21, internal jugular vein; 22, facial vein; 23, great hypoglossal nerve, with, 23', its descending branch.

external, gives off a number of branches, and is distributed to the superficial parts of the head and face and the tongue; the other, the *internal*, furnishes blood to the brain and eye. As a rule, the internal carotid has the deeper course, and lies behind the external, but not infrequently the two arteries lie side by side for some distance, the internal lying more posteriorly, and being recognized by the accompanying pneumogastric nerve. The two vessels are separated by the styloid process and stylohyoid ligament, also the styloglossus and stylopharyngeus muscles and glossopharyngeal nerve. The external trunk has two muscles and a nerve in relation to it anteriorly, viz., the digastric and stylohyoid muscles, and the hypoglossal nerve which hooks round one of its branches, the occipital. After passing behind the angle of the lower jaw the external carotid becomes embedded in the parotid gland.

Ligature of the external carotid is not a very easy operation owing to the number of branches given off from it, and the large venous trunks which lie over the lower portion may much increase the difficulties. The artery is reached by an incision in the line of the vessel, having its midpoint about the level of the hyoid bone. It is usually ligatured immediately below the digastric. It occasionally requires ligature in the course of operations for the removal of tumors about the angle of the jaw and neck.

Branches of External Carotid.—The most important branches in the neck are the superior thyroid, lingual, and the cervical portion of the occipital and facial.

The *superior thyroid* arises near the origin of the main vessel and curves downward, forward, and inward, beneath the depressors of the hyoid bone. It is distributed to the upper part of the thyroid gland, and can be readily exposed by an incision between the omohyoid and sterno-mastoid muscles. It sends a branch along the crico-thyroid membrane which is sometimes wounded in the operation of laryngotomy. The superior thyroid artery has lately been tied with success for the purpose of arresting the growth of an enlarging thyroid body.

The *lingual* artery arises from the external carotid nearly opposite the great cornu of the hyoid bone (it may however, arise in common with the superior thyroid and cross the hyoid bone). It runs above and parallel to the great cornu and beneath the hyoglossus muscle. It is frequently necessary to ligature the lingual previous to extirpation of the tongue.

In ligaturing this vessel the one guide which the operator must rely on is the great cornu of the hyoid bone—it can always be felt and its relation to the artery is nearly always constant. The best place to expose the artery is immediately above the great cornu. Some authorities advise ligature of the artery near its origin from the carotid; but here, owing to the large veins which cover it, the operation is more difficult, and besides we have no absolute guide as to the exact point of origin of the artery, which frequently varies. On the other hand, the relation of the vessel to the great cornu of the hyoid bone is nearly always constant. The incision should be a curved one, and should extend from near the symphysis menti to near the angle of the lower jaw. The convexity of the curve should be downward, and its lowest point ought to reach the hyoid bone. After dividing the skin, platysma, and deep fascia, the tendon of the digastric muscle should be searched for, and in the angle which the tendon forms with the hyoid bone the artery will be found running beneath the hyoglossus muscle; the hypoglossal nerve is seen running over this muscle. If the submaxillary gland cover the parts, it should be held aside with hooks. After carefully dividing the hyoglossus muscle the artery will be felt pulsating at the bottom of the wound. If the incision be carried too far back the facial vein may be wounded.

When it is necessary to remove the submaxillary gland the facial artery must be ligatured. The operation presents no difficulties and requires no special description.

The *subclavian artery* is, surgically, a very important vessel. The left subclavian lies deeper than the right and arises directly from the arch of the aorta, while the right is one of the terminal branches of the innominate and commences opposite the right sternoclavicular articulation. Each artery curves upward into the neck

under the anterior scalenus muscle, and then descends into the subclavian triangle under the clavicle and over the first rib. The subclavian vein lies in front and somewhat below the artery, from which it is separated by the anterior scalenus.

The artery is divided into three portions by the scalenus anticus muscle, viz., first, portion internal to the

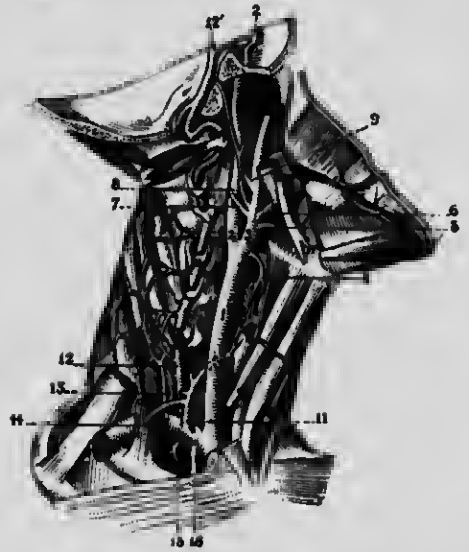

Fig. 3522.—Inferior Thyroid and Vertebral Arteries. (From Testut.) 1, Common carotid artery; 2, internal carotid artery; 3, external carotid artery and its branches; 4, superior thyroid artery; 5, lingual artery; 6, facial artery; 7, occipital artery; 8, inferior pharyngeal artery; 9, posterior auricular artery; 10, subclavian artery and its branches; 11, thyroid axis; 12, vertebral artery; 12', posterior cerebral artery; 13, deep cervical artery; 14, subscapular artery; 15, superior intercostal artery; 16, internal mammary artery.

muscle; second, portion beneath the muscle; and, third, portion external to the muscle reaching to the lower border of the first rib. Surgically, the third portion is most important. The external jugular vein crosses the artery, and the sternomastoid and the deep fascia which binds down the omohyoid muscle to the clavicle are in front of it; the brachial plexus of nerves lies above and to the outside of the third portion of the artery. Posteriorly the artery lies on the pleura and on the scalenus medius, and finally it rests on the first rib. The third portion of the artery can be felt pulsating above the clavicle, in the supraclavicular fossa, and here it may be readily compressed against the first rib with the thumb or the handle of an old-fashioned door-key wrapped in lint. The direction of the pressure should be vertical to the axis of the body; before attempting compression the shoulder should be lowered as much as possible. In compressing this vessel pain is sometimes caused by pressing on the lowest cord of the brachial plexus, which usually lies behind the artery; this may be easily avoided by rolling the nerve away from the artery, and then the proceeding is quite painless.

Some individuals (the writer among them) can arrest the pulse at the wrist by forcibly carrying the shoulder downward and backward. In this case the artery is compressed against the first rib by the subclavius muscle and clavicle.

Ligature of the subclavian is, as a rule, confined to the third portion, or that part lying in the supraclavicular space between the sternomastoid and trapezius muscles; the other portions are so deeply placed, so thickly studded with branches, and so closely connected with such important structures as the phrenic and vagus nerves, the junction of the internal jugular and subclavian veins, and, on the left side, with the thoracic duct, that ligature is rarely attempted. On the right side it is possible to ligature the vessel between the common carotid and the internal jugular vein.

The third portion of the vessel is comparatively superficial, being covered above the clavicle by no other soft parts than the skin, fascia, and fat. In at least fifty per cent. of subjects it is branchless, and when a branch is given off from the third portion it is almost invariably the posterior scapular.

To reach the artery an incision is made between the sternomastoid and the trapezius. The skin should be drawn down and the first incision should be made upon the clavicle to avoid wounding the external jugular, which pierces the deep fascia immediately above the clavicle. The vein should be held aside, or, better still, divided between two ligatures, and the deep fascia attached to the clavicle cut through; the finger should then be introduced and the scalene tubercle of the first rib searched for; this tubercle is usually found by following down the scalenus anticus muscle, which runs in the direction of the posterior edge of the sternomastoid. Having made out the scalene tubercle, the surgeon will feel the artery pulsating beneath the finger immediately outside the scalenus anticus muscle. The aneurism needle should be introduced from below upward to avoid the vein; it must hug the artery closely so that the lowest cord of the brachial plexus may not be included.

The operation is performed for aneurism of the axillary artery, and also of the innominate; also before amputating the whole upper extremity. In the latter case the common carotid is also tied. In axillary aneurism the operation is much complicated by the great distention of the veins and the great elevation of the clavicle.

Branches of the Subclavian.—The subclavian is rich in branches which are distributed in three different directions, viz., the vertebral and inferior thyroid, upward; the transversus colli and transversus humeri, outward; and the internal mammary and superior intercostal, downward. Most of the branches arise internal to the scalenus anticus; three of them, the transversus colli, transversus humeri, and inferior thyroid arise from a single trunk, the thyroid axis. The posterior scapular is frequently given off from the third part of the artery in place of from the transversus colli. The branches of the subclavian artery are subject to innumerable variations both as to their number and origin (see *Arteries, Anomalies of*). When the subclavian is ligatured, there being free anastomosis between its branches and those of the axillary artery, the nutrition of the arm is not interfered with.

The *vertebral artery*, which is the largest branch of the subclavian, arises from the upper and posterior part of

Fig. 3523.—Showing Line of Incision and Parts Exposed in Ligature of the Third Part of the Subclavian Artery. (Modified from Roser.)

the first portion, and ascends to enter the transverse process of the sixth cervical vertebra; after piercing the transverse process of the axis it makes a remarkable

curve (Fig. 3324, 5) outward and upward to reach the foramen in the transverse process of the atlas, and bending backward, runs in the deep groove on the upper surface of the atlas.

Immediately above the clavicle this vessel lies very deeply between the scalenus anticus and longus colli muscles. It has frequently been ligatured here for the relief of epilepsy; the operation is a difficult one, owing to the many important structures in close relation with the vessel. An incision is made along the posterior border of the sternomastoid muscle immediately above the clavicle, the transverse process of the sixth cervical vertebra (carotid tubercle) is now searched for, and the artery is found lying between the scalene and longus colli muscles.

Drs. Bright and Ranskill state that disease of the vertebral artery, immediately before it enters the skull, may lead to pain at the back of the head. The fact that the artery is here in close relation with the suboccipital nerve, which communicates with the great occipital nerve, may explain this symptom. (Treves.)

The vertebral artery is sometimes wounded by stabs in the neck; not a few cases are reported in which the artery was injured by stabs below the mastoid process. Dr. King (*Lancet*, November, 1885) records a case of injury of this artery in a young man, aged twenty-five, due to a deep wound below the left mastoid process; there was severe bleeding, so the wound was enlarged and the transverse process of a cervical vertebra was found broken; the finger placed between two transverse processes stopped the hemorrhage; the wound was plugged with strips of oiled lint, and in four weeks the patient had perfectly recovered. The plug was removed on the fourth day.

Hemorrhage from wounds of the vertebral artery between two transverse processes is difficult to arrest; wooden plugs have sometimes succeeded; occasionally the artery has been successfully tied by snipping away

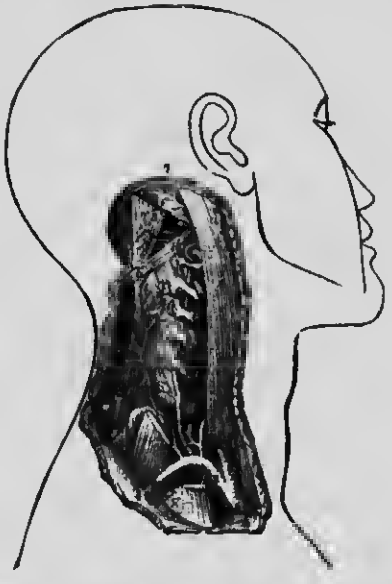

Fig. 3324.—Deep Dissection of the Neck, showing the Course and Origin of the Vertebral Artery (5). (Tiedemann.)

the transverse process and applying a ligature. If this cannot be done the bleeding vessel may be secured by artery forceps, which should be left in the wound.

Traumatic aneurisms of the vertebral artery may occur after a stab in the neck; the writer on one occasion saw this follow a wound of the vessel between the second and third cervical transverse processes. These aneurisms are commonly mistaken for aneurism of one of the branches of the carotid—as, for instance, the occipital—and the common carotid has been tied on this supposition, without avail, of course. The mistake has arisen from the surgeon finding that pulsation in the aneurism ceased on compressing the carotid in the neck. Of course, if it is compressed below the "carotid tubercle," the circulation in the vertebral is arrested as well as in the carotid; and even if pressure is applied at this point, the vertebral may be compressed, for it frequently fails to enter the foramen in the transverse process of the sixth cervical vertebra.

The ligature placed on the carotid should be first tightened, and, if this arrests the pulsations in the aneurism, the ligation may be completed; but if pulsation is not arrested, then it is probable that the vertebral is the artery affected, and ligature of the carotid is a useless proceeding.

The treatment of such aneurisms is very unsatisfactory; cases of cure are reported from continuous compression with shot-bag, but if this fail operative measures are of little avail; it is useless to ligature the artery low down, as the anastomosis above is so free; and if the aneurism is cut down upon, ligature at the seat of the aneurism is rarely satisfactorily completed. The writer once saw the carotid tied for vertebral aneurism due to a stab with a knife below the mastoid, and afterward the sac of the aneurism cut down upon; but the hemorrhage could not be arrested by plugging, or otherwise, and the patient died. In this case pressure on the carotid against the sixth cervical transverse process arrested pulsations in the aneurism, and it was supposed that the affection was connected with the occipital artery.

The inferior thyroid artery is sometimes ligatured at the same time as the superior thyroid for enlarged thyroid in exophthalmic goitre (Graves' disease). Any of the arteries may be temporarily ligatured during an operation by tying the ligature over a piece of rubber tubing placed on the vessel. The writer has done this with both the carotid and the subclavian arteries with success.

Veins of the Neck.—The *anterior jugular* vein has already been mentioned as lying along the inner border of the sternomastoid. It varies somewhat as to its course, and is sometimes double. Occasionally, the veins of the two sides are connected by a large transverse branch, which is a source of trouble in the operation of tracheotomy. The anterior jugular, if large and placed nearer the median line than usual, is liable to be wounded in tracheotomy. It might also be wounded in tenotomy of the sternomastoid for wry-neck. The two anterior jugulars may be replaced by a single trunk.*

In front of the trachea and thyroid gland is a large vein, the *inferior thyroid* (vena thyroidea ima), which, when large, complicates operations on the trachea.

The *external jugular* vein corresponds to a line drawn from the angle of the jaw to the middle of the clavicle; it runs beneath the skin and platysma and over the sternomastoid muscle, and ends by piercing the deep fascia above the clavicle to join the subclavian vein. In the operation of tying the subclavian in its third part, it (the vein) must be held aside or ligatured.

The *internal jugular* vein lies to the outer side of the common carotid artery, and when distended partially overlaps it. In operations for the removal of tumors or enlarged glands of the neck, this vessel may be wounded; ligature in such accidents is the proper procedure, and is not attended by any evil after-effects. The writer has on three occasions ligatured the internal jugular with the most happy results.

The *subclavian vein* is a continuation of the axillary, and is in close relation with the clavicle; it lies in front of and below the subclavian artery, from which it is

* The anatomy of this region has been ably described by Dr. Pilcher in the Annals of Anatomy and Surgery, vol. iii., 1881.

separated by the anterior scalenus muscle. On the left side the thoracic duct empties into it. The joint of junction of the subclavian and internal jugular veins is opposite the sternoclavicular articulation. The wall of

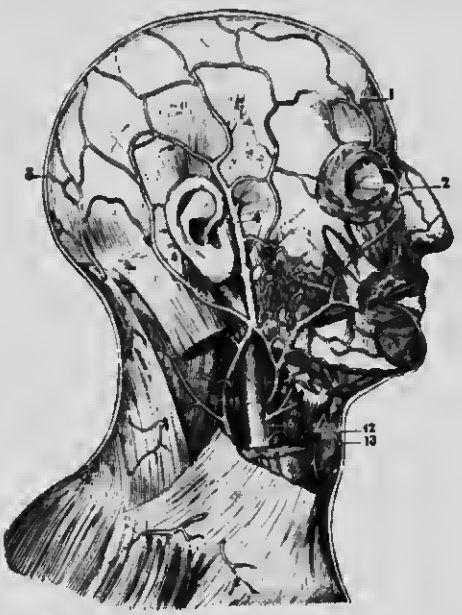

FIG. 332.—Superficial Veins of the Face, Head, and Upper Part of the Neck. (From Testut.) 1, Frontal veins; 2, parietal veins; 3, occipital veins; 4, superficial temporal vein; 5, internal maxillary vein; 6, mastoid vein; 7, angular vein; 8, facial vein; 9, external jugular vein; 10, point where the latter anastomoses with the facial vein; 11, lingual vein; 12, superior thyroid vein; 13, anterior jugular vein; 14, carotid artery; 15, internal jugular vein; 16, pneumogastric nerve.

the subclavian vein adheres closely to the fascial sheath by which it is invested; this sheath is connected anteriorly with the costocoracoid membrane and the clavicle, and when the shoulder is carried forward the vessel becomes expanded. (Quain.) In operations at the root of the neck great care should be taken to avoid wounding the large veins, for air is very apt to be sucked in during inspiration. These veins are so firmly united to the bones and muscles, that when wounded they do not collapse, but, on the contrary, gape. It should be remembered that the risk of air entering is increased by movements of the upper limb, which still further open the wounded vein.

THYMUS BODY.—This is a highly vascular organ consisting of two lateral lobes, one on each side of the larynx and trachea, connected by an isthmus which crosses the second and third rings of the trachea. The lobes are pear-shaped, and reach from the fifth and sixth rings of the trachea to the upper border of the thyroid cartilage; the lateral lobes are covered in front by the depressions of the hyoid bone, and posteriorly are in contact with the sheath of the great vessels of the neck. Each lateral lobe measures about two inches in length, one and one-fourth inch in breadth, and from three-fourths to one inch in thickness. The weight of the thyroid body is from one to two ounces, and is greater in females than in males. The isthmus is occasionally absent, the lateral lobes being connected by fibrous tissue only, as is the case in some animals, viz., the horse, donkey, etc.

Owing to the fact that the thyroid body lies over the great vessels of the neck, when enlarged it derives from them a visible pulsation, and a distinct thrill may be felt. Such pulsating tumors have been mistaken for aneurism, but as the thyroid body is closely connected with the larynx and trachea, it rises and falls in deglutition, and so is easily diagnosed from aneurismal or other tumors, which are not disturbed by deglutition. When hypertrophied the tumor resulting from an enlarged thyroid is called a "*bronchocele*" or *goitre*. When a goitre grows rapidly respiration is often interfered with, and operation has to be undertaken for its relief. It is not necessary to remove the whole gland to relieve the obstructed respiration, for division and removal of the isthmus only often gives very good results. Mr. Sidney Jones (*Lancet*, vol. ii., 1883) reports cases in which excision of the isthmus not only relieved the dyspnœa, but a month after the operation the lateral lobes had almost disappeared.

Since the advent of antiseptic surgery the extirpation of large bronchoceles by the knife has become most common, but the operation, owing to the very important structures in relation to it, is always a most formidable one. It is very important in this operation first to ligate the vessels supplying the gland, viz., the superior thyroid above, and the inferior thyroid below, and if present, the middle thyroid. In ligating the inferior thyroid artery, care must be taken not to injure the inferior laryngeal nerve, which winds among the branches of that artery. Simple cysts may be removed by enucleation. Owing to the conditions which follow complete removal of the thyroid, viz., myxœdema, and cachexia strumipriva, partial removal is the more common operation except in cases of malignant disease or when the growth becomes dangerous from pressure.

The ŒSOPHAGUS commences opposite the cricoid cartilage; it lies between the trachea and the vertebral column. At the lower end of the neck it inclines a little to the left, and for this reason œsophagotomy is performed on the left side. Strictures most commonly occur at its upper part, and foreign bodies are most apt to be arrested behind the larynx. Foreign bodies, such as fish bones, mutton or beef bones, have occasionally ulcerated through the œsophagus and perforated some of the large vessels with which it is in contact.

In performing *œsophagotomy* for the removal of an arrested foreign body, the incision is made between the sternomastoid and trachea, the middle point being opposite the cricoid cartilage. The inferior thyroid artery and recurrent laryngeal nerve must be carefully avoided. The carotid artery is in no danger of being wounded if proper care be taken.

In *œsophagostomy*, when a stricture exists high up, the in-

FIG. 333.—Transverse Section of Neck, Opposite Fourth Cervical Vertebra, showing Thyroid Body (*Gil. Th.*).

cision into the œsophagus is made for the purpose of feeding the patient by a tube, and so avoiding gastrostomy. The fact that the operation is performed low down makes it much more dangerous than œsophagotomy, and nearly all the reported cases have ended in death within a short time of the operation from diffuse inflammation of the neck.

Hyoid Bone.—This is one of the most important landmarks in the neck, and one which can always be felt in the slightest neck. It is the best guide for ligature of the lingual. In old age the different portions of the bone become ossified into one piece, and in consequence it is more easily broken by direct violence due to blows or throttling. Cases are reported of fracture of the hyoid from yawning and sudden extension backward of the head. The symptoms of fracture are pain, difficulty in speaking, in movements of the tongue, and in swallowing.

Larynx and Trachea.—The *larynx* is connected above with the hyoid bone by means of the thyrohyoid membrane, and is continuous below with the trachea. Posteriorly it helps to form the wall of the pharynx. It consists of several parts, which are closely connected together by ligamentous structures, muscles, and mucous membrane; these parts are the thyroid cartilage, epiglottis, cricoid, and arytenoid cartilages. On the upper margin of the thyroid cartilage is a bursa which prevents friction as the larynx ascends beneath the hyoid bone in deglutition. This bursa is sometimes enlarged, and has to be incised. The larynx is occasionally wounded in cases of attempted suicide by cutting the throat. Between the lower border of the thyroid and cricoid cartilages is the cricothyroid membrane, where the operation of laryngotomy is performed. A small lymphatic gland is occasionally found here, which may become enlarged. (For description of interior of larynx see *Larynx*.)

Foreign Bodies.—Children not infrequently swallow articles which are sucked into the larynx during inspiration; these may be arrested by the cords at the rima, or may lodge in one of the ventricles. If they pass the rima they usually lodge in the right bronchus. These bodies can frequently be seen with a laryngoscope and extracted with forceps, but very often the operation of tracheotomy is necessary to remove them.

The Trachea extends from opposite the sixth cervical vertebra to its bifurcation opposite the third dorsal, where it is crossed by the arch of the aorta. It measures from four to five inches in length, and from three-fourths to one inch in breadth. It is covered by the depressors of the hyoid bone, and has on each side at its upper end the

Fig. 327. Dissection of the Space in the Neck where the Operation of Tracheotomy is Performed. The trachea is exposed, having on each side of it the sternohyoid muscle, and lying on it below the inferior thyroid veins. (Roser.)

thyroid body. It is crossed by the isthmus of the thyroid gland opposite its second and third rings, and has also in front the inferior thyroid veins, and sometimes a transverse branch connecting the two anterior jugulars. When the middle thyroid artery is present it also lies upon the trachea in its course up to the isthmus of the thyroid. In children the thymus gland covers its lower portion. Laterally the trachea is in relation with the carotid artery and recurrent laryngeal nerve; posteriorly it is in contact with the œsophagus. The innominate artery crosses the lower end of the trachea; this occurs higher up in children than in adults.

The operation of *tracheotomy* is performed above or below the isthmus. It is required for the extraction of foreign bodies and for any obstruction to respiration having its seat in the larynx, as from diphtheritic membrane, new growths, etc. It is also performed as a preliminary to certain operations in the neck and mouth.

The distance between the cricoid cartilage and the upper border of the sternum, in ordinary individuals is about one inch and a half (4 cm.); when the head is thrown back three-fourths of an inch more is gained; so in performing tracheotomy the neck should be extended as much as possible by placing a hard round pillow under it, and the incision should be exactly in the middle line, so as to come between the two sternohyoid muscles and anterior jugular veins. In operating there is a choice as to where the trachea is to be opened, either above or below the isthmus. Above, the parts are more superficial and blood-vessels fewer, but the space is limited and the cricoid cartilage has often to be cut; below, although the trachea is deeper and the veins are more plentiful, still there is more room for incision, and we get farther away from the disease, which is an important point in diphtheria. With our present means of arresting hemorrhage the low operation is to be preferred.

Laryngotomy is performed in cases in which it is necessary rapidly to relieve suffocation, and in adults who have chronic affections of the larynx. It is performed by cutting the cricothyroid membrane transversely.

(For a more complete description of these operations see *Tracheotomy*.)

Lymphatic Glands of the Neck.—These are large and numerous. They frequently enlarge and become inflamed, and if not excised break down and suppurate, leaving unsightly scars. In scrofulous subjects the glands of the neck are the ones most frequently enlarged. The enlargement is always the result of some irritation, either of the mucous membrane of the throat, nose, ear, etc., or of the skin of the scalp, face, or neck. The glands are more liable to enlarge in persons of a scrofulous diathesis, and in them the amount of involvement of the glands is out of all proportion to the irritating cause; this may be an eczema of the scalp or a simple sore throat. In non-scrofulous individuals the glands are frequently enlarged from some special irritating cause, as a diseased tooth, tonsillitis, malignant disease of the tongue, lip, etc., but in these individuals the affection of the glands is not so widespread, nor is the enlargement so great, and the glands do not tend to suppurate.

In syphilitics the *glandulæ concatenatæ* in the posterior triangle of the neck are frequently enlarged and indurated but they do not tend to suppurate. In tonsillitis an enlarged gland is always felt beneath the angle of the lower jaw; this is erroneously supposed by many to be the enlarged tonsil which cannot be felt from the outside.

In eczema of the scalp the glands of the neck are frequently enlarged, especially if the eczema be of the pustular variety. In delicate children pediculi not only often cause an eczema of the nape of the neck, but the irritation frequently causes enlargement of the glands in the suboccipital and mastoid regions.

Occasionally a single gland becomes enlarged over the carotid artery, and this has been mistaken for aneurism on account of the strong pulsation communicated to the tumor by the artery; these tumors, however, cannot be emptied by lateral pressure, and when lifted away from the artery all pulsation, of course, ceases.

When one or several glands of the neck have become enlarged and show no tendency to diminish, it is much better to remove them with the knife. This can be easily done before the gland breaks down and suppurates, and so forms inflammatory adhesions to the surrounding parts. In cases of "scrofulous necks," in which nearly all

the glands are enlarged, their removal is advisable, for if left to themselves they break down and suppurate, and after months and perhaps years of discomfort, heal, leaving unsightly scars. An argument in favor of early excision is that foci of infection are removed, and the patient's chance of good health is much greater. Frequently thirty or forty glands have been removed at one operation, and the result is almost invariably good, the patient recovers rapidly, and the amount of scarring is very trifling. In dissecting out the glands in close relation to the large vessels, great care should be taken.

When the glands have suppurated and sinuses are left which will not heal, scraping the sinus and removal of the remains of the gland with a sharp spoon give very good results. Mr. Treves recommends puncture of softened caseous glands with a cautery; he also advises opening gland abscesses by the cautery highly heated.

The lymphatics of the neck are enlarged, with those of other parts of the body, in leukæmia and Hodgkin's disease, and care should be taken not to confound scrofulous glands with enlarged glands in these diseases. Removal of enlarged glands in Hodgkin's disease is, except for diagnostic purposes, of course, perfectly useless.

The lymphatic glands of the neck are arranged in the following groups: *Submaxillary* (ten to twelve in number), situated beneath the base of the inferior maxilla; these also include the *suprahyoid*, which are situated between the two anterior bellies of the digastric muscle in the middle line of the neck. *Superficial cervical* (four to six) situated along the external jugular vein beneath the platysma and deep fascia. *Deep cervical* (twenty to thirty). These are subdivided into *superior* and *inferior*. The *superior* are situated about the bifurcation of the common carotid, and reach to the base of the skull, lying along the internal jugular vein. The *inferior* are grouped around the lower part of the internal jugular vein, and extend outward into the supraclavicular fossa, becoming continuous below with the axillary and mediastinal glands.

The following table, from Sir F. Treves' book on "Scrofula and Its Gland Diseases," showing the relation certain glands bear to the periphery, will be found useful:

Scalp: Posterior part = suboccipital and mastoid glands; frontal and parietal portions = parotid glands; vessels from the scalp also enter the superficial cervical set of glands.

Skin of Face and Neck = Submaxillary, parotid, and superficial cervical glands.

External Ear = Superficial cervical glands.

Lower Lip = Submaxillary and suprahyoid glands.

Buccal Cavity = Submaxillary and deep superior cervical glands.

Gums of Lower Jaw = Submaxillary glands.

Tongue: Anterior portion = suprahyoid and submaxillary glands; posterior portion = deep cervical glands (superior).

Tonsils and Palate = Deep cervical glands (superior).

Pharynx: Upper part = parotid and retropharyngeal glands; lower part = deep cervical glands (superior).

Larynx, Orbit, and Roof of Mouth = deep cervical glands (superior set).

Nasal Fossæ = Retropharyngeal glands and deep cervical (superior). Some lymphatics from the posterior part of the fossa enter the parotid gland.

Parotid Gland.—This gland lies on the face in front of the ear, and extends deeply into the space behind the lower jaw; its inferior portion is situated partly in the neck behind the angle of the jaw, lying on the digastric muscles in the submaxillary region. It is connected with very important structures, being pierced by the external carotid artery and facial nerve. This gland not infrequently becomes inflamed and suppurates after fevers (as typhoid) and operations on the abdominal viscera. Cases are reported in which it has become inflamed after ovariotomy, and the writer has twice seen abscess of the parotid follow severe blows on the abdomen. These abscesses are very painful, owing to the tension caused by the investing fibrous capsule. In opening abscesses here the incision should be transverse, to avoid cutting the facial nerve, and should be in front of the line of the carotid artery. Abscesses of the parotid gland frequently burst

Fig. 3328.—Dissection of the Neck, showing the Triangles and their Contents. (Tiedemann.)

into the external auditory meatus. There are a number of lymphatic glands in relation with the parotid, which receive vessels from the scalp, pharynx, etc. Tumors are not infrequently found in this region, the extirpation of which gives rise to very severe hemorrhage. The facial nerve is frequently unavoidably injured in the removal of these tumors, and the external carotid artery sometimes requires ligature.

Submaxillary Gland.—The submaxillary gland is situated in the submaxillary region, between the anterior and posterior bellies of the digastric muscle. It lies partly on the mylohyoid and partly beneath it. The facial artery grooves the back part and upper border of the gland. The gland is sometimes involved in malignant diseases affecting the mouth and tongue. It is separated from the parotid gland by a fold of deep cervical fascia, the stylomaxillary ligament.

Nape of the Neck.—The superficial anatomy of this region has already been described. The most superficial muscle is the trapezius, which is covered by a layer of thick and tough fascia and is pierced by the great occipital nerve. To the outer side of the trapezius, and separated from it as it descends, is the sternomastoid muscle; crossing obliquely the interval between them are the splenius capitis and colli muscles. On removing the trapezius, which in this region is usually very thin, the complexus muscle comes into view, also pierced by the great occipital nerve; deeper down still are seen the muscles bounding the suboccipital triangle (rectus capitis untheus major, superior and inferior obliquus), where are seen the suboccipital nerve and vertebral artery. In the central line is the ligamentum nuchæ. It extends from the seventh cervical spine to the external occipital protuberance. In some animals this ligament is a very powerful elastic band which suspends the head; to it are attached muscles and fascia. The occipital artery becomes superficial midway between the mastoid process and external occipital protuberance. It runs along the outer border of the superior oblique, and is

accompanied by the great occipital nerve. The lesser occipital nerve winds round the posterior border of the sternomastoid, and supplies the lateral region of the occiput; the suboccipital, being a purely motor nerve, rarely reaches the skin.

Spinal Cord and Vertebral Column.—The accompanying figure (3539) shows well the situation of the spinal cord in the neck vertebræ. It is not so well protected against injury as in other parts, for in the space between the several arches, any sharp instrument piercing the muscular tissue could easily wound the cord. The vertebral artery, as has already been mentioned, is also liable to injury on its way from one vertebra to another. From the great mobility of this part of the spine dislocation occasionally occurs and death is caused by pressure on the cord. In caries of the upper cervical vertebræ, sudden death has taken place from the destruction of the ligaments between the atlas and axis. When this occurs—the head with the atlas inclining forward and leaving the axis in its proper position—the medulla oblongata is crushed against the odontoid process, and so instant death is the result. (Hilton.)

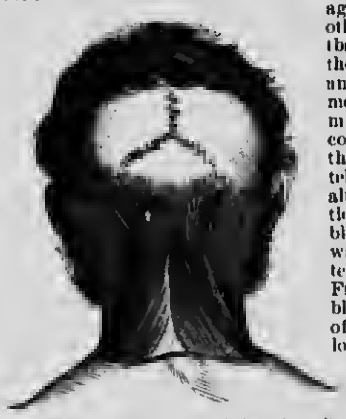

Fig. 3539. The Skin and Fascia have been Removed, and the Superficial Muscles Exposed. 1, Sternomastoid; 2, splenius capitis; 3, trapezius; 4, small occipital nerve; 5, great occipital nerve; 6, occipital artery. (After Roser.)

Caries of the spine in the cervical region is not uncommon. In its early stages the symptoms are somewhat obscure, the chief complaint being of pain in the course of the great occipital nerve, due to its implication in inflammatory exudation. The peculiar stiff way in which the patient carries his head, and the presence of a slight prominence which is excessively tender, enables the surgeon to recognize the disease. These cases occasionally result in a post pharyngeal abscess, which has to be opened. This may easily and safely be done by an incision along the posterior border of the sternomastoid. Some advise tapping it with a trocar through the mouth.

Branchial Fistulæ and Cysts.—In the mammalian embryo, at the fourth week, there are on each side of the head, behind the oral cavity, four fissures which communicate with the anterior part of the alimentary canal. These are the homologues of the clefts found in branchiate vertebrates. The third and fourth fissures in the human embryo disappear about the sixth week, and only the first remains at the end of the ninth week. This persists as the Eustachian tube, tympanic cavity, and external auditory meatus. The structures developed in the folds between the clefts (branchial arches) are as follows:

First Arch (*Mandibular*): Meckel's cartilage, the anterior portion of which is developed into the lower jaw, and the mandibular arch is completed by the malleus bone of the ear.

Second Arch (*Hyoid*): Incus, stapes (Parker), styloid process, stylohyoid ligament, and lesser cornu of the hyoid bone.

Third Arch: Great cornu and body of the hyoid bone.

Fourth Arch: No permanent remains.

Sometimes the clefts between these arches remain more or less open, and this fact explains the occurrence of congenital fistulæ of the neck, as well as that of cysts and diverticula from the œsophagus and larynx.

Paget says (Proc. Royal Med. Soc., 1877): "Cervical branchial fistulas occur as two or three minute orifices on one or both sides of the lower part of the neck, and they lead upward to the œsophagus and pharynx; the lowermost being near the sternal end of the clavicle in front of the sternomastoid muscle, the next opposite the thyroid cartilage, and the highest between the thyroid cartilage and hyoid bone." When two in number, they are often symmetrical; they vary in length from one-half to one and a half inches, and barely admit a probe. They have a smooth lining membrane, which secretes a clear mucous fluid. These fistulæ can be cured by cauterizing them with the galvanocautery. It is probable that many cysts and so-called hydroceles of the neck are due to imperfectly closed embryonal fissures.

Sanguineous cysts of the neck are probably originally branchial cysts, which have communicated with the internal jugular vein. Cases are on record in which, before removal of the cyst, the vein had to be ligatured (Glück; *Deutsche med. Woch.*, No. 5, 1886).

Branchial Dermoids.—These are occasionally seen in the neck, the most common situation being between the genlohyoglossi muscles, where the swelling projects into the submaxillary space and also into the mouth. They can usually be enucleated. A dermoid sometimes is seen under the deep fascia close to the carotid arteries.

Thyroglossal Fistulæ and Cysts.—These are met with on the tongue, at the hyoid bone, and lower down over the thyroid cartilage, cricoid, and upper rings of the trachea. They grow slowly with the growth of the individual, and are very difficult to eradicate. The cyst wall is thin and lined with columnar epithelium, perhaps ciliated. Their contents are mucoid. They sometimes burst, leaving fistulous openings which are difficult to close. Unless the cyst be entirely removed, it will recur, for if any part of the epithelial lining be left it will secrete and cause a persistence of the trouble. Thyroglossal cysts and fistulæ are the remains of the thyroglossal duct, which passes up the neck to the tongue

Fig. 3540.—The Superficial Tissues have been Removed to show the Vertebral Artery Passing Through the Transverse Processes of the Vertebræ, and also the Relation of the Cord to the Spinal Canal. (Roser.)

behind the hyoid bone. The lower part becomes the isthmus of the thyroid gland, while the upper part persists as the foramen cæcum of the tongue.

Tumors of the Neck.—The neck is a favorite site for tumors, fibroma, sarcomatous and others. Sarcomatous tumors in the early stages can be removed, but they nearly always recur. Tumors of the neck, which are

apparent, so freely movable that their extirpation would seem to be an easy matter, are found, when cut down upon, to be intimately connected with the deep vessels and nerves. In these cases the tumor is freely movable laterally, the vessels going with them, but there is no freedom of movement in the vertical direction. It is remarkable with what impunity large tumors may be removed from the neck, especially if they are benign. It is not uncommon in these cases to ligature both the internal jugular vein and the carotid artery, and to cut through the sternomastoid muscle, and yet have the patient make a rapid recovery from the operation; the tumor, as mentioned above, if sarcomatous, almost invariably returns, for it is impossible in the neck in such cases to remove sufficient of the surrounding healthy structures.

Aneurismal tumors at the root of the neck are comparatively common, and although in many cases these tumors may have the appearance of being connected with the subclavian or innominate arteries, yet they almost invariably proceed from the aortic arch, and push their way upward under the clavicle into the neck. Fusiform aneurisms of the aorta frequently simulate aneurism of one of the great branches.

Tumors in connection with the thyroid gland have been alluded to in the description of that body.

Francis J. Shepherd.

NECROBIOSIS.—The gradual death of tissue due to slowly acting injurious agents is known as *necrobiosis* or *indirect necrosis*, in opposition to *direct necrosis* or *immediate death*. In necrobiosis the death of the cell is preceded by some other retrograde change, such as atrophy, cloudy swelling, mucous, hydropic or fatty degeneration, or by one of the pathological infiltrations. In the case of direct necrosis death of the tissue takes place rapidly without the occurrence of preceding abnormal changes in cellular structure. The preceding retrograde change in necrobiotic processes is by some writers regarded as constituting the necrobiosis; but a distinction should be made between the preceding atrophy, degeneration or infiltration, and the molecular disintegration which constitutes the essential feature of necrobiosis. The retrogressive changes preceding this disintegration usually occur so gradually, and in themselves present such definite characteristics, as to be classed by themselves. The use of the term necrobiosis is more theoretical than practical, inasmuch as a practical distinction between direct necrosis and necrobiosis is at times very difficult or impossible. Necrobiosis is, therefore, best conceived of as a slowly progressive or incomplete necrosis. The gross appearances of necrobiotic tissues vary according to the nature of the preceding retrograde change and the degree of necrosis present. Microscopically, in addition to the characteristic changes presented by the accompanying retrograde change, the nuclei of the affected tissue show karyorrhexis and a greater or less degree of karyolysis. The ultimate picture of necrobiosis is that of necrosis; if the necrobiotic process has been characterized by cloudy swelling, simple necrosis follows; if by fatty degeneration, soft cuseation (fatty necrobiosis) occurs; if by hydropic degeneration, liquefaction necrosis results. The sequelæ of necrobiosis are essentially those of necrosis: regeneration, repair, cicatrization, calcification, and cyst formation. Likewise the causes producing necrobiosis are the same as those leading to direct necrosis: mechanical, thermal, chemical, infectious, and nutritional. The injurious agents may act separately or coincidently. As a general rule it may be stated that harmful agents of slight power but of long-continued action are more likely to produce necrobiosis than direct necrosis. Disturbances of blood supply, deficient nutrition and oxygenation, as in the case of chronic anæmia, are among the most important factors leading to necrobiotic processes. Chronic intoxications and infections also play a leading rôle in the production of necrobiosis. Clinically a neuropathic necrobiosis may be distinguished.

Aldred Scott Warthin.

NECROSIS, PATHOLOGY OF.—The condition of local death, the death of individual cells or groups of cells within the living body, is known as *necrosis*. If such local death occurs immediately or very quickly after the action of some injurious agent, it is termed *direct necrosis;* if, on the other hand, the death of tissue is of a slowly progressive nature preceded by other retrograde changes, the process is designated *necrobiosis* or *indirect necrosis*. The use of the word necrosis without modifying designation is usually taken as referring to direct necrosis.

Inasmuch as we have no definite knowledge, either chemical or histological, of the condition of cell life, the essential nature of cell death or necrosis is also unknown to us. The cellular change which marks the exact moment of the passage of life from the cell is at present beyond our knowledge; the slight histological changes taking place in cells at this moment do not permit us to determine with certainty the definite boundary between the states of cell life and cell death. Our conception of necrosis is, therefore, based upon the changes which follow necrosis rather than upon those taking place at the moment of cessation of life. The development of modern microscopical technique has, however, so perfected methods of tissue fixation that it is now possible to fix and preserve definitely the histological characteristics of the cells as they exist at the moment the tissue is placed in the fixing fluid. Our knowledge of the structure of normal living cells has been obtained from the study of cells killed and fixed by such means; and likewise our conceptions of pathological conditions are based upon the relative appearances of cells so treated.

As a result of such study certain pathological criteria have been created. Of these the condition of *necrosis* is that state of the cell which is characterized microscopically by the disappearance of the nucleus and certain molecular changes in the cytoplasm. The disappearance of the nucleus or its failure to respond to nuclear stains is to be taken as the most striking feature of necrosis, inasmuch as the nucleus is to be regarded as the most essential vital element of the cell. Cells may be dead and yet retain their nuclei, but necrosis becomes evident to us microscopically only when certain changes in cell structure have occurred to distinguish the dead cell from living ones. The loss of the nucleus may occur at the moment of death or subsequently; in either case it becomes the criterion of necrosis. To the disappearance of the nucleus and its loss of staining power the terms *karyolysis* and *chromatolysis* have been applied. These changes are very frequently preceded by fragmentation of the nuclear chromatin. This change is known as *karyorrhexis;* it has been shown to consist of regular and definite movements on the part of the chromatin elements. Small masses and granules of chromatin may leave the nucleus and pass into the cell body. With the disappearance of the cell membrane fine chromatin granules may be scattered throughout the cell detritus of the necrotic area. As a result of such diffusion of the chromatin areas of necrosis in the early stage may stain diffusely blue. In other cases the nucleus before its disappearance contracts and becomes smaller, at the same time staining more deeply than normal (*pyknosis*.) Very frequently the nucleus retains its normal form and size, but gradually loses its staining power and fades away, both nucleus and protoplasm being converted into a homogeneous hyaline mass.

Sooner or later, changes take place in the protoplasm of dead or dying cells. The normal granulation of the cytoplasm may disappear and the cell undergo hyaline change. The cell membrane ultimately disappears and the outline of the cell becomes irregular or lost altogether. Often the cell protoplasm becomes coarsely granular, the cell ultimately breaking up into a granular débris. Vacuolation may take place and the cell become enlarged and swollen from the imbibition of fluid. As the result of such swelling, breaks in the continuity of the protoplasm may occur. On the other hand, the dead cells may under certain conditions become inspissated,

Extrusion and constriction of portions of the protoplasm may occur during the process of dying. Amœboid cells usually assume a globular form. The disintegration of the protoplasm is termed *plasmorrhexis*. The ultimate result of the necrotic process is the conversion of both nucleus and cytoplasm into a granular débris; when such appearances are found microscopically, the condition is to be regarded as one of complete necrosis.

Causes of Necrosis.—The causes which may lead to local death of tissue may be classed as follows: nutritional, mechanical, thermal, chemical, toxic, infectious, and neuropathic.

Disturbances of nutrition through interruption of the circulation are among the most frequent causes of necrosis. Local anæmia due to arterial occlusion as a result of thrombosis, embolism, compression, ligature, or arteriosclerosis may be the direct cause of local tissue death (anæmic and hemorrhagic infarction). Likewise stasis due to mechanical, thermal, chemical, or trophic changes in the vessel walls or to weakened heart's action may be a primary or secondary factor of necrosis. Local asphyxia from any cause may result in cell death.

Traumatic violence may through crushing or tearing cause direct death of cells, or through damage to the blood-vessels it may cause necrosis through disturbed nutrition. Cells separated from their normal environment as a rule soon die.

Elevation of temperature from 54° to 68° C. for a short period of time causes the death of tissue; excessive cold produces the same result.

The prolonged action of *x*-rays may lead to necrotic changes. This has been explained as due to the destruction of nerves, but this point has not been definitely settled.

Chemical and toxic substances of various kinds may act directly upon cells and cause their death. The poison may destroy the cells directly or, through chemical union with the cell protoplasm or intercellular substance, render life impossible, or by producing changes in the blood-vessels give rise to necrosis secondarily. Most important of all as agents of necrosis are the bacterial toxins, particularly those of tuberculosis, typhoid, cholera, staphylococcus, and streptococcus infections. Chemical substances, originating within the body, may also give rise to necrosis under certain conditions.

The bile acids, uric acid, metabolic products in diabetes, pancreatic ferments, etc., may under certain pathological conditions give rise to necrotic processes. Fat necrosis is a striking example of necrosis arising from the action of a normal body product under abnormal conditions. The pancreatic juices are absorbed into the lymph and blood streams, the fat-splitting ferment, steapsin, causing necrosis of fat cells in the neighboring fat tissue, or even in such distant regions as the pericardium and fatty marrow.

The direct action of bacteria or other forms of vegetable and animal parasites may also produce necrosis of cells.

Primary lesions of the central nervous system and the peripheral nerves are considered by many writers to give rise to a trophic or neuropathic necrosis. The changes following such lesions are much more to be regarded as dependent upon circulatory disturbances than as trophic manifestations. As a result of lowered nutrition the normal resistance of the affected parts may be diminished and bacterial infection favored.

The causes mentioned above may act separately or coincidentally. The degree of necrosis depends not only upon the nature and severity of the exciting cause, but also upon the condition of the tissue at the time of injury. Tissues of lowered vitality, in conditions of general anæmia, marasmus, and cachexia, die more easily than normal tissue; hence long-continued pressure of slight degree, which under normal conditions would produce no effect, may in such conditions as typhoid fever, chronic valvular disease, etc., bring about necrosis (*decubitus, marasmic necrosis*). Necrosis occurs also in the tissues of the aged as a result of slight injuries (*senile necrosis*).

Varieties of Necrosis.—Though the loss of the nucleus and a greater or less disorganization of the cytoplasm form the essential features of necrosis, these changes may be more or less modified, or so associated with other processes as to give rise to different varieties of necrosis, recognizable either by gross or by microscopical appearances. The kind of necrosis depends upon the location and nature of the affected cells, the character and severity of the destructive agent, and the nature of the surrounding tissue, particularly with reference to the absence or presence of fluids. If the dead cells are on a surface exposed to evaporation, inspissation may take place; on the other hand, if there is an abundant supply of fluid, the cells may become hydropic and ultimately liquefy; if the factors necessary for the formation of fibrin are present, coagulation may occur either in the cells or between them. The character of the necrosis may be further modified by infection with putrefactive bacteria. It becomes therefore possible to distinguish the following varieties of necrosis, each form presenting distinct macroscopical and microscopical characteristics when occurring alone. Between these different varieties there is, however, no distinct boundary line. They are very frequently combined or may follow each other in certain cases, so that the practical diagnosis as to the original form may be difficult.

Varieties of necrosis.
- 1. Simple.
- 2. Coagulation. (Intercellular. / Intracellular.)
- 3. Liquefaction.
- 4. Mummification.
- 5. Moist gangrene.

} Caseation.

Simple Necrosis.—This form of necrosis is characterized microscopically by the disappearance of the nucleus and a hyaline or granular change in the cytoplasm, the original outlines of the tissue being preserved to a greater or less extent. Usually the dead cells are somewhat larger than normal, the protoplasm being more granular and staining heavily with eosin. Less frequently the cells are hyaline and homogeneous. By some writers this variety of necrosis is regarded as a form of coagulation necrosis, but it seems better to restrict the latter class to those forms

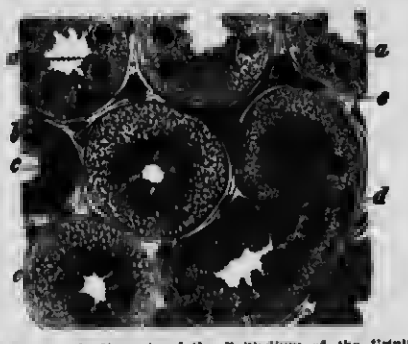

Fig. 3331.—Simple Necrosis of the Epithelium of the Uriniferous Tubes in a Case of Icterus Gravis. (From Ziegler.) *a*, Normal convoluted tubule; *b*, ascending loop tubule; *c*, convoluted tubule with necrotic epithelium; *d*, convoluted tubule with only a part of its epithelium necrotic; *e*, stroma and blood-vessels as yet unaltered. (Preparation hardened in Müller's Fluid, and stained with gentian violet.) Magnified 300 diameters.

of necrosis in which fibrin or fibrinoid substances are formed. Simple necrosis usually follows cloudy swelling; indeed, it may be regarded as a late stage of this degeneration advanced to such a degree that the nucleus has entirely disappeared. Early stages of simple necrosis may often be recognized by the presence of diffuse chromatin. The gross appearances of simple necrosis

Paracentesis Pericardii.—The pericardium is tapped with a Potain aspirating set in the same way as is the pleura. The only difference is in the selection of the points of puncture. An excellent method is first to freeze the part with an ethyl chloride spray, make a very small incision through the skin with a bistoury, then insert the needle at right angles to the chest wall for a distance of from one and a half to two inches. After consulting a large number of authorities upon the correct site for puncture, and finding that each writer advises a different location, I have come to the conclusion that if a fairly large effusion is present it is safe to puncture anywhere from an inch to the right of the sternum to an inch or so beyond the left nipple line, between the fourth and sixth ribs. One is cautioned to avoid wounding the internal mammary artery. Little attention need be paid to the intercostal arteries.

Rotch very strongly recommends the fifth right interspace 4 cm. (1½ in.) outside the right border of the sternum. He states that an effusion of even as little as 100 c.c. can be found at this point, and that there is no danger here of wounding the heart, or the right internal mammary artery, or the pleura. Osler recommends the fourth left interspace, either at the sternal margin or 2.5 cm. (1 in.) from it. He also speaks of the fifth left interspace an inch and a half from the left sternal margin, and close to the costal margin in the left costo-xyphoid angle, as the point where the needle may be thrust upward and backward.

Purulent effusions should be treated like any other abscess, by early free incision and drainage. Irrigation of the sac is not advisable except in selected cases.

The treatment of adherent pericardium is practically that of organic heart lesions (myocardial and valvular). It is necessary to keep up bodily nutrition by proper exercise and diet, and at the same time guard against overtaxing the weak heart. If symptoms of incompensation develop they should be treated by rest, diet, and cardiac medicines, as indicated elsewhere.

HÆMOPERICARDIUM and HYDROPERICARDIUM have been considered in detail in Vol. IV.

PNEUMOPERICARDIUM, because of its extreme rarity and hopeless prognosis, is of very little practical importance. By it is meant the presence of gas or air in the pericardial sac. As a matter of fact, gas is never present alone, but is in combination with fluid, usually pus, *i.e.*, pyopneumopericardium. The fluid may be ichorous. It is always secondary to some very serious destructive disease in which a communication is established between the pericardium and a cavity or tube containing air—as, for instance, perforation from the œsophagus, especially in connection with cancer; rupture into the pericardium of a lung cavity, or pneumothorax, or perforation of a gastric ulcer. It may occur as a result of penetrating wounds, such as fractured ribs, concussion or crushing of the chest, or injury from the side of the œsophagus. The gas in pneumopericardium varies in amount and in composition, and is generally offensive. It may be under so great pressure that when the pericardium is punctured the gas escapes with a hissing noise.

Symptoms.—These are very indefinite, and difficult to dissociate from the primary disease. If the gas is present in abundance there will be dyspnœa, cyanosis, attacks of syncope, collapse, a feeble and irregular pulse, and occasionally dysphagia and precordial distress.

Physical Signs.—There may be bulging of the precordial region. The apex beat is weak or absent. The heart movements may produce a very peculiar crackling sensation due to the bursting of bubbles.

Percussion signs are very striking. A metallic tympanitic note is heard over the distended pericardium. Because of the presence of fluid and air a freely movable area of dulness is detected in the dependent part, upon change of position. The quality of the tympanitic note may also vary with the change of position.

Auscultation.—The heart sounds are unusually loud and may have a metallic ring. If murmurs are present they take on the same quality. The cardiac movements and deep breathing agitate the fluid and gas present in such a way as to produce unusual adventitious sounds. They have a metallic ringing quality, and have been likened to the sound of a water wheel.

Treatment is expectant and supportive. It may at times be wise to allow the gas to escape through a fine trocar, or even to incise and treat surgically. Little can be done in a medical way.

New Growths and Parasites.—Under this heading are included tuberculosis, carcinoma, and hydatids. Tuberculosis is much more common than the latter two. It is very unusual to find the tubercles of acute miliary tuberculosis on the pericardium. In most cases tuberculosis of the pericardium is chronic and secondary to tuberculosis in other parts of the body, especially of the lungs and mediastinal lymph glands. In many cases of pulmonary tuberculosis the complicating pericarditis is of the simple serous type. The exudate in tuberculosis and carcinoma of the pericardium is likely to be blood-tinged, and may be purulent or ichorous.

Carcinoma of the pericardium is extremely rare and is always secondary, the sac being involved by extension from neighboring organs.

Hydatids of the pericardium are extremely rare. Clinically we have no means of recognizing the presence of a new growth in the pericardium, except as we infer its presence from the detection of similar disease in neighboring tissues. *James Rae Arneill.*

PERINEORRHAPHY. See *Obstetric Operations.*

PERINEUM, SURGICAL ANATOMY OF THE.—I. THE MALE PERINEUM.—In the skeleton the perineum corresponds to the outlet of the pelvis. It is a diamond or lozenge-shaped space bounded in front by the pubis and subpubic ligament, behind by the coccyx, and on each side, from before backward, by the ramus of the pubis and ischium, the great tuberosity of the ischium, and the great sacro-sciatic ligament.

The whole space measures about three inches and a half from side to side, and four inches antero-posteriorly. At the posterior part it is from two to three inches deep; anteriorly it only reaches the depth of one inch. The perineal space is separated from the pelvic cavity above by the recto-fascia and levatores ani muscles. A line drawn across from one ischial tuberosity to the other, and passing immediately in front of the anus, would divide the space into two parts (see Fig. 3794), the anterior of which is called the *urethral* triangle or true perineum, and the posterior the *anal* or rectal triangle. The anterior triangle contains the bulb and urethra, with the muscles of the perineum proper; the posterior triangle has in it the rectum and the two ischio-rectal fossæ.

FIG. 3794.—Outlet of the pelvis. Line dividing outlet into anterior or urethral triangle, and posterior or rectal triangle.

SURFACE ANATOMY.—In the undissected subject the superficial area of the perineum is very limited, especially when the thighs are brought together; it then consists of a narrow space or groove reaching from the coccyx behind to the symphysis pubis in front. In the centre of this groove is an elevation of the skin, called the median raphé, which runs from the front of the anus, over the scrotum, to the under surface of the penis. No vessels cross this line, and in this situation incisions may be made without any fear of hemorrhage. The osseous boundaries of the perineum may be easily made out through the skin; the great sacro-sciatic ligaments, however, being covered by the gluteal muscles, can be felt

only by pressing in a line drawn from the coccyx to the ischial tuberosity. In thin subjects they can be more easily felt. The anus is situated at the midpoint between the tuberosities, and its centre is about one inch and a half from the end of the coccyx. The central point of the perinæum is a little more than an inch in front of the anus; this point corresponds to the middle of the free border of the triangular ligament. A knife introduced here, and given a slightly upward direction, would reach the membranous urethra. Immediately in front of the central point may be felt, in all but very fat persons and children, the bulb of the urethra and the corpus spongiosum. Abscesses point, and urethral fistulæ are often seen, in this region.

FIG. 3795.—1, Bladder; 2, prostate; 4, bulb; 5-6, seminal vesicles and vas deferens; 7, ureter; 8, rectum; 9, sphincter ani. (Roser.)

The membranous portion of the urethra perforates the triangular ligament one inch below the symphysis pubis, and one inch and a half in front of the anus. The skin of the perinæum is thin and covered with hairs; about the anus it is of a brownish color and thrown into radiating wrinkles by the contraction of the external sphincter; these folds are much enlarged when the hæmorrhoidal veins are swollen and inflamed. If the skin of the anus be everted, a thin white line is seen which marks the junction of the skin and mucous membrane, and corresponds exactly to the lower margin of the internal sphincter. There are a number of follicles about the margin of the anus, and small subcutaneous abscesses frequently occur in this situation. These must not be confounded with fistulæ. The usual incision in lateral lithotomy passes between the anus and ischial tuberosity, a third nearer the tuberosity than the anus.

If the finger be introduced through the anus into the rectum, many important landmarks may be felt. The finger for the first inch is grasped by the sphincter muscles, principally the internal. Here the internal openings of fistulæ may be felt: these openings are rarely much above the upper border of the sphincter ani. One can easily feel ulcers and fissures in this situation, when they are present. In the front wall of the bowel the membranous portion of the urethra can be made out in the middle line, and when a catheter is introduced into the bladder it can be easily felt as it passes through the membranous portion; with the finger in the rectum a catheter can be guided into the bladder in cases of enlarged prostate, and if the instrument enters a false passage it can be detected and directed into the proper channel. The prostate gland can be felt one inch and a half from the anus, and its condition ascertained if it be enlarged or inflamed. Passing beyond the prostate the finger comes on the trigone of the bladder. When the bladder is distended it may be made out through the rectum as a soft fluctuating tumor. It is more easily felt when the other hand, placed above the pubis, presses the apex downward. The bladder, when distended, may be tapped through the trigone with a curved trocar, without there being any danger of wounding the peritoneum, which generally reaches only to within four inches of the anus. In rare cases the peritoneum passes down between the gut and the trigone. In such cases, of course, in this operation, it would inevitably be wounded.

The vesiculæ seminales can rarely be felt, unless affected by disease.

Stone in the bladder in children can often be diagnosed through the rectum. Above the trigone of the bladder transverse folds of mucous membrane in the rectum can be felt; these are soft and velvety when healthy, but when ulcerated or inflamed they feel thick and cause great pain on defecation. Many diseases are diagnosed by the finger in the rectum, viz., ulcers, polypi, hemorrhoids, stricture of the gut, diseases of the prostate, deep-seated abscess of the ischio-rectal fossa, pelvic tumors, etc.

With the whole hand introduced into the rectum the entire pelvis may be explored, as well as the lower part of the abdomen.

ISCHIO-RECTAL FOSSA.—The ischio-rectal fossa is the space which exists on each side between the rectum and ischial tuberosity. It is of a pyramidal shape, with the apex pointing upward to the pelvic cavity, and is from two to three inches in depth.

Boundaries.—Internally, the levator ani covered by the anal fascia; externally, the obturator internus muscle covered by the parietal layer of pelvic fascia; in front, the triangular ligament and transversus perinei muscle; behind, the lower edge of the gluteus maximus, the great sacro-sciatic ligament, and the coccygeus muscle.

The space is filled with fat, and crossing the fossa obliquely are the inferior hæmorrhoidal vessels and nerves. The anterior portion is crossed by the perineal vessels and nerves, and entering the fossa at its posterior part is the perineal branch of the fourth sacral nerve.

The tuberosities of the ischia have also a cushion of fat over them, and when this is removed several bursæ are seen. The apex of the space corresponds to the division of the pelvic fascia into parietal and visceral layers, or rather to the junction of the anal with the obturator fascia. When the anal fascia is removed the levator ani muscle is exposed, and internal to the levator ani is the visceral layer of pelvic fascia.

The lower end of the rectum is placed between the two fossæ, slung, as it were, by the meeting of the two levatores ani muscles, and held in place by the external sphincter and recto-vesical fascia. The fibres of the levatores ani muscles at the lower end of the rectum are separated from one another, and in this situation the anal fascia is also very thin, so that little resistance is offered to the entrance of pus.

Ischio-rectal Abscess and Fistula in Ano.—Abscess in the ischio rectal fossa is not an uncommon affection, and is often caused by the ulceration of foreign bodies, such as fish-bones, through the bowel into the fossa, and then setting up inflammation. Sitting on cold, damp seats after exercise is another, and perhaps the most common, cause of ischio-rectal abscess.

When pus forms in the fossa it presents at the points of least resistance, viz., the internal wall of the fossa and the skin at the base. When the abscess breaks through the skin it will be found that after a time a sinus remains, which generally communicates with the bowel; this sinus is called a *fistula in ano*. The internal opening of the fistula is usually within half an inch of the margin of the anus, as at this point pus can more easily penetrate the rectum, because of the thinness of the fascia and the scantiness of the muscular fibres. The external opening may be anywhere in the region of the posterior part of the perinæum. To prevent the formation of a fistula, the ischio-rectal abscess should be opened early and freely.

PERINEAL FASCIÆ.—The superficial fascia of the perinæum consists of two layers, between which, in the rectal triangle, is a large amount of fat; in the urethral triangle there is less, and as the fascia reaches the scrotum the fat is replaced by the muscle or fibrous tissue of that structure. The deep layer of fascia (fascia of Colles) is limited to the urethral triangle: it is attached to the base of the triangular ligament, to the anterior lips of the ramus of the pubes and ischia laterally, and anteriorly it is continuous with the fascia of the scrotum. By its junction with the triangular ligament posteriorly it forms a pouch, which is divided into two portions by a median septum.

This pouch has an important influence on the direction which urine takes when extravasated, or pus when it

forms, in this region. Owing to the attachment of the superficial fascia to the base of the triangular ligament and to the rami of the pubes and ischia, fluid cannot go back toward the anus or down the thighs, but, as the fascia is continuous anteriorly with the dartos of the scrotum, no resistance is offered to its progress forward and upward over the scrotum to the abdomen.

This is the course taken by urine when extravasated in front of the triangular ligament. When an abscess forms in the perineum, owing to the median septum, it is usually confined to one side of this pouch, and the swelling is triangular in shape. The pus, as it passes forward, on account of the deficiency of the septum in front, fills both sides of the pouch.

The anterior perineal pouch contains the superficial perineal muscles, vessels, nerves, and the root of the penis, which latter is made up of the two crura of the cavernous portions and the bulb of the spongy portion.

Muscles.—The muscles of the perineum bound the perineal triangle, in which the knife is entered in the operation of lateral lithotomy. The base of the triangle is formed by the transversus perinei muscle, the outer side by the ischio-cavernosus (erector penis) muscle, and the inner side by the bulbo-cavernosus (accelerator urinæ); the triangular ligament forms the floor of the triangle.

The point of meeting of the two transverse perineal muscles, the sphincter ani, and bulbo-cavernosus muscles is called the tendinous or central point of the perineum. Along the lower border of the transverse muscles is seen the transverse artery, a branch of the internal pudic.

*Triangular Ligament.**—This ligament divides the perineum into two portions—a deep and a superficial. It has very definite attachments to the subpubic ligament, the rami of the pubis and ischia, and the superficial fascia. It also blends with the central tendinous point

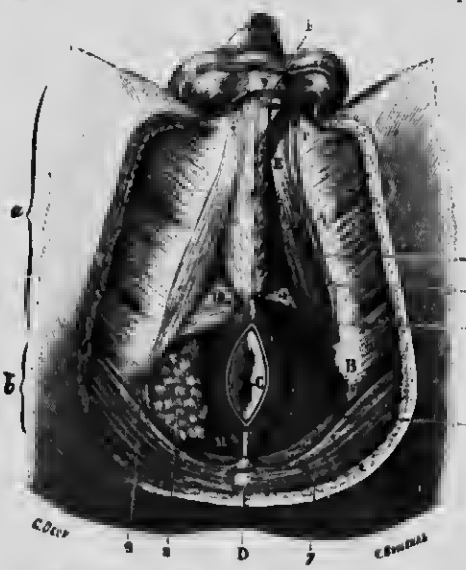

Fig. 3596.—Superficial dissection of the Muscles of the Perineum. 1, Bulbo-cavernosus muscle; 2, ischio-cavernosus; 3, transversus perinei; 4, triangular ligament; 5, sphincter ani; 6, coccygeus; 7, great gluteus muscle; 8, cellular fatty tissue of the ischio-rectal fossa; 9, sacro-sciatic ligament; *A*, ischio-pubic ramus; *B*, ischium; *C*, anus; *D*, coccyx; *E*, cavernous body.

of the perineum. As suggested by Prof. D. J. Cunningham, of Dublin, it is better to regard this ligament as a distinct membrane, and to class it in the same category as the obturator membrane; for "it lies in the same morphological plane as the bony and ligamentous wall of the

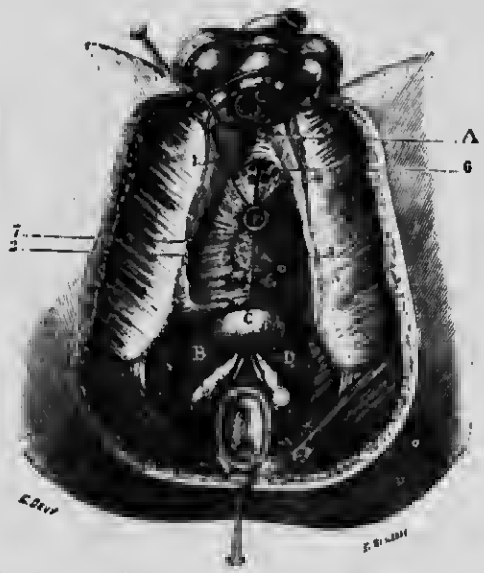

Fig. 3597.—The Muscles of the Perineum, Deep Dissection. *A*, Symphysis pubis; *B*, bladder; *C*, prostate; *D*, seminal vesicle; *E*, urethra cut transversely; 1, triangular ligament; 2, deep transverse perineal muscle; 6, Cowper's glands; 7, subpubic plexus of veins.

pelvis," and it completes the pelvic wall in front in the same manner as the thyroid membrane closes the thyroid foramen.

When the body is erect the lower surface of the triangular ligament looks downward and forward, and the deep surface upward and backward.

Structures in Relation with the Triangular Ligament.—In front are the structures named above as being contained in the perineal pouch.

The ligament is pierced by the urethra, and also by the dorsal vein and nerves of the penis and the internal pudic arteries. The urethra pierces the ligament one inch below the symphysis pubis, in the middle line. The parietal layer of pelvic fascia (posterior layer of the triangular ligament) is above and behind, and is attached to the ligament below, but as it proceeds upward the space between them widens. Between these two structures are the membranous portion of the urethra, the pudic vessels and nerves, with the artery of the bulb, the dorsal vein of the penis, the compressor urethræ muscle, which surrounds the membranous urethra, and Cowper's glands. These latter empty their secretion into the bulbous portion of the urethra; in inflammatory conditions of the urethra they may become inflamed and suppurate; they are the homologues of Bartholin's glands in the female.

The membranous portion is the least dilatable portion of the urethra, and is frequently the seat of *traumatic* strictures; it measures three-fourths of an inch in length.

Behind and above the pelvic fascia (posterior layer of the triangular ligament) is the apex of the prostate gland, covered by the levator ani muscle and by its own capsule. From this description it will be seen that the triangular ligament divides the perineum into two compartments, a superficial and a deep; the superficial contains the perineal muscles and root of the penis; the deep the membranous portion of the urethra, the pudic artery and nerves, the dorsal vein of the penis, the compressor urethræ muscle, and Cowper's glands. The base of the triangular ligament is the meeting-point of three fasciæ,

* This structure is sometimes named the anterior layer of the triangular ligament, the posterior layer being the parietal layer of pelvic fascia. It is also called the deep layer of the deep perineal fascia and the subpubic fascia.

viz.: (1) perineal fascia; (2) triangular ligament; and (3) the parietal layer of the pelvic fascia (posterior layer of the triangular ligament).

The triangular ligament sometimes offers an obstacle to the introduction of a catheter; for if the instrument be not kept against the upper wall of the urethra, it is apt to sag in the lower wall, which is very distensible, and reach the triangular ligament below the opening of the membranous urethra. After the triangular ligament has been successfully passed, the point of the instrument may be arrested in the membranous urethra by the spasmodic contraction of the compressor urethræ muscle which encircles it; this obstruction may be overcome, without exercising any force, by merely keeping the end of the instrument pressed gently against the obstructing point; after a short time the muscle relaxes and the instrument slips into the bladder.

Kicks in the perineum, or injuries from falling astraddle of anything, may rupture the membranous portion of the urethra, and in these cases blood and urine will be extravasated between the triangular ligament and the parietal layer of the pelvic fascia (posterior layer of the triangular ligament). Should the injury tear the triangular ligament, then the extravasated fluid would take the ordinary course upward over the scrotum and abdomen. When extravasation has occurred, free incisions should be made in the perineum, and if the urethra be completely torn across, the perineum should be opened in the middle line and an instrument introduced into the bladder.

Professor Cunningham, of Dublin, has pointed out, in his "Dissector's Guide," that in removing the various structures from the surface to the prostate gland, alternate layers of fascia and muscle are met with, viz.: (1) Superficial fascia; (2) *superficial perineal muscles*; (3) triangular ligament; (4) *compressor urethræ muscle*; (5) parietal layer of pelvic fascia, or posterior layer of the triangular ligament; (6) *levator ani muscle*; (7) capsule of the prostate and pubo-prostatic ligament.

Internal Pudic Artery.—The pudic artery is seen in the rectal triangle, enclosed within a sheath of pelvic fascia formed by the splitting of the obturator fascia. It lies about one and a half inches above the level of the ischial tuberosity and is accompanied by the pudic nerve and the two pudic veins; proceeding forward, it passes between the triangular ligament and the parietal layer of pelvic fascia (posterior layer of the triangular ligament), and then, running under cover of the ramus of the pubis and ischium, pierces the triangular ligament from behind,

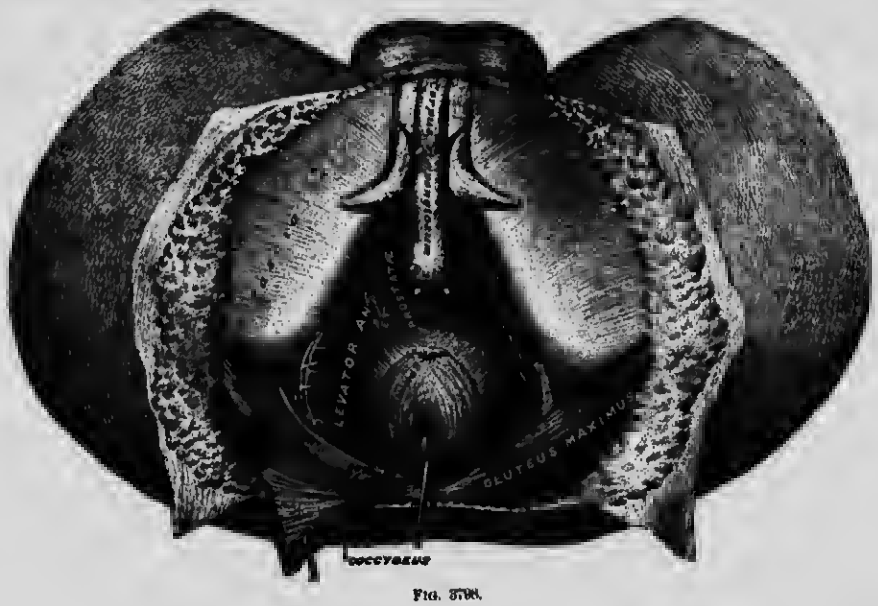

FIG. 3798.

half an inch below the symphysis and a little to one side of the middle line. It then divides into its two terminal branches, the artery to the corpus cavernosum, and the artery to the dorsum of the penis. The pudic artery, while in the ischio-rectal fossa, gives off the hæmorrhoidal, and a little farther forward the superficial and transverse perineal, arteries. While passing behind the triangular ligament, it gives off the artery of the bulb, the wounding of which was formerly so much dreaded by surgeons. The pudic artery itself is said to be in danger of being wounded in lateral lithotomy, but this accident could occur only to the most careless operators, when withdrawing the knife and sweeping it outward. It is possible to wound it only after it has left the protection of the pubic arch.

EXPLORATION OF THE BLADDER THROUGH THE PERINEUM.—This operation is little more than a perineal section. According to Sir Henry Thompson, after introducing a grooved staff an incision should be made in the median line, commencing three-fourths of an inch in front of the anus, and the parts should be divided till the staff is reached in the membranous portion of the urethra; the finger is introduced into the bladder through this incision, the prostatic urethra dilating easily; the staff is now removed and the exploration of the bladder is made. Through this median incision tumors and stones of moderate size can be removed. There is little hemorrhage, even should the bulb be wounded, for this latter structure is not very vascular in the median line.

Parts Divided in Lateral Lithotomy.—The incision is commenced one inch and a half in front of the anus, and is carried downward and outward to a point between the anus and great tuberosity, a little nearer the tuberosity than the anus.* In order to reach the staff in the membranous urethra the following structures must be cut:

In the first incision: Skin and superficial fascia; trans-

* The incision employed in lateral lithotomy falls about in a line parallel with the ascending ramus of the pubis and the ischio-cavernosus muscle. (Roser.)

verse perineal muscle and artery; base of the triangular ligament; the hemorrhoidal vessels and nerves.

Second incision: The knife is now guided by the fore-finger, passed up behind the triangular ligament, its point placed in the groove of the staff, and the blade is lateralized and pushed along the groove into the bladder. In this incision the following parts are divided, viz.: Membranous portion of the urethra and compressor urethræ muscle; parietal layer of pelvic fascia (posterior layer of the triangular ligament); anterior fibres of the levator ani and left lobe of the prostate.

Parts to be Avoided.—(1) Artery of the bulb, (2) rectum, (3) pubic artery.

(1) The danger from a wound of the artery of the bulb is not great, and is somewhat traditional; with the modern methods of arresting hemorrhages no one need fear wounding the artery of the bulb. Very frequently it is abnormal in its distribution, and its division cannot be avoided.

(2) The rectum may be cut, especially in children, if the bowel is not emptied previous to operation, or if the incision be carried down too vertically.

(3) The pubic artery need never be wounded in a properly performed operation. It can be cut only by lateralizing the knife too much in withdrawing it. If wounded, it may be secured with the modern artery forceps without great difficulty.

In the withdrawal of the knife a too vertical incision may cut through the prostate, and so divide the visceral layer of pelvic fascia. Should this accident happen, no ill results will follow if the wound be kept sweet and be thoroughly drained. Wounding of the visceral layer of the pelvic fascia is a danger much dwelt on by the older lithotomists, and surgeons of the present day still have a traditional fear of this accident happening. In children, lateral lithotomy can scarcely be performed without cutting through the prostate gland, and at the same time the visceral layer of pelvic fascia; yet no ill results follow; on the contrary, the operation is safer in children than in adults. The real danger in adults is not from wounding the pelvic fascia, but from wounding the prostatic plexus of veins and the ejaculatory ducts. The prostate gland when enlarged can be removed through a perineal incision either transverse or vertical. Also the seminal vesicles can be reached through the same route. When affected with tuberculous disease it is sometimes necessary to remove them. The ureter as it enters the bladder can be reached through the perineum, and stones which have become lodged there successfully extracted.

Testicle in Perineum.—During the descent of the testicle, and after it has passed through the external abdominal ring, it may, instead of entering the scrotum, pass down into the perineum (ectopia perinæalis). In these cases it may be felt slightly movable under the skin, about an inch and a half in front of the anus. The scrotum of the side in which the testicle is lodged in the perineum is deficient if the affection be congenital; if the case is of traumatic origin the scrotum of that side is present. The displacement has no evil effect on the testicle, which is always of a good size. The abnormal position of the testicle renders it liable to injury, and patients apply to the surgeon for relief. An operation has been devised for restoring the misplaced testicle to its proper position in the scrotum, but its success has been only moderate. Excision is sometimes demanded to rid the patient of his trouble.

II. The Female Perineum.—The space occupied by the female perineum, owing to the wider pubic arch, is somewhat larger than that of the male. It differs from the male perineum in being perforated in the median line by the vulvo-vaginal opening. This opening occupies the place in the female which in the male is the situation of the bulb. In the female this bulb is, as it were, divided into two halves, as is also the muscle covering it. The space between the divided bulb is the opening of the vagina. The *vagina* extends upward and backward be-

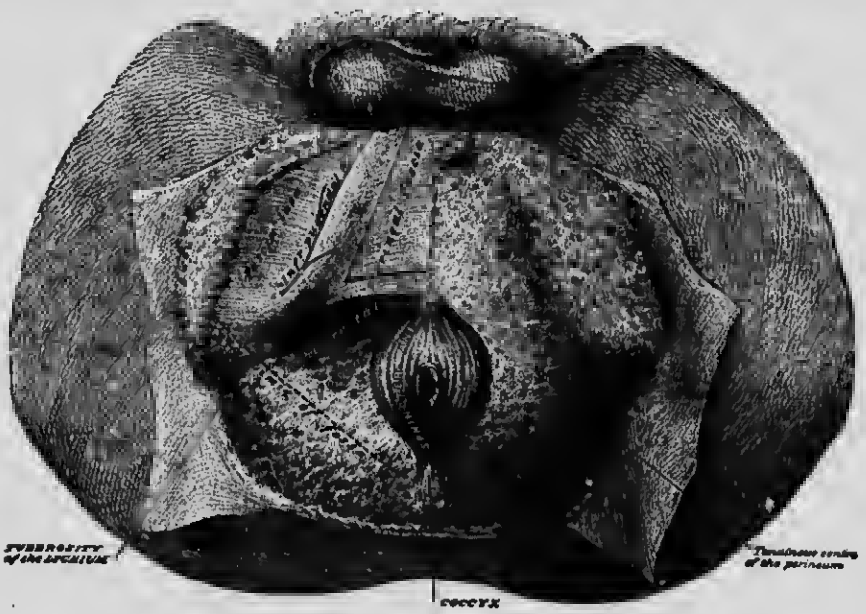

Fig. 3799.

tween the bladder and rectum, its upper part being covered by peritoneum, and thus it is in close relation with the peritoneal cavity.

The *triangular ligament* is also divided into two halves, and on this divided ligament rests the divided bulb, the vagina passing between. So we have a bulb which is called the "vestibular bulb" on each side of the vagina, and these bulbs are joined above by a small plexus of

vessels called the "pars intermedia." The bulbs are covered by the sphincter vaginæ muscle (bulbo-cavernosus). This is the homologue of the fused *bulbo-cavernosus* muscle in the male. We also see the anterior fibres of the

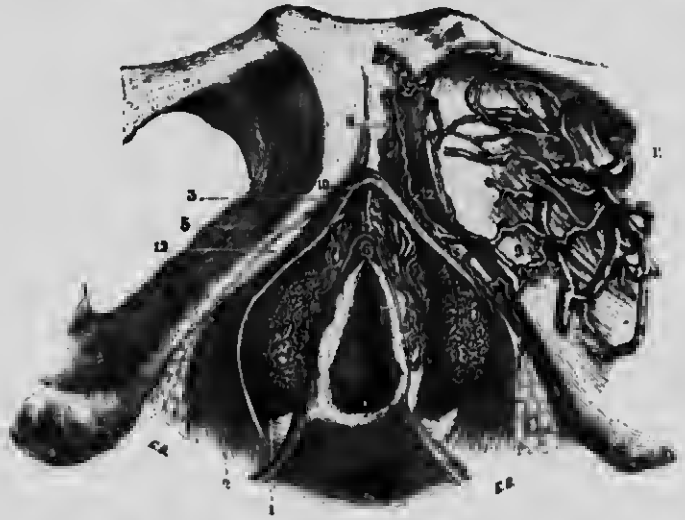

FIG. 380.—The Bulb of the Vagina with the Venous System of the Clitoris, Viewed from in front. (After Kobelt.) 1, Bulb; 2, constrictor muscle; 3, glans of clitoris; 5, communication with the obturator veins; 12, cavernous body.

levator ani muscle embracing the vagina as they do the prostate gland in the male.

The *superficial fascia* and *Colles' fascia* have the same attachments as in the male, but differ in being perforated by the vagina.

The glands of Bartholin and Duverney are situated on each side of the commencement of the vagina behind the triangular ligament, and correspond to Cowper's glands in the male. Their ducts open on each side between the hymen and labium minus. It is not uncommon to have abscesses connected with these glands, to cure which they have to be dissected out.

The *clitoris* and nymphæ correspond to the penis in the male. The clitoris is composed of two corpora cavernosa and a rudimentary glans. It is much smaller than the penis, and is not perforated by the urethra. The corpora cavernosa are attached to the inner side of the pubic arch in front of the triangular ligament, and, as in the male, are covered by a muscle, the ischio-cavernosus (erector clitoridis). The glans is surrounded by a membranous fold, which is the homologue of the prepuce in the male.

The *vulvar cleft* opens on the surface between the two labia majora; anteriorly opening into this cleft is the urethra, and posteriorly is a recess called the fossa navicularis, and in the centre is the vagina. The space anteriorly between the clitoris and the urethra is called the vestibule, and this is bounded on each side by a labium minus.

The *labia majora* are two thick folds of skin covered with hair and united in front to form the mons veneris. In each labium are blood-vessels and dartous tissue as in the scrotum of the male, of which they are the homologue. The vestibule corresponds to the lower prostatic and membranous portion of the urethra in the male.

On separating the labia majora the nymphæ or labia minora are seen. These are folds of skin which are continuous above with the prepuce of the clitoris and below join the *labia majora* about the centre. As a rule they do not project beyond the labia majora, but in the dark races they are of larger size and project considerably beyond the vulvar cleft. In old age they are also more prominent.

The *hymen* is a thin fold of mucous membrane of various forms, which partially occludes the vaginal orifice; in some cases the vaginal orifice is completely closed, and then we have what is called an *imperforate hymen*. Occasionally the hymen is absent or has been destroyed by inflammatory action in childhood. Its presence is not necessarily a proof of virginity nor is its absence significant of the loss of the same. When the hymen has been ruptured, and in women who have borne children, the remnants are seen as small rounded elevations called "caruncuhe myrtiformes."

The vessels and nerves of the female perineum do not differ essentially from those of the male; the pudic artery is smaller, while the superficial perineal artery going to the labia is larger. Owing to the small size of the clitoris as compared with the penis, the nerves and blood-vessels supplying it are much smaller.

The Perineal Body, or the so-called perineum of the obstetrician, fills in the space between the vagina and the rectum; in section it is triangular in shape, with the base of the triangle downward, corresponding to the skin between the posterior part of the vagina and the anterior border of the anus. Anteriorly is the fossa navicularis, and posteriorly is the rectum. The perineal body measures at its base about one and one-quarter inches from before backward, and laterally extends from one tuberosity to the other; in this space is the tendinous point of the perineum, to which are attached several muscles, such as the levator ani, sphincter ani, transversus perinei, and sphincter vaginæ. Laterally we have the ischio-caver-

FIG. 381.—Dissection of the Vulvo-vaginal Orifice with the Glands of Bartholin. 1, Orifice of vagina; 2, hymen; 3, meatus urinarius; 4, navicular fossa; 5, bulb of vagina; 6, vulvo-vaginal or Bartholin's glands; 7, 8, duct with opening cut through orifice of vagina; 10, constrictor vaginæ partly resected on left side to show the glands of Bartholin; 11, transversus perinei muscle.

nosi muscles. Running across the perineal body we have a transverse septum which, in the female, is very strong and consists of connective tissue, yellow elastic tissue,

and involuntary muscular fibres; it can be felt as a hard body when examined through the posterior commissure of the vagina. The "perineum" is a highly distensible body, as is well seen in childbirth, when it is almost obliterated. Above the perineal body the vaginal and rectal walls are in apposition, loosely connected with areolar tissue. This so-called perineum is frequently torn in first labors, and if the rent be not sewed up immediately so as to enable union by first intention to take place, the vaginal orifice will be much enlarged and the support of the perineal body be lost. Occasionally these rents extend into the rectum, and a very miserable condition results, there being partial or complete incontinence of feces. Operations undertaken for the repair of this condition are most successful even when of old standing. It is, however, much better to repair the rent as soon as possible after its occurrence.

Tearing of the perineum with general relaxation of the pelvic floor and increase in the intra-abdominal pressure predispose to prolapse of the uterus. This condition is rarely seen in the nullipara or in well-to-do multipara. It is the hard-working woman, who gets up to work too soon after childbirth, in whom this condition is most frequently seen.

Francis J. Shepherd.

PERIOSTEUM, ACTINOMYCOSIS OF.—Actinomycosis is rarely primary in the periosteum; but the periosteum is not infrequently involved by direct extension from actinomycotic processes in neighboring structures. In primary actinomycosis of the mouth the periosteum of the jawbone is first involved, later the bone; in actinomycosis of the lungs the process may extend to the pleura and thence to the periosteum of the ribs and vertebræ. In these cases of secondary extension there occurs first an *actinomycotic periostitis* with formation of granulation tissue. As a result of this a superficial caries is produced and the interior of the bone becomes involved. Here the process develops more rapidly, the bone becomes filled with granulation tissue, and expands into a honeycombed shell. Over this the periosteum may develop irregular masses or spicules of bone or thick layers of fibrous tissue. The microscopical picture is that of a strong reactive inflammation; numerous mast and plasma cells are present. The clinical and diagnostic features are given under the head of *Actinomycosis*.

Aldred Scott Warthin.

PERIOSTEUM, TUBERCULOSIS OF.—Primary tuberculosis of the periosteum is regarded by most writers as a very rare condition; but it probably is of not infrequent occurrence. Though the majority of cases of primary tuberculosis of the bones are of myelogenous origin, there can be little doubt that numerous cases begin as a *tuberculous periostitis* (*periostitis tuberculosa*). The process begins with the formation of a granulation tissue beneath the inner layer of the periosteum. This shows little tendency to caseate, but on the other hand becomes ossified. Small tubercles are found in the early stages, but the process shows a great tendency to self-healing through the formation of bone (ossifying periostitis). As a result of such healing, exostoses or hyperostoses are formed. The writer believes that many of the so-called inflammatory local hyperplasias of bone are tuberculous in origin. In other cases the process may break through the periosteum and a tuberculous sinus or a "cold abscess" may be formed; or in some cases the bone becomes involved, and the clinical picture becomes that of a bone tuberculosis. Superficial caries may follow, either with or without the formation of deep foci. As in the case of gummatous periostitis, pseudo-cysts may be formed by the liquefaction of encapsulated caseous areas. The cyst wall may be bony. Secondary tuberculosis of the periosteum is very common in connection with bone or joint tuberculosis.

Aldred Scott Warthin.

PERIOSTEUM, TUMORS OF.—The primary tumors of the periosteum belong wholly to the connective-tissue growths. They are both benign and malignant; the former, usually arising from the inner osteogenetic layer of the periosteum, are covered by its outer fibrous layer; the latter break through the fibrous layer and invade the neighboring tissues. Occasionally both benign and malignant forms may arise from the outer layer.

Benign Growths.—The *osteoma* is the most common benign growth of the periosteum, occurring usually as a circumscribed bony growth, termed an exostosis. The periosteal osteomata are classed by some writers under the general term *osteophyte*; but by others the latter term is used to indicate a very small bony growth of the periosteum. Larger, more diffuse periosteal osteomata are known as *hyperostoses*. A *circumscribed hyperostosis* differs from an exostosis in being less circumscribed and more superficial. According to their structure the periosteal osteomata may be classed as: *exostosis eburnea*, composed of hard compact bone without marrow spaces; *exostosis spongiosa*, composed of spongy bone about equally made up of bone tissue and marrow spaces; and *exostosis medullaris*, containing very large marrow spaces. The marrow in the exostoses presents the same general appearance as the bone marrow proper. According to histogenesis the periosteal exostoses may be divided into two classes: those arising from the connective tissue of the periosteum (*exostosis fibrosa*), and those of cartilaginous origin (*exostosis cartilaginea*). The former may arise either from the inner or from the outer layer of the periosteum; in the first case they are immovable (*immovable periosteal exostosis*) in the latter they are movable (*movable periosteal exostosis*). The cartilaginous exostoses may arise from a proliferation of the periost-perichondrium, usually from the epiphyseal cartilages. They occur most frequently in young children and are usually multiple. In other cases cartilage may first form from the periosteum, and this may later develop into bone. Exostoses are found most frequently on the cranial bones, the bones of the trunk, and the long bones of the lower extremities. Many of them are not neoplasms strictly, but are hyperplasias of inflammatory origin.

Chondroma of the periosteum is of less frequent occurrence. It may develop from the inner layer (*immovable periosteal chondroma*) or from the outer layer (*movable periosteal chondroma*). The cartilage may be formed from pre-existing cartilage (*epiphyseal*), or from connective tissue, or from embryonal inclusions of cartilage *in situ*. They occur most frequently upon the short bones of the extremities, the shoulder blades, the ribs, and the femur. They are very likely to undergo secondary changes: myxomatous degeneration, calcification, etc. They show a marked tendency toward malignancy. *Osteochondroma* of the periosteum sometimes occurs; and there is also a peculiar growth, the *osteoid chondroma*, which may reach an enormous size. It is found chiefly on the long bones of young individuals and shows a tendency to become malignant. The surface of the growth is usually smooth, the cut surface partly hyaline and transparent, partly lamellated and reticular.

Fibroma of the periosteum is rare. It occurs most frequently in the periosteum of the bones of the mouth and nose (fibroid epulis and fibroid polyps). Through excessive development of blood-vessels the growth may assume the character of a *angioplastic fibroma*. It is also very likely to become calcified (*fibroma ossificans*) or to undergo myxomatous change. Malignant changes may develop.

Myxomata arise rarely from the periosteum. They are seldom pure myxomata, but present the appearance of myxochondroma, myxofibroma, myxosarcoma, etc. They form round or oval masses covered on the outside by a dense layer of fibrous tissue.

Lipomata of the periosteum are known as parosteal lipomata. They are very rare, and are nearly always congenital. They usually contain areas of striped muscle fibres. The exact nature of these growths is not yet known. They have been reported as occurring on the anterior surface of the cervical vertebræ, body of the pubis, frontal bone, scapula, etc.

Angiomata of the periosteum are very rare. They

have been observed on the cranium and sternum. An ectatic condition of the blood-vessels is very common in all of the tumors arising from the periosteum.

Pseudocysts may be formed beneath the periosteum as the result of the liquefaction of the contents of subperiosteal hæmatomata or of subperiosteal tubercles or gummata.

Sarcoma is the most important of the primary growths of the periosteum, and—next to the periosteal exostosis—of most frequent occurrence. It may occur at any age, but is more frequent in the young. The periosteal sarcomata may occur in any part of the skeleton, but are more frequently seen near the ends of the long bones, particularly of the lower extremities. They may be divided into the *hard* and the *soft* forms. The soft growths show a variegated surface, and usually contain areas of softening and extravasation; the firmer whitish portions of the growth may be homogeneous or fibrous. The harder growths are usually whitish, and present a more or less fibrous, radiating surface. As a rule, the growths are more or less nodular. Originating in the majority of cases from the inner layer of the periosteum, the growth assumes a more or less spindle shape and tends to surround the bone. Later, it breaks through the periosteum and invades the soft tissues adjacent.

Microscopically, the periosteal sarcomata represent nearly every form of sarcoma; round cell, spindle cell, polymorphous cell, giant cell, alveolar forms, fibro-sarcoma, osteosarcoma, osteoid sarcoma, chondrosarcoma, osteochondro-sarcoma, myxosarcoma, angiosarcoma, and numerous combination forms. The most common variety is the spindle-cell form containing bone or osteoid tissue. The most cellular, and consequently the softest forms, are the most malignant. The malignancy of the different varieties varies somewhat with the location. The giant-cell epulis of the jaw is of relatively slight malignancy, but a growth of the same structure on the long bones is much more malignant. The hard fibrosarcoma, and the osteo-, chondro-, and osteoid sarcoma, often show relatively slow growth and but little tendency to set up metastases; but under certain conditions any one of these forms may take on an increased malignancy. Metastases of periosteal sarcomata usually appear first in the lungs, later in the lymph glands, and finally in any part of the body. The metastases are frequently of a softer and more cellular nature than the primary, but may develop bone or osteoid tissue or even cartilage.

As the result of the growth of the periosteal tumor the bone may become infiltrated and rarefied, and in some cases undergo spontaneous fracture; or in other cases there is set up, in the neighborhood of the tumor, an ossifying osteomyelitis which leads to the most marked sclerosis of the bone. New bone is very frequently formed in the sarcoma, particularly next to the old bone upon which the tumor rests, so that the latter seems to spring from an osseous base. In other cases trabeculæ or delicate spicules of bone may be formed in a radiating manner through the tumor mass, or irregular bony masses or spicules may be scattered through it (ossifying sarcoma or osteosarcoma). The degeneration of portions of the growth, as is commonly seen in the softer varieties, may lead to cyst formation, or to ulceration, abscess formation, or gangrene, as the result of secondary infection. Large hæmatomata may result from hemorrhage into the tumor. With the exception of the epulis and the hardest forms, sarcoma of the periosteum usually runs a malignant course. The growths show a great tendency to recur after operation, and as a rule they give rise to metastases.

Secondary tumors of the periosteum are not infrequent; both sarcoma and carcinoma may invade the periosteum from primary growths of neighboring structures. Secondary carcinoma is the more frequent. Caries and secondary involvement of the bone may result. An ossifying periostitis is almost always set up, so that the secondary tumors come to be more or less surrounded by newly formed bone, or contain irregular bony masses or spicules.

Aldred Scott Warthin.

PERIOSTITIS. See *Ostitis*, etc.

PERISTALSIS. See *Intestinal Movements.*

PERITONEUM. (ANATOMICAL.) See *Abdomen.*

PERITONEUM, NEW GROWTHS OF.—Primary tumors of the peritoneum are relatively rare; secondary involvement by malignant tumors, which are primary in some one of the abdominal or pelvic organs, is on the other hand of very frequent occurrence. Further, tumors which are primary in the retroperitoneal tissues are to be placed in a separate class from those which are primary in the tissues of the peritoneum proper, that is, which develop either from the endothelium or from its basement membrane.

Primary Peritoneal Growths.—The most important of the primary growths of the peritoneum is the *endothelioma*, often called *endothelioma carcinomatosum* or *endothelial cancer*. By some writers it is spoken of as *primary carcinoma* of the peritoneum, but the latter usage is confusing and should be avoided. The designation primary carcinoma of the peritoneum should be applied only to those rare carcinomata of the peritoneum which arise from the columnar epithelial cells of embryonal inclusions of intestinal *Anlage*. The primary *endothelioma* of the peritoneum forms multiple flat plaques or flattened nodules, which are more or less confluent or bound together by flattened cords or strands. Rarely the nodules may be larger and more elevated. About the larger plaques there are often seen numerous minute flattened nodules, solitary or becoming confluent into little groups. The color is usually white and the consistency soft; in some cases it is hard and firm (endothelioma fibrosum). The peritoneum about the plaques is more or less thickened. In many of the nodules a yellowish caseous centre is present, the appearances closely resembling small caseating tubercles. A serous or sero-fibrinous exudate, usually hemorrhagic, is often present in the early stages; in the advanced stages it is invariably so. Microscopically the flattened tumors are found to consist of a firm connective-tissue stroma enclosing cords and strands of cells, which are often low columnar, and arranged upon a basement membrane after the manner of gland cells; so that the tumor possesses a distinctly *tubular* character. In many of the tubule-like cords an apparent lumen may be seen. The surface endothelium is usually absent over the larger plaques and nodules, but over the small ones it may be greatly thickened, forming a layer consisting of many strata of cells. Simple necrosis and caseous necrosis are found throughout the larger growths, and occasionally there is a mucoid change. The vascular supply is usually rich. The cells of the tumor appear to rise both from the surface endothelium and from the endothelium of the lymph spaces and vessels (*endothelioma lymphangiomatosum*). The anastomosing cords and strands follow the lymphatics. Metastasis into the solid organs is rare; secondaries when found occur in the pleura, dura mater, or other serous membranes. The pleura may be involved by direct extension. The growth is identical in structure with the flat tubular endothelioma of the other serous membranes; and it should be borne in mind that the peritoneal growths may be the result of direct extension from the pleura or they may be metastatic. The writer has seen one case in which the peritoneum, pleura, and dura seemed equally involved; and the only apparent reason for assigning the primary origin to the peritoneum was the greater area involved in the case of this membrane.

Primary angiosarcoma of the peritoneum occurs very rarely. It may develop as a plexiform angiosarcoma, consisting of newly formed blood-vessels, whose walls proliferate and form cylindrical masses of cells. Myxomatous change is not infrequent in these growths (*myxoangiosarcoma*), and under such conditions the tumor may be mistaken for a colloid carcinoma. In other cases the sarcoma may show the structure of a *perithelioma*. Kaufmann describes a case in which the entire perito-

The velocity of the true peristaltic wave, of which the chief function is to move the food onward in the intestine, is very low, amounting only to about 2 cm. per second; so that in the cat it has been estimated that it would require about an hour and a half for this form of wave to travel from one end to the other of the intestine. The rate of progress is very regular, and, when the local nervous mechanism represented by Auerbach's plexus is in action, it passes only from above downward. But after the nerve cells of this plexus have been paralyzed by nicotine or cocaine, the contractions which are then purely myogenic pass equally from a point directly stimulated, in either direction up or down the tube. This change in character after paralysis of the local nerve centres demonstrates that the normal true peristaltic wave is a local reflex, and the same, it is stated, can also be shown for the other more rapid type of rhythmical contraction which is connected with the pendular movements.

Mall has shown that the local reflex consists of a dilatation of the wall in front of the advancing wave, due to the localized constriction which travels down the tube, and Bayliss and Starling, who have recently investigated the subject, confirm this view, and state that the combination of a contraction wave preceded by a wave of relaxation, "the law of the intestine."

The purpose of this diphasic wave is almost self-evident: the wave of contraction at and behind the advancing mass of intestinal contents gives the propelling force which drives the mass slowly forward, while the dilatation wave in front makes the passage easy by widening the lumen of the portion of gut into which the mass is being pressed, and so diminishes the resistance to its progress.

That true peristalsis, when under the influence of the nerve cells of Auerbach's plexus, passes only in one direction is beautifully demonstrated by a procedure due to Mall, in which a loop of gut is resected, and then, in one experiment is replaced in normal position, and in another experiment is replaced in a reversed direction so that what was normally the upper end is afterward the lower end. In the first case, peristalsis remains normal and no obstruction occurs, but in the latter the waves pass from lower to upper end in the resected portion so that obstruction occurs when the food is other than of a thin fluid consistence.

It may here be pointed out that this local reflex forms an important distinction between the peristalsis of the œsophagus and that of the intestine. The difference is illustrated by the effects of completely severing transversely the muscular coats of the two tubes and then exciting a wave of contraction above the section of injury; when, in the case of the œsophagus, the peristaltic wave passes the point of severance as if no disunion existed and without any period of delay whatever, while in the case of the intestine the wave is completely stopped and does not appear at all in the lower segment of the gut.

The pendular or rhythmic movements are best seen when the peritoneal cavity is opened under a bath of warm saline. They recur fairly regularly with a rhythm of ten to thirteen per minute, and are caused by contraction waves which travel many times more rapidly than the true peristaltic waves, viz., at the rate of 2 to 5 cm. *per second*, as compared with 2 cm. *per minute* (*vide supra*).

It is only comparatively recently that physiologists have reached the conclusion that the pendular movements first noticed by Ludwig and the rapid rhythmical contractions of the wall arise from a common cause, viz., the simultaneous contraction of both circular and longitudinal muscular coats. When inspected by the eye alone the pendular movements which cause oscillating transitory movements of the loops of gut as a whole, backward and forward, are not apparently connected with any change in the cross section of the intestine. When, however, a distended rubber ball connected with a recording tambour is placed in the intestine it is at once obvious that a synchronous rhythmical change in volume of the intestine accompanies the swaying movements, further that any factors which influence the amplitude of one form of movement similarly and correspondingly alter the other, and that both become completely inhibited together by stimulation of the splanchnic nerves. There is hence little doubt that the older view, which attributed these pendular movements to the contractions of the longitudinal fibres only, is erroneous, and that they are merely an accompaniment of the rapid rhythmic contractions.

The purpose of these rapid rhythmic movements is not, as in the case of the true peristaltic waves, to force the food along the intestine. Digestion would be almost completely prevented by them, if they forced the food along at the rapid rate at which they travel, for the food would then traverse the entire intestine in a few minutes. Further, examination by means of the Roentgen rays of food to which subnitrate of bismuth has been added, as it is undergoing digestion in the small intestine, demonstrates that several hundreds of such waves may pass over a given mass of food without causing it to move downward in the slightest degree. Onward progress takes place at intervals only, when the quite distinct wave of true peristalsis sets the contents in translatory movement.

Although the intestinal movements are co-ordinated by the local nervous mechanism, control is exercised upon them by the central nervous system, chiefly through the vagus and splanchnic nerves. Various opinions have been expressed as to the action of the vagus, but the most carefully experimentation upon the subject is that of Bayliss and Starling, who found that the effect obtained here ran pari passu with successive stimulation, and that the most typical result obtained was an inhibition with a latent period of less than one second, followed by an augmentation in amplitude of the rhythmic contractions, which augmentation develops after an interval of from ten to thirty seconds and lasts for some considerable time after the cessation of the stimulus. Stimulation of the splanchnic nerve invariably causes diminution of the rhythmic movements and, when the stimulus is sufficiently strong, complete stoppage of the movement, which lasts for a few seconds after the stimulus is removed.

The Roentgen rays were first utilized for the study of the effect of the rhythmic movements on the intestinal contents by Grützner, who administered insoluble pellets containing nitrate of bismuth with the food, and found that these were chiefly rolled about from side to side of the intestinal tube in an oscillatory fashion by the rapid waves, while their progress along the intestine was very slow and inconstant, being sometimes for a short interval retrograde.

This method of studying the effects of the rhythmical contractions upon the intestinal contents has recently been improved by Cannon, who, instead of administering insoluble pellets containing the bismuth salt, has mixed the latter, to the extent of ten to thirty per cent, in fine powder, with the food. Cats were the animals experimented upon, and the food used was powdered salmon mixed as described above with subnitrate of bismuth (see also *Stomach, Shape, Position and Movements of*).

Cannon's experiments demonstrate that the most important result of the rapid rhythmic movements is the segmentation and resegmentation of the food many times repeated, with the result that the contents are intimately mixed with the digestive juices and that new surfaces are constantly exposed to the villous wall, by which means the process of absorption is enormously facilitated and hastened. A large mass is almost simultaneously divided into many minute segments, each segment is then again divided and the parts of adjacent segments are combined to form a new segment. This process is continuously repeated many hundred times, so that the contents are in this way most intimately mixed up with the digestive secretions.

Movements of the Large Intestine.—The movements of the large intestine have also been investigated by Cannon, using the method which has been indicated above in connection with the movements of the small intestine. He finds that the usual movement of the transverse and

ascending colon and cæcum is an *antiperistalsis*. The movements occur in intermittent periods, which come on at intervals of about fifteen minutes. Each period of activity lasts for about five minutes, and is followed by a quiescent interval of about ten minutes. The waves recur during an active period at the rate of eleven waves in two minutes. During activity the ileo-cæcal valve is closed and the contents are better churned up, intimately mixed, and exposed to absorption, without in any way interfering with the processes going on in the small intestine. When new portions of material enter the large intestine, a strong general contraction sets in along the rectum and ascending colon so forcing some of the material already present onward. As soon as this has been effected the antiperistaltic movements described above commence. With the accumulation of material in the transverse colon, deep tonic constrictions appear one after another and carry the material into the descending colon, thus leaving the transverse and ascending portions free for the play of the antiperistaltic waves.

Cannon found the ileo-cæcal valve perfectly competent for material passing in the ordinary course of digestion from ileum to colon, regurgitation into the small intestine never being observed; but in the case of a nutrient enema exceeding a certain bulk, regurgitation did occur, under the pressure of the antiperistaltic waves, into the empty ileum. Such a regurgitated nutrient enema underwent segmentation in the small intestine exactly as in normal digestion.

Cannon further observed that strong emotion, caused by fear, distress, or rage, totally inhibited all the intestinal movements. The movements continue in a normal fashion while the animals are asleep.

Benjamin Moore.

The literature relating to intestinal movement is an extensive one, but a key to most of the researches on the subject will be found in the following papers in which earlier work on the subject is also reviewed:

Bunch: Journ. of Physiol., 1897, vol. xxii., p. 357; *ibid.*, 1899, vol. xxiv., p. 72.

Grützner: Arch. f. d. ges. physiol., 1898, Bd. lxxi., s. 492.

Bayliss and Starling: Journ. of Physiol., 1899, vol. xxiv., p. 99; *ibid.*, 1901, vol. xxvi., pp. 125-324.

Starling: Schäfer's Textbook of Physiology, 1900, vol. ii., pp. 324-335.

Cannon: Amer. Journ. of Physiol., 1902, vol. vi., p. 251.

INTESTINAL OBSTRUCTION, (SURGICAL.)—In describing the treatment of this affection, acute and chronic obstruction will first be dealt with generally, and after describing in detail the various remedies and methods employed, the special treatment of the individual forms of obstruction will be considered.

ACUTE OBSTRUCTION.—The treatment of acute obstruction is a subject surrounded with difficulties, and one about which there was formerly a great variety of opinion. The men of the older generation relied entirely on the "rest, opium, and starvation" treatment, and held that operative measures are seldom, if ever, necessary; the modern surgeons, on the other hand, think that the treatment by "rest, opium, and starvation" is almost useless, and the employment of such treatment is a waste of valuable time if the diagnosis of acute obstruction is correct. The only sensible procedure is to open the abdomen and if possible find out the cause and, if possible, remove it.

The practitioner without much experience, looking into his text-book for guidance, might imagine, from the very exact description given of the symptoms peculiar to each form of intestinal obstruction, that the differential diagnosis is a simple matter, and that should he meet with a case, he would only have to employ a certain method of treatment for a certain form of obstruction, and so relieve his patient, if relief were possible. In actual practice, however, the diagnosis of the special form of obstruction we have before us is by no means easy, and in most cases the exact nature of the affection cannot be determined except by laparotomy, or on the post-mortem table. The sermons preached daily by the morbid anatomists are valuable checks to the sin of diagnostic dogmatism in abdominal affections.

There are, however, certain general principles to be followed in cases in which acute obstruction is evident.

In the early period of these cases purgatives should be strictly avoided; enemata may be administered, but purgatives never. Food should not be given to the patient by the mouth, as it is always rejected, but the strength should be maintained by nutritious enemata.

If, after washing out the lower bowel several times, the fluid injected returns unchanged, and at the same time the vomiting continues incessantly, no relief can be hoped for by any other means than laparotomy. Delay in these cases is most dangerous; we should not wait for the vomiting to be fecal (that is evidence of obstruction of some duration), but should open the abdomen at once, for the earlier the operation is performed the greater are the chances of success. In the fatal cases following operation this result is not, as a rule, caused by the laparotomy, but by its too late performance and the advanced condition of the grave changes in the bowel which result from the long continued obstruction. This is especially apt to be so in those subacute cases due to intussusception, local inflammation, and hernia, in which, the symptoms not being very urgent, operation is delayed till too late (Wheelhouse). Wheelhouse[1] says the previous history of the patient is important. "If he has had peritonitis, perityphlitis, enteritis, or other inflammations where lymph may be poured out and bands afterward form, the indications for operation are more urgent."

In those cases which have all the symptoms of a strangulated hernia, and yet no hernia can be made out externally, it is reasonable to suppose that the case is one of internal strangulation, which can be relieved only by operation, as reduction by taxis is out of the question.

In subacute cases which have lasted five or six days, many patients, if operated on, die of exhaustion, and, according to Mr. Treves,[2] in cases of intussusception, after death a process of spontaneous cure, nearly complete, has been found, and apparently was arrested only by exhaustion owing to the patient's inability to take food.

In CHRONIC OBSTRUCTION, where there is reason to believe that a stricture exists in the intestines, due to internal or external causes, it is very important that proper food should be taken, so that nothing that is not perfectly fluid or in a pultaceous condition should enter the bowel. The swallowing of all indigestible substances, such as orange pips, plum or cherry stones, raisins, etc., should be strictly avoided. Should constipation be present, mild laxatives may be cautiously administered, or simple enemata, but *purgatives should on no account be given*. If the stricture be within reach, as, for instance, in the rectum, it may be dilated with bougies or bolsed. Excision of a cancerous stricture of the lower end of the rectum is an operation which has afforded very good results, and, if performed early, the life of the patient may be prolonged for years and his comfort not seriously interfered with. When almost complete obstruction occurs from narrowing of the lumen of the bowel by the increased growth of the stricture, then the question arises as to the advisability of establishing an artificial anus. If the growth can be felt through the rectum, inguinal colotomy should be performed, if it is deemed inadvisable to excise the growth. Cancerous strictures nearly always occur in the large bowel, and, if the stricture cannot be felt through the rectum and the age and appearance of the patient indicate malignant disease, an exploratory operation should be undertaken and an endeavor made to excise the growth, bringing the cut ends of the bowel together with sutures or Murphy's button.

If the stricture be in the small bowel the abdomen should be opened and an artificial anus established, or the affected portion of bowel should be resected and the divided ends sutured or united by Murphy's button.

In cases of chronic obstruction which have lasted for months and the cause cannot be exactly determined, an exploratory incision is the proper procedure, for by the establishment of an artificial anus life may be, in many cases, much prolonged. Often the growth may be excised and the cut ends of the bowel brought together; and

for the success of this procedure, the earlier the operation is undertaken the better, before the system has become debilitated, as the better the condition of the patient at the time of operation so much the greater is the chance of success. Patients, as a rule, refuse operation till the discomfort of the obstruction is so great and their condition so deteriorated that operation is performed only as a *dernier ressort*.

METHODS OF TREATMENT IN DETAIL.—*Rest, Starvation, and Opium.*—This treatment is of very old date, and many yet believe it to be the only treatment that should be pursued in cases of acute intestinal obstruction. It consists, in short, of entire abstinence from food, from physical exploration of the parts, enemata, etc., and the administration of opium or morphine. All are agreed as to the propriety of adopting this treatment in the very early stages of acute cases, but, as already mentioned, surgeons of the present generation are in favor of further treatment by operation.

Opium.—Many cases of obstruction are recorded as being cured by the free administration of opium; it is certainly very probable that not a few cases of commencing invagination have ended favorably by its administration. But we must not trust to opium, even when combined with rest and starvation. Opium has its dark as well as its bright side, and if given early in cases of obstruction it obscures the symptoms and so lessens the chance of making a diagnosis; the patient's condition, no doubt, improves, vomiting and pain may be less, the pulse better, and the skin moist; but at the same time the bowel may be in a gangrenous condition, and the patient dies only the easier from having been dosed with opium. Again, the lessening of the severity of the symptoms may so lull the suspicions of the medical attendant that operation is delayed and the patient deprived of his only chance of life. I repeat that opium is a valuable drug in the treatment of obstruction if used with discretion, and with a full knowledge of its effects; it is rarely curative, but always relieves pain and lessens the peristaltic action of the bowels.

Belladonna.—Dr. Brinton first introduced the use of this drug in the treatment of intestinal obstruction, because of its power to produce relaxation of the unstriped muscular fibres of the bowel. Many speak very highly of it used alone or in combination with opium, as it lessens the sickness and depression caused by opium given alone. It may be administered by the mouth, or atropine may be injected hypodermatically. It has been used externally on the abdomen in form of ointment or plaster. Belladonna is sometimes useful in cases of fæcal accumulation, or in cases of paralysis of the bowel due to sepsis, but in cases of true obstruction it can be of but little service.

Enemata.—In cases of chronic obstruction of the bowels enemata are of considerable benefit; they are especially useful in those cases in which vomiting occurs. In cases of obstruction due to fæcal accumulation enemata are particularly beneficial. Warm water is generally sufficient, by repeated injections, to clear out the large intestines, but in cases of impacted fæces enemata of sweet oil, with one drachm of spirits of turpentine to the pint, give extremely satisfactory results.

Enemata have frequently proved useful in effecting the reduction of an intussusception; to be of service they must be administered early and copiously. Some recommend that they should be administered with the patient in the inverted position.

In cases of acute obstruction the benefit of enemata is not so clear; many medical men in these cases object to them altogether, because they are liable to increase the peristaltic action of the bowels.

In certain cases enemata are inadvisable and often injurious. They cannot possibly be of benefit in cases of intussusception in which the invaginated bowel has reached low down, in stricture of the rectum, or in cases of volvulus of the sigmoid flexure; in this latter affection enemata only increase the amount of twisting, and so do infinite harm.

Some surgeons recommend that copious enemata should be given, in every case of intestinal obstruction, before any other method is tried. Dr. Rhoney,[2] not content with the ordinary enema syringe or siphon apparatus, recommends the use of a force pump which can throw a continuous stream; if this fail, then he advocates laparotomy. In reading over the account of the discussion on intestinal obstruction at the Liverpool Medical Institution,[3] the writer was much struck with some remarks of Dr. Barr, and thought that they applied to those cases of intestinal obstruction successfully treated by enemata. Dr. Barr said: "If you look upon all cases where you have got severe pain in the abdomen, constipation, and vomiting, with perhaps more or less shock, as cases of intestinal obstruction, then, no matter what line of palliative treatment you adopt, you ought to have a very good percentage of recoveries; but if you belong to a more exclusive school, and in your anxiety for accurate diagnosis eliminate all cases of colic, constipation, enteralgia, etc., then you will find you have a terrible disease left, which tends more frequently toward a fatal issue than to recovery."

If we were as certain of the correct diagnosis of the disease treated as of the successful result of the treatment in many of the reported cases, much confusion and difference of opinion as to the value of certain remedies in the treatment of intestinal obstruction would be avoided.

Enemata have been used for diagnostic purposes. If during the injection the fluid can be heard gurgling in the cæcum, it is almost certain that the obstruction is in the small intestine; if it is stopped at some intermediate point, it is probable the obstruction is at that spot.[4]

Metallic Mercury.—This very old method of treatment is now never practised, though comparatively recently it has been advocated by Matignon, of Paris, and cases of intestinal obstruction successfully treated by this means are occasionally reported in the journals. The cases in which it is of use are those of old fæcal accumulation; for other forms of intestinal obstruction it should never be employed; it cannot possibly do good, and may do much harm.

Shot.—Dr. Mayilien,[5] of Paris, reports cases of ileus successfully treated by the administration of shot. He mixes seven ounces of shot with four ounces of olive oil, and gives two drachms of the mixture every half-hour. This treatment may do more harm than good, and is mentioned merely as a curiosity. It replaces the treatment by bullets of the physicians of the sixteenth century.

Washing Out the Stomach.—Kussmaul was the first to introduce washing out of the stomach for intestinal obstruction, and a number of successful cases are reported as the result of this mode of treatment. The good result is explained on the ground that evacuation of the distended bowel affords opportunity for the spontaneous reduction of a herniated or twisted loop of bowel. The temporary relief afforded is said to be very great, and the practice is so simple and harmless that it is worthy of a trial. Of course, the majority of cases of intestinal obstruction could not possibly be relieved by it.

Massage and electricity have been extensively practised in the treatment of intestinal obstruction and still have their advocates. It is now the opinion of most surgeons that in cases of acute obstruction, at any rate, they do more harm than good. The only cases of obstruction likely to benefit by them are those due to fæcal accumulations. E. O. Day[7] reports two cases of intussusception successfully treated by massage. He had seen two cases of this affection, and the only recoveries were [illegible] so treated by manipulation and massage.

Puncture of Bowel with an Aspirator Needle — Gas Trocar.—This method has its advocates, and cases are reported in which, after the bowel has been punctured and a large amount of gas and fluid fæces evacuated, the obstruction has been relieved. As a rule the procedure is not a dangerous one, but occasionally, owing to paralysis of the coats of the bowel, the punctures do not close, fæces escape, and a fatal peritonitis is the result. At best, puncture is a proceeding in which the element of

chance exists to a large extent; one can never tell whether the proper part is punctured, or whether the needle has not entered a portion of bowel bordering on gangrene. Mr. Treves[8] has met with several instances in which perforation of the bowel, which had been previously threatening, took place immediately after the relief of the distended coil by puncture.

In some cases the needle has punctured the bowel below the obstruction, without, of course, relieving the patient.

Emptying the bowel above the obstruction may in certain cases relieve a portion of the gut which is in some abnormal opening or held lightly under a band, and may relieve obstruction due to kinking. In cases of stenosis in which there is temporary obstruction it may give relief, and also in those cases of chronic obstruction which suddenly become acute (Treves).

Puncture of the bowel is a favorite method of procedure with veterinary surgeons for the relief of distended bowel in cattle. A very large trocar is used, and no evil results ever follow, owing to the immunity cattle have from peritonitis.

Dr. Largnier, of Paris, speaks highly of the continuous use of a trocar. He introduces a trocar 5 to 6 mm. in diameter, and leaves it in the intestines two or three days. Sometimes fecal fistulæ are formed (Treves). As this operation must necessarily be done at haphazard and is not free from danger, it cannot be recommended.

Laparotomy.—Surgeons are daily becoming more and more certain of the necessity of this operation in the majority of cases of obstruction; there is still some difference of opinion as to the cases in which it is suitable, and also as to the proper methods of its performance, but a larger experience will soon enable us to lay down definite rules for the guidance of surgeons. C. L. Gibson,[9] of New York, has collected 646 cases (exclusive of hernia) of intestinal obstruction treated by laparotomy with a mortality of 47 per cent.

The incision should be made in the median line below the umbilicus, and should be long enough to allow the whole hand to enter the abdomen. Having opened the peritoneal cavity, after all hemorrhage has been arrested the hand should be introduced through the wound, and the right iliac fossa first examined. If the obstruction be not found in cæcum or ileum, collapsed coils of intestine should be searched for. These are generally found hanging in the pelvis. If found, they can be passed through the fingers till the constriction is reached. Mr. Treves[10] advises that a large, warm, carbolized sponge should be placed in the pelvic cavity, as by this means much manipulation is saved. The intestines should, if possible, be prevented from extruding by means of warm flat sponges or aseptic gauze pads wrung out of hot water. The extrusion of intestines, if much distended, as they are almost sure to be, gives rise to considerable trouble, and if they cannot be kept within the peritoneal cavity, it would be well to incise the most distended portion and allow the gas and contents to escape. The incision should afterward be closed by a Czerny-Lembert suture. If the obstruction cannot be made out by the introduction of the hand, it would be proper to allow the bowel to extrude and to make a systematic search. The extruded bowel should, of course, be protected by warm aseptic gauze towels. Mr. Greig Smith[11] says the most dilated portion of the bowel rises to the surface, and there is a great probability that the obstruction will be found near this point. The hernial orifices should be examined, also the foramen of Winslow, the sigmoid pouch, duodenojejunalis fossa, etc., the diaphragm must not be overlooked, openings in the mesentery searched for, the presence of a tumor or intussusception as a cause must be kept in mind; also Meckel's diverticulum or the possibility of a properitoneal or retroperitoneal hernia.

When the obstructed point is found, the intestine should be carefully examined; if of good color it should be returned, but if gangrenous it should be excised and the two ends immediately sutured, or an artificial anus established. If the obstruction be due to constricting bands, these should be divided between the two catgut ligatures. Should an intussusception exist, it may be reduced by gentle traction if the case be a recent one; but if the parts be tightly glued together by effused lymph, so as to render reduction impossible, the affected portion of bowel should be resected and sutured, or an artificial anus should be established. Occasionally in these cases the obstruction is found to be due to cancerous or other stricture, or to a peritonitis; if the former condition exists and excision is impossible, an artificial anus should be established above the constriction; if the latter is the cause of the trouble, the peritoneal cavity should be washed out with a normal saline solution.

It is possible, my probable, that the cause of the obstruction may not be found, for it is by no means easy thoroughly to search the abdominal cavity (even if the whole hand is introduced) when the bowels are greatly distended; in such a case it is the duty of the surgeon to establish an artificial anus in the most distended portion of bowel, and to await results.[12] In cases operated on late, the value of dechlorinated saline solution injected subcutaneously, or the intravenous introduction of the solution cannot be overestimated. Even rectal injections are of benefit, and filling up the abdomen after operation with hot saline solution and leaving it there is a most useful antidote to shock.

Pedaihon[13] advises lateral laparotomy in preference to the median incision in cases of intestinal obstruction; with this incision, he holds that the distended intestines are less likely to extrude, and that the wound is more easily closed. The lateral incision should be made in the inguinocolic line region, parallel to the fibres of the external abdominal oblique muscle. Here the lips of the wound close easily, and the diaphragm is less liable to force the distended bowel through the wound. This incision is all very well if the point of obstruction is diagnosed and is on one side or the other, but in the majority of cases we are quite in the dark as to the site of the obstruction, and for a systematic exploration of the abdominal cavity no incision is so convenient and useful as the median.

Enterectomy is called for in certain cases of intestinal obstruction; for instance, those due to simple and malignant strictures of the small intestine, neoplasms, irreducible intussusception, and also in those cases in which an opening the abdomen the bowel is found to be in a gangrenous condition. It has been most frequently performed for the latter condition. After the affected portion of bowel has been resected, the question then arises as to the propriety of immediately uniting the divided ends of the bowel by suture, or of establishing an artificial anus by fixing them to the abdominal wound. The latter method, in cases of intestinal obstruction in which the condition of the patient is by no means good, is probably the better one. The immediate suture of the bowel prolongs an already severe operation, and so lessens the patient's chance of recovery.

If desired, when the patient recovers, and regains his strength, the artificial anus may be closed by a second operation. For the manner of performing resection the reader is referred to the article on *Intestinal Surgery*.

Enterotomy.—This operation for the relief of obstruction was first performed by Nélaton, and consists in opening the small bowel in the right iliac, by an incision, a little above the crest of the ilium, parallel with Poupart's ligament. It has been performed many times with success, and is more suitable to the more chronic forms of obstruction when, owing to the disease being high up in the large intestine, left inguinal colotomy is unsuitable. The portion of bowel opened is generally the lower coil of the ileum. It is also performed in those cases of intestinal obstruction in which, after the abdomen is opened, the affected portion of bowel cannot be resected. In cases of recovery the patients complain bitterly of the situation of the fecal fistula, as no apparatus seems to be able to keep in the discharges.

For the treatment of obstruction due to hernia, the reader is referred to that subject, also the treatment of diaphragmatic hernia (of which Gibson has collected

thirty-four cases), and gangrenous hernia must be looked for under the head of *Hernia*.

Treatment of Special Forms of Obstruction.—*Treatment of Internal Strangulation.*—If the obstruction be complete and the symptoms very acute, the immediate performance of laparotomy is called for. Whatever be the cause of the strangulation, laparotomy is our only hope of effecting a cure. Occasionally, but very occasionally, the patient may recover owing to the bursting of a constricting band or the spontaneous reduction of a herniated loop of bowel, but we should not wait for the chance of a cure being effected by nature. The immediate danger is too great, and the hope of a natural cure too slight, to justify us in postponing opening the abdomen and relieving the obstruction. There is no reason why these cases should be treated in any way differently from those of strangulated hernia when reduction by taxis has failed. Some go even further than this, and recommend that where this form of obstruction is suspected the patient should not be allowed to die without an exploratory laparotomy.[14] There is far more danger in operative interference being delayed until the period when it may be of no avail, than that a hasty and unnecessary operation should be done (Pilcher[15]). Opium may be given to relieve pain and lessen peristaltic action, but it is useless to trust to it as a curative measure. Enemata may prolong life, but cannot cure the disease. Its apparent improvement, due to the administration of sedatives, etc., should not deceive the surgeon or encourage him to postpone operative measures.

Volvulus.—This occurs most frequently in the sigmoid flexure. Rest, starvation, and opium may delay the fatal issue, but will never relieve the volvulus. Enemata are injurious, as they tend to increase the twist by distending the bowel. Laparotomy is the only method of treatment that affords any reasonable hope of success, and, to be of benefit, it should be performed early. When the operation is performed, and the volvulus found, its reduction is by no means a simple matter, even after the distended bowel has been relieved by puncture or incision. If reduction is impossible, an artificial anus should be established or the bowel resected. Volvulus was seen in 121 cases of the 646 collected by Gibson, and of these 66 per cent. ended fatally after operation. In 79 cases the bowel was untwisted and only 29 per cent. were fatal; 81 per cent. ended fatally after resection or artificial anus.

Bands.—Of the 646 cases of intestinal obstruction operated on, and tabulated by Gibson, 180 were due to bands; of these 76 were fatal (41 per cent.); most of these bands occurred in connection with the small intestines. In 126 the bands were cut or removed, and the mortality was 26 per cent. Owing to gangrene, resection had to be done in 17 cases, with a mortality of 52 per cent. This gave a better result than artificial anus, in which in 18 cases the mortality was 94 per cent. It is well to remember that there may be more than one band; failure to search for a second band has been the cause of more than one death.

Intussusception (Acute).—There is no doubt that occasionally intussusception, if recognized early, before adhesions have formed, may be treated successfully without operation. It is unnecessary to state that purgatives are harmful, and that expectant treatment, when every moment increases the severity of the affection, is of no avail. Mr. Jonathan Hutchinson has said[16]: "I have not found any case recorded in which spontaneous return of a well-recognized intussusception occurred, and those in which art succeeded are comparatively rare." If we are certain that the case is one of acute intussusception then immediate operation is called for. Insufflation of air or the injection of water have long been advocated as early treatments, and many yet believe in them; for some time, however, the modern surgeon has considered these measures mere loss of time, and prefers immediate laparotomy. The methods of insufflation and of administering enemata are given below.

Mr. Clement Lucas[17] advises the following method of inflation: "An ordinary bellows is connected with a gum-elastic enema tube by means of a piece of rubber tubing which is firmly wired at the end; around the end of the enema tube flat should be wrapped so as to make a conical air-tight base; the tube is inserted about three inches into the rectum, and the anus closed by a conical plug of flat. Further to guard against the escape of air, an assistant should press the buttocks of the patient close together; an anæsthetic should be administered." Mr. Lucas advises that inflation should be performed with the patient in the inverted position.

There are different methods of administering enemata: the ordinary enema syringe will do very well, but the fountain or siphon syringe is much better. The return of water is prevented by an assistant, who presses the buttocks of the patient firmly together. The water should be warm, and should be injected slowly and continuously. The difficulty of retaining the injected fluid may be obviated by the employment of Lund's elastic ring and handle.[18] This instrument was devised by Mr. Lund to prevent the return of air in insufflation, and so is suitable to cases in which either air or water is injected.

Should the surgeon be fortunate enough to effect reduction by these means, the after treatment is simple: milk diet, with small doses of opium to relieve pain and give rest to the parts.

Laparotomy by median section is the preferable operation. If, on opening the abdomen, reduction prove impossible owing to the firmness of the adhesions, the affected portion of bowel should be resected and the divided ends immediately sutured and returned into the abdomen, or stitched to the abdominal wound, and an artificial anus established. Dr. Charles L. Gibson,[19] of New York, has collected 187 cases in which an operation was done for intussusception, with a mortality of 51 per cent.; 81 cases were in children under one year, and of these 38 died and 43 recovered. The invagination was reduced in 126 cases, with 46 deaths and 80 recoveries. Resection was performed in 32 cases, of which 28 were fatal. Artificial anus was made in 5 cases, of which all were fatal. Resection and artificial anus in 19 cases, with 14 deaths. Twenty-three cases were gangrenous and only one of these patients recovered. The results of early operations in these cases of intussusception are fairly satisfactory.

Widerhofer and Herz,[20] of Vienna, report each a series of 10 cases of laparotomy for invagination, with 3 recoveries in each series, or a mortality of 70 per cent.

Wolmbechner advocates median laparotomy within twenty-four hours in children and forty-eight in adults.

Other methods of treatment are advocated for acute intussusception. Kussmaul recommends the free washing out of the stomach. Busch[21] has practised massage three times without success. When low down, reduction by bougies has been well spoken of by some, but this treatment is dangerous and cannot be recommended.

Wolbechner,[22] when the invagination is low down in the sigmoid flexure or in the rectum, has five times ligatured the invaginated portion by introducing a rubber tube and passing a ligature over it. Others,[23] when the invagination was low down, have cut off the invaginated portion, and then returned the bowel.

L. W. Hotchkiss (*Annals of Surgery*, November, 1901) has drawn attention to the fact that acute obstruction may occur after the operation for appendicitis; it must not be forgotten that acute obstruction may be one of the seq[uelæ] and persistent vomiting the invariable symptom. This vomiting of course may be caused by sepsis, and if in any doubt it would be well to open the abdomen in the middle line and examine. These cases are more frequent than is generally supposed, and the only hope is early operation. Obstruction may come on a few days or weeks, or even a year, after the operation. I have seen and operated on cases at all these periods, and success has followed early operation.

Intussusception (Chronic).—Chronic intussusception is attended by a great mortality. Medicinal treatment is of little avail; opium and laxatives give temporary relief, and reduction has in rare cases been effected by inflation and enemata. The only means by which relief can be

hoped for when the foregoing measures have failed is abdominal section. If, when the abdomen is opened, the reduction cannot be accomplished, the whole mass ought to be excised and an artificial anus established.

In some cases in which the intussusception is low down and chronic, it may be temporarily relieved by the performance of a right inguinal colotomy.

Foreign Bodies.—The cases of obstruction caused by foreign bodies are not common. Gall stones are most frequently the foreign bodies found. Free doses of opium should be given, followed by aperients, and, when complete obstruction exists, laparotomy should be performed, the intestine incised, and the wound closed with a Czerny-Lembert suture and the bowel returned. Gibson has collected 40 cases of gall stones which were operated upon because of the obstruction produced; of these 21 were fatal (57 per cent.). Lange [22] reports a case of obstruction caused by impacted gall stones and general peritonitis. Laparotomy was performed, but the patient died in eight hours. Dr. H. F. Beam [24] relates a case of intestinal obstruction caused by a calculus in the ileum the size of a walnut; it could be felt through the abdominal walls. An incision was made over the spot and the calculus removed. The patient made a rapid recovery. In incising the intestine to remove a gall stone it is better not to incise directly over the stone, for at this point the intestine may be injured by pressure of the stone.

P. J. Wising,[25] in recognized cases of ileus from gall stone, recommends first the employment of purgatives; if these fail, then copious enemata of water. Simple enemata, he holds, are perfectly harmless, but those of an irritating character should be avoided. Opiates should be given, and the strength of the patient sustained by nutrient enemata. He does not advise early laparotomy, but says that, when everything else fails, it should be undertaken.

Fæcal Accumulation.—Obstruction due to fæcal accumulation is of occasional occurrence. The point of obstruction is generally in the rectum, which is filled with a hard, immovable mass, above which the bowel is much distended with semi-fluid fæces. The best means of relief are afforded by copious enemata of warm water administered in the knee-and-elbow position. Continuous irrigation by the siphon syringe is very efficacious, and, if employed for half an hour at a time, the hardest mass softens and gradually becomes disintegrated. The stream of water should be directed against the obstructing mass by means of a rectal tube. Before enemata are commenced it is often advisable to inject a few ounces of olive oil. Some physicians recommend copious injections of sweet oil with spirits of turpentine in the proportion of one drachm to the pint of oil. Metallic mercury was a favorite remedy with the old physicians, and has been strongly advocated by Matignon, of Paris. Occasionally, when low down, the fæcal mass may be removed by scoop or spoon.

Colotomy has been performed in cases of obstruction due to fæcal accumulation. In most of these cases, however, there has been a mistake in diagnosis. It can be only rarely required in fæcal obstruction, and should not be resorted to till all other means of relief have failed.

Stricture.—The treatment of obstruction due to stricture is considered under Chronic Obstruction.

Francis J. Shepherd.

[1] British Medical Journal, April 18th, 1885.
[2] Intestinal Obstruction, p. 429.
[3] American Journal of the Medical Sciences, January, 1888.
[4] Lancet, December 13th, 1884, p. 1085.
[5] J. K. Fowler: London Lancet, June 30th, 1883.
[6] Bull. de Thérapie, May 15th, 1870.
[7] London Lancet, vol. II., 1885, p. 559.
[8] Intestinal Obstruction, p. 446.
[9] Annals of Surgery, vol. xxii., 1901.
[10] British Med. Jour., August 24th, 1885.
[11] *Ibid.*
[12] See case of Mr. Lawson, London Lancet, vol. I., 1879, p. 87.
[13] Gaz. Méd. de Paris, April 25th, 1896.
[14] John Syer Bristowe, in Reynolds' System of Medicine, vol. III., p. 83.
[15] New York Medical Journal, February 29th, 1896.
[16] Medico-Chirurgical Transactions, vol. lvii.
[17] London Lancet, January 18th, 1896.
[18] *Ibid.*, 1889, vol. II., p. 649.
[19] *Loc. cit.*
[20] Quoted in La Semaine Médicale, April 7th, 1886.
[21] La Semaine Médicale, April 7th, 1886.
[22] Fuller in New York Medical Record, October 14th, 1882.
[23] Medical News, January 16th, 1886.
[24] New York Medical Record, October 17th, 1885.
[25] Nord. Med. Ark., Bd. xvii., No. 18 (quoted in Centralblatt f. Chir., No. 24, 1885).

INTESTINAL SURGERY.—This field of surgical work differs slightly from others in certain essentials affecting natural repair of serous surfaces—and in the understanding of a few mechanical aids which are necessary in successful healing of intraperitoneal wounds.

The peritoneal cavity is so susceptible to contamination and so quick to yield fatal results if soiled, that it was considered a forbidden field of invasion prior to the present generation of surgeons. Through accumulated and vast experience, however, it has now become possible to deal with it with perfect safety if established principles are recognized.

First in importance is recognition of the fact that no solution should be used in the peritoneal cavity but boiled water, to which a little salt has been added (℥ iss, to O ij,—"decinormal salt solution"). This is entirely non-irritating to a healthy peritoneum and, for an infected one, is mechanically cleansing as well as destructive to the life of colon bacilli. Considerable quantities of it may, under certain circumstances, be left in the cavity with advantage, and in any event with safety.

The second underlying principle—which applies here as elsewhere—is, that nothing but aseptic gauze pads are to be used for sponging, and that aseptic ligatures, instruments, and hands (preferably covered by rubber gloves, boiled and dry-sterilized and free from punctures) can be relied on to insure safe work.

The third principle covers the understanding of repair by lymph exudate, the process being peculiar to this field, and of the mechanical aids which the surgeon may employ to bring it about. Under the latter are included the use of suture material and various ingenious mechanisms.

The student will understand that under favorable circumstances a firm lymph or gluey exudate, which is a natural means for repair, is promptly thrown out and spread around and upon any wound of the peritoneum, either visceral or parietal. It often begins to appear, firm and available to hold surfaces together, within two hours. The usual time, however, when it may be expected to afford efficient support, is after at least six hours have elapsed. In some cases a still longer period—one or even two days—may be required. Such a protracted delay depends on the poor disease-resisting power of the patient (feeble leucocytosis?), or, in certain cases, on the solvent action of bacteria in excess.

The presence of mechanical substances, or of chemical irritants, provokes a quicker formation of an exudate. Thus, the suture thread is, if it is aseptic, speedily buried in firm lymph—the first step in nature's effort to incarcerate it as a foreign body.

If, however, an impure suture material is used, one will see the parts speedily fall asunder owing to the solvent action of bacterial secretions.

The best suture material, it is universally conceded, is fine silk, sterilized by boiling, and black by preference, so that each stitch may more easily catch the eye of the operator.

The best needle is the ordinary round one, though with care an operator may use any variety. For much of the careful work necessary, it is better to have also a sharp-pointed needle, curved one-third of a circle, which, while having cutting edges, has a flat surface on the convexity (like an eye needle), and is not more likely than a round one to wound small veins and produce subserous hæmorrhages. The spear-pointed, or Hagedorn, needle often causes troublesome bleeding.

Thus, with simple expedients and a recognition of the few simple principles enumerated, one may accomplish all that skill can do in effecting the repair of peritoneal wounds.

even though there may be no evidence of lues, iodide of potassium freely given may be of great benefit.

Hyperæsthesia of taste is seldom met with, but pain located in the tongue alone is quite common. Aside from the pain attending many diseases, elsewhere considered, we have some rare neuralgias limited to this organ, and, as a rule, to one side only.

Spasm of the Tongue.—*Clonic spasm* is a rare affection observed by Erb and others. The tongue may be protruded involuntarily, being pushed forward against the dental arch, or it may show involuntary muscular contractions on one or both sides. Clonic spasm is seen in hysteria and in the epileptic seizure. Bromide of potassium and electricity are recommended. The condition may be looked upon as a neurosis of the hypoglossus.

Chorea-like movements, limited to the tongue, have been reported as occurring in hemiplegia to the extent of interfering with speech. The movements grow less as the paralysis improves.

Tonic spasm is seen in hysteria, and in other conditions, probably due to reflex irritation.

Unilateral spasm of the tongue has been observed by Wendt. The attacks would last for several minutes at a time, the right half of the organ becoming suddenly hard and contracted by repeated twitchings. The patient recovered under galvanism.

Inflammatory Conditions.—The causes which may be active in producing inflammations of the tongue are multiple. Thus it may follow a great variety of injuries, bites and stings of insects, and the application of irritant substances, and it may be found in eruptive and other fevers. It may be acute or chronic. When deep-seated, inflammation of the tongue may endanger life through suffocation, and in the acute form its onset is often sudden and may end in pus formation, and the subsequent abscess may press upon the epiglottis and thus also threaten life.

In two instances I have seen glossitis result from the accidental taking of ammonia. The tongue, under these circumstances, is first made white, becomes much enlarged and painful, and then subsequently casts off its coating of epithelium. In one of the cases referred to, the patient, who was a sufferer from asthma, mistook the hartshorn for the whiskey bottle at night, and by the time I reached him the thickened tongue filled and protruded from the mouth, causing difficulty of breathing, which, added to that of the asthma, was distressing in the extreme.

Abscess of the tongue may be the result of acute inflammation of the tongue; in such cases it is deeply seated, and has been mistaken for cancer, the tongue having been removed on account of it. The more chronic forms are usually circumscribed and deep-seated, and may occur without preceding glossitis or herpes. The swelling is firm and elastic, and there is no superficial discoloration, so that it may readily be mistaken for a cyst. The abscess is generally situated toward the anterior portion of the tongue, near the edge, and is usually very chronic. An exploratory puncture quickly clears up the diagnosis when fluctuation is not clear or "pointing" is delayed. Treatment by longitudinal incision readily brings the case to a favorable conclusion.

Early operation to prevent suffocation is sometimes indicated, though spontaneous rupture after rupture occurs in most cases; and if the patient is seen early the application of ice and cooling lotions or emollient washes prevents the more serious condition.

Actinomycosis now and again occurs as a primary disease in the tongue, developing as a deep-seated inflammation of the base, with a wood-like hardness of the entire suprahyoid region. The occupation of the patient may lead to suspicion, and confirmation will be found in the discovery of the characteristic yellow granules. As is well known the tongue, in actinomycosis in herbivorous animals, is frequently affected with nodular swellings of various sizes; and as the affection is becoming more and more frequent in man, and as infection usually takes place by way of the mouth, it will not be surprising if tongue cases become more numerous.

Anthrax.—Malignant pustule occurs in connection with lesions upon the external surface, or, in the edematous form, upon the tongue with formation of pustules. It occurs also in rare cases as a primary lesion, as reported by Rammstedt.[8]

Chancroid may begin as a reddened fissure, to be followed by ulceration and attended with submaxillary adenopathy.

Syphilis.—The most common form in which the syphilitic poison manifests itself upon the tongue is that of the mucous patch. The primary sore may occur upon the tongue, and in the later stages we have the gummy tumor and ulceration, fissures, plaques, and tertiary ulcerations. Men are more prone to suffer relapses than women, probably owing to their greater use of tobacco and alcohol.[9]

Chancre of the tongue is commonly located at or near the tip. It may run its course before a diagnosis is made. Chancre is apt to be hollowed out, bowl- or crater-shaped, with sides gently sloping to the centre, while a tuberculous ulcer has irregular borders and base, and shows granulations which make it uneven, while here and there at the periphery are little yellow points somewhat suggesting miliary abscesses. From chancroid it is recognized by its red or rosy color, while the latter has a yellow base.

Condylomata as well as papillomata are found in syphilis; the distinction between the two being that the former are more flattened and, besides the hypertrophy of papillæ, there is a tumefaction of the intervening tissue making a more firm or solid as well as a more flattened tumor.

Gummata, which may be confounded with primary sclerosis, occurs upon the surface or within the substance of the tongue. They are rather late manifestations. Nodules the size of a pea or smaller occur upon the posterior part of the dorsum, and might escape notice if they remained unirritated. When single and laterally situated, beginning cancer is simulated. Those located within the parenchyma are not so easy of diagnosis. They may reach the size of a large hickory nut and are not very sensitive. For some reason they occur most often in men. Carcinoma is single and situated at the border, while a gummy tumor is apt to be multiple and more centrally located. Chronic abscess of the tongue is more clearly defined than gumma.

Treatment by large doses of iodide of potassium almost invariably brings about speedy resolution and cure, and this may at times prove of value as a diagnostic test. Locally, nitrate of silver stick, lightly applied, will in most cases soon cause them to disappear. If this does not act well, a solution of chromic acid (strength of from ten to fifty per cent.) will almost always bring about a rapid cure.

Cysticercus cyst of the tongue is more frequent than the echinococcus. The diagnosis is established only on incision or after suppuration. Though the occurrence of this parasite in the tongue is common in animals it is certainly rare in man. In one case the larva of the Taenia solium was found upon incision of a painful tumor of the tongue.

Echinococcus disease involves the tongue in rare instances. The diagnosis can be made only after incision or by the coincident involvement of other parts.

Diphtheria at times presents patches upon the tongue; never, however, unless the throat is coincidently affected.

Erysipelas involves the tongue by extension from neighboring parts. Primary erysipelas of the tongue has been reported by a number of observers, but while some maintain that the organ does not become tumefied, others describe the swelling to be of such a size as to render it impossible to close the mouth.

Erythema Exudativum Multiforme.—Lesions of the exudative form of erythema occur at times upon the tongue, but the quickly rupturing bullæ would be difficult of recognition were no lesions present on the skin.

Since this affection likewise is apt to recur, it has been confounded with recurrent herpes of the tongue.

Herpes, in connection with the same disease, upon the face, lips, etc., is a not very uncommon condition. Actual vesicles are naturally present for only a very short time, and when the patient is seen a red, inflamed, tender, and somewhat indurated area shows where the primary lesions were situated. It is found almost wholly upon the tip and edges of the tongue.

For treatment, the application of powders containing acacia, bismuth, prepared chalk, etc., frequently repeated, or of borax in honey by means of a camel's hair pencil, acts beneficially, and when the parts are less tender, borax, alum, or tannin washes may be used.

Aphthous sore mouth often begins as a vesicular eruption.

Keloid is among the great rarities. Sedgewick[1] describes an instance seen in a young girl who had, besides the tumor on one side of the tongue, true keloid on various parts of the body. There was slow extension toward the tip of the organ.

Lepra may produce lesions upon the tongue quite similar to those which occur upon the integument. Campana saw in a leper boy a group of small papillifor.. tumors, that formed an oval plaque as large as a twenty five-cent piece, slightly elevated, and with a rough surface. Some of the separate tumors were conical in form and some rounded. They had a rose color and were painless. Characteristic bacilli were found in one which was removed and examined microscopically.

A microscopical section through a leprous tongue showed bacilli collected in groups and in ball-like masses.

Lichen planus, it would appear, not infrequently causes tongue lesions which would present difficulties of diagnosis were the skin lesions absent. Erasmus Wilson first pointed out the possibility that lichen may develop upon the tongue, with roughness and the formation of round whitish patches. Jonathan Hutchinson subsequently observed lesions consisting of small papules. Neumann reports papules similar to those of psoriasis of the mucous membrane, being flattened and lentil-sized. Touton mentions a case in which the tongue was covered with flat, round, grayish-white plaques. Pospelow saw lichen planus papules which were flat and without central atrophy.

The lesions of the tongue may be more or less extensive at the time when the cutaneous eruption is first observed, or the tongue lesions may precede or follow those of the skin. In most cases the lesions occupy the mucous membrane of the cheeks and of the lips at the same time, though I have observed one patient in whom the lichen lesions were limited to the tongue and the glans penis. They occur as sharply defined white spots, rounded or slightly irregular, without marked projection above the surface, isolated or joined in groups, or as parallel lines along the borders of the tongue. Thibierge[2] thinks we must look upon these as lesions of lichen planus, although they do not itch.

According to Tuna, the lichen ruber of Hebra is also accompanied by mouth lesions. In a case observed by him, there were lesions upon the tongue in the form of multiple erosions, which were altogether different from the plaques of lichen planus.

Lupus is rarely found on the tongue without having previously existed on the face, larynx, soft palate, or nose. It occurs mostly upon the back part, near the epiglottis, more rarely upon the tip, as small isolated nodules, with soft granular surface; star-shaped cicatrices result. Lebdr, Clarke, and others have observed primary lesions here located, and Spires[3] records fourteen observations in connection with lupus elsewhere. The tip in one case was completely destroyed. It was probably inoculated from lupus upon the lips. In distinguishing the disease from tuberculous ulcer we have, as characteristics of the former, much less pain or entire absence of pain, and a much slower evolution.

Neuralgia of the tongue is a most distressing affection, and one difficult to eradicate without operation. Fortunately it is not common. I have observed one instance of it in a lady with arthritis deformans. The paroxysms are of short duration but of frequent repetition, and the attacks may come on at intervals of a few months. The pain is usually located along one border of the organ.

Papilloma of the tongue is an occasional cause of neuralgia, but more often the lingual nerve is affected. Daily scraping of the tongue has been accused of favoring its development. A rheumatic or other diathesis may be found as a predisposing cause.

Duhrenil reports a case in which he performed resection of the lingual nerve in a woman forty-five years of age, whose neuralgia had lasted for four years.

Nigrities Linguæ.—In black tongue the discolored area, is limited to the middle of the dorsum, as a rule, and the edges are not so black as the middle portion. The elongated oval area is limited at first, but slowly spreads. Desquamation usually follows. The affection may last weeks, months, or even years. The papillæ seem much longer and thicker than normal, and the color makes them appear still more prominent. Subjective symptoms are usually wanting. Many cases of so-called black tongue are undoubtedly accidentally or intentionally made black by iron, ink, or dyes. It has been observed under widely varying conditions. The blackness is marked and persistent, and invariably spreads from a small beginning; the color toning down from black to brown, and from the centre to the sides. Raymond speaks of its resemblance to "a field of corn laid down by wind and rain."

Dessels[4] has described, under the name of glossophyton, a fungus found in the epithelial deposits and débris making up the black deposit upon the elongated papillæ. A black fungus of the class of Hyphomycetes, found by Schmiegelow, has been thought to be the cause.

The treatment consists in frequent applications of peroxide of hydrogen on absorbent cotton. Friction with Hebra's spiritus saponis, followed by mild salicylic ointment, or a five-per-cent. salicylic solution in ether, with the addition of five-per-cent. collodion to form a thin coating when painted on the affected areas, has been found the most efficacious by Brosin.

Pemphigus has been known to occur upon the tongue, and well-marked bullæ distended with fluid have even preceded the eruption upon the skin in the acute form. The pain is here greater than in the lesions of pemphigus vulgaris. The diagnosis must usually be made from the coincident eruption upon the skin, since the bleb almost at once is transformed into an erosion. Menzel believes that pemphigus can exist upon the tongue in the form of reddened plaques without actual bullæ.

Periglossitis sublingualis, or inflammatory edema of the cellular tissues about the tongue, is an exceedingly rare condition, of which Henoch has recorded one instance. There is pain and difficulty in speaking and eating. The cause is unknown.

This list of affections of the tongue comprises most of those which possess some importance, but the limited amount of space which has been allotted to this topic compels me to omit a number of less important diseases. For information regarding them the reader will have to consult one of the larger monographs on the subject.

Charles Worrenne Allen.

[1] Bul. de la Soc. Méd. des Hôp., 1891.
[2] Hist. de l'Acad. R. des scien., 1718.
[3] Die Missbildungen des Menschen. Jena, 1861.
[4] Le Progrès médical, October 25th, 1883.
[5] Trans. Belgian Surg. Soc., January 22d, 1888.
[6] Münch. med. Woch., No. 19, 1889.
[7] Pathological Transactions, 1861, vol. xv.
[8] Archives cliniques de Bordeaux, 1891.
[9] Gaz. des Hôp., No. 28, 1879.
[10] Allen: Syphilis of the Mucous Membranes of the Mouth and Tongue. Morrow's System, col. ii., p. 223.

TONGUE, SURGERY OF THE.—INJURIES OF THE TONGUE.—*Burns and Scalds.*—The tongue is not uncommonly the subject of injury from burns and scalds. Slight burns or scalds are of but little consequence, the superficial portion of the covering of the tongue only

being destroyed; in a few hours, or, at most, at the end of a day or two, the tenderness disappears without treatment. To relieve the pain, applications of sweet oil, borax and honey, bicarbonate of soda, or astringent lotions, are useful. The most severe burns are those caused by chemical agents, such as mineral acids, caustic alkalies, corrosive sublimate. When these substances have been accidentally or intentionally swallowed, the tongue is not the only part that suffers, for the whole of the interior of the mouth, the fauces, and the throat are also affected. It is often possible to recognize the poison taken by the appearance of the tongue. In poisoning by corrosive sublimate the tongue is white and shrivelled. Carbolic acid renders the mucous membrane white and hard. Vegetable poisons, as a rule, produce no alteration in the appearance of the tongue in cases of acute poisoning (Butlin).

Scalds of the tongue are not uncommon in young children, and are often produced by sucking the spout of a tea kettle. This accident is more common in England than in this country. The injury to the tongue in such cases is of small importance compared with the grave complications which arise from injury to the larynx and air passages. The tongue swells, becomes red, and is soon covered with blisters; it is of course tender and painful, and food in any form is difficult to take. This difficulty, however, soon subsides, and is of little moment compared with the grievous results which follow injury to the air passages.

Effects of Cold.—In winter, in this country, one occasionally sees an injury to the tongue in children produced by cold, and this, although it is not dangerous, is sufficiently painful. It is generally caused by the child licking with the tongue iron or other metal at a low temperature. In such cases the tongue adheres to the metal, and the child, pulling the tongue quickly away, leaves behind a considerable portion of the mucous membrane. The writer has frequently seen this accident happen to children playing out of doors when the thermometer registers a temperature considerably below the freezing point. On one occasion several children were induced by a mischief-loving companion to place their tongues on an old iron pot, the result being that each one was deprived of a large amount of the covering of the tongue and suffered considerably, especially during meals, for several days afterward. The treatment of such cases is the same, of course, as that of burns.

Stings of Insects.—In England it is not uncommon for insects, such as wasps and bees, to be taken into the mouth, concealed in fruit, and serious inflammation has resulted from their stings. In such cases Fairlie Clark[1] recommends that the mouth be frequently washed with an alkaline solution to neutralize the formic acid. A weak solution of ammonia is very efficacious.

Wounds.—Usually wounds of the tongue are not serious, but Bryant,[2] of London, mentions a case in which death followed a wound of the tongue, in a small child, from trickling of blood down the larynx, the child dying asphyxiated. Wickham Legg[3] relates cases of death following bites of the tongue in persons the subjects of hæmophilia.

Wounds of the tongue may be produced in various ways, but most commonly the wound is caused by the teeth. Epileptics not infrequently bite the tongue severely during a fit. The tongue may be severely wounded by a fall on the chin, or by a violent blow on the jaw when the tongue is protruded. The protruded portion of the tongue may be completely bitten off, or one side only be injured. Injuries to the tongue may be caused by dentists' forceps while the patient is under the influence of an anæsthetic.

The hemorrhage resulting from injury to the tongue is seldom dangerous, and is usually easily controlled by ice or exposure to air. Should the hemorrhage be profuse, its source should be sought for and the bleeding vessel usually the ranine artery, tied. Oozing from the wound is generally arrested by bringing the edges of the wound together with sutures. In certain cases in which the wound is far back, it may be necessary to pass a ligature through the tip of the tongue, to draw it out, and to examine the wound thoroughly; if it be small, then it should be enlarged and the bleeding vessel secured. In some cases it may be necessary to use the cautery to arrest the hemorrhage; its use, however, interferes with primary union. Sutures are not necessary if the wound be small, but if it be large and a portion of the tongue is hanging loose, then the edges of the wound should be carefully brought together with deeply placed silk or catgut sutures. A case is related by Mr. Gant in which the tongue was severed by an incised wound extending nearly through the substance of the organ, and dividing the lingual and hypoglossal nerves on both sides. The detached portion, which hung by a mere shred on the left side, was replaced promptly and secured, complete union took place, and the tongue slowly recovered power of motion and the sense of taste. The after-treatment of wounds of the tongue is similar to that of other wounds of the mouth. The mouth should be washed out frequently with weak Condy's fluid, or a paint of iodoform and alcohol may be used.

Wounds of the tongue may be caused by foreign bodies, such as the stem of a tobacco-pipe, crochet needles, splinters of wood, etc. Foreign bodies are occasionally driven into the tongue in cases of gunshot wounds; these consist of teeth, portions of the jaw, etc.

Foreign bodies have been found embedded in the tongue months and years after the accident. A case is related of a soldier who was shot in the face at the battle of Gross Guerschen, in 1813; the bullet passed through the cheek and tongue, carrying away some of the molar teeth; the wound in the tongue quickly healed; in 1845, thirty-two years after, the tongue became swollen and discharged the second molar tooth which had been carried into it by the bullet in 1813.[4] Mauget relates the case of a patient in whose tongue a ball had been lodged for six years. During this time the man stammered excessively, but when the ball was extracted, the stammering ceased.[5]

When a wound of the tongue does not readily heal, or when there is secondary hemorrhage, then a foreign body may be suspected; or again, if a sinus exists and an indolent swelling remains, it is very probable that a foreign body is present. When the foreign body is removed, the wound usually heals up. According to Butlin,[6] the removal of the foreign body does not always bring about such a happy result; in more than one case this procedure has been followed by hemorrhage which has caused death.

A case is related of a sailor, aged thirty, who was keeping watch on deck, and at the same time smoking; he either fell or struck against some object by which the pipe in his mouth was driven into his tongue and broke. There was at first but little apparent injury and only slight hemorrhage, but subsequently the tongue began to swell, and on the fourth day he was taken to the London Hospital. His mouth was closed, and he had swallowed little or nothing since the accident. There was swelling at the upper and back parts of the neck; the tongue was enormously enlarged and fluctuating. An incision was made, and an ounce of purulent fluid, mixed with blood, escaped. This gave some relief, but the symptoms soon returned with greater intensity than before. A probe was then passed into the tongue by the opening made with the lancet, and something hard was felt in the deep substance of the organ. This was grasped with forceps and extracted; it proved to be a piece of pipe stem four inches long. Immediately after its removal a frightful torrent of blood gushed from the mouth and nostrils, and the man was dead in little more than a minute. At the autopsy it was found that the pipe stem had entered the right side of the tongue near the tip, passed just below the left tonsil, and completely transfixed the left carotid artery and internal jugular vein.[7]

TONGUE-TIE, or shortness of the frænum linguæ. The tongue is bound down and cannot be protruded beyond

the incisors. This is a congenital defect which is not uncommon, and when it exists to a high degree it prevents the child from sucking, and later may interfere with articulation. In such cases it is necessary to divide the tightened band; this should be done with a pair of scissors with blunt points. The points should be directed to the floor of the mouth to avoid wounding the ranine arteries. Cases are on record of fatal hemorrhage occurring from accidentally cutting these vessels. In dividing the frænum only a small cut is necessary, and then the rest may be torn through with the fingers. This even is generally unnecessary, for the child, in crying, still further frees the tongue. Petit[8] drawsattention to another danger of cutting too freely. He relates three cases in which vigorous sucking in strong and hungry children tore the wound in these tissues still further open, so that the tongue, losing its anterior attachment, turned back and was embraced by the muscles of deglutition, and pressed the epiglottis firmly over the larynx until suffocation was produced. Two of the cases ended fatally before help could be afforded.

The frænum may be congenitally too long, and cases of death from suffocation have been recorded owing to this condition, the patient swallowing the tongue. A number of cases are reported in which by repeated practice the patient has acquired the habit of tongue-swallowing.

Macroglossia.—This is a congenital hypertrophy of the tongue analogous to elephantiasis. It is of slow development, and as the tongue enlarges it causes great trouble, the mere size interfering with deglutition and speech. The tongue may protrude over the chin and reach even as far as the sternum. The subjects of this affection frequently suffer from epilepsy. The great enlargement causes deformity of the teeth and jaws, especially the lower. The teeth frequently become carious and fall out, and the lower jaw has been known to have been distorted by the pressure.[9] There is constant dribbling of saliva, and the protruded tongue is much altered in appearance, indurated, swollen, and purplish in color; later, nodes, irregularities, and fissures appear on its surface, and occasionally the tongue ulcerates. On puncturing it there is not much bleeding, but there is oozing of large quantities of serum. The disease is not, as a rule, noticed for the first two years, as sucking appears to stop the growth of the organ by continuous pressure. The pathology of this disease was first elucidated by Virchow; he found that there was an overgrowth of interstitial connective tissue, with a remarkable infiltration of the whole organ with white cells collected here and there in a delicate network, and forming true lymphoid tissue. The disease, no doubt, is due to congenital defect aggravated by frequent attacks of glossitis.

Treatment consists in removal of the protruded portion of the tongue. In some cases the removal of a V-shaped portion has given the best results. Strapping with plaster has never entirely been successful, but excision is the best method of treatment. A few years ago a German surgeon reported a case in which great improvement occurred in a child aged thirteen months, treated by Pirogoff's method, viz., ligature of the lingual arteries.[10] This is an old method of treatment which years ago was tried and found wanting.[11] Ligature of the portion of tongue protruded has been successfully practised, but nothing is so safe or simple as excision with knife, galvano-cautery, or écraseur. The hemorrhage usually is not great, and the result is almost invariably satisfactory. When bleeding is feared in young children, the removal by écraseur should be preferred, but in adults the knife or scissors is better, as their use is not followed by sloughing. The tongue should be drawn forward by means of ligatures passed through its substance behind the line of incision, and the incision should be made in such a manner that the tongue will be left somewhat pointed; the bleeding vessels should be tied at once. The after-treatment is the same as that used for partial removal of the tongue for any other cause.

In a case of this kind in which I removed a large portion of the tongue a number of years ago, the result has been excellent, the patient now having an almost normal tongue, and speaking with great distinctness and facility.

Tumors of the Tissues.—*Vascular Tumors.*—Nævi are occasionally found in the tongue; if superficial, they may be treated by nitric acid or by puncture with the galvano-cautery needle. When the growth is prominent and can be isolated, it may be excised with scissors or treated by ligature. When a nævus growth is treated by excision, the healthy tissue should be cut all around, the hemorrhage then being inconsiderable. If there is much danger of hemorrhage, the galvano-cautery knife may be used. When the growth is large and more diffuse, excision by means of the wire écraseur is a valuable method of treatment; the écraseur should cut through healthy tissue. Ligature is seldom necessary in such cases, but when used it should be passed deeply into the substance of the tongue and tied very tightly.

Sir Joseph Fayrer has described[14] an affection called *circoïd aneurism* of the lingual vessels. It simulated ranula.

Cystic tumors of the tongue are not uncommon. They may be due to dilatation of the mucous follicles, and contain a gelatinous mucus.

Sebaceous cysts occur in the tongue but very rarely; they should be treated by excision.

Fatty tumors are sometimes met with, and are usually of small size and easily removed.

Enchondromata have been described by Weber.[15]

Sarcomata of the tongue are almost unknown as primary growths.

Keloid has been noticed by Sedgwick.[16]

Vascular tumors of the tongue have been described by Mason,[17] Clarke,[17] and others. They occur mostly in adults and may be congenital; these tumors are situated on the dorsum of the tongue and are quite painless and innocent. Treatment should be by excision.

Papillomata or *warty tumors* occur on the dorsum of the tongue, and consist merely of hypertrophied papillæ. Bullin[19] describes a case in which there was warty enlargement of all the fungiform papillæ. The diagnosis is easy when the affection occurs in early life, but when it exists in old people it is sometimes difficult to diagnose from epithelioma.

Treatment.—Removal by scissors is the simplest and best mode of treatment when the growths are small, when they are large, ligature is more satisfactory. If there be any induration at the base or the slightest suspicion of the growth being malignant, then, to insure its complete removal, the healthy tissue around should be excised as well as the growth. Bullin[20] says, "that the treatment of the larger and doubtful warts in persons over forty years of age, by caustics and other similar measures, cannot be too strongly deprecated." The writer has frequently seen commencing epitheliomas in middle-aged persons treated for several months by caustics, under the supposition that the case was one of warty growth; such treatment increases the rapidity of the growth if cancerous, and lessens the chance of a cutting operation being successful.

Ulceration of the Tongue.—Ulceration of the tongue may be simple, syphilitic, tuberculous, cancerous, or mercurial.

Simple ulcers may be due to irritation from a sharp tooth or to traumatism of any kind. We may have a simple ulcer as the result of long-standing superficial glossitis. Dyspeptic ulcers of a superficial character are not infrequently met with, also aphthous ulcers. These are more common in children than in adults, and general treatment by salines, combined with astringent lotions of alum or tannin, is often of great benefit. Borax and chlorate of potash washes are also useful. In treating simple ulcers the removal of the cause is generally sufficient to cure the disease. If the ulcer does not heal readily, Bullin[20] recommends the frequent painting of the surface of the sore with a solution of chromic acid (gr. x to ʒ i. of water), or with a lotion of borax (ʒ ss.), glycerin (♏ xx.), and water (ʒ i.). Burning these ulcers

with nitrate of silver, especially in the obstinate, is not to be recommended, as the irritation caused may induce a cancerous condition in those predisposed. Should the ulcer not heal rapidly under simple treatment in a man over forty years, then cancer is to be suspected, and the ulcer should be cut out. A simple operation of this kind may save the patient much future trouble.

Tuberculous ulcers usually occur on the tip of the tongue. When extensive, they are difficult to diagnose from cancer. The ulcer is irregular, with sharp-cut edges or pale flabby granulations at the base. There is very little induration of the surrounding tissue. The ulcer in its advanced stages may eat deeply into the tongue. It is generally acutely painful, so much so that the lingual nerve has been divided to ease the sufferings of the patient. In the late stages there is considerable salivation. A tuberculous ulcer of the tongue may be the primary manifestation of tubercle, or it may occur secondarily. *Primary* ulcers are rare, *secondary* more common. The writer has seen several cases which were secondary to ulceration in the larynx and tuberculous disease of the lung. When the ulcer is primary the diagnosis is difficult. From syphilitic ulcer it may be distinguished by the history; syphilitic ulcers are usually on the central part of the tongue, and if due to gummata they are preceded by local swelling. With tertiary ulcers the glands are never affected, with tuberculous ulcers they are frequently enlarged. A tuberculous family history and the existence of tubercle bacilli will help one to a correct diagnosis.

The *diagnosis* between carcinoma and tubercle is more difficult still, for in both affections the lymphatic glands are involved. The age of the patient and the existence of extensive induration would point to cancer. Cancer does not usually occur under the age of thirty. A difficult case presented itself to the writer quite recently; a young girl, aged twenty-two, with a decidedly tuberculous family history, had extensive ulceration of the right side of the tongue with slight induration, and with involvement of the lymphatic glands of that side; the ulcer was painful to the touch and there was considerable salivation. A portion was excised and under the microscope it presented the typical characters of epithelioma; no bacilli were found in this case. The patient declined operative interference.

The *prognosis* of tuberculous ulcer is quite as unfavorably as that of cancer, and the patient succumbs to the disease in from a few months to two years.

Treatment.—An endeavor should be made to relieve the pain by soothing lotions, etc. Papaitine often relieves pain, and according to some it is curative, but this the writer cannot indorse. Scraping with a sharp spoon and then painting with tincture of iodine has been advised.

Butlin[24] strongly recommends excision when possible, even if the ulcer be secondary, as both a painful disease and a focus of further infection are thereby removed. Great relief has followed the application of the following: finely powdered iodoform, gr. i.; morphine, gr. ¼; borax, gr. iij. The surface of the ulcer should be cleansed and dried before application, and the powder should be applied three or four times a day. Should the pain be intense and confined to one side, division of the lingual nerve must be thought of. General treatment by cod liver oil and tonics should not be omitted.

Syphilitic ulceration commonly occurs during the secondary stage of syphilis, along the edges of the tongue. The ulceration is superficial, and a white patch on the mucous membrane of the cheek, corresponding to the ulcer of the tongue, will nearly always be found. Fissures or cracks which plough up the dorsum of the tongue in every direction are peculiar to syphilis; these are usually the result of tertiary syphilitic ulceration; single cracks or fissures are sometimes seen in the secondary variety. Superficial syphilitic ulcers have no induration at the base. Mucous tubercles or patches may also appear on the tip and borders of the tongue during the secondary stage, but at the same time they exist on the lips, vulva, and anus; they are oval or round in shape, grayish in color, and covered with partly macerated epithelium.

The *deep syphilitic ulcer* is caused by the breaking down of a gumma, and is usually situated on the dorsum of the tongue. It has sharp-cut edges which may be undermined, the base is sloughy and ragged, and there are always some induration and swelling of the neighboring parts.

Diagnosis.—These cases are difficult to diagnose from cancer; however, the history of the case and the situation of the ulcer will help one to form an opinion. If syphilitic, such ulcers are preceded by a lump; in cancer the induration follows the ulcer and does not precede it. There may be two or more gummata on the tongue, but a cancerous ulcer is always single. Cancerous ulcerations occur more commonly on the side of the tongue, syphilitic on the dorsum. In tertiary syphilis the glands are rarely enlarged; in cancer which has existed for some time the lymphatic glands are always enlarged. Syphilitic ulceration yields to antisyphilitic treatment. Many cases, however, occur in which the diagnosis is very difficult and can be settled only by the microscope.

It must be borne in mind that the primary lesion of syphilis may occur on the tongue, the infection being usually due to inoculation from secondary sores. The occurrence of a primary sore on the tongue is rare, and presents the appearance of primary sores in other parts. The submaxillary lymphatic glands are usually enlarged from the first. In the superficial forms of secondary syphilitic ulceration the treatment should be constitutional as well as local, viz., mercury internally, in the form of gray powder, with local application of half a grain of bichloride of mercury to one ounce of water. Butlin speaks highly of chromic acid as a local application (ten grains to one ounce of water), applied three or four times a day.

In the tertiary syphilitic ulcer, iodide of potassium in doses of from ten to twenty grains three times a day, largely diluted, combined with tonics, will effect a rapid cure; local applications other than those of a soothing character are rarely necessary. Syphilitic ulcers always leave scars; the puckered and furrowed scar left behind by a sharp ulcer is characteristic.

Cancerous Ulceration.—This form of ulceration of the tongue is always of one variety, viz., epithelioma. It generally commences as a small ulcer on the side of the tongue, though no part of the tongue is exempt. The posterior half is, however, much less commonly affected than the anterior half. In eighty cases collected by Butlin,[25] cancer affected the sides and borders of the tongue in seventy-one. It occurs more frequently in men than in women; according to Barker,[26] in the proportion of two hundred and forty seven to forty-six. It will be found, on examining the various statistics, that cancer of the tongue occurs more frequently between the ages of forty-five and fifty-five. Billroth[27] states that it is more common between the ages of fifty and sixty, and such has been the writer's experience. It very rarely occurs in young adults. Barker mentions a case at twenty-six years of age. The writer has seen one case in a woman, twenty-two years of age, in which the diagnosis was verified by the microscope.

There is no doubt that smoking predisposes to cancer of the tongue, as many cases are preceded by leucoma or the so-called psoriasis of the tongue. This condition may be produced by dram-drinking, smoking, and also by syphilis. In eighty cases collected by Butlin,[28] sixteen were preceded by leucoma. The psoriasis and scars produced by syphilis, injury, or any other cause, will predispose to cancer; any irritation such as a sharp tooth, the stem of a tobacco-pipe, a bad fitting tooth plate, etc., will in some persons excite ulceration which may take on a cancerous action. The writer saw one case of epithelioma of the hard palate in an old man, produced by the irritation of the stem of a clay pipe, which continually rested at that point owing to the toothless condition of the gums. There is no doubt, however, that cancer of the tongue may originate without any pre-existing ills-

case or irritation, but in the majority of cases some form of irritation is the exciting cause of the disease. Many practitioners who are consulted by elderly people for ulcers of the tongue are in the habit of cauterizing the sore freely with nitrate of silver or other caustic; this is a most pernicious custom, and one which, while it does no good, may do infinite harm; for, should the ulcer be cancerous, it only aggravates it, and it may excite cancer in an ulcer which is of a simple, non-malignant character, by the continued irritation. Again, it does harm in cancerous ulcers by putting off operative measures until a period when operation can be of but little use, by soothing the patient with the idea that something is being done for him. Ulceration of the tongue in people over forty years of age should always be regarded with suspicion, and if there be any doubt as to its nature, the ulcer and a portion of healthy tissue around it should be excised. When the cancerous ulcer is well developed, or the infiltration at its base is marked, the diagnosis is not so difficult, but if there be any doubt a portion should be excised, and the microscope will usually establish the character of the disease.

Pain is an early and characteristic symptom, not always in the tongue, but in the lower jaw, gums, ear, and sometimes the back of the head. Salivation is also often an early symptom. When the ulcer commences on the border of the tongue it rapidly infiltrates not only the tongue, but the floor of the mouth and the gums, and finally the bone of the jaw itself is affected. The tongue becomes fixed and its motion is so limited that it cannot be protruded. Should the disease begin further back, the ulceration or infiltration extends to the pillars of the fauces, soft palate, and tonsils. These cases have proved fatal from hemorrhage caused by ulceration into the lateral carotid or tonsilar arteries. When the disease has advanced thus far the glands in the neighborhood become enlarged. First, there is tenderness in the submaxillary region, with pain which shoots up to the ear; later, the glands may be felt small and hard but movable; as they increase in size they become fixed. In some cases, in the early stages of the disease, the glands may be affected, yet the fact may not be recognized by external manipulation. The first glands to become affected are the submental in the floor of the mouth, then the submaxillary, afterward the carotid at the bifurcation of the arteries, and finally the parotid. Of course the glands are involved on the same side as the cancerous disease. When the tip of the tongue is the part involved the submaxillary glands and suprahyoid glands are first affected. There are several lymphatic glands embedded in the submaxillary salivary gland. If the root of the tongue be ulcerated, then usually the parotid lymphatic glands near the angle of the lower jaw and the carotid glands are first affected, making the case a much more serious one. The lymphatic channels between the disease and the glands are usually free, a condition, according to Heidenhain, common to epithelioma. As the disease progresses deglutition and speech become difficult, there are profuse salivation and a horrible fetor of the breath. Patients may die from hemorrhage due to the growth ulcerating into some large vessel, or there may be frequent hemorrhages from smaller vessels which may hasten the end. The usual mode of death, however, is from exhaustion due to pain, sleeplessness, starvation, slaughing, etc. The average duration of the disease in patients who have had no operation is from a year to eighteen months. Many cases seen only in less than a year, and few live longer than two years.

Diagnosis.—In the advanced stages of cancerous disease of the tongue the diagnosis is not difficult; the foul, deeply excavated ulcer with everted ragged edges and widely infiltrated base, with large granulations protruding from it, the pain, the fixation of the organ, and the induration of the submaxillary glands, stamp the affection unmistakably as carcinoma. At this stage operation is not very hopeful.

The diseases with which carcinoma of the tongue are most likely to be confounded are: (1) Syphilitic ulceration, primary and tertiary; (2) tuberculous ulcer; and (3) simple ulcer. The differential points of diagnosis between these diseases and cancer have sufficiently dwelt on above. The writer would strongly urge that when the diagnosis is doubtful, the disease should be treated as cancer and removed; for, should the surgeon wait until all doubt is dispelled by the involvement of the glands and the infiltration of the surrounding tissues, then he has committed a grave fault, and one which cannot be repaired. Butlin[24] truly says: "Medical men are coming to the belief that, to 'give the patient a chance,' means usually to give the carcinoma a chance of obtaining a firm and irresistible hold, and to take all chance of complete recovery from the patient." It is much better to remove a suspicious wart or ulcer by a simple and safe operation, and thus save the patient from the ravages of a fatal disease, than to wait until the disease is pronounced, when to operate means not only great danger to the patient, but the certainty of a rapid recurrence of the disease.

Prognosis.—Cancer of the tongue, like cancer of other parts, if not operated on, proceeds invariably to a fatal termination. It is of the utmost importance that the disease should be recognized in its early stages, when it is a purely local affection. At this period, if operation by removal of the tongue be undertaken, the chances of the patient remaining free from the disease are greater, and should the disease recur the interval of freedom is much increased.

Treatment.—There is but one method of treatment of cancer of the tongue, viz., removal by surgical operation. Operation always relieves, if it does not cure. In Hatilla's table of 80 cases already referred to, 70 were operated on, and 9 patients were in good health a year after the operation. Heath reports a case well eleven years after operation. Dr. Fenwick, of Montreal, reports a case in which the patient lived fifteen years after operation. Bryant,[25] of London, mentions a case well ten years after operation, and one in which the disease recurred fifteen years after operation. Barker[26] found 17 recoveries in 170 cases. According to Billroth's[20] statistics, 14 per cent. of cases are cured after operation. Even such a small percentage of cures is very creditable to surgery, and would in itself more than justify removal; but, putting aside the cures, the patient's life is prolonged and suffering is diminished by operation.

With regard to other methods of treatment by caustics, pastes, etc., they are not only useless but hurtful. It cannot be too strongly insisted on that the treatment of cancerous ulcers by caustics is bad treatment, and that the only chance the patient has of a cure is in the early removal of the disease by surgical operation. In cases of ulcers, warts, etc., on the tongue of a person over forty years of age, in which the diagnosis is doubtful, if any treatment is desired previous to removal, it should be of a soothing, non-irritating character; all irritating substances, as tobacco, spirits, highly spiced foods, etc., should be avoided. If the sore is produced by a sharp tooth this should be extracted. Caustics should be shunned, as nothing is more likely to convert a simple into a cancerous ulcer than continued irritation by caustics.

Operations for Partial and Complete Removal of the Tongue.—Small warts, whether they are on the border, tip, or dorsum of the tongue, are most easily removed with curved scissors; no anæsthetic is required. Should the growth be of larger size and far back, it is better to anæsthetize the patient and place a gag in the mouth; then the tongue may be drawn out by a strong ligature passed through the tip, or by means of a vulsellum. The growth should be removed with a knife and the bleeding points secured with ligatures or arrested by the thermo-cautery. Some surgeons advise the use of the galvano-caustic loop, as by this method all fear of hemorrhage is banished and the tissues for a short distance round the base of the growth are destroyed.

Removal of a Portion of the Tongue.—Should the cancer of the tongue be confined to the tip or a small part of

the border of the anterior half of the tongue, and should the submaxillary glands not be enlarged—in other words, if the ulcer be early recognized to be cancer,—the removal of a portion of the tongue is justifiable and gives a fair chance to the patient, without submitting him to the much more formidable operation of excision of the whole tongue. Partial removal of the tongue may be performed with galvano-écraseur, thermo-cautery, knife, or scissors. Czerny of late years has frequently used the thermo-cautery, and he thinks there are fewer recurrences after this method of treatment than when the knife is used. Roedliger (*Beiträge zur klin. Chirurgie*, vol. xxxi., 1901) also strongly recommends it, and says that after its use there was no fever, œdema, or secondary hæmorrhage. The knife is to be preferred when it is necessary to remove only a small part of the tongue. Should the ulcer be on the border of the tongue, then the tongue should be split in the median line and the affected half removed with knife, scissors, or écraseur. In all operations on the tongue of any magnitude the mouth should be kept open with a suitable gag, such as Coleman's, Whitehead's, Hutchinson's, etc., and the tongue drawn out by a stout ligature passed through its tip, and the disease removed by the method recommended by Mr. Baker.

Baker's Method.[31]—A gag having been introduced, the tongue is drawn out by means of two ligatures placed one on each side of the median line of the tongue near the tip. The tongue is then split down the middle and the diseased half is freed from the floor and side of the mouth with scissors. Needles are now passed through the tongue behind the disease, and the loop of the écraseur is placed as far back as possible, tightened, and the affected half removed. The loop of the écraseur should be of wire or whip-cord. The objection to the use of the galvano-cautery is the troublesome slough which follows.

Removal of the Whole Tongue.—In cases in which the cancerous ulcer involves the posterior half of the organ or is very extensive, it is necessary to remove the whole tongue. The complete removal of the tongue is the better operation, even when the ulcer is small, for the chance of recurrence is much less than when only part of the organ is taken away.

In removing the tongue one of the chief dangers is from hæmorrhage, and before proceeding further it might be as well to mention a very simple and efficacious method of arresting hæmorrhage, occurring either accidentally during operation or afterward. This method was introduced by Mr. Heath, of London, and has been adopted by most surgeons. It is this[32]: "The forefinger, passed well down to the epiglottis, is made to hook forward the hyoid bone and drag it up as far as practicable toward the symphysis menti. The effect of this is to stretch the lingual arteries so as to completely control for a time the flow of blood through them, and in this way portions of the anterior part of the tongue may be cut off almost bloodlessly." In operating on the tongue for cancerous disease, the question arises as to the kind of operation which should be performed. After even the most radical operation the disease is apt to recur; in fact, the more severe the operation, as a rule, the more rapid the return of the disease. Some surgeons hold that the operation is merely palliative, especially if the glands are enlarged in the submaxillary region and under the sterno-mastoid. In such cases, they advise simply a removal of the tongue and non-interference with the glands.[33] Others again, as Kocher, hold that the extirpation of the diseased glands cannot be too thorough, and they in every case make an incision in the neck to search for enlarged glands, which cannot be found by external manipulations. They argue that if the glands in the axilla are removed in all cases of excision of the breast for cancer, it is quite as important to remove the submaxillary lymphatic glands in operation for cancer of the tongue. It is a simple enough operation to remove a portion of the tongue with the écraseur; the recovery from the operation is rapid, but so is also the return of the disease. In cases between the ages of forty-five and sixty a radical operation, with extirpation of the glands, is the proper one, but in cancer in old people approaching seventy years of age the case is different, and a simple removal of the tongue will probably be as successful as a most complete and radical operation. When there is extensive involvement of the glands of the neck, the case is hopeless and operation should be undertaken for the relief of the patient only, as it is impossible to remove all the disease in such cases.

Operations for the removal of the tongue, or part of the tongue, are much facilitated by dividing the cheek horizontally from the angle of the mouth to the border of the masseter muscle; this incision gives much more room and the scar left is insignificant. Jaeger first advocated this method, and Gant and Furneaux Jordan practised it in Great Britain. This procedure does not add to the risk of the operation, and it gives the operator greater facility for arresting hæmorrhage.

Removal of the tongue through the mouth by the écraseur or scissors, without a submental incision, is only suitable in those cases in which the disease is limited to the anterior part of the tongue and when the glands are not involved; or it may also be practised in those cases in which the degree of gland infiltration is so great that extirpation is hopeless, and the tongue is removed purely for the purpose of relieving the patient from great suffering. In all other cases some form of submental operation should be practised, for then the enlarged glands can be easily reached and removed, and the chance of a permanent cure is much increased if the glands be extirpated. The points to be kept in view in operations on the tongue for malignant disease are: (1) The possibility of removing all the disease; (2) the prevention of hæmorrhage; (3) the avoidance of the entrance of blood into the air passages; and, after operation, (4) the preservation of an aseptic condition of the mouth and secretions until healing is complete. In order to accomplish this, some form of submental operation is necessary. Operations involving division of the jaw are more serious, are disagreeable to the patient, and delay convalescence.

The operations which have been practised for the removal of the whole tongue are very numerous. The most popular operation with English surgeons at the present day is that known as Whitehead's, viz., removal of the tongue by scissors; this may be done with or without preliminary ligature of the linguals. A few years ago nearly every surgeon employed the galvanic or wire écraseur, but the occurrence of secondary hemorrhage when the slough separates is so frequent that the écraseur is much less popular with surgeons than formerly, and has been supplanted by the scissors. With scissors the entire tongue can be removed easily and simply.

Whitehead's Method.[34]—"1. The mouth is opened to the full extent with Mason's or any other suitable gag, the duty of attending to this important part of the operation being entrusted to one of the two assistants required.

"2. The tongue is drawn out of the mouth by a double ligature passed through its substance an inch from the tip. This ligature is given in charge of the second assistant, with instructions to maintain through out the operation a steady traction outward and upward.

"3. The operator commences by dividing all the attachments in the tongue, to the jaw and to the pillars of the fauces, after the manner suggested by Sir James Paget, with an ordinary pair of straight scissors.

"4. The muscle attached to the base of the tongue are then cut across by a series of successive short snips of the scissors, until the entire tongue is separated on the plane of the inferior border of the lower jaw, and as far back as the safety of the epiglottis will permit.

"5. The lingual or any other arteries requiring torsion are twisted as divided. It is generally found that a moment's pressure with a piece of sponge held in sponge forceps, suffices temporarily, if not permanently, to arrest any bleeding; it is, however, regarded as desirable to twist, either immediately or after the tongue is removed, every bleeding vessel.

"6. A single loop of silk is passed by a long needle through the remains of the glosso-epiglottidean fold of mucous membrane, as a means of drawing forward the floor of the mouth, should secondary hemorrhage take place. This ligature may with safety be withdrawn the day after operation, and, as it is invariably a source of annoyance to the patient, it is always desirable to adopt this rule.

FIG. 4726.—Incisions for Operations on the Tongue. *a*, incision through the cheek, after Jaeger; *b*, von Langenbeck's incision, with division of the jaw; *c*, incision for removal of glands and ligature of lingual arteries as practised by the writer.

"The after-treatment consists in feeding for the first three days absolutely and solely by nutrient enemata, satisfying thirst by occasionally washing out the mouth with a weak iced solution of permanganate of potash; forbidding any attempt at speaking, and requiring that all the wishes of the patient shall be expressed in writing or by signs. The difficulties and dangers of the operation are few and more imaginary than real. Hemorrhage, the *bête noire* of most surgeons who contemplate removing the tongue, is in reality easily controllable and frequently trifling. I have twice removed the entire tongue without having to secure a single vessel, and more than once have only had to twist one lingual artery." The operation practised by the writer is that commonly known as Billroth's, viz., excision of the tongue by scissors with preliminary ligature of the linguals. This operation enables the surgeon not only to avoid danger from hemorrhage, but also to remove the neighboring glands and structures which are involved in the disease through the same incision made for ligating the lingual arteries. In Billroth's operation the mortality is not greater than that following other operations.

Billroth's Operation.[35]—The head of the patient having been well thrown back and the chin turned to the side opposite to that on which the artery is to be tied, a curved incision is made from near the symphysis menti to near the angle of the lower jaw, the convexity downward, having its lowest portion running along the upper border of the great cornu of the hyoid bone. A careful dissection is then made through the platysma and deep cervical fascia, and if any veins are cut they should be ligatured before proceeding further with the operation. The tendon of the digastric muscle should now be searched for, and in the angle which this tendon forms with the hyoid bone, the artery will be found—but not immediately, for covering it we have the hyoglossus muscle with the hypoglossal nerve and ranine vein running over it. The hyoglossus muscle should be carefully divided, and then, all bleeding having been arrested by Pean's forceps and ligatures, the artery is felt pulsating at the bottom of the wound. Hemorrhage should now be completely arrested and the artery being brought into view can be easily tied. The artery on the opposite side having been secured in the same way, any glands that may be involved should be looked for and removed through these incisions in the neck. As a rule, they can be found without difficulty. It is a good rule to remove all the submaxillary lymphatic glands as well as the submaxillary salivary gland on the same side as that in which the cancer is. It is well before clearing the submaxillary space to ligate the facial artery.

The mouth should now be kept open with a gag and the tongue drawn out by a double ligature passed through its substance about an inch from the tip. The operator, holding the ligature in his left hand, draws the tongue outward and upward and removes it with a straight pair of scissors. The attachments of the tongue to the jaw and pillars of the fauces should first be freed and then the muscles at the base, and now, the attachment to the hyoid bone being divided with a few short cuts, the whole tongue will come away, leaving the epiglottis behind. The removal of the tongue takes, as a rule, only two or three minutes. If the tissues of the floor of the mouth be involved, they should now be attended to.

The wounds in the neck, which during the excision of the tongue should be filled with carbolized sponges, are then sewed up and dressed with aseptic gauze dressings. If the floor of the mouth has been removed it will be better to pass a large drainage tube into the mouth through the neck incision; in fact, this ought to be done in every case. The mouth is now packed with sticky iodoform* gauze and the operation is complete.

The after-treatment is the same as after excision of the tongue by other methods.

The advantages of the operation above described are many:

1. The diseased structures, and especially the glands, are discovered and removed with the greatest ease through the neck incisions.

2. The removal of the tongue is bloodless, and there is no fear of secondary hemorrhage.

3. The incision made by the scissors is a clean-cut one, and there is no bruising of the tissues as in the operation with the écraseur.

4. The tongue can be more completely and more easily removed with scissors than with any écraseur.

5. Drainage of the mouth can be more thoroughly carried out by means of the incisions in the neck.

6. The operation is easy of performance and few instruments are required, no more than every surgeon possesses, viz.: straight scissors, knife, and a few pairs of Pean's forceps.

Kocher's Operation.[36]—A still more radical and extensive operation than the one described above is the operation performed by Kocher, of Berne. It is the only operation for the removal of the tongue which aims at preserving the parts in a thoroughly aseptic condition. Tracheotomy is first performed and a well-fitting cannula introduced; the pharynx is then packed with a carbolized sponge with a cord attached, so that it can be easily removed when necessary. An incision is now made commencing a little below the tip of the ear and extending down the anterior border of the sterno-mastoid muscle to

FIG. 4727.—Line in Neck showing Extent of Kocher's Incision for Removal of the Tongue.

*The sticky gauze is prepared with resin, alcohol, and iodoform. Wehr, of New York, recommends the following formula as an improvement on that introduced by Billroth: Resin, 10 parts; castor oil, 6 parts; iodoform, 5 parts, and alcohol, 15 parts. This is rubbed into the gauze, and certainly, as the alcohol evaporates, it is sticky enough. The writer has, in cases in which the gauze failed to remain in the mouth, painted the surface over with the liquid.

about its middle, then forward to the body of the hyoid bone, and along the anterior belly of the digastric muscle to the jaw. The resulting flap is turned upon the cheek and the lingual artery is ligatured as it passes under the hyoglossus muscle. The facial artery and any veins that may be in the way are also secured. Commencing from behind, all the structures in the submaxillary fossa are removed, viz., the lymphatic glands, the submaxillary, and, if necessary, the sublingual glands. The opposite lingual artery is now tied by a separate incision if the whole tongue is to be removed. The mucous membrane along the jaw and the mylo-hyoid muscle are then divided and the tongue is drawn out through the neck incision, and removed with scissors or galvano-cautery; the latter is preferred by Kocher, as there is less liability to after-oozing. The after-treatment is most important: if the operation be an extensive one, the external wound should not be closed. Kocher's endeavor is to avoid the two great after-dangers of excision of the tongue, pneumonia and general septicæmia. To prevent the discharge causing infection, the whole cavity of the mouth and pharynx is plugged with carbolized sponges and iodoform gauze. The operation as first described was performed under the spray. The patient is fed by the rectum partly, but chiefly by the throat with a tube, twice a day, when the dressings are changed. Thus, if all the minute directions are enforced, the wound remains aseptic throughout, and no food or discharge from the wound can possibly enter the air passages. There is one thing that Kocher has not guarded against, and that is vomiting; should the patient vomit, as is so often the case after the administration of anæsthetics, the elaborate preparations against sepsis may come to naught.

FIG. 4728.—Curved Line Below the Chin, showing the Extent and Situation of Billroth's Incision.

In Kocher's hands this operation has been most successful. He had one death in fourteen cases, eight recurred, one died a year afterward of pneumonia, one lived fourteen months, two five years, and one six and a half years.

With the modern methods of keeping the mouth aseptic, and performing all operations in the mouth with the patient in the Trendelenburg position, tracheotomy is rendered unnecessary. There is no doubt that it adds to the danger of the operation. The one death in Kocher's series of cases was caused by hemorrhage from the tracheotomy wound.

Billroth's modification of Regnoli's operation is very simple and much to be preferred to the original operation. The longitudinal incision is omitted and the curved incision is carried farther outward on each side, so that the linguals may be ligatured before removal of the tongue. It is a very suitable operation in those cases in which the submaxillary fossa is involved in the disease.

The tongue can be removed by scissors.

Removal of the Tongue after Division of the Lower Jaw.—This operation was introduced by Sédillot, of Strasburg, and afterward practised by Syme, of Edinburgh. It consists in making a vertical incision in the lower lip, sawing through the inferior maxilla at the symphysis, separating the two sides of the jaw, and drawing out the tongue and removing it by scissors, écraseur, or knife. The divided portions of the jaw are afterward wired together. It is a good plan to make the holes for the sutures before dividing the jaw.

Von Langenbeck [32] has advised a lateral section of the jaw opposite the first molar tooth. The skin incision is made from the angle of the mouth downward (see Fig. 4726). Division of the jaw adds to the danger of the operation, and makes it more unpleasant for the patient. Convalescence in these cases is usually prolonged. It is seldom necessary to divide the jaw in extirpating the tongue, even when the disease is most extensive, for the infiltrated glands in the floor of the mouth can be easily removed by one of the submental operations, with less danger and greater comfort to the patient. In some cases in which the disease has extended to the gums and bone itself, a portion of the jaw may require resection. It is often sufficient to remove the alveolar process only.

Occasionally, after removal of the tongue through the mouth, it is found that the glands in the submaxillary region subsequently become enlarged, although apparently healthy at the time of operation; then, if they appear movable and there is no recurrence of the disease in the mouth, a special operation for their removal is advisable. If, on the other hand, the glands are fixed and the tissues infiltrated, operation is of little avail. In cases of carcinoma in which the glands and the sterno-mastoid are first affected, operation is usually of little benefit.

Butlin [33] recommends that after removing part or the whole of the tongue, as the case demands, the surgeon should wait three or four weeks, and then by a separate operation remove the glands in the cervical, submental, and submaxillary regions. An incision is made along the anterior border of the sterno-mastoid muscle, from the mastoid to below the thyroid cartilage, and a second incision from the symphysis menti to the first incision about the level of the thyroid cartilage; the flap is lifted up from below and all the glands are removed, and then the flap is replaced and sutured.

The following list of operations, taken from Barker's article in "Holmes' System of Surgery," vol. ii., 1882, will prove of interest to the reader, and will serve to give him some knowledge of the history and progress of the operation of excision of the tongue.

Earliest Irregular Operations.

1. *Pimpernelle.* Died 1656, was probably the first to excise the tongue with success.
2. *Marchetti,* 1664. Extirpated a cancer of the tongue by actual cautery; probably the first recorded extirpation for this disease.
3. *Val. Hoffmann,* 1692. Removed a tongue affected with macroglossia.
4. *Ruysch,* 1737. Excised tongue with knife.
5. *Memoniata,* 1737. Cauterized with a hot iron.
6. *Heister,* 1743. Gave the first methodical description of operative treatment of cancer of the tongue.
7. *Burdorf,* 1754. Excised a true cancer of the tongue with knife.
8. *Guthrie,* 1756. Was probably the first English surgeon to excise a cancer of the tongue, using the knife, followed by cauterization of the cut surface.
9. *Louis,* 1756. Ligatured a fungus of the tongue, and in 1774 spoke in favor of total excision for cancer.

Definitely Designed Operations.

Ligature.

10. *Inglis,* 1803. Introduced ligature of the tongue from the mouth for cancer, the cords being drawn with needles through the tongue and round the tumor. (*Edin. Medical and Surgical Journal,* 1805, p. 34.)
11. *Major,* 1827. Split the tongue down the centre in apply ligature to the diseased half through the mouth.
12. *Choquet,* 1827. Also split the organ, but introduced the ligature by suprahyoid incision and strangled the diseased half. (*Archives Gén.,* xii., 511.)

Wedge-shaped Excision.

13. *C. J. Langenbeck,* 1810. Introduced wedge-shaped excision of the diseased part of the tongue with careful suture of resulting flaps. ("Biblioth. f. Clin. u. Augenh.," Bd. 2, 487.)

Preliminary Ligature of the Lingual.

14. *Mirault,* 1833. Introduced preliminary ligature of lingual artery to give a clear, bloodless field for extensive incisions. He was followed later by Roux and Roser. (*Archives Gén.,* vi., 5, 636.)

Ecrasement.

15. *Chassaignac,* 1854. Introduced the écraseur, employing Cloquet's suprahyoid method and defining it more exactly, i.e., ing puncture instead of incision. ("Traité de l'écraseur. 3m., p. 31.)

16. *Mühlhäuf*, 1884. Introduced the galvanic écraseur (*Schmidt's Jahrbücher*, Bd. 105 :230.)
17. *Nunneley*, 1856. Introduced the suprahyoid use of the écraseur into England. Adopting Chassaignac's modification. (*Med. Times and Gaz.*, 1862.)
18. *Giraudeau*, 1857. Employed circumpuncture with rods of caustic. (*Archives Gén.*, 1857.)

Division of the Cheek.

19. *Jaeger*, 1831. Was the first to divide the cheek for free access to the tongue. ("De Extir. Linguæ," 1831.)
20. *Maisonneuve*, 1858. Divided both cheeks from the angle of the mouth for same purpose.
21. *Collis*, 1867. Reintroduced Jaeger's operation, using the écraseur. (*Dub. Quart. Journ.*, xliii., 1867.)

Division of the Lower Jaw.

22. *Roux*. Died 1836. Was the first to divide the lower jaw and lip in mid-line in order to gain free access to the floor of the mouth and tongue. (Maisonneuve, Thèse, p. 149.)
23. *Sédillot*, 1844. Improved this method by dividing the bone by a serrated cut. (*Gaz. des Hôp.*, 1844, 85.)
24. *Syme*, 1857. Divided the jaw in mid-line and excised with knife. (*Lancet*, 1858, vols. I. and II.)
25. *Billroth*, 1862. Divided the jaw and soft parts at the side in two places, and turned down the flaps of skin and bone so formed, replacing and wiring the bone afterward. (*Archiv f. klin. Chir.*, 1862.)
26. *B. von Langenbeck*, 1875. Divided the jaw and soft parts opposite the first molar tooth on one side, in order to gain access to the side of the mouth for removal of tongue, glands, and part of palatal arch and tonsil.

Inframaxillary Operations.

27. *Regnoli*, 1838. Opened the floor of the mouth from below by an incision from middle of hyoid bone to chin, ending in another semilunar incision along the border of the jaw. The tongue was drawn through the opening and excised. (*Bull. Sci. méd. Bologne*, 1838.)
28. *Czerny*, 1870. Modified Regnoli's procedure, forming lateral flaps.
29. *Billroth*, 1871-76. Modified it still further, extending both ends of the curved incision much farther backward, and omitting the incision in mid-line. (*Archiv f. klin. Chir.*, Bd. 16, 101, 2.)
30. *Kocher*, 1880. Introduced a method of opening the mouth from behind and below the angle of the jaw to reach the base of the tongue and remove it with all the lymphatic glands situated there. (*Deutsche Zeitschrift f. Chir.*, Bd. xiii., 146, 1880.)

Results of the Operation.—The immediate results following excision of the tongue are fairly good, considering the severity of the operation. Whatever operation for excision of the tongue is practised, the mortality in a series of cases is about the same, so that the method of operating seems to have less effect on the result than the after-treatment. Still, certain operations are more favorable than others as regards the recurrence of the disease, and it is reasonable to suppose that when the disease is most completely removed it is least likely to return.

Whitehead in 139 operations had 20 deaths, or 14.3 per cent. Butlin[31] has collected 333 cases of excision of the tongue from the statistics of 4 operators, and finds that there were 42 deaths due to the operation. Of 202 uncomplicated cases only 14 died. In 109 cases in which there was either division of the lower jaw or excision below the jaw, the mortality was 25. About twenty per cent. of patients live three or more years after operation.

With regard to the *frequency of recurrence* it may be said that recurrence is the rule. Barker[32] has collected 170 cases in which the whole or part of the tongue was extirpated, and in only 17 cases was there non-recurrence after an interval of a year. According to the same author the duration of the disease, in cases not operated on, was 11.7 months, and in those operated on 19 months, a clear gain of 7.3 months. The longest period of freedom from the disease after operation seen by the writer was 28 months. It is to be hoped, with the modern methods of antisepsis which are now so universally practised, that the excision of the disease will be more complete, and hence the period of freedom from recurrence prolonged, and also the mortality after operations much decreased.

Dangers of Excision.—Formerly the danger most dreaded during and after operations on the tongue was hemorrhage, primary and secondary. Since the galvanic écraseur has been discarded, secondary hemorrhage is much less frequent, and both primary and secondary hemorrhage is avoided by preliminary ligature of the linguals. This procedure is a very simple one when the tongue is removed by one of the submental operations, as Billroth's, Kocher's, etc. Even should the linguals not be previously ligatured, there is usually little danger from hemorrhage, owing to the facility with which a bleeding vessel can be seized by the modern artery forceps.

The greatest danger connected with excision of the tongue is without doubt septic pneumonia, or other lung affection, produced by direct infection from the fetid discharges of the decomposing wound. In some cases there is gangrene of a portion of the lung, or numbers of small, foul, circumscribed abscesses; in others a condition of bronchopneumonia. Whatever affections of the lung ensue after excision of the tongue or severe operations on the mouth and jaws, they are all due, either to the inhalation of fetid gases from the sloughing wound in the mouth, or to discharges from the same source passing down the trachea to the bronchi and lungs. In other words, the lung affection is produced by direct infection from a foul wound. Barker[32] has collected 53 cases of death following operation; of these 30 were fatal from some pulmonary affection; 12 from septic affections, in 6 of which no mention is made of the condition of the lungs; and in the remaining 10, death was due to various causes, as shock, collapse, asphyxia, exhaustion, etc. The passage of blood into the trachea during operation is another cause of lung affection, and, to avoid this, anæsthesia should not be too profound. Usually symptoms of pneumonia and bronchopneumonia appear soon after the operation. The case may go on favorably for two or three days, then there is a troublesome collection of ropy mucus in the mouth and the wound becomes very fetid, cough is complained of, the temperature and pulse run up, respirations are very rapid, and the patient becomes cyanosed and dies in a few days with symptoms of pneumonia. The breath during all this period has been horribly fetid. The autopsy discloses acute congestion of the trachea and bronchi, and in the lungs are numerous small foul-smelling abscesses with, in places, patches of gangrene. Cases occur also in which the patient dies of simple pneumonia threatening to become gangrenous.

Treatment after Excision.—The most important point in the after-treatment is to preserve a condition of asepsis in the wound, for, as has been shown above, the greatest danger is due to direct septic infection from the wound itself. Again, the swallowing of blood at the time of operation, tainted with the foul discharges of the cancerous ulcer, should be carefully guarded against by having the mouth thoroughly and frequently washed out with some antiseptic solution, as Condy's fluid, carbolic acid, etc., before operation, and, during operation, avoiding a condition of too profound anæsthesia. After operation the wound in the mouth should be packed with sticky iodoform gauze as recommended by Billroth, painted over with alcoholic solution of iodoform and resin, or at least dusted with iodoform crystals. Billroth, as already mentioned, had seventeen cases of excision without a death or even a serious symptom, owing to the mouth being kept thoroughly aseptic by the packing with sticky iodoform gauze, which in a day or two becomes incorporated with the wound. The writer has found great difficulty in keeping the gauze in the mouth after the first day; he has found that it becomes loose and covered with mucus, and that the patient finds it very troublesome. He has used with good results the following paint, advocated by Weir, of New York, to impregnate gauze: Iodoform, 5 parts; resin, 10 parts; castor oil, 6 parts; and alcohol, 15 parts. When painted on, the alcohol evaporates and leaves the resin and iodoform behind coating the surface of the wounds. This should be painted on twice daily. The first three or four days after operation the patient should be fed entirely by the rectum, and occasionally allowed to rinse out his mouth with water to allay thirst. After this, feeding should be by the mouth through a tube introduced into the œsophagus. A very good arrangement is a soft catheter with a piece of rubber tubing attached to it, and to this again is attached a glass funnel; by pouring liquid food into the funnel the patient can be easily and

comfortably fed. Should any fœtor appear in the wound, the mouth should be frequently washed out with a solution of Condy's fluid, carbolic acid, or chlorate of potash. Washing out is much facilitated if there is a drainage tube through the incision in the submaxillary region.

Palliative Treatment of Cancer of the Tongue.—The object is to relieve pain and lessen fœtor and salivation. To relieve pain, division of the lingual nerve is advised, and also the administration of opium. Fœtor and salivation may be controlled by frequent washings with some antiseptic solution, as Condy's fluid or carbolic acid, and afterward the dusting on of iodoform or salicylic acid. Bleeding, which so frequently terminates the case, may be controlled by styptics, or by lint soaked in tincture of the muriate of iron and kept continually pressed against the bleeding points with forceps. Should the bleeding be distinctly arterial, then ligature of the lingual artery of that side is the only remedy.

Excision or Stretching of the Lingual Nerve.—Division of the lingual nerve was first put in practice by Hilton [41]; then Moore [42] advised a more simple procedure than Hilton's. This was to make an incision with a curved bistoury through the mucous membrane in a line from the last molar tooth to the angle of the jaw. The simplest method is as follows, and this method is suitable for division, excision, or stretching. The writer has practised it and found no difficulty in reaching the nerve. The mouth should be opened with a suitable gag, then a ligature is to be passed through the tongue near the tip, and the tongue drawn out to the side opposite to that on which it is desired to stretch the nerve; this puts the nerve on the stretch and it can be felt standing out as a cord at the side of the tongue; a sharp hook is passed under it, and then the nerve is exposed by a small incision, pulled out by a blunt hook, and excised or stretched as the necessities of the case may indicate. Mr. Clement Lucas [43] was the first, as far as the writer's knowledge goes, to put this plan in practice.

Francis J. Shepherd.

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TONICS.—Tonics are medicines that promote nutrition and thus increase the strength of the body when it is reduced. The term tonic is derived from the Greek word *tanos*, tension, and was applied to agents that restore the normal strength, because it was supposed that they specially increase the tone or tension of the contractile tissues, that is, restore the constant, active, but weak, involuntary contraction normally existing in all organs containing such tissues. They were held to act either directly upon the contractile tissues, or upon the nerves by which they are innervated. This view is no longer entertained, as it is evident that the tone or strength of all organs and tissues depends upon the state of their nutrition, any diminution of which becoming manifest in more or less weakness and loss of functional power.

For practical purposes all tonic medicines may be divided into three classes: *gastric tonics*, *blood tonics* or *hæmatinics*, and *general tonics*. Gastric tonics improve the digestive process when it is enfeebled, thus enriching the blood, and supplying all the organs and tissues with an abundance of nutritive material. Blood tonics, or hematinics, supply the blood with material in which it is deficient, especially increasing the number of red blood corpuscles. General tonics increase the nutrition and weight of the body by augmenting or otherwise modifying the process of assimilation in the tissues.

GASTRIC TONICS.—Some of the medicines that improve the process of digestion when it is weak or imperfect, act directly upon the organs of digestion, enabling them to perform their function more powerfully; others, however, have no direct influence upon the stomach and intestines, and act only upon the substances undergoing digestion, hastening this process. The latter are distinguished from the former by the term *digestives*.

Nearly all gastric tonics have an intensely bitter taste, and act similarly upon the digestive organs. Hence they are called *bitter tonics*. Since they closely resemble one another in action, it is unnecessary to consider them separately, with the exception of the principal alkaloids of cinchona and nux vomica, which are supposed to promote nutrition by acting also upon other organs.

BITTER TONICS.—All bitter tonics increase the secretion of saliva, and, soon after coming into contact with the gastric mucous membrane, produce a feeling of hunger. In consequence of the stronger appetite a larger quantity of food is eaten. In cases of atonic dyspepsia the digestion of the large meal is not attended by the feeling of heaviness and discomfort, and other symptoms which usually result from slow and imperfect digestion, showing that the bitter tonics cause some decided improvement in the digestive process. This improvement, however, follows only when the bitter tonics are given in moderate doses; excessive doses, especially if frequently repeated, soon causing symptoms of gastro-intestinal catarrh, nausea, vomiting, and diarrhœa.

In regard to the mode of action of bitter tonics the following facts have been ascertained:

1. They increase the salivary secretion. The saliva hastens the digestion of amylaceous food and stimulates the gastric glands, and thus excites an abundant secretion of gastric juice. It has been held that this sufficiently accounts for their utility in cases of atonic dyspepsia (Leube).

2. They gently irritate the gastric mucous membrane, and thus, it is supposed, excite the feeling of hunger. As the larger quantity of food consumed is digested more easily and speedily in cases of dyspepsia, it may be assumed that the secretion of gastric juice becomes augmented, either directly by the moderate irritation, or indirectly by the greater relish of the food. It is supposed that in many cases of dyspepsia due to slight catarrh of the stomach, the moderate irritation gradually restores the normal circulation of the gastric mucous membrane.

3. In experiments it has been found that bitter tonics retard fermentation and putrefaction. The small doses usually effectual in atonic dyspepsia may doubtless exert some antiseptic influence, but it is improbable that their utility is chiefly due to this action.

4. Cetrarin and calumbin, injected into the jugular vein of animals, cause a rise of the general blood pressure by exciting the vaso-motor centre (Koehler). Hence it has been supposed that possibly all bitter tonics may to some extent act like digitalis, which, in indigestion dependent upon enfeebled heart action, improves the

digestive process by causing the supply of arterial blood to the stomach to be increased. But no changes of the blood pressure have been observed after the administration of bitter tonics until a notable improvement of the general nutrition of the body has resulted. It seems probable, however, that the action of quinine and strychnine upon the digestive organs is in part due to an improvement of the general circulation.

The bitter tonics display their therapeutic power most markedly in atonic dyspepsia, that is, in cases of dyspepsia in which the slow and imperfect digestion results solely from weakness of the stomach. In such cases the appetite is feeble, and the tongue clean or only thinly coated, and generally pale and flabby. Unless only very digestible food be eaten, in moderate quantities, the meals are soon followed by a feeling of weight in the epigastrium, and often by fulness and eructations which sometimes have a rancid taste. But decided pain in the region of the stomach, and thirst, fever, and vomiting are absent.

The bitter tonics are also employed in dyspepsia due to chronic catarrh of the stomach; generally small doses, in slight or mild cases, soon cause a notable abatement of the symptoms; but they generally aggravate severe catarrh, and are decidedly injurious in ulcerative affections of the stomach. They should therefore not be used when there are present severe pain and tenderness of the epigastrium, a heavily coated tongue, and vomiting of blood or large quantities of mucus.

As the bitter tonics improve general nutrition and strength solely by their action upon the digestive organs, they are useless in all forms of general or local debility which are not attended by enfeebled or disordered digestion.

As a rule, the bitter tonics should be given a short time before meals, so that a keen appetite may set in as soon as food is taken. Of the official preparations, the tinctures are the most useful in atonic dyspepsia; generally the compound tincture of gentian, the compound tincture of cinchona, the tincture of quassia, and the tincture of calumba are sufficiently active in doses of one-half to one drachm. The tinctura of nux vomica is effective in doses of five to ten drops, and even smaller quantities sometimes in slight catarrh of the stomach.

If no other morbid state is present requiring active remedies, the bitter tinctures may be prescribed undiluted, the patient being told to take each dose in a small quantity of water or sweetened water. Sometimes they are ordered with a small quantity of syrup or with an aromatic water to modify their taste. The following formulæ illustrate the usual modes of prescribing in atonic dyspepsia: ℞ Tinct. cinchon. comp., ʒ iss.; syrupi, ʒ ss. M. Sig.: A teaspoonful in water before meals. ℞ Tinct. gentian. comp., ʒ iss.; syrup. aurantii, ʒ ss. M. Sig.: A teaspoonful in water before meals. ℞ Tinct. quassiæ, ʒ iss.; syrup. zingiberis, ʒ ss. M. Sig.: A teaspoonful before each meal. ℞ Tr. nucis vom., ʒ i.; aq. menth. pip., aq. destill., āā ʒ i. M. Sig.: A teaspoonful before each meal.

Quinine.—In dyspepsia due to weakness of the stomach the salts of quinine seem to act in the same manner as other bitter tonics. But they are more efficient than the latter when dyspepsia is associated with malarial affections, or is consequent upon pulmonary and cardiac diseases. Probably this is due to the fact that, given in moderate tonic doses, they somewhat increase the general blood pressure.

The opinion is prevalent that quinine may sustain the strength of the body under circumstances contraindicating bitter gastric tonics, such as prolonged fevers with a high temperature. Very commonly doses of two or three grains are given three or four times daily, or even more frequently, in typhoid fever, pneumonia, pleuritis, and other similar diseases. Whether this use of quinine is ever beneficial is very doubtful, and there is reason to suppose that in typhoid fever, especially if the quinine be not given in acid solution, it may increase the tendency to hemorrhage and perforation.

As gastric tonics the salts of quinine should be given in small doses, one-half to one grain, or at most two grains, preferably in solution. ℞ Quin. sulph., gr. xvi.; acid. hydrochl. dil., q.s.; tinct. cinchon. comp., syrup. aurantii, āā ʒ i. M. Sig.: A teaspoonful before each meal. ℞ Quininæ hydrochl., gr. xvi.; glycerini, ʒ ss.; aq. menth. pip., ʒ iss. M. Sig.: A teaspoonful before meals.

Strychnine.—The salts of strychnine are frequently employed as gastric tonics, and are very efficient. They are preferred to all other bitter medicines when feeble digestion is associated with diseases of the respiratory organs impairing the breathing process, such as phthisis, chronic bronchitis, and emphysema. Doses of one-thirtieth grain often notably ameliorate both dyspnœa and dyspepsia. In those diseases of the heart which are productive of disorder of the general circulation, and of slow and feeble digestion, strychnine also should be preferred to those bitter tonics which act solely on the digestive organs. In cases of dyspepsia complicated with habitual constipation, small doses of strychnine sometimes restore normal intestinal peristalsis. As a gastric tonic it should be given in solution or in powder. ℞ Strychn. sulph., gr. ss.; acid. hydrochl. dil., ʒ ss.; tinct. gentian. comp., syr. aurantii, āā ʒ i. M. Sig.: A teaspoonful before meals. ℞ Strychn. sulph., gr. ss.; sacch. lactis, ʒ i. M. Div. in partes æquales xvi. Sig.: One powder before each meal.

Alcohol.—As a tonic no substance is more beneficial when properly used, or more detrimental when abused, than alcohol. Taken in small quantities well diluted, as contained in some alcoholic beverages, especially light wines and malt liquors, it is doubtless the most pleasant and active remedy in cases of atonic dyspepsia. It was observed from time immemorial that wine, taken very moderately with meals, enables a weak stomach to digest food more easily and speedily, and increases the general vigor of the body. Hence the advice of St. Paul to Timothy: "Drink no longer water, but use a little wine for thy stomach's sake, and often infirmities."

In experiments it has been found that alcohol, applied in small quantity to the gastric mucous membrane, causes a more copious secretion of gastric juice than any other substance. Doubtless it is this action, a decided increase of the secretion of gastric juice when wine is taken with full meals, which augments the appetite and enables the stomach easily to dispose of the larger quantity of food. Taken in excessive quantity alcohol retards digestion and causes gastric catarrh. This effect always results if large quantities are rapidly imbibed so as to produce decided intoxication. It is frequently observed also in individuals who habitually drink to excess, especially in those who take ardent spirits before meals. Some persons, however, who indulge excessively in beer or light wine, do not exhibit any symptoms of gastric disorder.

In cases of atonic dyspepsia only light wine or malt liquor should be recommended for prolonged use, as the danger of excessive indulgence and hence injury to the stomach is much greater from ardent spirits. If it becomes necessary to use whiskey or other strong alcoholic, the patient should be warned against taking it undiluted before meals.

Alcohol is superior to other gastric tonics not only because it is more agreeable, but because it exerts a more favorable influence on general nutrition. It is now well established that alcohol is nearly completely consumed in the body, and that in undergoing oxidation it yields heat and other force, and thus behaves in the same manner as other non-nitrogenous food. Robust persons with strong digestive organs, who easily dispose of sufficient food to maintain perfect nutrition, do not require alcohol as a nutrient; but those who naturally have a weak stomach and "often infirmities," are decidedly benefited by moderate quantities.

Alcohol displays its greatest utility in diseases so profoundly disordering the digestive organs that little or no ordinary food can be digested. In typhoid fever it is often the means of saving life. As it requires no diges-