SURFACE AND RADIOGRAPHIC ANATOMY— LEARMONTH and McWH

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SURFACE, SURGICAL AND RADIOGRAPHIC ANATOMY

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FOREWORD

It is hoped that many students of anatomy will welcome the reappearance of separate bound sections of Cunningham's Text-Book of Anatomy which were last issued in this form fifty years ago. Unlike their predecessors, the volumes now issued are each complete in themselves and may be used independently of the rest of the text as the sections have been arranged so that each of the principal anatomical systems is complete within a single volume. The full index to the Text-Book has been included in each volume as an aid to cross reference from one volume to another since it is felt that many students will use two or more of these separate volumes. As a further aid to quick reference, a Table facing the first page of the index gives the pagination of each section of the book; those sections now issued as separate volumes are distinguished not only by the volume number alongside each entry, but also by the use of roman type; italic is used for those sections not yet available except in the complete Text-Book.

The sections now issued are those most frequently used in a number of medical schools where the complete Text-Book has not been adopted, and it is hoped that not only will the smaller volumes be found more convenient to handle, but that where only one or two sections are required, the considerable saving in the purchase price will be appreciated. The text is that of the ninth edition of the complete work and it will be seen that the page numbers remain the same. Pages 1 to 16, which form an introductory chapter to the complete Text-Book, have been omitted from Volume I, Human Embryology, in which the text commences on page 17. The sections now available as separate volumes are as follows:

Volume I HUMAN EMBRYOLOGY.

Volume II THE LOCOMOTOR SYSTEM.
Containing (i) Osteology. (ii) Arthrology. (iii) Myology.

Volume V THE NERVOUS SYSTEM.
Containing (i) Central Nervous System. (ii) Peripheral Nervous System. (iii) Autonomic Nervous System.

Volume VI SURFACE AND SURGICAL ANATOMY.
With an appendix on Radiographic Anatomy.

Two further volumes containing the remaining sections may be issued later if it is felt that there is a sufficient demand for them.

The complete Text-Book will remain available as a single volume and the present volumes are intended principally for those who do not require the whole text.

CONTENTS

SURFACE AND SURGICAL ANATOMY

BY

SIR JAMES LEARMONTH

RADIOGRAPHIC ANATOMY

BY

R. McWHIRTER

SURFACE AND SURGICAL ANATOMY

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With an Appendix on RADIOGRAPHIC ANATOMY

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Surface Anatomy and Surgical Anatomy are associated studies which occupy an important and significant place in the medical curriculum, as they are an expression of the application of anatomical knowledge to the everyday practice of Medicine and Surgery. Their inclusion in a text-book of Anatomy is therefore fully justified; and it may serve to remind students of the importance of that study of the living body which has been mentioned in the General Intorduction as their chief aim (p. 2).

Surface Anatomy fulfils a twin-purpose; it is a description of the topography of the body-surface as influenced by the conformation of superficial structures (including skeletal landmarks), combined with a surface-orientation of related structures that lie at a deeper level. It is therefore the essential basis for the primary physical examination of a patient and for the appreciation of the significance of the symptoms and signs of disease in general.

Surgical Anatomy is directed towards a more special purpose. It is a presentation of the anatomical facts which have a local significance in relation to injury and particular diseases or to the surgical interference which these may entail.

The use of X-rays is of the greatest value in the study of both these practical aspects of Anatomy. Frequent reference is therefore made to radiographic observations and to the Plates which illustrate them—supplementing the relevant paragraphs throughout the text-book; and, since the interpretation of radiographs requires some elementary acquaintance with the methods employed in their production and some knowledge of the meaning of the appearances which they present, an Appendix has been added on the Principles of Radiography and of Radiographic Anatomy.

The Section itself is arranged on a regional basis.

HEAD AND NECK

CRANIUM

Scalp.—The first and third layers of the scalp, namely, the **skin** and the **occipito-frontalis muscle**, are firmly united by fibrous processes which pass from the one to the other through the second or subcutaneous **fatty layer**. These three layers are separated from the pericranium by a **layer of loose areolar tissue** which supports the small vessels passing between the scalp proper and pericranium. The **pericranium**, although regarded anatomically as periosteum, possesses limited bone-forming properties; over the vertex it can be readily separated from the skull-cap

except along the lines of the sutures, where it is united by sutural ligaments to the external layer of the dura mater.

The free **blood-supply of the scalp** nourishes its abundant hair-follicles and glands. The main vessels lie in the dense subcutaneous tissue, and are therefore superficial to the occipito-frontalis muscle (Fig. 1183). The arteries that supply the frontal region are derived from the internal carotid, and those for the remainder of the scalp spring from the external carotid. The two groups of vessels anastomose with one another, and also with those of the opposite side—hence it is impossible to control bleeding from one side of the scalp by ligature of the corresponding external carotid artery.

Wounds of the scalp bleed freely, and the vessels are difficult to ligature on account of the fixation of their walls to the dense subcutaneous tissue. In extensive flap-wounds and in

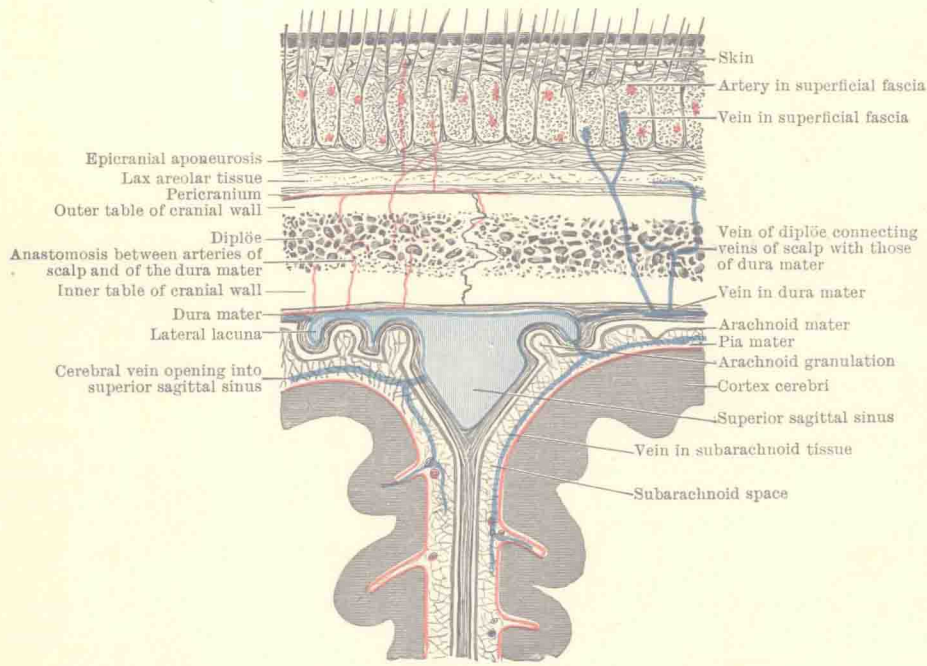

FIG. 1183.—DIAGRAMMATIC REPRESENTATION OF CORONAL SECTION THROUGH SCALP, CRANIUM, MENINGES, AND CEREBRAL CORTEX.

diffuse suppuration deep to the occipito-frontalis muscle there is little danger of sloughing of the scalp. **Abscesses** and **hæmorrhages** superficial to the occipito-frontalis muscle are usually limited on account of the density of the subcutaneous tissue. Hæmorrhage deep to the occipito-frontalis muscle is seldom extensive on account of the small size of the vessels, but suppuration in that situation may rapidly undermine the whole muscle and its aponeurosis —the epicranial aponeurosis. The area under cover of the occipito-frontalis is sometimes termed "the dangerous area", and in cases of extensive infection the swelling may extend from the superior nuchal lines to the superciliary arches, and from one zygomatic arch to the other. Incisions to evacuate the pus are made early, parallel to the main vessels of the scalp (Fig. 1076) and at a level which will ensure dependent drainage. Extravasation of blood deep to the pericranium leads to a hæmatoma which is limited by the sutures (cephalhæmatoma).

The **veins** of the scalp communicate with the intracranial venous sinuses: (1) directly through their anastomoses with the large emissary veins—the parietal, which open into the superior sagittal sinus, and the mastoid and condylar, which open into the sigmoid sinus; (2) through the anastomoses of the supra-trochlear and supra-orbital veins with the ophthalmic vein, which opens into the cavernous sinus; (3) through the veins of the diplöe, which connect the veins of the scalp and the pericranium with those of the dura mater and the venous sinuses; (4) through small veins which pass from the pericranium through the bones and the sutural ligaments to the dura mater. It is along these various channels that pyogenic infection may extend from the scalp and pericranium, through the bone, to

the dura mater and venous sinuses, and from the sinuses to the cerebral veins, the pia-arachnoid, and the substance of the brain. More rarely infection spreads from the skull or from the cranial cavity along the emissary veins to the scalp.

The **lymph-vessels** of the anterior part of the scalp join the facial lymph-vessels; those of the temporal and parietal regions end in the parotid lymph-glands, situated in front of and below the ear, and in the mastoid glands on the insertion of the sterno-mastoid muscle. The lymph-vessels of the occipital region end in the occipital glands, which lie close to the occipital artery and the greater occipital nerve after they have pierced the origin of the trapezius (Figs. 1177, 1178).

Bony Landmarks of Cranium (Fig. 1184).—At the root of the nose there is the fronto-nasal suture, the mid-point of which is the **nasion**; and immediately above is the **glabella**—a slight prominence which connects the superciliary arches. About 2·5 cm. below the posterior pole of the cranium, and 5 cm. above the spine of the axis vertebra, is the external occipital protuberance (the centre of which is the **inion**). In the child this protuberance is not developed; but its position is identified as a point at the junction of the upper and middle thirds of a line drawn from the posterior pole of the skull to the spine of the axis vertebra.

About a third of the distance from the nasion to the inion is the **bregma** or junction of the coronal and sagittal sutures; with the head in the natural erect posture the bregma is at, or close to, the middle of a line carried across the vertex from one tragus to the other. At birth the position of the bregma is occupied by the **anterior fontanelle**—a rhomboidal membranous area which is usually completely ossified towards the end of the second year. The size and date of closure of the fontanelle, as well as its tension and pulsation, are points to be carefully noted in the clinical examination of children (Fig. 174, p. 208, and Pl. V, p. 150).

The **lambda**, or junction of the sagittal and lambdoid sutures, situated 6·5 cm. above the inion, can generally be felt through the scalp as a slight depression; a line drawn from it to the **asterion**—the articulation of the postero-inferior angle of the parietal bone with the temporal and occipital bones—corresponds to the **lambdoid suture**.

The **parietal eminence**, which varies considerably in the definiteness with which it can be recognized, overlies the **termination of the posterior ramus** of the **lateral sulcus** of the cerebrum. The **frontal eminence** (better marked in the child) overlies the **middle frontal gyrus**.

Crossing the supra-orbital margin, a finger's breadth from the median line, are the **supratrochlear nerve** and **vessels**; the artery nourishes the flap in the operation of rhinoplasty. On the supra-orbital margin, two finger-breadths from the median line, is the **supra-orbital notch** or **foramen**—the guide to the **supra-orbital nerve** and **vessels**. A little above the level of the lateral angle of the eye is the **fronto-zygomatic suture**, immediately above which is the **zygomatic process** of the frontal bone. At the posterior end of the suture, the **zygomatico-temporal nerve** pierces the temporal fascia to reach the skin; and 1·3 cm. above the suture is the **lower margin** of the **cerebral hemisphere**. The **temporal line** marks the upper limit of the temporal muscle. It begins at the zygomatic process of the frontal bone, arches upwards between the temple and the forehead; then, curving backwards, it skirts the lower part of the parietal eminence, and, finally, turning downwards, it joins the supramastoid crest near the top of the root of the auricle; the anterior part of the line is the only part easily felt. The **supramastoid crest** curves upwards and backwards from the external auditory meatus for 2·5 cm., but it is obscured by the auricle.

The **zygomatic arch**, an important landmark, is horizontal when the head is in the natural position, and it is at the same level as the inferior margin of the orbit and the inion; its upper border is at, or not infrequently a little above, the level of the infero-lateral margin of the cerebral hemisphere. The upper border of the zygoma may be traced backwards immediately above the tragus and the external auditory meatus to become continuous with the supramastoid crest. The **superficial temporal vessels** and the **auriculo-temporal nerve** cross the zygoma immediately in front of the tragus. The termination of the auriculo-temporal nerve in the neighbourhood of the parietal eminence is often the seat of a neuralgic pain in irritative

conditions at the external auditory meatus—the meatus being in part supplied by that nerve.

Five centimetres vertically above the middle of the zygomatic arch is the **pterion.** This is a point which cannot be felt, but is nevertheless of topographical importance, as it overlies the point where the lateral sulcus of the cerebrum breaks up into its three rami and the point where the **anterior branch** of the **middle meningeal artery** is most deeply embedded in the bone.

Fractures of Skull.—The thickness of the skull-cap varies at different parts and in different subjects. The inner table is only half the thickness of the outer table, but both possess the same degree of elasticity. When the vault is fractured from direct violence, the inner table is more extensively fissured than the outer table, the reason being that the force having passed through the outer table shows a wider distribution in respect of the inner table. The weak areas at the base of the skull through which fractures are liable to extend are:—(1) In the anterior cranial fossa—the orbital plates of the frontal bone, and the cribriform plate of the ethmoid. (2) In the middle cranial fossa—the region of the articular fossa and of the foramen ovale. (3) In the posterior fossa—the fossæ of the occipital bone. The petrous part of the temporal bone, though strong, is weakened by the tympanic cavity and by the jugular fossa.

Cranio-Cerebral Topography.—While there are methods by which cranio-cerebral topography is indicated in considerable detail, it is better to employ a scheme by which the primary sulci of the brain may be outlined on the skull. It should be pointed out that the position of the cerebral landmarks may vary within normal limits, and that when pathological cerebral conditions are present they are usually displaced. The lines which are used to indicate their position are only approximate, though they are sufficiently reliable for clinical and operative purposes. The following scheme is recommended (Figs. 1185, 1186). A **base-line** is drawn from the lower margin of the orbit backwards through the upper border of the external auditory meatus to the occipital region; the cerebrum lies entirely above the level of this line, while the greater part of the cerebellum occupies a position below the level of the posterior third of the line.

Primary Sulci.—The position of the **central sulcus** is now outlined by a line which begins 1·3 cm. behind the mid-point of a sagittal line passing from the nasion to the inion and extends downwards and forwards to the mid-point of the posterior ramus of the lateral sulcus.

The stem of the **lateral sulcus** reaches the lateral surface of the cerebrum opposite the *pterion*. It divides there into three rami; the **anterior two rami** are short, and pass forwards and upwards, diverging from each other; the **posterior ramus** is the most important part of the sulcus. It is indicated by a line that begins at the pterion, is drawn backwards and slightly upwards to a point below the parietal eminence, and is curved sharply upwards to end at that eminence.

The upper end of the **parieto-occipital sulcus** is 1·3 cm. or less above the lambda in the adult, and a line drawn laterally from this point for a distance of 2·5 cm. indicates the position of the part of the sulcus which appears on the supero-lateral surface of the cerebral hemisphere.

Lobes.—By means of the lines for these sulci, the position of the lobes can be gauged roughly. The **frontal lobe** is the part in front of the central sulcus; the **temporal lobe** is below the posterior ramus of the lateral sulcus and extends from the margin of the orbit to the lower half of a line from the parieto-occipital sulcus to the back of the root of the auricle. The **occipital lobe** is behind that line; the **parietal lobe** is between the central sulcus and the upper half of that line (Fig. 1186).

Gyri and Secondary Sulci.—Each lobe is divided into gyri by secondary sulci. In the frontal lobe the **pre-central sulcus** runs parallel to the central sulcus 1·5 cm. in front of it, cutting off the **pre-central gyrus.** The remainder of the frontal lobe is divided into the *superior, middle,* and *inferior frontal gyri* by two sulci—*superior* and *inferior frontal.* The lower part of the inferior frontal gyrus is divided into three portions by the anterior rami of the lateral sulcus. These three portions, together with the lower part of the pre-central gyrus, comprise the **motor speech-centre,** which is developed on the left side of the brain in right-handed people.

In the parietal lobe the **post-central sulcus** is 1·5 cm. behind and parallel to the

central sulcus, and delimits the **post-central gyrus**. The *intra-parietal sulcus* runs backwards from the post-central sulcus, and divides the rest of the lobe into two parts named the *superior* and *inferior parietal lobules*. The inferior lobule is divided into three parts that surround the upturned ends of the lateral sulcus and the temporal sulci. These parts contain centres for the interpretation of printed and written words ; and it should be noted that the anterior part underlies the parietal eminence of the skull.

The **motor area** for individual movements occupies the anterior wall of the

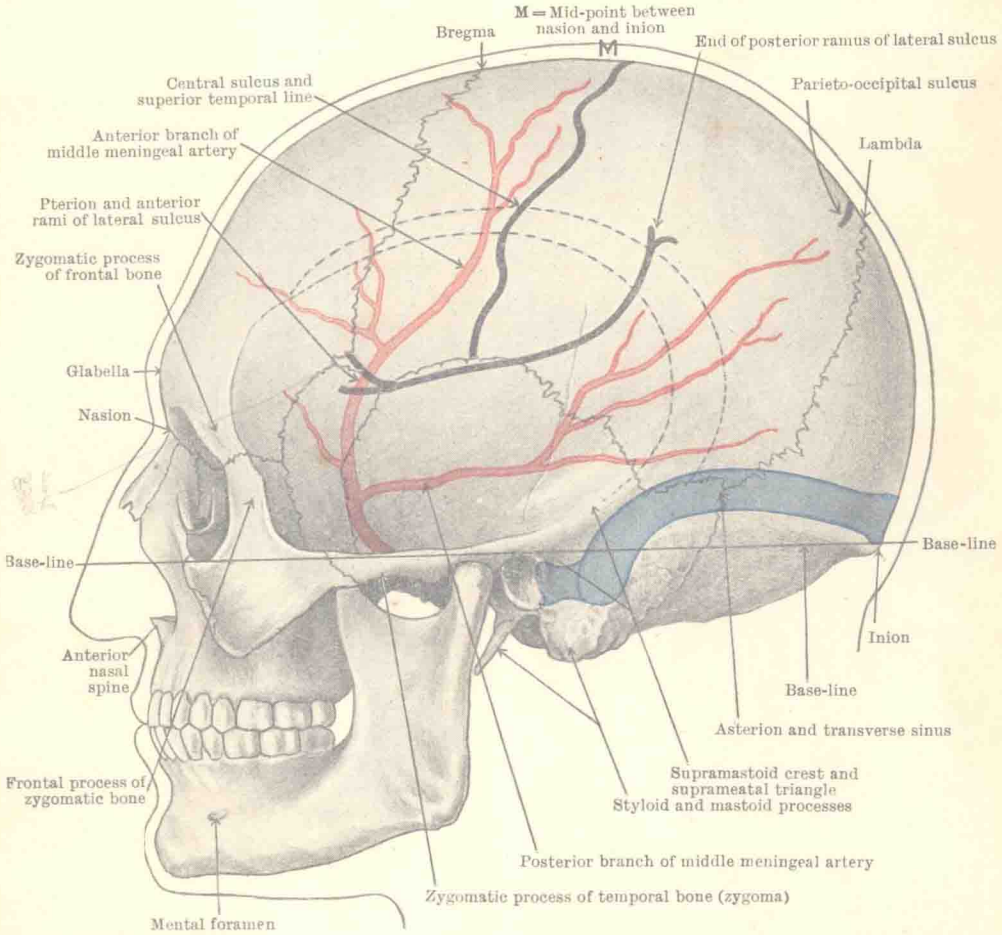

FIG. 1184.—CRANIO-CEREBRAL TOPOGRAPHY I : Landmarks of Skull ; Chief Sulci of Cerebrum ; Transverse and Sigmoid Venous Sinuses ; Middle Meningeal Artery.

central sulcus and the adjoining free surface of the pre-central gyrus; it also extends into the paracentral lobule on the medial surface. The body is inverted in this area, and the relative position of the parts as represented in the cortex is shown in Fig. 1186. The **sensory area**—that is the centre for the reception of common sensation—is in the posterior wall of the central sulcus and the adjoining free surface of the post-central gyrus ; in it also the body is inverted.

The lateral surface of the temporal lobe is divided into *superior, middle,* and *inferior temporal gyri* by the *superior* and *inferior temporal sulci,* which are parallel to the posterior ramus of the lateral sulcus. The **auditory area**—that is, the centre for the mere reception of sound—is in the middle of the superior tmeporal gyrus.

The arrangement of sulci and gyri in the lateral surface of the occipital lobe is very inconstant. The **visual area**—the centre for the reception of impressions

of light—is on the medial surface of the lobe in relation to the calcarine and post-calcarine sulci, but in some hemispheres the post-calcarine sulcus extends on to the supero-lateral surface, carrying a portion of the centre for sight with it. This portion is immediately above the external occipital protuberance.

Lateral Ventricle.—The central part of the lateral ventricle occupies a level between the posterior ramus of the lateral sulcus and the middle part of the

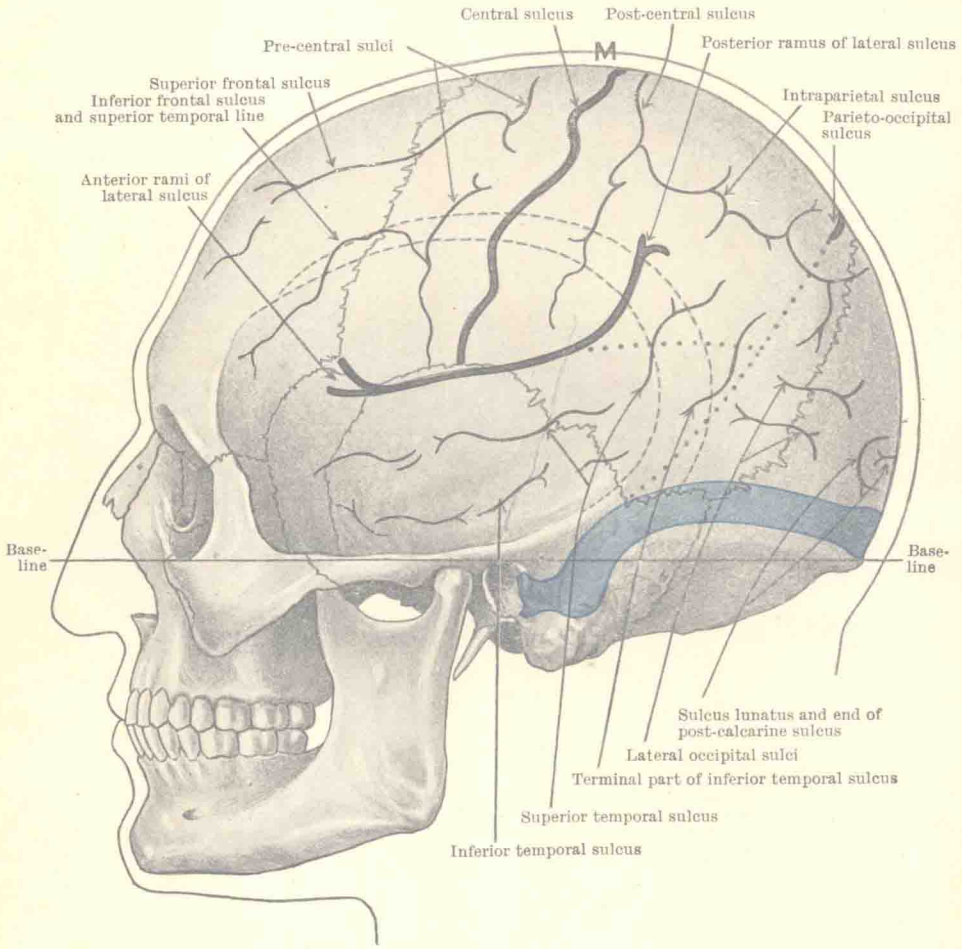

FIG. 1185.—CRANIO-CEREBRAL TOPOGRAPHY II: Venous Sinuses (blue); Chief Sulci (thick black); Secondary Sulci (thin black); Artificial Boundaries between Lobes (dotted lines); Temporal Lines (curved lines of dashes).

temporal line. The anterior horn of the ventricle is immediately above the level of the pterion; the posterior horn is opposite the posterior part of the temporal line but is very variable both in length and width; the inferior horn corresponds to the middle temporal gyrus.

The lateral ventricles may be tapped or drained after holes have been drilled 9 cm. anterior to the inion and 4 cm. from the midline. Cannulæ are inserted anteriorly, slightly downwards and parallel to the sagittal plane; they enter the ventricles at the junction of body and posterior horn, at a depth of 7-8 cm. from the skin (Dott, 1928). The procedure of *ventriculography* is carried out by positioning the head so that cerebro-spinal fluid escapes through the lower of the two cannulæ, while a corresponding volume of oxygen or air is introduced through the upper. When replacement is complete, stereoscopic radiographs are taken in various planes. The ventricles are outlined by the oxygen, and changes in their size and shape may be used to identify the site of a pathological process (p. 1557, Pl. LXXIV, p. 945 and Pls. LXXV, LXXVI p. 960).

The **cerebello-medullary cistern** is situated between the under surface of the cerebellum and the medulla oblongata; it may be tapped by suboccipital puncture—the needle passing through

the posterior atlanto-occipital membrane. The needle is inserted close to the median line immediately above the atlas vertebra, and its direction is from the point of insertion towards the nasion.

To expose both hemispheres of the cerebellum, two flaps are reflected by a "cross-bow" incision. The curved, horizontal limb is made a little above and parallel to the superior nuchal lines, and, if possible, the ends of the incision should not reach the mastoid emissary vein (a finger's breadth behind the root of the auricle at the level of the meatus), for it may give rise to

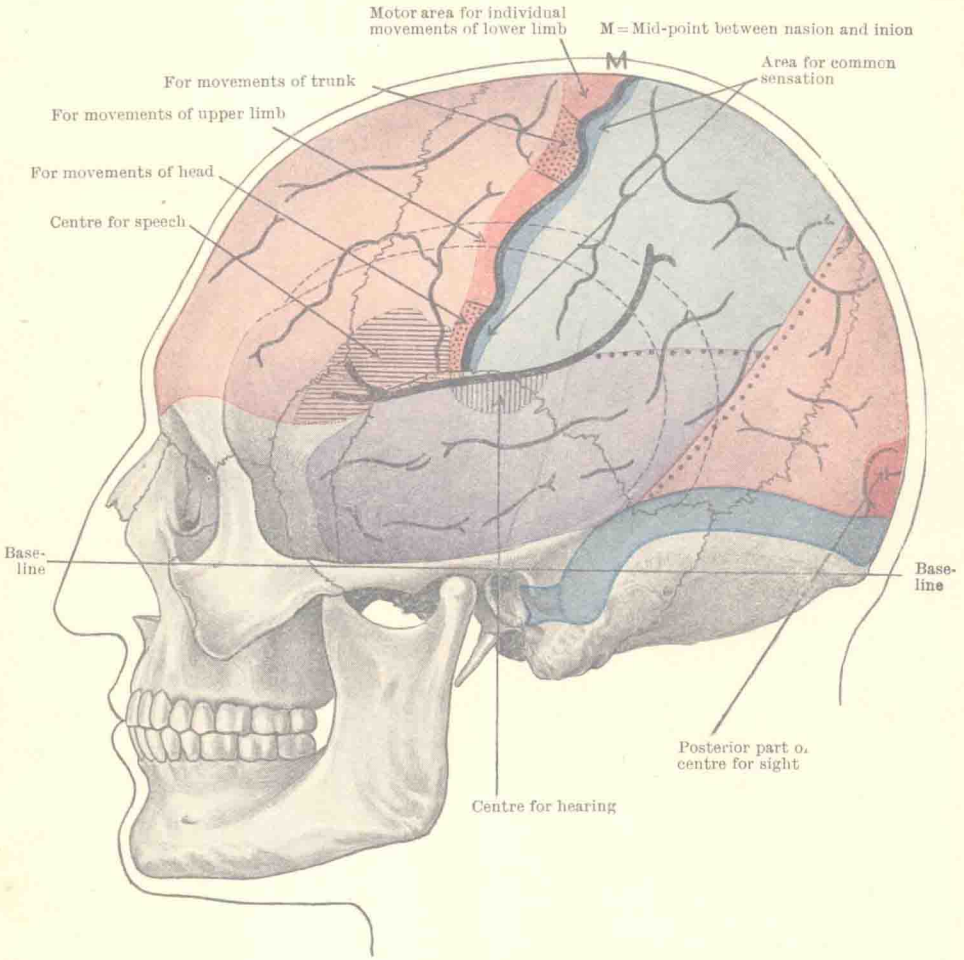

FIG. 1186.—CRANIO-CEREBRAL TOPOGRAPHY III: Lobes of Cerebrum; Motor and Sensory Areas; Centres for Speech, Hearing, and Sight. *Frontal* and *occipital* lobes (red); *parietal* lobe (blue); *temporal* lobe (purple).

troublesome bleeding. The occipital arteries (2·5 cm. lateral to the inion) are divided. The vertical limb of the incision descends in the median line to the level of the spine of the axis vertebra. The occipital sinus is divided between two ligatures. After division of the dura, either hemisphere of the cerebellum may be displaced towards the median plane to expose a tumour of the auditory nerve, which occupies the angle between the cerebellum and the pons.

Meningeal Arteries.—When the calvaria is removed the **meningeal arteries** remain attached to the dura mater, for they are in its outer layer. Of these vessels the middle meningeal **artery** is the only one of surgical importance. It may be lacerated in fractures of the skull; the blood is generally extravasated between the dura and the bone, and the bleeding point is deep to the clot. After entering the cranial **cavity** through the foramen spinosum, the *main trunk* runs laterally and slightly forwards to divide into anterior and posterior branches at or a little above the level of the zygomatic arch, midway between the orbit and the auditory meatus (Fig. 1184).

The *anterior and larger branch* passes upwards (with a slight forward

convexity) to the pterion and then upwards and backwards towards the mid-point between the nasion and the inion, giving off branches on its way. Its main trunk is opposite and parallel to the motor area and is therefore encountered in operations on that part (Pl. VII, p. 154).

The *posterior branch* passes backwards and upwards towards the lambda.

To expose the *trunk* of the vessel and its bifurcation, bone is removed immediately above the middle of the zygomatic arch. At the pterion, the artery frequently runs in a canal for a distance of 1·5 cm., and during the removal of bone bleeding may occur from the artery as it lies in the canal. The trunk of the vessel may be traced proximally to the foramen spinosum, where it is secured.

Venous Sinuses of Dura Mater.—The **superior sagittal sinus**, which enlarges as it extends backwards, occupies the median plane of the vertex from the glabella to the internal occipital protuberance, where it becomes continuous usually with the right transverse sinus. Opening into the sinus, especially in the posterior part of the parietal region, are the **lacunæ**, into which arachnoid villi and granulations project.

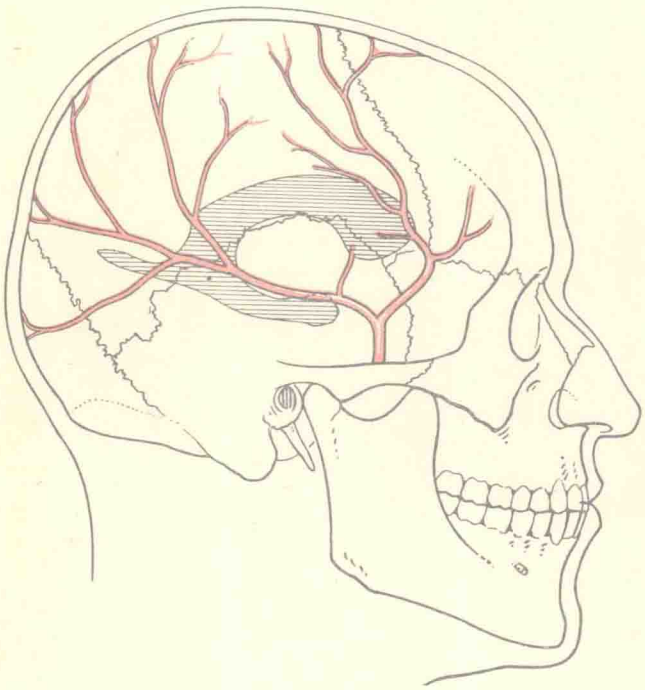

Fig. 1187.—Topography of Normal Lateral Ventricle and Middle Meningeal Artery. (Fraser & Dott, 1922.) See also Pls. VII, p. 154, LXXIV, p. 945 and LXXV, p. 960.

The **transverse sinus** may be mapped out on the surface by a line, slightly convex upwards, *drawn* from a point a little above the inion to the upper part of the back of the root of the auricle. The **sigmoid sinus** is indicated by a line which begins at this point and is drawn downwards along the back of the root of the auricle to the level of the lower margin of the meatus, and then forwards to the margin of the meatus, which is opposite the jugular foramen. In wounds of the sinus the hæmorrhage is very free, owing to the inability of its walls to collapse.

Cerebral Arteries.—Of the **cerebral arteries**, the *middle* supplies almost the whole of the motor area, and one of its striate branches, which enter the brain at the anterior perforated substance, is called "*the artery of cerebral hæmorrhage*" from the frequency of its rupture in apoplexy. The extravasated blood involves the motor part of the internal capsule. The postero-medial central branches of the *posterior cerebral* artery, which enter the brain at the posterior perforated substance, supply the thalamus and walls of the third ventricle; hæmorrhage from one of those branches is apt to rupture into the ventricle. The postero-lateral central branches of the posterior cerebral artery supply the thalamus, and when one of these vessels ruptures the hæmorrhage is apt to invade the posterior part of the internal capsule, where the fibres for *sight* and *hearing* are situated. (For radiography of the cerebral arteries during life, see Pl. LXXX, p. 1217.)

Trigeminal Ganglion.—The topography of the trigeminal ganglion is important in relation to the operation of division of its sensory root for the relief of

trigeminal neuralgia. The ganglion is situated between the layers of the dura mater in the middle cranial fossa, at the apex of the petrous portion of the temporal bone.

The surgeon reaches it by an extradural route through an opening immediately above the zygomatic arch. The bone is removed down to the level of the infratemporal crest, which forms the boundary line between the lateral wall and floor of the middle cranial fossa. The dura mater is elevated from the floor of the fossa so as to admit of the ligature of the middle meningeal artery immediately after its entrance through the foramen spinosum. The dura mater is separated from the bone still farther in a medial and backward direction till the mandibular nerve is reached. The sheath of the nerve is then incised horizontally, and the upper surface of the ganglion is exposed. The sensory root passes backwards from the ganglion, and is enclosed in a tube of arachnoid mater. The arachnoid is incised posterior to the

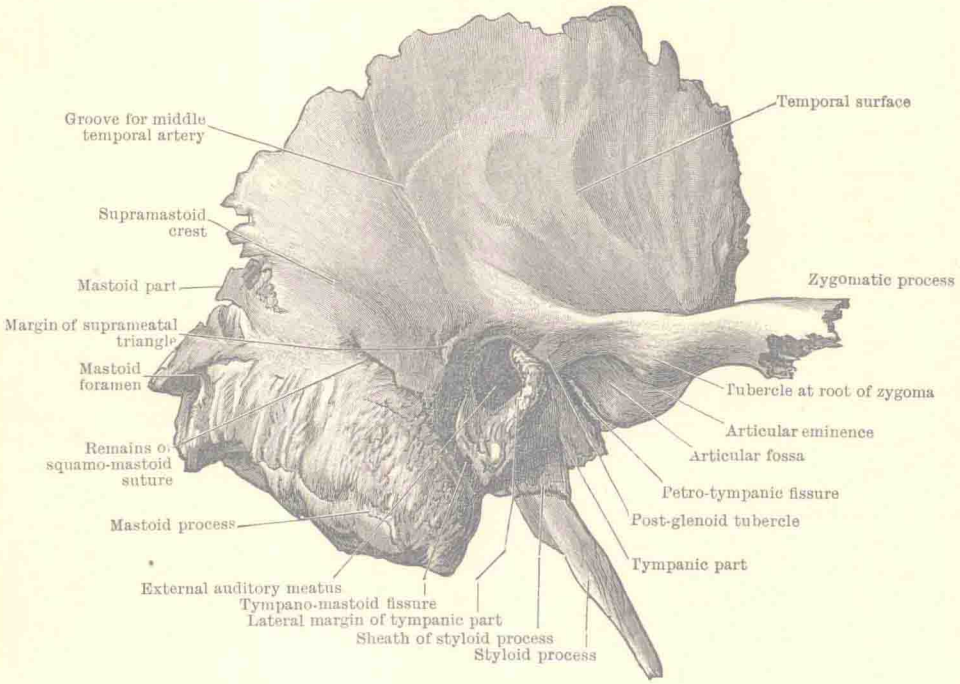

FIG. 1188.—LATERAL ASPECT OF RIGHT TEMPORAL BONE.

ganglion. The sensory root is then gently raised on a hook and its bundles carefully divided without injury to the motor root, which lies deep to the sensory root.

Ear.—The skin of the lateral surface of the **auricle** is tightly bound down to the perichondrium; and inflammations of it are attended therefore with little swelling but much pain. The **posterior auricular artery**, which ascends along the groove at the posterior attachment of the auricle, is immediately in front of the incision for opening the tympanic antrum.

The general direction of the **external auditory meatus** is medially, forwards, and downwards; it is thus curved both vertically and horizontally. The highest part of the upward convexity, which is also the narrowest part of the canal, is situated at the middle of its osseous portion; beyond that the floor sinks to form a recess in which foreign bodies are apt to be imprisoned. Of the two horizontal curves the lateral is convex forwards, the medial concave forwards. The skin of the osseous portion of the canal is thin and adherent to the periosteum. Boils in the canal are extremely painful; when situated on the posterior wall and associated with cellulitis the condition may be difficult to distinguish from mastoiditis.

The relations of the osseous walls of the meatus are of importance to the surgeon. The whole of the upper wall and the upper half of the posterior wall, developed from the squamous portion of the temporal bone, consist of two layers of compact bone, an upper and a lower, which are continuous with the inner and

outer tables of the skull. The upper plate passes medially to the petro-squamosal suture, where it becomes continuous with the lateral edge of the tegmen tympani, which roofs over the epitympanic recess and the tympanic antrum; the lower plate bends downwards and medially at its deepest part to form the infero-lateral wall of the recess and the anterior part of the lateral wall of the antrum. On the upper and posterior segment of the external auditory margin is the **suprameatal spine**. It occupies the middle of the base of a small depression, called the **supra-**

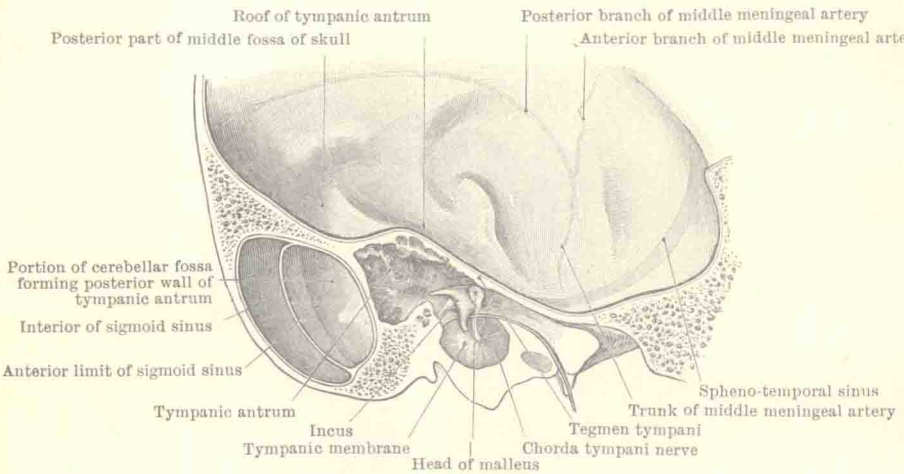

FIG. 1189.—VIEW OF LATERAL WALL OF MIDDLE EAR.

Section through the left temporal bone of a child, to show the relations of the tympanum and tympanic antrum to the middle and posterior fossæ of the skull.

meatal triangle, which lies between the supramastoid crest and the postero-superior quadrant of the external osseous meatus. The spine can sometimes be felt in the living subject if the forefinger is placed in the external meatus and pressed upwards and backwards.

The lower half of the posterior wall of the osseous meatus (posterior part of the tympanic plate) is fused with the anterior part of the mastoid portion of the temporal bone, and closes the lower and anterior set of mastoid air-cells (border cells).

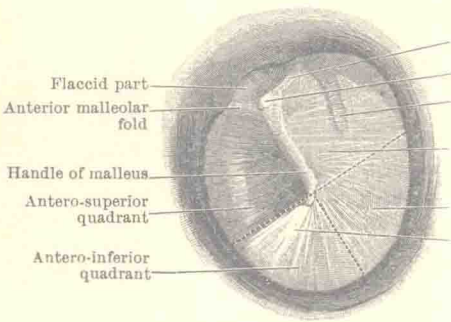

FIG. 1190.—LEFT TYMPANIC MEMBRANE VIEWED FROM EXTERNAL AUDITORY MEATUS. ×3.

Anteriorly and inferiorly the osseous meatus is related respectively to the **mandibular joint** and the **parotid gland.** Hence it follows: that blows upon the chin may fracture the tympanic plate as well as the base of the skull; that pain on mastication is usually complained of in acute inflammatory affections of the meatus and middle ear; and that in young children, in whom the tympanic plate is incompletely ossified, suppurative inflammation is apt to extend from the parotid region into the external auditory meatus.

To obtain a view of the **tympanic membrane** a speculum and a reflecting mirror are employed or the membrane is illuminated by direct light. The auricle is pulled upwards, backwards, and laterally in order to straighten the cartilaginous part of the meatus. The healthy membrane is pearly grey, semi-opaque, slightly concave, and obliquely

placed, the upper and posterior portion being nearer to the observer than the anterior and inferior part.

The handle and lateral process of the malleus, both embedded in the tympanic membrane, are the only objects distinctly seen when the healthy ear is examined with the speculum. The lateral process of the malleus projects laterally, and presents itself, therefore, as a distinct knob-like projection at the upper part of the membrane; passing forwards and backwards from that process are the **anterior** and **posterior malleolar folds** of the membrane; they form the lower limit of the *flaccid part* of the membrane, and correspond to the line of the chorda tympani nerve. The handle of the malleus, situated at the junction of the upper two quadrants, is seen passing downwards and backwards to the point of maximum convexity of the membrane (umbo), situated a little below its centre (Fig. 1190); passing downwards and forwards from

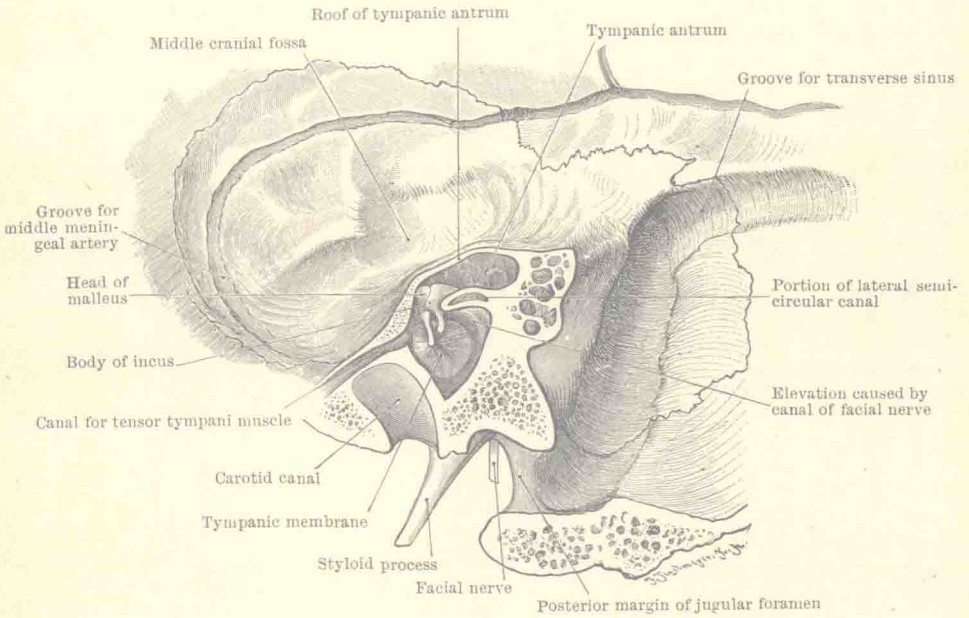

FIG. 1191.—SECTION THROUGH PETROUS PORTION OF RIGHT TEMPORAL BONE OF ADULT VIEWED FROM THE DEEP SURFACE.

Showing the relation of the tympanum to the middle and posterior fossæ of the skull.

the umbo is the *triangular cone of reflected light*, to which too much importance must not be attached, since its appearances vary considerably in healthy ears. Normally, the long process of the incus is but faintly visible, and still less so are the promontory and fenestra cochleæ; in the condition of obstruction of the pharyngo-tympanic tube, however, in which the membrane is indrawn, those structures, along with the malleolar folds, become more distinct.

In the operation of *paracentesis of the tympanic membrane* the incision is made through the two posterior quadrants, as, in addition to good drainage being provided, they are farthest removed from important structures such as the chorda tympani nerve.

In order that the clinical importance of the parts seen through the translucent membrane may be understood, it is necessary to study the relative position of the structures in that part of the tympanum which lies opposite the tympanic membrane. The head of the malleus and the body and short process of the incus are altogether above the tympanic membrane, and they occupy the **epitympanic recess** (Fig. 1191). At the junction of the upper two quadrants of the membrane is the **handle** of the **malleus**, which is directed downwards, backwards, and medially; the tendon of the tensor tympani muscle crosses the tympanic cavity from its medial wall to be attached to the upper part of the handle. The **lateral process** of the **malleus** is directed laterally a little below the deepest part of the roof of the osseous external auditory meatus. Opposite the postero-superior quadrant are the **long process** of the **incus**, which descends behind and almost parallel to the handle of the malleus, and the **stapes**, which is directed medially and also slightly upwards and backwards to the fenestra vestibuli. The **chorda tympani**

nerve runs from behind forwards between the lateral surface of the upper part of the long process of the incus and the medial surface of the neck of the malleus. At the deepest part of the roof of the osseous external meatus, above the chorda tympani nerve and the lateral process of the malleus, is the **tympanic notch**, which is occupied by the flaccid, highest portion of the tympanic membrane; the notch is due to a deficiency in the tympanic ring, which forms only about five-sixths of a circle. Opposite the postero-inferior quadrant of the drum-head is the **promontory** caused by the first coil of the **cochlea**, below and behind which is the **fenestra cochleæ**. Opposite the antero-superior quadrant are the **cochleariform process**, the **tendon** of the **tensor tympani**, and the passage leading towards the **pharyngo-tympanic tube**.

The *medial wall* of the tympanic cavity is related to the internal ear. The *roof* separates the tympanic cavity (epitympanic recess) from the middle cranial fossa and the brain. It is formed by the **tegmen tympani**—a thin plate of bone which is continued backwards to roof over the tympanic antrum, and forwards to form the roof of the canal for the tensor tympani muscle immediately above the osseous portion of the pharyngo-tympanic tube. Laterally the tegmen is limited by the **petro-squamous suture**, which may persist for some years after birth, thus affording a channel along which pyogenic infection may spread from the middle ear to the meninges and brain. Infection may spread also along the small veins which convey blood from the tympanum to the superior petrosal and transverse sinuses, and to the posterior fossa of the skull along the vessels which pass from the medial wall of the tympanic antrum through the subarcuate fossa, beneath the dome of the superior semicircular canal.

The floor of the tympanum is constituted mainly by the bone bounding the **jugular fossa**, which is occupied by the upper bulb of the internal jugular vein. When the sigmoid sinus is large and unusually far forward the bulb also is large; the fossa is consequently deeper, and arches up into the floor of the tympanic cavity, from which it may be separated merely by a thin and translucent plate of bone which occasionally shows an osseous deficiency. In cases where that condition existed the jugular bulb has been wounded in the operation of paracentesis of the tympanic membrane.

Anteriorly the tympanic cavity leads into the **pharyngo-tympanic tube**, which brings it into communication with the nasal part of the pharynx. In the child the tube is shorter and wider than in the adult; inflammations of the pharynx are therefore more apt to reach the tympanum along this route in an infant than in an adult.

Above the level of the tympanic membrane is the **epitympanic recess**, which communicates posteriorly by means of a triangular opening (*aditus ad antrum*) with the tympanic antrum. The epitympanic recess contains, from before backwards, the head of the malleus, the body and short process of the incus—the process being attached by a ligament to the floor of the aditus. When these structures are covered with inflamed mucous membrane or granulations, drainage from the tympanic antrum into the tympanum is interfered with. The *boundaries of the aditus*, important surgically, are as follows: superiorly, the tegmen tympani; medially, an eminence of compact bone containing the lateral semicircular canal; below and in front of them is a second smaller prominence, corresponding to that portion of the canal for the facial nerve which curves immediately above and behind the fenestra vestibuli. The wall of the facial canal in that situation is thin or even deficient, so that inflammation may readily spread from the tympanum to the facial nerve. The lateral wall of the aditus is formed by the deepest part of the upper wall of the osseous external auditory meatus.

The *posterior wall* of the tympanum, below the aditus ad antrum, is formed by diploic bone which contains the descending portion of the canal for the facial nerve. Immediately below the floor of the aditus, on the posterior wall of the tympanum, is the pyramid, through which the tendon of the stapedius muscle emerges to be attached to the neck of the stapes (Fig. 1192).

The lymph-vessels from the auricle and external meatus open into the mastoid and parotid lymph-glands—the latter receiving also the lymph from the middle ear. The efferent vessels from these glands open into the glands that lie deep to the upper part of the sterno-mastoid muscle; hence it is that these groups of glands are so frequently found to be diseased secondary to tuberculosis of the middle ear; and care must be taken not to mistake an abscess in one of the mastoid glands for subperiosteal mastoid suppuration associated with middle-ear disease.

The **labyrinth** may become infected in cases of suppurative otitis media. In acute cases the infective process may pass into the inner ear through the fenestra vestibuli or fenestra