MANUAL
OF
SURGICAL ANATOMY

Sir John Bruce

Robert Walmsley

James A Ross

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MANUAL OF SURGICAL ANATOMY

Sir John Bruce

CBE TD MB FRCSE FRSE

REGIUS PROFESSOR OF CLINICAL SURGERY UNIVERSITY OF EDINBURGH

HONORARY SURGEON TO HM THE QUEEN IN SCOTLAND

SURGEON ROYAL INFIRMARY OF EDINBURGH

Robert Walmsley

MD FRCSE FRSE

BUTE PROFESSOR OF ANATOMY ST SALVATOR'S COLLEGE UNIVERSITY OF ST ANDREWS

James A Ross

MBE MD FRCSE

SURGEON EASTERN GENERAL HOSPITAL EDINBURGH

SENIOR LECTURER IN SURGERY UNIVERSITY OF EDINBURGH

The Authors

Preface

About 30 years ago, the two senior authors (John Bruce and Robert Walmsley) were invited to undertake the revision of the 4th Edition of the *Manual of Surgical Anatomy* which had been the work of the late Mr. Lewis Beesly and Professor T. B. Johnston. In that revision and in the subsequent 5th Edition, much of the earlier text was rewritten and a considerable amount of new material introduced.

The present text is based on the 5th Edition of ' Beesly and Johnston ', but a more drastic revision than before was called for in consequence of the surgical developments of the past three decades.

The terminology adopted in the book is largely that of the *Nomina Anatomica* (1960) but, in some instances, where the recommended terms appear to be either confusing or misleading, we have adhered to the original B.N.A. nomenclature. A two-column page has been used as it is believed to be more easily readable and more aesthetically pleasing than the single column format.

The book is an attempt to present in an abbreviated form the anatomical basis of surgical practice, and advantage has been taken to include some of the classical operations which involve a detailed anatomical description. The authors are very conscious that they have undertaken a difficult task in attempting to integrate the preclinical science of anatomy with a clinical discipline and they are fully aware in their own review of the published text of many of its shortcomings. It is to be hoped, however, that this new volume on surgical anatomy will prove to be of value to both senior clinical students in surgery and to those who are pursuing surgery after graduation.

We are indebted to a host of colleagues for help with the various special regions, and in this connection we would like to thank Professor J. F. Gillingham, Professor G. I. Scott, Mr. Philip Harris, Mr. R. B. Lumsden and Dr. J. Bruce Dewar for assistance in the chapters on the Head, the Eye, the Ear and the Female Pelvis.

We would also like to acknowledge with gratitude the assistance we have received in the compilation of the text and the selection of radiographs, from Professor Norman Dott, the late Mr. J. J. M. Brown, Miss C. Burt, Dr. D. Hunter Cummack, Mr. D. Lamb, Mr. Andrew Logan, Dr. R. T. McKay, Dr. W. McLeod, Dr. Eric Samuel, Dr. J. W. Smith and Dr. G. B. Young.

The drawings have been chiefly the work of Mr. Shepley and his assistants and to them, and to Mr. James Brown, who was responsible for all the photographs, we would also like to express our thanks and appreciation. Professor Thomas Nicol, of King's College London University, has been good enough to allow us to reproduce a number of his figures and we gratefully acknowledge his kindness.

In the preparation of the 5th Edition of Beesly and Johnston's Manual of Surgical Anatomy, the late Dr. E. B. Jamieson gave considerable help and wise counsel. In view of the interest he expressed in the book, we believe that we would have had his sanction in using certain of the plates from his 'Illustrations of Regional Anatomy', the copyright of which is now held by E. & S. Livingstone.

A number of friends have assisted us in the reading of the proofs; we thank them all, especially Dr. T. Murphy and Dr. W. Gill. The important, time consuming labour of preparing the index has fallen to Mrs. Walmsley; she knows how grateful we are to her.

Finally, at all stages in the production of the text, we have enjoyed the help and cooperation of Mr. Macmillan and Mr. Parker of E. & S. Livingstone: without their guidance and encouragement, the book would not have seen the light of day!

September, 1964

JOHN BRUCE.
ROBERT WALMSLEY.
JAMES ROSS.

Contents

Chapter 1

Head

A great part of the head is formed by the skull with the brain and its meninges enclosed in the cranial cavity. The organs of special sense also lie within the skull bones or in cavities bounded by them. Arising from the brain are the twelve pairs of cranial nerves and of these the first eight and the twelfth pairs are distributed to the nose, the eyes, the muscles of the face, the inner ears, the tongue and both the superficial and deep structures of the head. The ninth, tenth and eleventh cranial nerves do not restrict themselves to the innervation of head structures; nevertheless, it may be fairly claimed that the study of the head is largely concerned with the skull, brain and the organs of the special sense, to which the majority of the cranial nerves are distributed.

Surface Marking

The *external occipital protuberance* lies immediately above a small depression which indicates the upper end of the nuchal furrow when the head is held erect. The most bulging part of the head usually lies a little above the protuberance but the form of this part of the head, like body form generally, varies considerably and is frequently not the same on the two sides. The parietal eminence, which overlies the supramarginal gyrus of the brain, can be felt on the side of the skull about two inches above the auricle. It is crossed by the *temporal line,* which can be traced downwards and forwards to the zygomatic process of the frontal bone, and downwards and backwards to a point a little above and behind the mastoid process. The **pterion,** where the great wing of the sphenoid articulates with the antero-inferior angle of the parietal, is 4 cm. above the mid-point of the zygomatic arch. It is not indicated by either protuberance or depression but its surface marking is important on account of the structures which lie deep to it. Underlying it is the meningeal vein which accompanies the anterior branch of the middle meningeal artery, and deep to these vessels is the stem of the lateral sulcus of the cerebral hemisphere which there breaks up into its three rami. The *asterion* is the point at the articulation of the mastoid angle of the parietal bone with the temporal bone and it forms a depression above and behind the external acoustic meatus. It lies a little more than 2·5 cm. behind the upper part of the root of the ear. Other bony landmarks are dealt with on p. 67.

SCALP

The scalp in most of its extent consists of five layers, viz. skin, subcutaneous tissue, the galea aponeurotica (epicranial aponeurosis), a loose areolar tissue and the pericranium (Fig. 1).

The skin of the scalp contains a large number of sebaceous glands, and is therefore a common site for sebaceous *cysts* or *wens.* These swellings are embedded in the superficial tissue which contains very small lobules of fat. They can be moved with the scalp, and this feature distinguishes them from swellings in connection with the pericranium.

Numerous arteries supply the scalp, ramifying for the most part in the superficial

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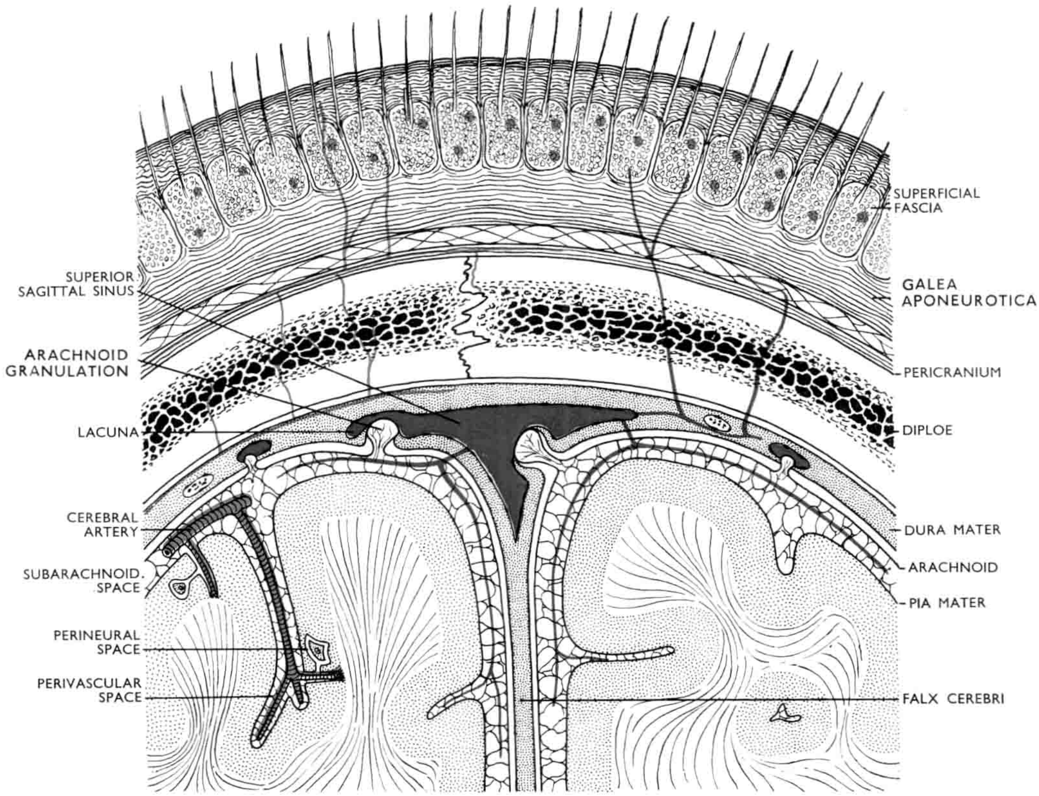

FIG. 1

Schematic figure of coronal section upper part of head. It illustrates: (a) layers of scalp; (b) sagittal suture of skull; (c) superior sagittal venous sinus; (d) relation of arachnoid granulations to superior sagittal sinus and venous lacunae; and (e) relation of blood vessels to subarachnoid space. The perivascular and perineuronal spaces shown in this figure are now generally regarded to be artefacts.

fascia. They are derived from both the external and internal carotid arteries, and ascend towards the vertex from the orbit, face and neck. A free anastomosis occurs between the two groups of vessels and also across the median line. In consequence, ligature of one external carotid fails to cure a *cirsoid aneurysm* of the superficial temporal artery. Subcutaneous haemorrhage is limited in amount owing to the density of the superficial fascia, and for the same reason septic infections remain localised and are extremely painful. When one of the arteries is cut the bleeding is plentiful, as its wall is held open and prevented from retracting by its attachment to the fibrous septa. At the same time the density of the subcutaneous tissue renders the cut vessels difficult to pick up in artery forceps but moderate pressure usually suffices to stop the haemorrhage. The special arrangement of the scalp vessels necessitates other than the usual methods of *arresting bleeding in cranial operations.* Infiltration of the subcutaneous plane with a local anaesthetic containing adrenalin reduces capillary bleeding while the incision is being made; the larger vessels are temporarily controlled by finger pressure against the skull on each side of the wound. Before the pressure is released, artery forceps are applied along the edge of the galea and thrown over so as to evert the aponeurosis, a manoeuvre that effectively occludes the vessels for as long as is necessary. Owing to its rich blood supply, the scalp possesses remarkable vitality. Large areas may be stripped up, and although they may remain attached only by narrow pedicles will if replaced heal with little loss from sloughing.

The arteries of the scalp are accompanied by the *nerves* which likewise approach the crown of the head from the front, sides and back. The density of the superficial fascia in which they lie tends to prevent the ready diffusion of local anaesthetic in the scalp; there is also a considerable overlap of the nerve branches so that many areas of skin are innervated by more than one trunk.

Vessels and Nerves. The *superficial temporal arteries* supply the lateral portions of the scalp and ascend to the vertex to anastomose with each other. They divide into anterior and posterior branches which communicate freely with the supraorbital and supratrochlear arteries in the forehead and with the posterior auricular and occipital arteries behind the auricle. The superficial temporal artery is accompanied by the auriculo-temporal nerve. The *supraorbital* and *supratrochlear arteries* accompany the nerves of the same name (Fig. 10) and both are branches of the ophthalmic which arises from the internal carotid. The *posterior auricular artery* runs backwards and upwards from the external carotid, and lies superficial to the mastoid temporal bone. It supplies the auricle and the adjoining area of the scalp, and is accompanied by the terminal branches of the great auricular nerve (p. 109). The *occipital artery* is also a direct branch of the external carotid and supplies the back of the scalp; its branches accompany those of the greater occipital nerve (p. 107).

Galea Aponeurotica. This thin tendinous sheet, formerly called the ' epicranial aponeurosis ', unites the frontal and occipital bellies of the occipitofrontalis to each other. Unless it is cut through in a transverse direction, scalp wounds tend not to gape. The lateral margins of the aponeurosis blend with the strong temporal fascia and together with the line of origin of the muscular bellies, completely shut in the subaponeurotic space which separates the galea from the pericranium (which is the term frequently given to the periosteum on the outside of the skull). This space contains only some loose areolar tissue and a few small arteries, but it is traversed by the important emissary veins which are valveless and connect the intracranial venous sinuses with the superficial veins of the scalp. When pus or blood collects in this space it can spread in all directions and elevate the scalp. Incisions for the evacuation of such a collection are made near its lower border and parallel to the larger blood vessels. The pus may destroy the pericranium and thus cause necrosis of the bones of the skull; and it may produce septic thrombosis of the *emissary veins,* and the thrombosis or emboli may spread to the intracranial sinuses and to the brain.

Venous Return. Venous blood from the scalp may pass by (1) the extracranial or (2) the intracranial route.

1. The *extracranial route* is constituted by the veins corresponding to the branches of the external carotid artery which are found in the scalp, and by the supraorbital and supratrochlear veins which unite to form the facial vein (p. 70).

2. The *intracranial route* is along the parietal emissary veins to the superior sagittal sinus, and along the mastoid and condyloid emissary veins to the sigmoid sinus. Further, the supraorbital veins communicate with the ophthalmic veins, and by this route venous blood may be returned from the scalp to the cavernous sinus.

In addition to the veins already mentioned, emissary veins occasionally connect the superior sagittal sinus with the veins of the nasal mucous membrane through the foramen caecum, and the cavernous sinus with the pterygoid venous plexus.

Pericranium. This layer represents the periosteum of the outer surface of the skull. It is easily stripped off except at the sutures, where it is continuous with the periosteum on the inner surface of the skull (endosteum) which provides the skull bones with their

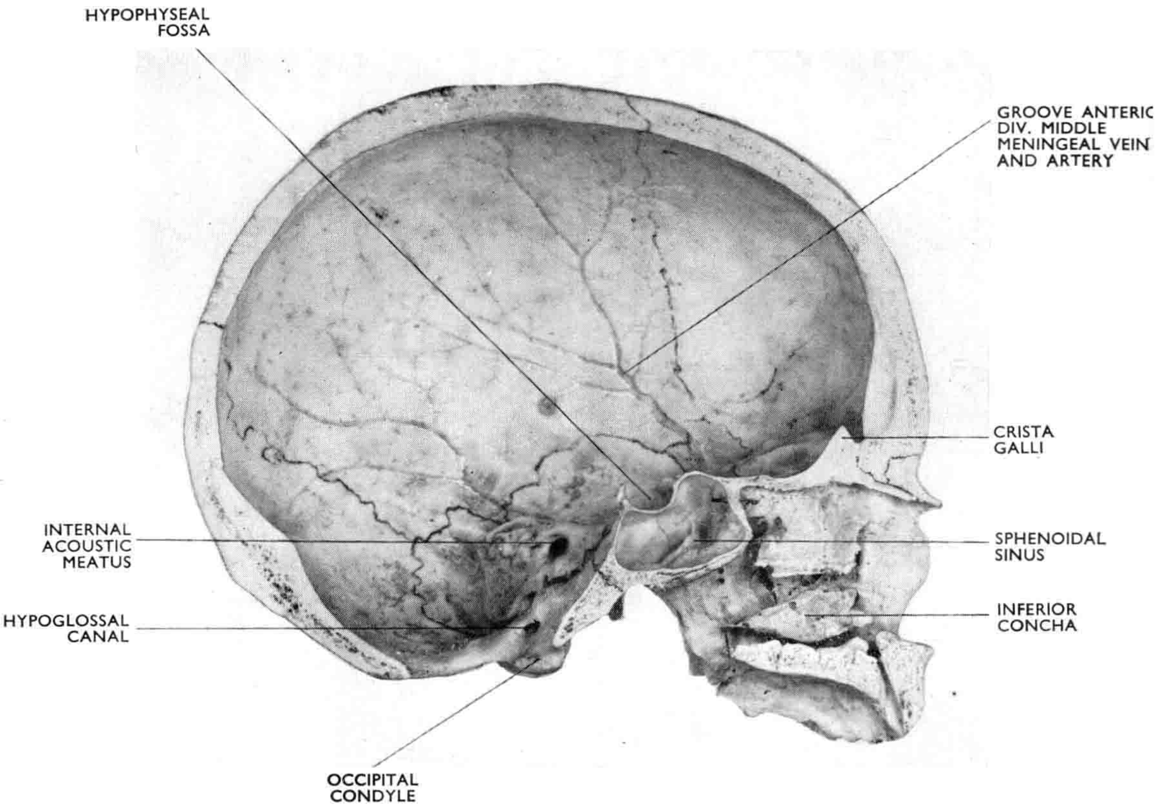

FIG. 2

Skull was sectioned in median plane and nasal septum entirely removed. The ostium of the sphenoidal sinus, in which a black rod was placed, opens into the spheno-ethmoidal recess; this recess lies above and behind the small superior concha.

blood supply. It is on this account that the loss of portions of the pericranium in compound injuries of the skull is not necessarily followed by death of the exposed bone.

A *subpericranial haemorrhage,* or *cephalhaematoma,* is limited to the surface of a particular bone by the sutural ligament. It is caused by rupture of the sutural veins during moulding of the foetal head and can easily be distinguished from *caput succedaneum,* which is bleeding in the scalp, and not limited, therefore, to the surface of any particular bone.

CRANIUM

Development

During development the cranium expands rapidly to accommodate itself to the rapidly growing brain. At first it consists of a *membranous capsule,* with cartilaginous bars in its base. The bars become ossified, and about the same time centres of ossification appear in the membrane to form the parietal and the squamous portions of the temporal bones, and the occipital and frontal bones. At birth the skull is still incompletely ossified and in the regions of the *anterior* and *posterior fontanelles* membrane takes the place of bone. The anterior fontanelle is placed at the area where, in the adult, the coronal and sagittal sutures meet, and through it intracranial pulsations can readily be seen and felt. When the intracranial pressure is raised, *e.g.* in crying, the anterior fontanelle becomes tense but it is sunken in conditions of malnutrition, dehydration and

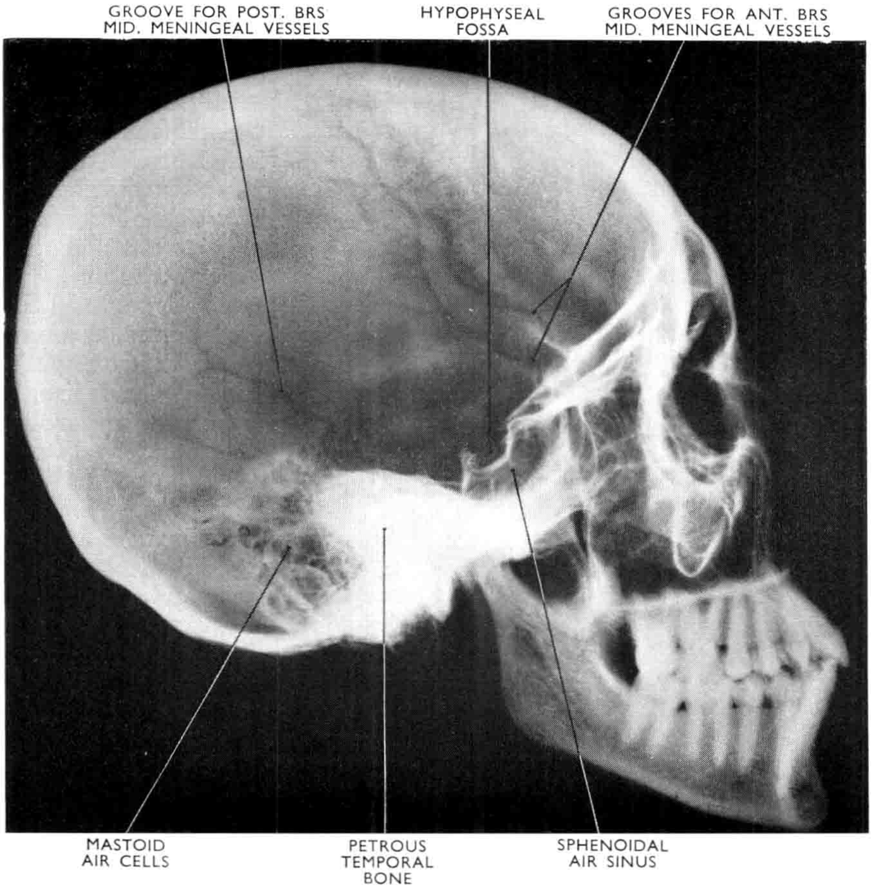

FIG. 3
Lateral radiograph of adult skull. The dorsum sellae is seen to form the posterior wall of the hypophyseal fossa.

exhaustion. Normally it is closed by the end of the second year, but in rickets it is still widely open at that age.

A patent fontanelle provides an easy and safe route for the administration of therapeutic infusions or blood to the small child. A short lumbar puncture needle is inserted at the posterior angle of the anterior fontanelle and passed downwards and backwards into the superior sagittal sinus. Its entry into the sinus can be appreciated readily by experienced hands; but care must be taken not to plunge the needle beyond the sinus, for a haematoma may then form between the cerebral hemispheres. Access to the lateral ventricles and to pathological collections of fluid in the subdural space, *e.g. chronic subdural haematoma,* also is easily obtained through the anterior fontanelle (p. 4).

A portion of the cranial contents protruded through a congenital defect in the cranial wall forms the *cephalocele* of infancy. It is the result of a failure in the development of the membranous skull which should enclose the cerebral tissue completely. If portions of nerve tissue escape inclusion in the mesodermal envelope, a cephalocele results.

The cephalocele may consist of a membranous sac containing fluid—*meningocele*—or a sac containing nerve tissue and fluid—*encephalocele*. Meningocele is more common in the occipital region, whereas encephalocele occurs more frequently in the frontal area immediately above the root of the nose.

The cranial deformities produced by hydrocephalus (p. 15) are determined also by the condition of the sutures at the onset of the disease. If it occurs after the closure of the sagittal suture the frontal and occipital regions are both affected, but if the lambdoid suture also is closed the bulging is confined to the region of the forehead.

The cranial sutures may close prematurely, giving rise to the deformity of *craniostenosis*. The resulting shape of the skull depends on the particular sutures that become fused. Oxycephaly, acrobrachycephaly and scaphocephaly are the best known types of craniostenosis. In each, since the skull fails to expand and to accommodate the enlarging brain, symptoms of raised intracranial pressure may develop.

Adult Skull

In late childhood, the skull bones assume the characteristic adult structure; there are two tables of compact bone, separated by a varying quantity of vascular bone—the diploe. In certain situations the spongy bone is absent and the frontal, ethmoidal, maxillary and sphenoidal sinuses are formed by outgrowths of the mucous membrane of the nose into the bones.

Fractures of the Skull

Cranial fractures are very common, and assume great importance because they are apt (1) to cause laceration of the brain; (2) to tear through certain of the meningeal vessels or the venous sinuses; and (3) to provide a ready route for the passage of infection to the intracranial contents.

The mechanism of fracture of the skull varies with the nature of the force and the site of the trauma. If a severe blow is inflicted over a localised area, the skull is indented and tends to fracture at the seat of injury. The inner table is more brittle than the outer table and therefore fractures more extensively, so that considerable damage may be inflicted on the underlying brain. In the adult it is even possible for the inner table to be fractured alone, and the fragments, if displaced inwards, may then lacerate the brain without external signs of serious injury.

The skull, however, has a certain amount of inherent elasticity, and if a force is applied over a large area the contour of the cranial globe is altered. Depression occurs at the point of impact, and bulging at the points of counter-resistance (the opposite side of the skull in crushing injuries and the occipital condyles in falls or blows on the top of the head). If the trauma is transient and not too severe the skull resumes its normal shape when the force is withdrawn. Otherwise, if the indented area is less elastic than the bulging parts, a *fracture by bending* occurs and from it fissures and cracks may radiate for a considerable distance. If the bulging part is less resilient it may give way, and an indirect *fracture by bursting* results.

A rare and rapidly fatal fracture of the base is sometimes produced by a heavy blow or sustained pressure over the vertex. The lateral masses of the atlas may then offer so much resistance that a circle of bone is punched off and, with the atlas, driven into the cranial cavity.

In childhood, fracture of the skull is less common and more limited in its effects because the bones possess considerably more resilience than in the adult; there is practically no diploe, and the individual bones are joined by strong fibrous tissue which tends to prevent the transmission of force from one bone to another. The common form of lesion is a circumscribed indentation or ‘ pond ’ fracture.

Fracture of the base of the skull may affect any of the three cranial fossae, and the clinical effects vary accordingly.

Anterior Fossa. Fracture of the cribriform plate of the ethmoid bone is usually accompanied by laceration of the dura mater and of the mucous membrane of the roof of the nose. This injury, therefore, gives rise to epistaxis accompanied or followed by a discharge of cerebrospinal fluid. In addition, there is frequently some loss of smell from tearing of the olfactory nerves as they pass upwards from the nose. The importance of the dural injury is that it affords a route whereby infection can extend from the nose

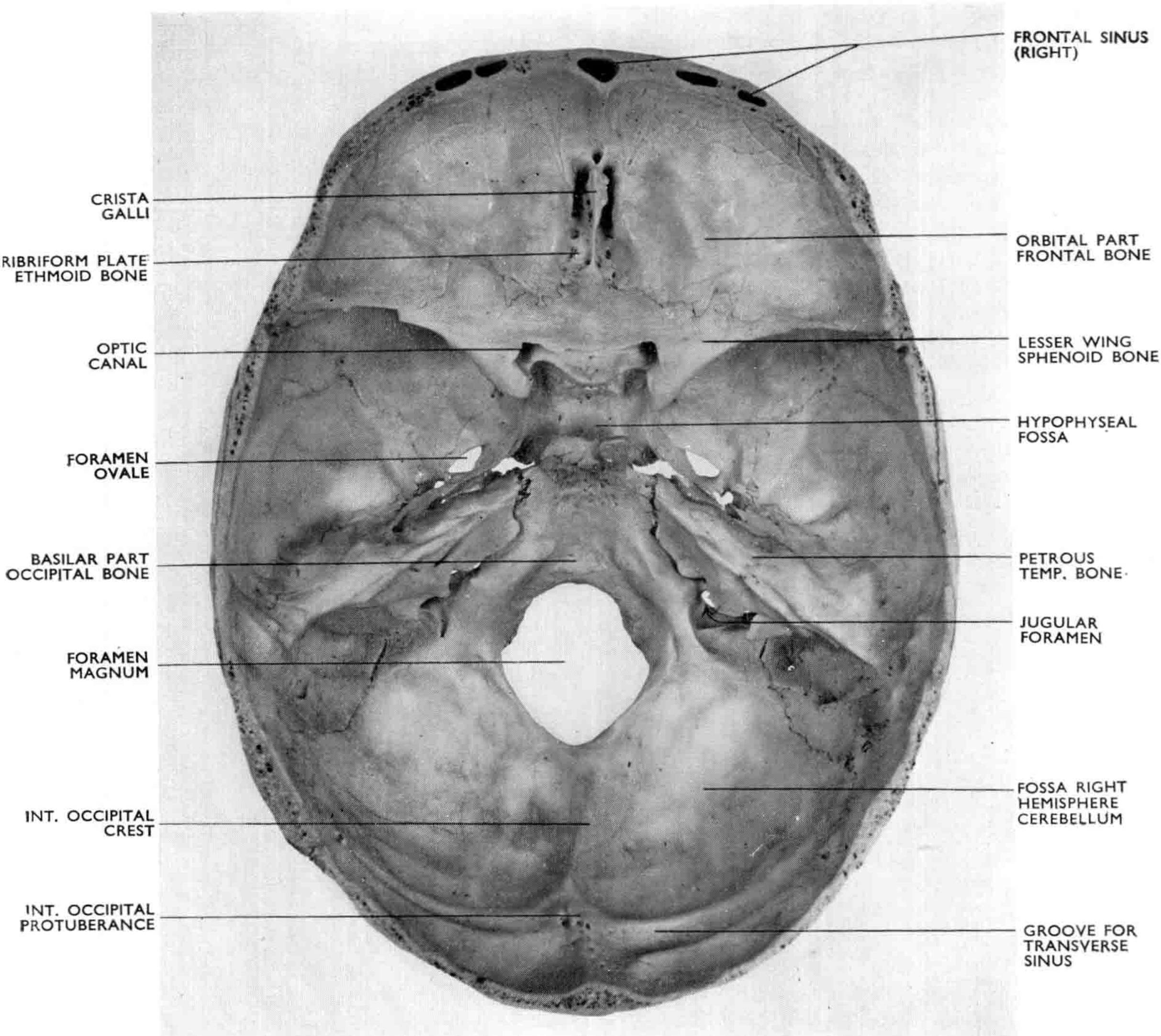

FIG. 4

Photograph of base of skull. The three cranial fossae, anterior, middle and posterior, are clearly demarcated in their lateral parts by the posterior border of the lesser wing of the sphenoid and by the superior border of the petrous temporal bone. The foramen spinosum, which transmits the middle meningeal vessels, lies posterolateral to the foramen ovale. The bone of the skull is thinner than normal.

to the intracranial contents. Meningitis, or more rarely an abscess in the frontal lobe, or on occasions a pocket of air in the brain (*pneumatocele*) or even a *spontaneous* (*air*) *ventriculogram* are therefore occasional sequelae of this fracture. The cribriform plate usually does not heal after fracture and, if the dural tear also remains unrepaired, there may be a continuous discharge of cerebrospinal fluid from the nose (*cerebrospinal rhinorrhoea*). Attempts are sometimes made to repair the defect with pericranium or fascia lata (Cairns). In fracture of the orbital part (plate) of the frontal bone, subconjunctival ecchymosis is a characteristic feature, and the haemorrhage within the orbit may produce exophthalmos. When the frontal air sinus is also injured, blood may pass down the frontonasal duct (infundibulum) to the middle meatus and be discharged from the nose. In these cases the haemorrhage arises from the torn branches of the anterior meningeal arteries or, more rarely, from the ophthalmic vessels. Some of the blood may be swallowed, giving rise to haematemesis.

Middle Fossa. This is the commonest site of fracture of the base of the skull, partly because of its position but also because it is weakened by numerous canals and foramina. The tegmen tympani (p. 102) is usually fractured, and the tympanic membrane torn. There is bleeding from the external acoustic meatus and a leakage of cerebrospinal fluid (*cerebrospinal otorrhoea*), and the facial and vestibulocochlear (seventh and eighth cranial) nerves may be damaged. Sometimes the walls of the cavernous sinus are lacerated, and the nerves (third, fourth, and sixth cranial) which lie in relation to its lateral wall may be injured (p. 11). A fracture extending across the body of the sphenoid may lead to communication between the subarachnoid space and the sphenoidal air sinus, with resultant cerebrospinal rhinorrhoea.

Posterior Fossa. In this fossa the haemorrhage does not become evident at once, unless the basilar part of the occipital bone is fractured and the mucous membrane of the pharyngeal roof torn. Otherwise the blood is situated deeply at the back of the neck, and discoloration does not become apparent for some days. It reaches the surface in the posterior triangle of the neck or in the neighbourhood of the mastoid process.

Blood Supply of Skull Bones

The principal blood supply of the skull bones is through the meningeal arteries, but this is considerably reinforced round the base of the skull by additional vessels situated at the areas of muscular attachment. Since the major cranial operations require the sacrifice of the meningeal supply, it is important to plan bone flaps so that they are hinged below on a muscular attachment.

Formerly it was the rule to approach the cranial contents by removing a segment of the skull completely (craniectomy). This necessitated the separation of the overlying scalp and, unless the resulting gap was adequately covered by muscle, a protrusion of the cranial contents—*hernia cerebri*—occurred whenever the intracranial pressure rose. The method has been almost entirely abandoned, except when a decompression only is required. Otherwise, a flap of bone is separated and reflected along with its undisturbed scalp, and at the conclusion of the operation replaced (*osteoplastic craniotomy*). Should it be found desirable to allow for permanent relief of tension, some of the bone at the base of the flap can be nibbled away. When the skull is divided, bleeding from the large venous channels in the diploe may cause some difficulty. It can be controlled by sealing the cut edge of the bone with special wax.

BRAIN AND ITS MENINGES

The brain and the spinal cord are enclosed in three membranes (meninges) which are called from without inwards, the dura mater, the arachnoid and the pia mater.

The **cerebral dura mater** is a strong fibrous membrane consisting of two layers; the two layers are fused with each other where they line the skull except in the region of the venous sinuses.

The *outer layer* is the periosteum of the inner surface of the skull and is commonly referred to as the endocranium; it is attached to the bone by numerous fibrous processes, but it is only on the floor of the cranial cavity and along the suture lines that it is firmly adherent. This is partly due to the continuity at the numerous foramina in the skull base of the endocranium with the periosteum on the outer surface of the skull (pericranium). The endocranium and pericranium are continuous with each other at the foramen magnum and it is therefore only the *inner* layer of the cranial dura mater which is continuous with the *spinal* dura mater. The meningeal vessels lie in the substance of the outer layer—the veins being superficial to the arteries—and, owing to the ease with which the membrane can be stripped off most of the bones, extradural blood clots may attain sufficient size to exert a fatal increase in intracranial pressure.

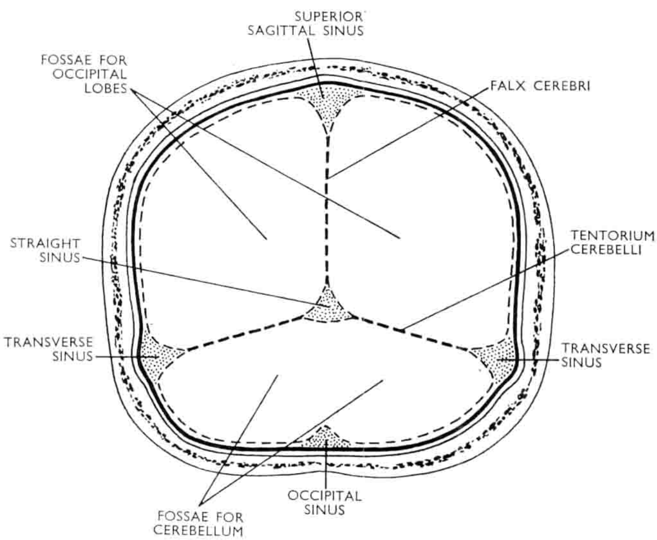

FIG. 5

Oblique diagrammatic section through posterior part of skull showing the relationship of the dura mater to the cranial venous sinuses. The outer fibrous layer of the dura mater is shown by the solid line, and the inner (meningeal) layer by the interrupted line. Where these layers line the skull they are fused with each other except at the venous sinuses.

The *inner* (or *meningeal*) *layer* is separated from the arachnoid by a subdural space containing lymph; it forms a covering for the brain and supports, either alone or along with the outer layer, the thin endothelial walls of the cranial blood sinuses, which consequently do not collapse when they are wounded. The *falx cerebri* is a fold of the inner layer, which passes downwards in the middle line between the two cerebral hemispheres (Fig. 1). Posteriorly a similar fold, the *tentorium cerebelli,* projects inwards between the cerebellum and the cerebrum (Fig. 5); and the two cerebellar hemispheres are partially separated by the *falx cerebelli,* a small fold the base of which extends from the internal occipital protuberance to the posterior border of the foramen magnum.

The *sensory nerves* to the dura of the skull vault are few, whereas the dura of the floor of the skull is relatively richly innervated and is sensitive. The nerves to the dura of the anterior and middle cranial fossae are derived from branches of the trigeminal (ophthalmic to anterior fossa and maxillary and mandibular to middle fossa) whereas the posterior fossa is innervated by the meningeal branch (or branches) of the vagus nerve.

The **middle meningeal artery** enters the skull through the foramen spinosum, and runs laterally and slightly forwards over the floor of the middle cranial fossa in the outer layer of the dura mater although most of its branches are concerned with the blood supply of the cranial bones. It divides into anterior and posterior branches at a variable point on the base. The *anterior branch* runs upwards and crosses the deep surface of the pterion (p. 1) and is then continued upwards along the anterior border of the motor area of the brain. The *posterior branch* runs backwards, parallel to the posterior ramus of the lateral sulcus of the cerebrum and lies about 4 cm. above the level of the zygomatic arch.

The artery is accompanied by the middle

meningeal vein; the vein lies between the bone and the artery and is sometimes within a canal in the bone. Bleeding may occur from the meningeal vessels in fracture of the skull and cause a type of extradural haematoma. The resulting increase of intracranial tension may necessitate the removal of the blood clot and ligation or electro-coagulation of the vessels. The approach is similar to that for subtemporal decompression (p. 26). The common site of injury is well above the skull base, so that double ligature is usually easy; but occasionally the torn vessel lies in a bony canal and then the foramen spinosum must be plugged. It is usually the anterior branch of the artery and/or its accompanying vein that are torn, and the burr-hole for the craniectomy should be centred about 3-4 cm. above the mid-point of the zygomatic arch. In the case of the posterior branch the burr-hole should be made at a point 4 cm. above and 4 cm. behind the external acoustic meatus.

Cranial Venous Sinuses

The **cranial venous sinuses** are spaces between the layers of dura mater: they are lined by endothelium which is continuous with the endothelium of the veins. They receive the veins of the brain and also have communications with the meningeal and extracranial veins; they terminate, directly or indirectly, in the internal jugular vein.

The communications between the venous sinuses and the extracranial veins are through the emissary veins to which reference has already been made (p. 3). These important channels are valveless and the blood flow in them may therefore be in either direction. They are very numerous and not only pass through the foramina of the skull and its sutures but also penetrate many parts of the surfaces of the bones. It has been shown that the flow of blood is from within outwards and it has been calculated that about 20 per cent. of the blood which is brought to the cranium by the internal carotid artery is returned to the heart via the external jugular vein (Shenken, Harmel and Kety). It is customary to name only some of the larger channels and reference to these is made when the appropriate venous sinus is described.

The **superior sagittal sinus** lies in the upper margin of the falx cerebri (Fig. 5). It begins at the foramen caecum, where it sometimes communicates with the nasal veins (p. 3), and as it runs backwards to the internal occipital protuberance it increases in size. At this protuberance it turns laterally, usually to the right, to form the transverse sinus. The terminal part of the superior sagittal sinus is dilated, as also is the adjacent part of the straight sinus (*vide infra*) with which it communicates freely, and the two dilations are known as the *confluence of the sinuses*. It is about 1 cm. in breadth posteriorly and, on account of this size and that of the venous lacunae which open into it, openings in the vault should not be made less than 2·5 cm. from the median line. In addition to the parietal emissary vein (p. 3), it receives numerous cerebral veins which run forwards and medially to enter the sinus. If thrombosis spreads from the superior sagittal sinus to the cerebral veins a bilateral paralysis may follow which begins in the feet and rapidly ascends.

The inferior sagittal sinus is relatively small and lies in the lower border of the falx cerebri; it is joined posteriorly by the larger *great cerebral vein* (*of Galen*) and they together form the *straight sinus,* which runs backwards along the line of junction of the tentorium cerebelli and the falx cerebri (Fig. 5). At the internal occipital protuberance the straight sinus bends laterally to form the transverse sinus, usually of the left side.

The **transverse sinus** runs laterally and forwards from the internal occipital protuberance to the lateral part of the petrous temporal bone where it becomes continuous with the sigmoid sinus. It grooves the inner surface of the occipital and the mastoid angle of the temporal bones and the tentorium cerebelli is attached to the upper and lower lips of the groove (Fig. 4).

The transverse sinus corresponds roughly to the superior nuchal line of the occipital bone. In mapping it out on the surface it must be borne in mind that the sinus is about 1 cm. wide. It commences a little above the external occipital protuberance and runs