ANATOMY FOR SURGEONS: VOLUME 1

The Head and Neck

SECOND EDITION

W. Henry Hollinshead, Ph.D.

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PREFACE

This Second Edition of Volume 1 of *Anatomy for Surgeons* attempts to present, as did the First Edition, anatomical facts and concepts concerning the head and neck that are of particular interest to the surgeon. It is not intended to be a complete descriptive anatomy, but rather to serve both as a ready reference in which the surgeon can find general descriptions and as a review of anatomical details not otherwise readily available to him without wide reading outside his own special field. While no attempt has been made to describe the indications for, or detailed technic of, specific operations—for these are matters that belong to surgery and not to anatomy—accounts of the anatomical and physiologic details underlying specific surgical procedures have been given throughout.

Most of the anatomy described in the First Edition is still both valid and pertinent. However, additions, improvements, and refinements in our understanding of anatomical details and their functional importance have contributed to, and, in turn, have been contributed to by similar additions, improvements, and refinements in diagnostic and operative procedures on the head and neck to such an extent as to make a thorough rewriting of this book necessary. The basic descriptions have been carefully scrutinized for minor errors and reworded, re-arranged, or partly rewritten as those seemed to serve the interests of greater accuracy or clarity; discussions of material that now seems largely of historical value have been shortened or eliminated; and much new material has been added.

Entirely new to this volume is the description of the skeletal anatomy of the calvaria, cranial fossae, facial skeleton, mandible, and bony palate. In the first edition knowledge of this anatomy was assumed, whereas now figures and brief descriptions of it are given. In all of the chapters, numerous minor revisions have been made to incorporate up-to-date clinical findings and applications where appropriate.

The following indicates, chapter by chapter, some of the changes included in the present edition:

Chapter 1 contains short descriptions of the bony anatomy of each cranial fossa; a fuller account of emissary veins; more information and new illustrations of the ventricular system and the subarachnoid cisterns, and on the venous system of the brain, particularly the deep veins, and new information on cerebral blood flow.

Chapter 2 has updated material on the upper eyelid; the iridocorneal angle; the anatomy of the eyeball in general, including its blood and nerve supply; and the finer anatomy of the optic chiasma.

In Chapter 3 is additional, mostly new, material on the anatomy of the middle

ear cavity; conduction of sound through the middle ear; operations for otosclerosis; the anatomy and physiology of the internal ear, including observations on the perilymph and endolymph, and theories of cochlear function; and treatment of endolymphatic hydrops.

Chapter 4 gives an improved description, with some additional details, of the anatomy of the nasal septum and of the nasal cavity, while in Chapter 5 the terminology has been changed and parts have been rewritten for greater clarity.

Chapter 6 contains a new description of facial bones, slight changes have been made throughout the text, and new references have been added.

In Chapter 7 is a new description of the maxilla; more detail on the anatomy of a tooth; a description of the bony palate and related anatomy of the external base of the skull; some of the more recent views of management of cleft palate; a new description of the mandible; and more material on the temporomandibular joint.

Chapter 8 has new material on movement of the soft palate in phonation and on the mechanism of swallowing, and discussion of the mechanism of the vocal folds has been rewritten to include newer observations and concepts.

Chapter 9 provides new information on variations of arteries of the neck, a discussion of current views of neurovascular compression and its treatment, and a more detailed description of the cervical sympathetic trunk.

Many new references have been added and others eliminated, in an effort to make the Reference lists up-to-date guides to the literature when further details are required. As in the First Edition, no question of priority or superiority is implied in the selection of these references and they are almost without exception to literature written in English.

Since the publication of the first edition of this work the International Congress of Anatomists has formulated and published a revised Nomina Anatomica, or N.A., that in all countries supersedes the B.N.A. and the numerous variations of that formerly in use. In this present volume, the terminology of the Third (1966) Edition of the N.A., mostly in anglicized form, is used throughout in both text and figures. However, for the benefit of those readers who have had no reason to become familiar with the N.A., as well as for those who are familiar with that but will hear and see B.N.A. and other terms, many of the more common synonyms are also given, and listed in the index, if they differ appreciably from the N.A.

Perhaps most striking in the present edition are the new halftones. Some 75 additional roentgenograms, photographs, and halftone drawings of surgical anatomy have been included. The line drawings originally made for the first edition have been relabelled and revised for greater accuracy or clarity as necessary, while a few have been replaced.

As in all my books, I have drawn freely from the knowledge and experience of my colleagues in the preparation of this one. I am indebted to a number for loans of figures and clarification of difficult points, and especially indebted to those, listed as Surgical Consultants on the preceding pages, who read and criticized for me the various chapters after they had been revised. Their advice has been most helpful, but they are in no way responsible for the finished product; any omissions and errors are my own.

Among others who particularly aided

in the preparation of this book are several members of the Section of Medical Illustrations, under the direction of Mr. Vincent Destro; Dr. Carl Gambill, of the Section of Publications; and of course my secretary, Miss Esther Peters. To these, and to my publishers for their cooperation, my thanks.

Rochester, Minnesota

W. HENRY HOLLINSHEAD

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CHAPTER 1

The Cranium

THE SCALP

THE three layers of the scalp (Fig 1-1) —the skin, the subcutaneous tissue, and the aponeurotic layer (galea aponeurotica, epicranial aponeurosis) with its associated epicranial muscles—are intimately fused together and move as a unit with the contraction of the muscles. The dense subcutaneous tissue of the scalp contains the larger blood vessels and nerves, and its strong retinacula not only unite the skin and the galea, but afford support to the blood vessels. These layers are separated from the external periosteum or pericranium by a loose fourth layer which allows easy movement of the scalp and also ready spread of fluid or infections beneath it. Because of the latter fact, the subaponeurotic layer is sometimes referred to as the danger space of the scalp; fluids contained therein find exit with difficulty, typically into the periorbital connective tissue. The periosteum is fairly tightly attached to the bone, especially at the sutures; it is through the loose subaponeurotic tissue that separation occurs most easily in tears or surgical reflections of the scalp.

NERVES AND VESSELS

The nerves and blood vessels of the scalp run up into it from below, the larger ones on the forehead and in the temporal and occipital regions; although the blood vessels anastomose so freely with each other that there is relatively little danger of reducing markedly the blood supply to an area of scalp unless a skin flap with an extremely narrow inferior pedicle is produced, the nerve supply must be taken into consideration when incisions for skin flaps are planned, or else an area of denervated or partially denervated scalp, with resulting numbness or paresthesia, will be produced.

Since the arteries of the scalp anastomose freely with each other and with those of the opposite side, they form a part of the potential collateral pathway available after ligation of the external or common carotid artery on one side. It is because of these abundant anastomoses, also, that wounds of the scalp involving the subcutaneous tissue typically show arterial bleeding from both cut surfaces.

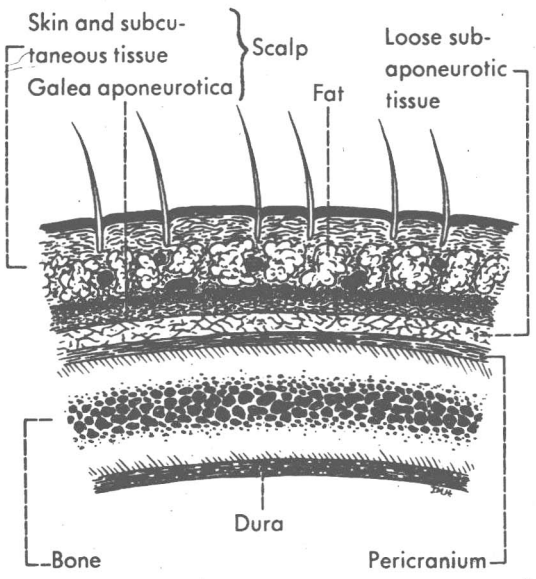

Fig. 1-1. The scalp.

The profuseness of the bleeding is further contributed to by the fact that the blood vessels lie largely in the dense subcutaneous tissue, by which they are supported and to which they are attached, and tend therefore to be held open by this tissue when they are cut. The arteries of the scalp also send small twigs to the underlying bones of the skull.

The nerves to the scalp are branches of cranial and spinal nerves (Fig. 1-2), the spinal nerves being derived both from the cervical plexus and from the posterior primary rami of the upper cervical nerves. Generally speaking, these nerves accompany the blood vessels of the scalp, which are derived largely from branches of the external carotid, but anteriorly are from the ophthalmic branch of the internal carotid.

Since the nerves of the scalp approach it from all directions, and have of course a considerable overlap, it is usually impossible to produce adequate anesthesia of any large area of the scalp by a purely local injection; rather, the area in which anesthesia is desired must be ringed by a whole series of injections. Further, the nerves, like the vessels, run mainly in the subcutaneous tissue, and the solution must therefore be placed in this layer rather than in the subaponeurotic layer where it could spread much more easily, but would be separated from the nerves by the tough galea aponeurotica.

SUPRAORBITAL NERVE AND ARTERY

The supraorbital nerve (from the ophthalmic branch of the trigeminal) and the supraorbital artery (from the ophthalmic artery) emerge through the supraorbital notch or foramen to turn sharply around the upper margin of the orbit and be distributed to the scalp. At first they lie deep to the frontalis muscle but subsequently pierce this to run in the dense subcutaneous tissue of the scalp. The small supraorbital artery forms anastomoses with the other vessels of the scalp, while the supraorbital nerve supplies a very large area on the scalp, extending backward over the vault of the skull to approximately the interauricular line or slightly beyond it. Medial to the supraorbital nerve and artery are the smaller supratrochlear nerve and the supratrochlear (frontal) artery, also branches of the ophthalmic nerve and artery; the nerve supplies a limited medial region of the forehead.

Because of the extensive distribution of the supraorbital nerve, frontal skin flaps or curved incisions over the front of the vault of the skull should be large if an area of denervated tissue is to be avoided.

AURICULOTEMPORAL NERVE

Laterally, in front of the ear, the auriculotemporal nerve (a branch of the mandibular division of the fifth nerve)

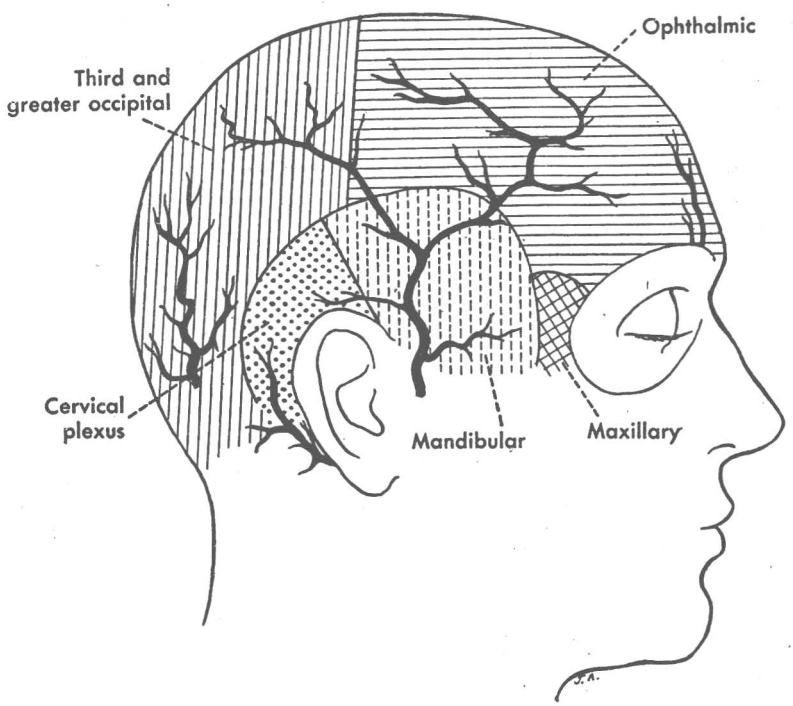

Fig. 1-2. General areas of distribution of the main nerves to the scalp, and the positions of the principal arteries. The unlabeled arteries, from left to right, are the occipital, posterior auricular, and superficial temporal branches of the external carotid, and the supraorbital and supratrochlear branches of the ophthalmic.

extends upward with the superficial temporal vessels, to supply the chief portion of the temporal region of the side of the head as high as the superior temporal line on the skull—that is, especially over the area of origin of the temporalis muscle. More anteriorly, supplying skin behind the orbital process of the zygomatic bone, but not extending so far upward, is the zygomaticotemporal branch of the maxillary division of the fifth cranial nerve. To avoid interference with this nerve supply, and with the superficial temporal artery whose main branches, parietal and frontal, spread out in this same area, temporal skin flaps should be in the shape of a U or a horseshoe, with the base widely attached below.

GREAT AURICULAR NERVE

While a small and probably variable area of skin behind the ear and over the mastoid process is innervated by the auricular branches of the seventh, ninth, and tenth cranial nerves (Chap. 3), the larger nerve distributed here, and extending upward to the scalp, is the great auricular from the cervical plexus (C2 and C3). The artery in this location is the posterior auricular branch of the external carotid, which roughly parallels the nerve. More posteriorly over the mastoid process is the mastoid branch of the occipital artery, which aids in supplying the scalp and also sends a branch into the bone to supply mastoid cells.

OCCIPITAL NERVES

Behind the area of distribution of the great auricular nerve is the *lesser occipital nerve,* also ascending from the cervical plexus (primarily second cervical). Small skin flaps over the mastoid region may be turned down by a U-shaped incision passing upward from the ear to the temporal line, and then curving backward and downward along this line; larger reflections of scalp here will usually involve the distributions of the auriculotemporal or occipital nerves.

The *greater occipital nerve* is derived largely from the dorsal (posterior) primary branch of the second cervical nerve; it typically appears in the suboccipital region at about the lateral border of the trapezius muscle, and becomes subcutaneous by piercing the fascia between the attachments of the trapezius and the sternocleidomastoid muscles to the skull; here it is joined by the occipital artery, and is distributed over the posterior part of the cranial vault to the vicinity of the interauricular line. Its area of distribution here overlaps that from the supraorbital branch of the ophthalmic, and laterally, at the level of the temporal line, overlaps the areas of distribution of the great auricular and lesser occipital nerves. Medial to the greater occipital nerve the *third occipital* (representing the dorsal ramus of C3) extends also upward to the scalp, but for a relatively short distance.

Straight midline incisions, and curved ones along the temporal lines, lie in general between nerves; incisions connecting the two necessarily denervate some scalp, but if the skin flap is turned downward with its base left attached in the occipital region its innervation can be preserved.

VEINS

The veins of the scalp parallel the arteries. They receive many of the emissary veins of the cranium, and through these communicate with the cranial venous sinuses. The usual *emissary veins* are the parietal that penetrate the parietal bones posterior to their midpoints a little on each side of the midline, connecting the occipital veins and the superior sagittal sinus; one or more mastoid veins that penetrate the posterior aspect of the base of each mastoid process and connect the sigmoid sinuses to the occipital or posterior auricular veins; and the condylar (condyloid) veins, not as constant, that traverse the condylar (condyloid) canals and connect the confluence of the sinuses to the suboccipital venous plexus. Occasionally there is an unpaired occipital emissary vein penetrating the external occipital protuberance and connecting the confluence of the sinuses to an occipital vein.

Arteriovenous malformations, more common in the head than elsewhere, occur most frequently in the scalp; they may be continuous through the skull with similar endocranial formations, or formed by dural arteries which penetrate the skull—in either case, of course, being supplied by the external carotid system.

LYMPHATIC VESSELS

The lymphatic vessels from the frontal region of the scalp drain downward and backward into the superficial parotid (preauricular) lymph nodes; those from the parietal and temporal regions pass downward both in front of and behind the ear to end in the superficial parotid, superficial cervical, and retroauricular (mastoid) nodes, or bypass these and end directly in upper nodes of the deep cervical group; those from the occipital region drain for the most part into both the occipital and upper deep cervical nodes, but one large vessel from this region is said to follow the posterior

border of the sternocleidomastoid muscle to reach lower deep cervical nodes.

Sensitivity of the Scalp

Ray and Wolff, in their study of the pain-sensitive structures in the head, found that while the skin of the scalp is sensitive to all the usual forms of stimulation to which skin is elsewhere, the *galea aponeurotica* is sensitive only to pain; where the extracranial blood vessels are in close contact with the galea the pain sensitivity was found to be greater than at other points. Like the galea, the fascia over the temporal and occipital muscles, and these muscles themselves, were reported as sensitive only to pain, this pain being appreciated near the point of stimulus.

The *periosteum* on the outside of the skull was found to be variable in regard to its sensitivity, that over the vertex being entirely insensitive; there was a general increase in sensitivity just over the eyebrows, low in the temporal regions, and low in the occipital region—that is, in the areas in which the nerves were approaching the scalp. Even here, however, the periosteum apparently is not particularly sensitive, since stripping of periosteum around the base of the skull produced only moderate pain in the neighborhood of the point of stimulation.

The *arteries* of the scalp were all found to be sensitive to pain, while the veins were either less sensitive or not at all so.

The *bony skull* itself, as also its veins, was found to be insensitive to all types of stimulation.

THE CALVARIA

THE bony vault of the cranium, the calvaria, consists, from before backward, of the unpaired frontal bone, the paired parietals, and the unpaired occipital bone (Fig. 1-3). Laterally, the greater wings of the sphenoid bone, and posterior to them the temporal bones, complete the sides of the brain case.

The calvaria is of course covered with periosteum on both its outer and inner surfaces; the inner periosteum is fused to the dura, forming its outer layer. The periosteum of the skull is, however, markedly deficient in osteogenic power in the adult, as compared with the periosteum of long bones, and relatively little regeneration of the bones of the skull may be expected following a craniotomy unless the bone flap is replaced. Areas of bone removed and replaced in the temporal region usually heal better than bone elsewhere, presumably because of the greater blood supply furnished them by the deep temporal arteries.

The bones of the vault of the cranium show three distinct layers: hard external and internal laminae (outer and inner tables) and a cancellous middle layer or diploë. The inner table is distinctly thinner than is the outer, and may be fractured by blows that leave the outer table intact, thus rendering more difficult the diagnosis of fractures of the skull.

Surgical approaches to the cerebral hemispheres, both diagnostic and operative, are usually made through the calvaria, as are also approaches to the other contents of the anterior and middle cranial fossae. A preliminary step is trephining the calvaria at a suitable and relatively safe spot; through the trephine opening a needle or other small instrument can be inserted or if a larger opening is desired several trephine openings can be made, and connected by sawing through the intervening bone.

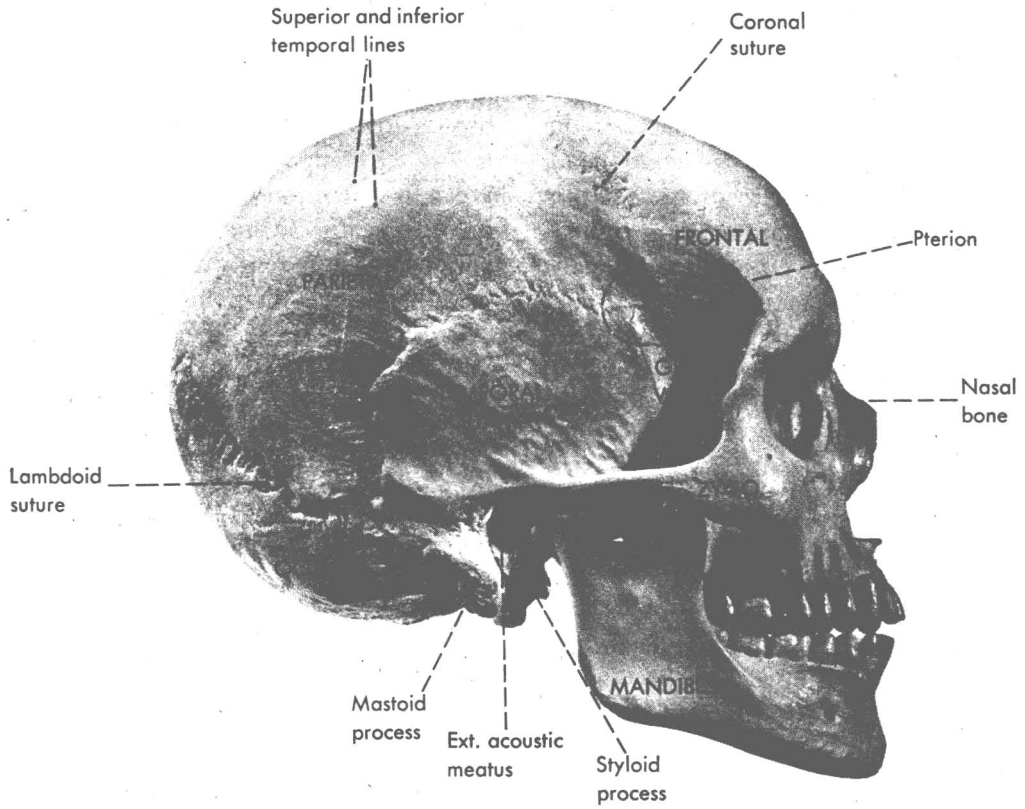

Fig. 1-3. Lateral view of the skull. MAX., OCC., SPH. GR. WING, and ZYGO. identify the maxillary and occipital bones, the greater wing of the sphenoid, and the zygomatic bone.

In planning trephine operations on the calvaria, factors to be considered are not only the relations of the calvaria to the various subdivisions of the cerebral hemispheres, but also the positions of the cranial venous sinuses—the superior sagittal and the transverse sinuses—related to the calvaria, and the position of the frontal sinus and the mastoid cells.

THICKNESS OF SKULL

The bony vault of the skull is relatively thick, averaging perhaps about 5mm., but average measurements of this are of little use to the surgeon. The thickness of the skull varies considerably with the individual, and in addition shows regional variations. It thus becomes much thicker in the region of the external occipital protuberance, and particularly thin in the temporal region, where it is, however, in part protected by the overlying temporal muscle. The thinness of the temporal region is taken advantage of in "turning" frontal and temporal bone flaps, by sawing through the thicker bone and leaving the base of the flap in the temporal region, where it can be relatively easily fractured.

DIPLOIC VESSELS

The diploë is supplied by small but numerous diploic branches from the ar-

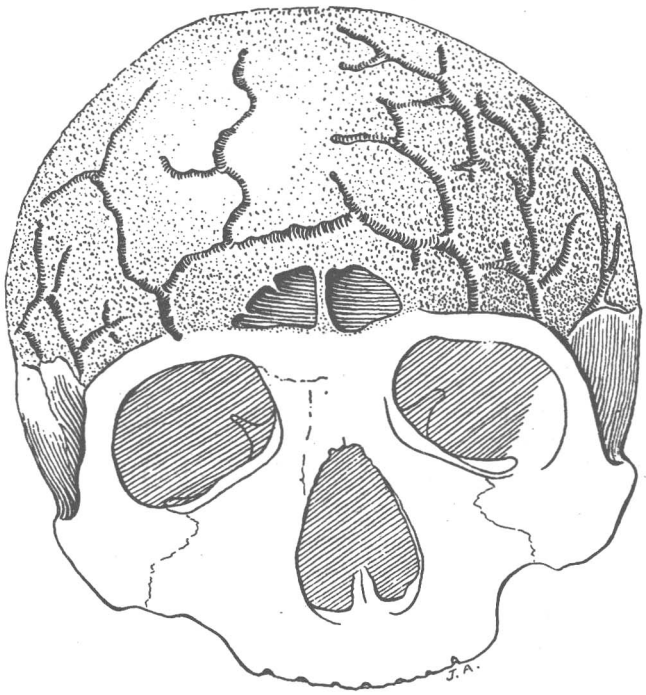

Fig. 1-4*a*. The diploic veins from the anterior aspect. (Redrawn from Jefferson, G., and Stewart, D.: *Brit. J. Surg. 16:*70, 1928.)

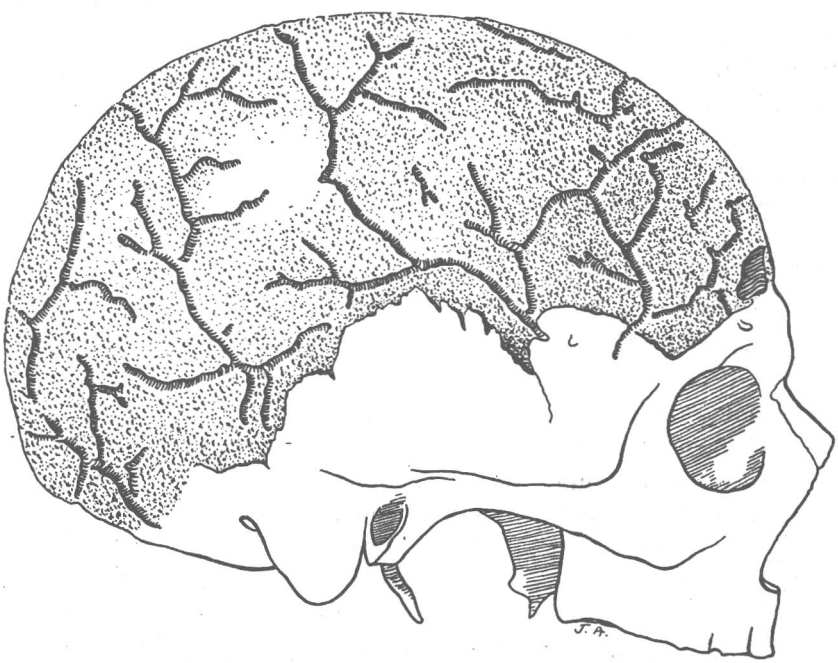

Fig. 1-4*b*. The diploic veins from the lateral aspect. (Redrawn from Jefferson, G., and Stewart, D.: *Brit. J. Surg. 16:*70, 1928.)