

Jaroslav Kos, Jiří Heřt,
and Jaroslava Hladíková

Survey of Topographical Anatomy

revised and updated by Josef Stingl,
David Kachlík, and Vladimír Musil

KAROLINUM

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Preface

The original text was published in 1964 by the anatomists Jaroslav Kos, Jiří Heřt and Jaroslava Hladíková from the Medical Faculty of Charles University in Pilsen. This publication was important in that it represented the first Czech post-war textbook of topographical anatomy based on Weigner's teachings. The first edition was an overwhelming success among medical students and physicians alike, as the topography of the entire body was described in a brief and understandable manner.

*The popularity of the text was echoed by its repeated republications and such was the demand that each subsequent edition was out of print within a short period of time, with the last edition being published over 20 years ago. The authors are of the opinion that this publication remains a valid and useful contribution to topographical anatomy and have as such decided to re-edit and republish a more modern form of the original text. This new and 'revitalised' edition contains the updated English and Latin Terminology (*Terminologia Anatomica*, Thieme, Stuttgart, New York, 1998), digitally enhanced diagrams and figures; and some minor changes to the original text. All cited authors are listed at the end of the text. Unofficial Latin terms, usually used in the Czech anatomy literature but not included in the *Terminologia Anatomica*, are designated by (–).*

It is our hope that this new edition will meet with the same popularity as the original, while at the same time will pay homage to the previous generations of authors whose contributions made this publication possible.

Prague, Spring 2014

Josef Stingl, David Kachlik, Vladimír Musil

Introduction to the first Czech edition (1964)

Following completion of teaching in systemic anatomy, lectures on topographical anatomy will commence in the second half of the third semester, the benefits of which are twofold. First, it allows the knowledge obtained during the study of systemic anatomy to act as a foundation in the further study of topographical anatomy and second, it provides the repetition required to prepare for the final exam.

Currently, there remains unavailable a single concise textbook of topographical anatomy. Weigner's five-volume monograph, utilised by the pre-war generations of physicians, is too extensive for medical students. The alternative 'Introduction to Topographical Anatomy' by prof. Žlábek, lacks the necessary illustrations and ceased editing a long time ago.

It is for this reason that we decided to publish our 'Survey of Topographical Anatomy', the content being based on the lectures at our medical school and the documentation comprising mainly schemes and regional sections drawn during those lectures. The diagrams and figures, although simple, were designed by the authors and finalised by the artists Mr. V. Kacerovský and Mrs. R. Smetanová from the Medical Faculty in Plzeň, and to whom we would like to express our sincere thanks.

Topographical anatomy of the head

Superficial border between the head and neck represents a line, running from the external occipital protuberance along the superior nuchal line to the external acoustic meatus; from here it extends along the posterior and inferior margin of the mandible to the chin (*mentum*). The deep border is represented by the external surface of the cranial base.

Topographically, the head can be subdivided into both the cerebral and facial part. The border between these divisions runs from the external acoustic meatus, along the zygomatic arch and superior margin of orbit, to the root of nose.

I. The Cerebral Part of the Head

Topography of the scalp

The cerebral part represents the neurocranium (brain vault), containing the brain and its meninges. The brain vault is further subdivided into the calvaria and cranial base. The calvaria can be, for practical purposes, subdivided into regions, each of which is bordered (approximately) by the extents of the particular bones (frontal, parietal, occipital and temporal region).

The external surface of the calvaria (of desmocranial origin) is covered by the soft scalp. Its layers consist of: 1. skin, 2. subcutaneous tissue, 3. epicranial aponeurosis (*galea aponeurotica*), 4. loose subgaleal connective tissue, 5. external periosteum. Internally to the (6.) calvaria, are 7. the layer of the inner periosteum, and 8. the dura mater with its sinuses, vessels and nerves.

1. **Skin.** This is very thick and its thickness increases in a ventrodorsal direction. It is covered by hair, except around the forehead (*frons*). Hair cover along the anterior border is sharp and blunt dorsally and laterally. Following hair loss, the skin atrophies and becomes smooth and glossy.
2. **Subcutaneous layer.** This consists of short bundles of connective tissue, radiating from the epicranial aponeurosis to the skin, with granular adipose tissue contained between the bundles.
3. **Epicranial aponeurosis.** This represents the flat tendinous centre of the epicranium. In man its remnants are the frontal belly ventrally and occipital belly dorsally, while bilaterally it attaches to the aponeurosis of the temporoparietalis.
4. **Loose subgaleal connective tissue.** This lacks adipose tissue and allows easy movement of the superficial layers against the periosteum. At the same time this can lead to 'scalpation' by dissection or injury. Injury to this space can also result in large haematomas. Sectional or incisional injuries involving only the skin and subcutaneous tissue do not dilate, while those that penetrate the epicranial aponeurosis into the subgaleal space tend to be very opened.

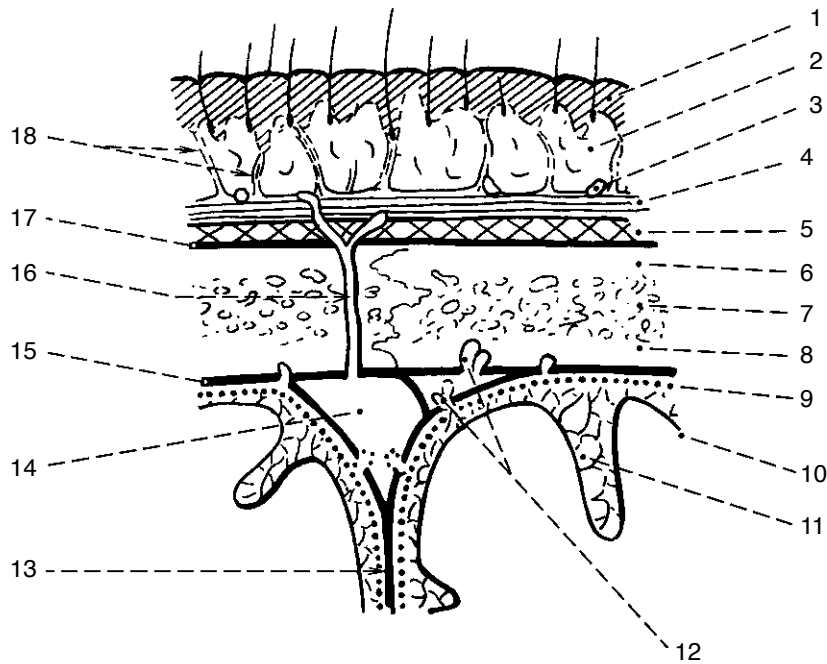


Fig. 1 Layers of the scalp on schematic section

1 – skin, 2 – subcutaneous tissue, 3 – blood vessels, 4 – epicranial aponeurosis (*galea aponeurotica*), 5 – subgaleal connective tissue, 6 – external table of calvaria, 7 – diploe, 8 – internal table of calvaria, 9 – arachnoidea mater, 10 – pia mater, 11 – subarachnoid space, 12 – arachnoid granulations, 13 – falx cerebri, 14 – superior sagittal sinus, 15 – dura mater, 16 – emissary vein, 17 – pericranium, 18 – connective tissue bundles between the epicranial aponeurosis and skin

5. **External periosteum, pericranium.** In adults and the elderly this remains firmly attached to the bones, most particularly around the sutures. In new-borns this layer can be easily peeled.

Blood supply and innervation of the scalp

Blood vessels and nerves are spread throughout the subcutaneous connective tissue, here they anastomose with one another and extend their branches into the superficial and deep layers of the scalp.

- a. **Arteries.** The frontal region is supplied by branches of the internal carotid artery, ophthalmic artery: supraorbital and supratrochlear arteries which extend from the orbit over its margin below the frontalis and continue into the subcutaneous layer. The superficial temporal artery, a terminal branch of the external carotid artery, arrives to the temporal region approximately 1cm ventrally to the external acoustic meatus (together with its vein and auriculotemporal nerve) and extends its frontal and parietal ramus. Both branches have a tortuous course and are well visible, particularly in older individuals. The occipital and parietal regions are supplied by the thinner posterior auricular artery and the larger occipital artery, originating from a horizontal position, approximately midway between the external occipital protuberance and mastoid process.
- b. **Veins.** These follow the arteries and drain the frontal region into the orbital and facial veins, the temporal region into the retromandibular vein and the occipital region into the external jugular vein.
- c. **Lymphatics.** These drain the frontal and anterior temporal regions into the parotid nodes, the parietal, posterior temporal and occipital regions into the occipital nodes. The efferent vessels of all these nodes continue to the superficial and deep cervical nodes.
- d. **Nerves.** The muscles of the scalp receive their motor innervation via branches of the facial nerve. Anterior to the interauricular line, sensory innervation comes from the trigeminal nerve (the frontal region by branches of the ophthalmic nerve, temporal region by the auriculotemporal

nerve and to a small extent the zygomaticotemporal nerve). Posterior to the interauricular line, the cervical nerves (lesser and greater occipital nerve) are responsible for sensory innervation. The small region behind the auricle is supplied by the great auricular nerve.

6. **Calvaria.** The bony cranial vault is constructed by the parietal bones and the squamous parts of frontal, temporal and occipital bones. The superficial convex surface is smooth, while the inner concave surface contains impressions of the sinuses, cerebral gyri and arachnoid granulations. The outer surface of the vault contains the compact external lamina of the cranial bones, a middle spongy diploe with canals for the diploic veins and the inner (again compact) internal lamina. The thickness of the entire wall is individually variable, the thinnest being the temporal region (2 mm) and occipital (5 mm), with thickness increasing ventrodorsally. The diploe of the frontal bone contains the variable sized frontal sinus, the internal surface of which is covered by thin mucosa, which continues into the mucosa of the nasal cavity.

The internal lamina of the cranial bones is more curved than the external one (with thickness varying ventrally, in the middle and dorsally) and contains many impressions and canaliculi, thus it is more fragile and susceptible to fracture during blunt head trauma.

Several emissary veins (parietal and mastoid) pass through the bony vault of the cranium, connecting superficial and intracranial venous systems.

In adults the cranial bones are connected to each other via sutures, whereas in newborns, fontanelles (*fonticuli*) are located in the regions of sutural crossings.

7. **Inner periosteal layer.** It is thinner than the outer one and is firmly attached to the cranial dura mater. Both layers can be easily isolated, one from the other, which happens typically in epidural bleeding (from the disrupted meningeal arteries or venous sinuses). On the other hand, the cranial dura mater is attached to the periosteum in the sutures, which is the reason why the epidural hematomas do not pass over the sutures. Therefore, these hematomas appear on the X-ray, CT scans and MRI as shadows of a spindle-like shape.
8. **Cranial dura mater.** This covers the inner surface of the cranial bones and contains the sinuses, blood vessels, and nerves. To the inner face of the cranial dura mater is attached a doubled layer of the soft meninges – the outer avascular cranial arachnoidea mater and the inner cranial pia mater. Between both layers is the subarachnoid space, containing the cerebrospinal fluid. The richly vascularized cranial pia mater covers the brain surface along its all curvatures. According to the type of the disruption of the blood vessels they are distinguished as epidural, subdural and subarachnoid bleedings. Epidural bleeding is a result of blood leakage between the inner periosteal layer and the cranial dura mater, which forms an artificial epidural space(–) – see above. Subdural bleeding is a result of blood leakage into the space between the cranial dura mater and the cranial arachnoid mater (mostly from the disrupted bridging veins – terminal parts of the superficial cerebral veins before their openings into the intracranial sinuses) this kind of hematoma leads to the formation of another artificial space, the subdural space(–); this hematoma passes over the sutures and its contours are of a half-moon shape. The subarachnoid bleeding appears as a blood leakage into the cerebrospinal fluid in the real subarachnoid space (from the disrupted arteries or aneurysms of the Willis' circle). Intracerebral (parenchymatous) bleeding is a result of the blood leakage from lesser arteries within the cerebral parenchyma leading to the mechanical damage of the surrounding cerebral tissue.

Temporal region

Aside from the layers of the scalp, this region also contains the temporalis muscle. It is bordered cranially by the superior temporal line, ventrally by the zygomatic process of the frontal bone and caudally by the zygomatic arch.

The superficial temporal artery and its rami, followed by veins and the terminal branches of the auriculotemporal nerve, run within the subcutaneous layer of the region. Below the subcutaneous

temporoparietalis is located the thick aponeurotic temporal fascia which covers the temporalis. The temporalis occupies the entire temporal fossa, i.e. the space between the fascia and bone, and is attached to the top and medial face of the coronoid process of mandible.

The temporal fossa is narrowest by the superior temporal line and enlarges more caudally and ventrally, where it seamlessly continues into the facial region, through the infratemporal gap between the zygomatic arch and infratemporal crest. The space between the fascia and muscle contains loose adipose tissue and continues further along the coronoid process of mandible into the buccal fat pad (see further).

The deep temporal arteries, branches of the maxillary artery and deep temporal nerves from the mandibular nerve for the temporalis run beneath the muscle. The veins follow the arteries and drain blood into the pterygoid plexus, while the lymphatics open into the parotid nodes.

The dura mater and middle meningeal vessels run through the intracranial surface of this region, the path of which can be seen on the surface of the skull with the help of several projection lines. Our description is based on Kroenlein's system.

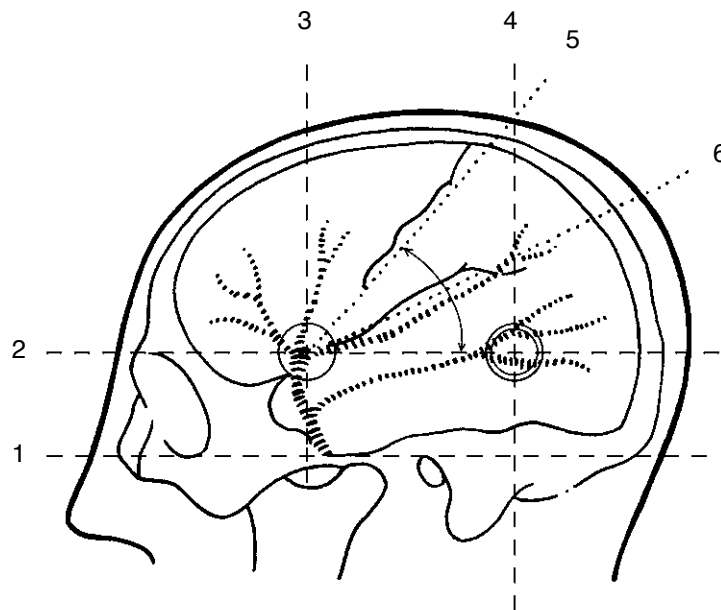


Fig. 2 Kroenlein's craniocerebral projections (after Weigner). Explanation see in the text

The projections described by Kroenlein (Fig. 2) use 4 supporting lines:

1. Auriculo-orbital horizontal line (the so-called horizontal line of Frankfurt), connects the inferior margin of the orbit with the superior margin of the external acoustic meatus;
2. supraorbital horizontal line, located parallel to the previous line and passing the superior margin of the orbit;
3. zygomatic vertical line, located perpendicular to the previous lines and running through the middle of the zygomatic arch;
4. retromastoid vertical line, which runs along the posterior margin of the mastoid process.

The stem of the middle meningeal artery crosses the junction of the auriculo-orbital and zygomatic lines, while its frontal and parietal branches traverse the crossings of the zygomatic and retromastoid vertical lines with the supraorbital line.

It is possible to open the skull at these locations for ligation of the aforementioned branches of the middle meningeal artery if injured.

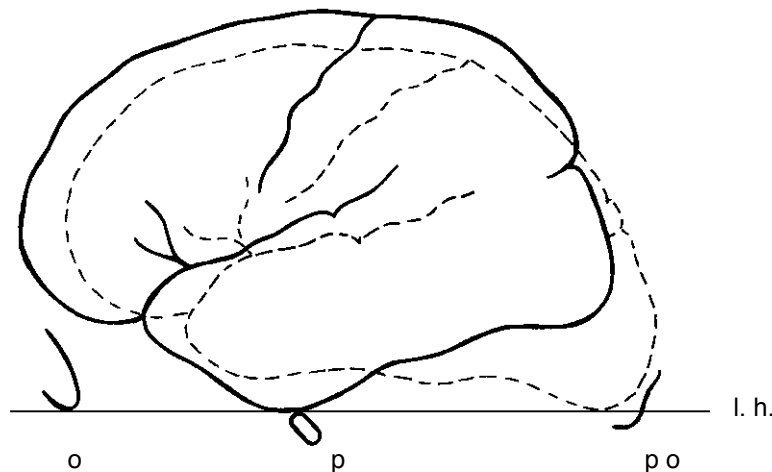


Fig. 3 **Brain of frontipetal (full line) and occipitopetal (interrupted line) type, after Froriep** (partially after Weigner)
(o – inferior orbital margin; p – external acoustic meatus; po – external occipital protuberance; l. h. – auriculo-orbital horizontal line)

The aid and, more importantly, the knowledge of these lines enables the understanding of important projections of cerebral sulci and gyri on the skull surface:

- the central sulcus (of Rolando) projects onto the so called Roland line (5) and connects the anterior trepanation point with the crossing of the posterior vertical with the midline. The precentral gyrus projects anterior to the Roland line, with the postcentral gyrus behind;
- the lateral cerebral sulcus (of Sylvius): its posterior ramus projects into the so called Sylvius line (6), dividing the angle between the Roland and superior horizontal lines. The end of the sulcus reaches the posterior vertical line. The Sylvius line allows the identification of the projections of the gyri, sulci and centers localized along the lateral sulcus.

Note: Kroenlein's description is valid more for frontipetal-shaped brains and less for those of occipitopetal shape. Frontipetal brains are those that appear in short, high skulls where the brain is contained ventrodorsally and the central sulcus is oriented vertically.

The occipitopetal-shaped brain is present in long and low skulls, where the central sulcus is oriented more dorsally.

The configuration of the occipital bone plays an important role in the formation of these types of brains. Those of frontipetal type tend to have a shorter occipital bone behind the external acoustic meatus and an external occipital protuberance that runs above the auriculo-orbital line; whereas, those of occipitopetal type tend to have a longer occipital bone and an external occipital protuberance that reaches the auriculo-orbital line; or running just below it.

Projection of the lateral ventricles

The frontal horn of the lateral ventricle reaches the vertical line, passing the border between the anterior and middle third of the zygomatic arch, averaging with its distance from the forehead surface some 6–7 cm.

The occipital horn of the lateral ventricle touches the vertical line running 5 cm dorsally from the tip of the mastoid process and is approximately 4 cm deep from the skull surface. In the vertical aspect, the posterior ventricle extends between two horizontal plains: the first running 2 cm, and second 5 cm above the zygomatic arch. The temporal horn of the lateral ventricle is located some 4–5 cm from the temporal surface.

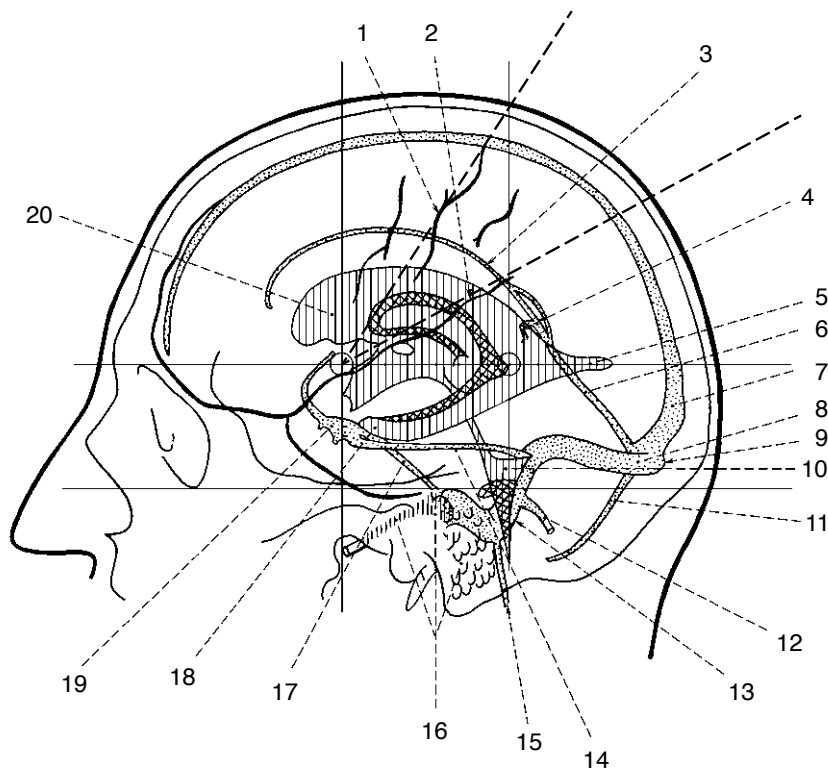


Fig. 4 Projection of the sinuses and cerebral ventricles onto the surface of the skull

The projection of the choroid plexuses is labelled 'X' (after Pernkopf)

1 – central sulcus, 2 – lateral sulcus, 3 – inferior sagittal sinus, 4 – great cerebral vein, 5 – occipital horn, 6 – straight sinus, 7 – superior sagittal sinus, 8 – transverse sinus, 9 – confluens sinuum, 10 – fourth ventricle, 11 – occipital sinus, 12 – mastoid emissary vein, 13 – sigmoid sinus, 14 – superior petrosal sinus, 15 – condylar emissary vein, 16 – auditory tube, tympanic cavity, mastoid cells, 17 – inferior petrosal sinus, 18 – temporal horn, 19 – cavernous sinus, 20 – frontal horn

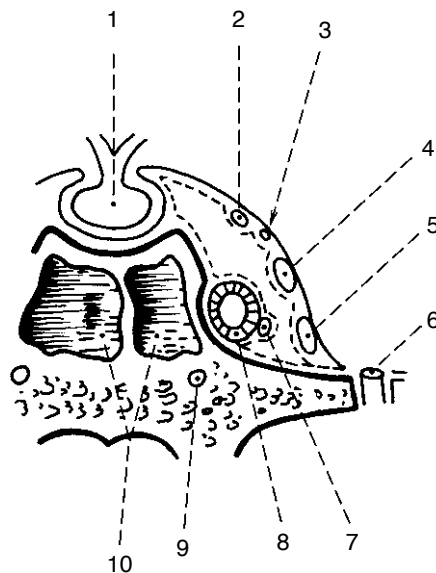


Fig. 5 Cavernous sinus and its relationship to the nerves and to the internal carotid artery

1 – pituitary gland, 2 – oculomotor nerve, 3 – trochlear nerve, 4 – ophthalmic nerve, 5 – maxillary nerve, 6 – mandibular nerve, 7 – abducent nerve, 8 – internal carotid artery, 9 – nerve of pterygoid canal, 10 – sphenoidal sinus