Jaroslav Kos, Jiří Heřt,
and Jaroslava Hladíková

Survey of Topographical Anatomy

revised and updated by Josef Stingl,
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KAROLINUM

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Translated based on the Czech original
(*Přehled topografické anatomie* published
by Karolinum Press in 2014) by Josef Stingl.

Co-operation on illustrations with Johana Hrabíková Vojnárová.

Published by Charles University in Prague, Karolinum Press
Ovocný trh 3–5, 116 36 Prague 1, Czech Republic
Prague 2014
Edited by Alena Jirsová
English language supervision by Bruce O'Donnell, M.D.,
and Peter Kirk Jensen
Layout by Jan Šerých
Typeset by Karolinum Press
First English, revised, and updated edition

ISBN 978-80-246-2820-2
ISBN 978-80-246-2837-0 (pdf)

Univerzita Karlova v Praze
Nakladatelství Karolinum 2015

www.karolinum.cz
ebooks@karolinum.cz

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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 nut 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 Kachlík, 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 subgalear 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 epicranius. 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 subgalear 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 subgalear space tend to be very opened.

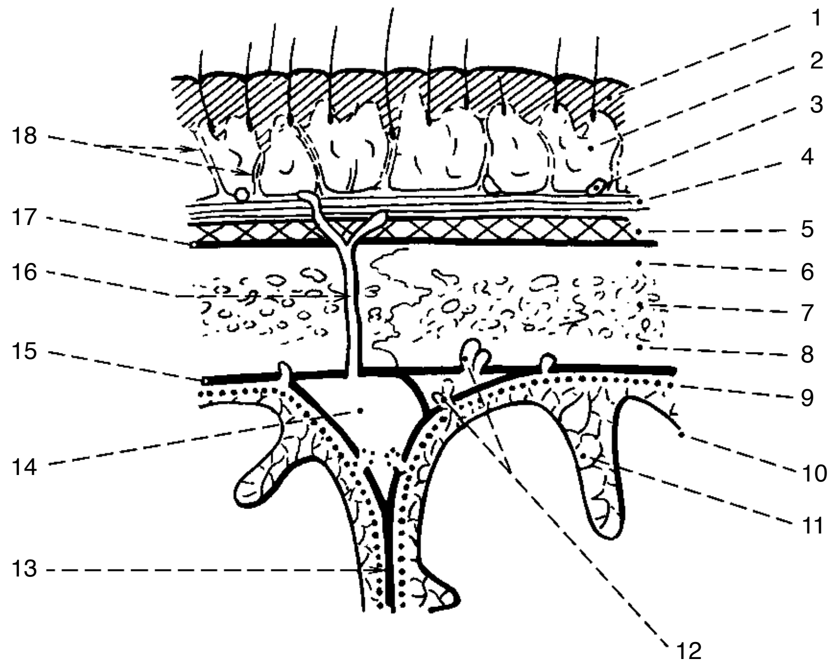

Fig. 1 **Layers of the scalp on schematic section**

1 – skin, 2 – subcutaneous tissue, 3 – blood vessels, 4 – epicranial aponeurosis (*galea aponeurotica*), 5 – subgalear 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 ventrodorsaly. 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 subaranchnoid bleedings. Epidural bleeding is a result of blood leakage between the inner periostal 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.

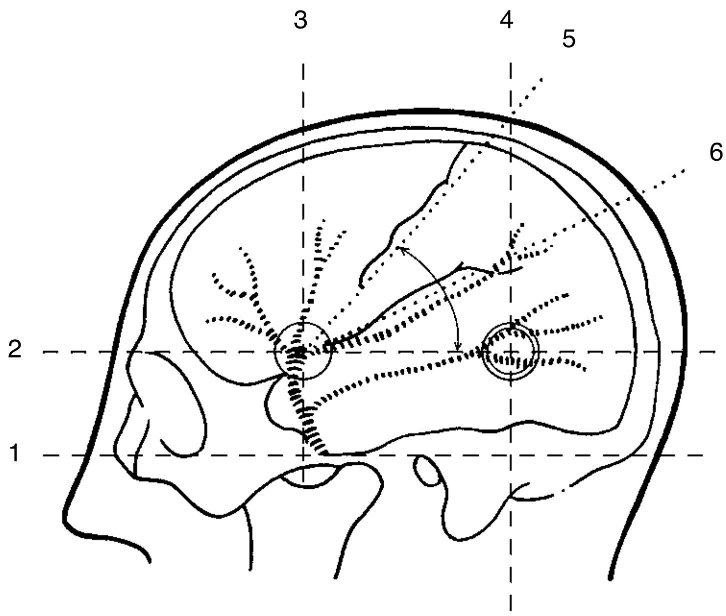

Fig. 2 **Kroenlein's craniocerebral projections** (after Weigner). Explanation see in the text

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.

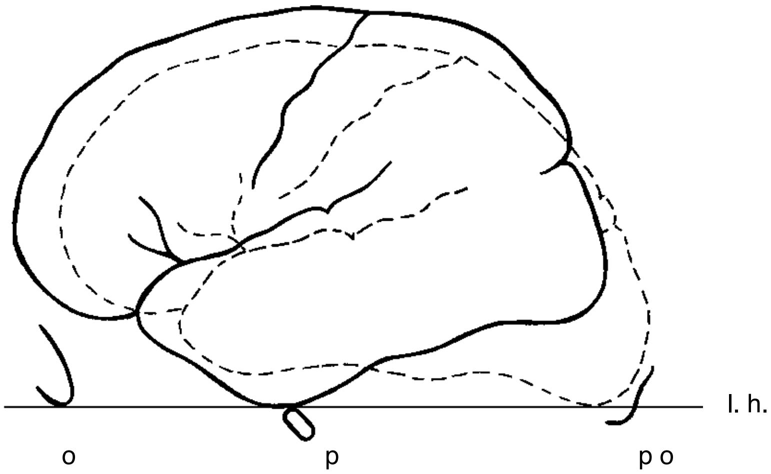

Fig. 3 **Brain of frontipetal (full line) and occipitopetal (interrupted line) type, after Froriep** (partially after Weigner) (o – inferior orbital margin; p – external acoustic meatus; po – external occipital protuberance; l. h. – auriculo-orbital horizontal line)

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.

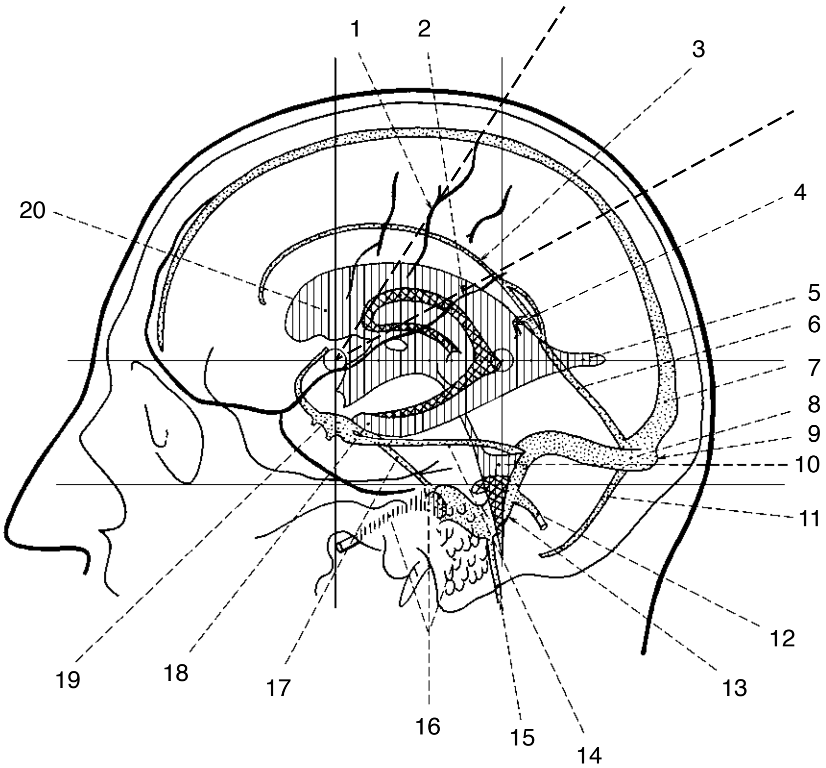

Fig. 4 **Projection of the sinuses and cerebral ventricles onto the surface of the skull**
The projection of the choroid plexuses is labelled 'X' (after Pernkopf)
1 – central sulcus, 2 – lateral sulcus, 3 – inferior sagittal sinus, 4 – great cerebral vein, 5 – occipital horn, 6 – straight sinus, 7 – 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

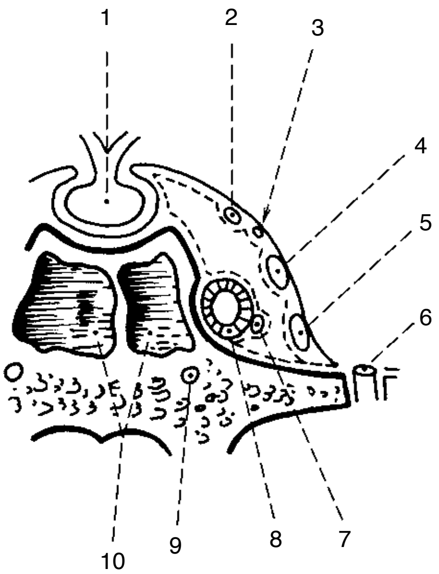

Fig. 5 **Cavernous sinus and its relationship to the nerves and to the internal carotid artery**
1 – pituitary gland, 2 – oculomotor nerve, 3 – trochlear nerve, 4 – ophthalmic nerve, 5 – maxillary nerve, 6 – mandibular nerve, 7 – abducent nerve, 8 – internal carotid artery, 9 – nerve of pterygoid canal, 10 – sphenoidal sinus

Projection of dural venous sinuses (Fig. 4)

1. The superior sagittal sinus extends ventrodorsally along the midline, shifting slightly to the right as the left hemisphere is usually larger than the right.
2. Confluens sinuum is marked by the external occipital protuberance.
3. The transverse sinus projects onto the line connecting the superior margin of the external acoustic meatus with the external occipital protuberance. The sinus is slightly elevated along the base of the mastoid process, turns at a right angle caudally and continues on as the sigmoid sinus at the angle of the parietal bone.
4. The sigmoid sinus flows to the jugular foramen, located in the sigmoid sulcus (which is occasionally flat and quite deep) and projects onto the dorsal aspect of the mastoid process, where it has an important relationship with the mastoid cells and tympanic cavity. The bony wall which separates them is generally paper-thin and should be carefully considered during middle-ear trepanation.
5. The cavernous sinus is situated bilaterally to the sella turcica of the sphenoidal bone and has an important relationship to the blood vessels and nerves (Fig. 5).

The internal carotid artery, embraced by sympathetic nervous fibers (internal carotid plexus), leaves the carotid canal and enters the sinus, moving ventrally and turning upwards against the cerebral base. From here the hypophysial arteries and ophthalmic artery extend, with the wall being connected by bundles of connective tissue which bridge across the sinus. The abducent nerve remains in close contact with the lateral side of the artery. The oculomotor, trochlear and ophthalmic nerve (n.V1) move along the lateral wall of the sinus, pass through the superior orbital fissure into the orbit, while the maxillary nerve (n.V2) traverses the lateral wall of the sinus before passing through the foramen rotundum.

Internal surface of cranial base (Fig. 6)

Its shape and detailed description are covered in systemic anatomy. The borders between the particular fossae can be identified on the surface with the aid of two lines, extending from the mastoid process on one side to the zygomatic process on the contralateral frontal bone. The lines transect each other at the sella turcica.

1. The anterior cranial fossa has a relationship with the inferior face of the frontal cerebral lobe (orbital gyri, straight gyrus). The olfactory bulb is located on the cribiform plate which transmits the olfactory nerves (*fila olfactoria*) from the nasal cavity. The anterior ethmoidal artery and vein also pass through this region, extending thin anterior meningeal vessels. The optic canal is located in the base of the lesser wing of the sphenoidal bone and contains the optic nerve and ophthalmic artery.
2. The middle cranial fossa contains the temporal cerebral lobe, with the relationships between the various fissures and gyri being demonstrated in the diagram. The sella turcica contains the pituitary gland, which is covered by cranial dura mater (sellar diaphragm) and on which lays the basal surface of the hypothalamus. The cavernous sinus is located along the sides of the sphenoidal bone, along with its vessels and nerves (see above).

Superior to the trigeminal impression around the apex of the petrous part of the temporal bone, the cranial dura mater forms a small space known as the trigeminal cavity (of Meckel), containing the trigeminal ganglion (of Gasser). Caudally, the greater and lesser petrosal nerves run transversally, passing through the sphenopetrosal synchondrosis. The mandibular nerve leaves the middle cranial fossa through the foramen ovale and is joined by the venous plexus of foramen ovale that connects the cavernous sinus with the pterygoid plexus. Laterally, through the foramen spinosum, run the middle meningeal vessels and the meningeal branch of the mandibular nerve.

The inferior surface of the occipital lobe lays on the cerebellar tentorium, covering the posterior cranial fossa. The relationships between the particular gyri and the tentorium are outlined in Fig. 6.

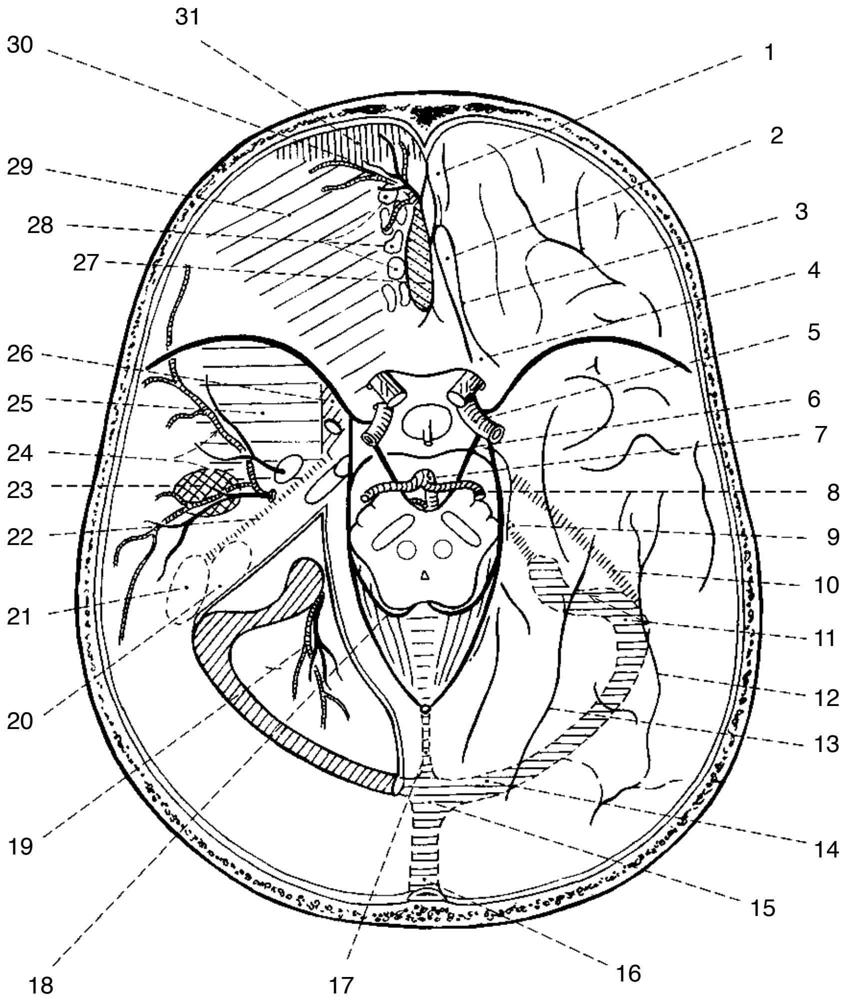

Fig. 6 **Relationships of the internal surface of cranial base to the inferior surface of brain (right) and to the regions and structures on the external cranial base (left). The topography of the tentorial notch.** (Combined after different authors)
1 – straight gyrus, 2 – olfactory bulb, 3 – olfactory tract, 4 – olfactory triangle, 5 – internal carotid artery, 6 – oculomotor nerve, 7 – basilary artery, 8 – posterior cerebral artery, 9 – inferior petrosal sinus, 10 – superior petrosal sinus, 11 – sigmoid sinus, 12 – inferior temporal sulcus, 13 – collateral sulcus, 14 – transverse sinus, 15 – confluens sinuum, 16 – superior sagittal sinus, 17 – straight sinus, 18 – trochlear nerve, 19 – posterior meningeal vessels and meningeal branch of ascending pharyngeal artery, 20 – cavities of inner ear, 21 – tegmen tympani, 22 – auditory tube, 23 – mandibular fossa, 24 – middle meningeal vessels and nerve, 25 – infratemporal fossa, 26 – pterygopalatine fossa, 27 – nasal cavity, 28 – ethmoidal labyrinth, 29 – roof of orbit, 30 – anterior meningeal vessels and nerve, 31 – frontal sinus

3. The posterior cranial fossa contains the cerebellum, the anterior surfaces of the mesencephalon, the pons and the medulla oblongata (the basilar artery runs along their ventral surfaces and reaches the clivus). The superior surface of the cerebellum is covered by the tentorium cerebelli which contains the superior petrosal sinus laterally, the rectus sinus medially and the transverse sinus dorsolaterally.

The openings and contents of the posterior cranial fossa include: n. VII and n. VIII run through the internal acoustic meatus; n. IX, n. X and n. XI are contained in the ventromedial part of the jugular foramen, while the transition of the sigmoid sinus into the superior bulb of the internal jugular vein is located in its dorsolateral part; the hypoglossal canal contains the hypoglossal nerve and a venous plexus. The spinal cord continues into the medulla oblongata one through the foramen magnum (of the occipital bone). The spinal root of the accessory nerve and the vertebral artery also pass through the foramen magnum into the cranial cavity, the latter extending the anterior spinal artery backward into the vertebral canal, and also the posterious spinal arteries (branches from the posterior inferior cerebellar artery) and the venous connections between the marginal sinus, veins of the spinal cord and the suboccipital venous plexus. The sigmoid sinus is connected to the superficial veins via the mastoid emissary vein.

The topographical relationships of the tentorial notch (*incisura tentorii*) (Fig. 6)

are clinically significant for a number of reasons. For example, the tentorial notch contains the mesencephalon, whose peduncle may be compressed laterally by a tumor. This can lead to a compression of the corticopontine tracts (clinical signs are generally absent) or in more serious cases, compression of the corticospinal tracts, in particular the lateral part, which contains the tracts to the lower extremities. Minor compression can result in paresis of the lower extremities, while increased pressure can lead to paresis of the upper extremities. This impression of the cerebellar tentorium into the peduncle is called the crescent of Kernohan-Woltman.

The oculomotor nerve is located in the interpeduncular fossa on the ventral side of the mesencephalon, where it runs ventrolaterally towards the cavernous sinus. Superior to the nerve, the posterior cerebral artery passes laterally and inferior to the nerve, runs the superior cerebellar artery; thus, the oculomotor nerve is located between the two arteries.

The trochlear nerve, whose intracranial segment is the longest of all cranial nerves, exits the mesencephalon on its dorsal surface, travels along the tentorial notch where it enters the cavernous sinus below the fold of the notch.

The relationship of the parahippocampal gyrus and the hypothalamus to the tentorial notch are also of clinical importance, as some pathological processes (tumors, edemas) can result in these structures being compressed within the notch (tentorial herniation, temporal conus).

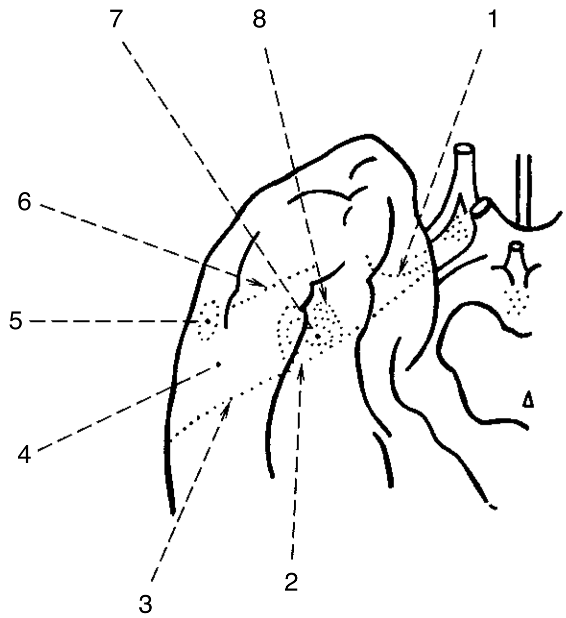

Fig. 7 **The relationship between the inferior surface of the cerebral temporal lobe to the anterior surface of the petrous part of the temporal bone** (after Waljaschek and Weigner)

1 – trigeminal impression, 2 – arcuate eminence, 3 – groove for superior petrosal sinus, 4 – tegmen tympani, 5 – external acoustic meatus, 6 – petrosquamos suture, 7 – vestibule, 8 – cochlear cupula

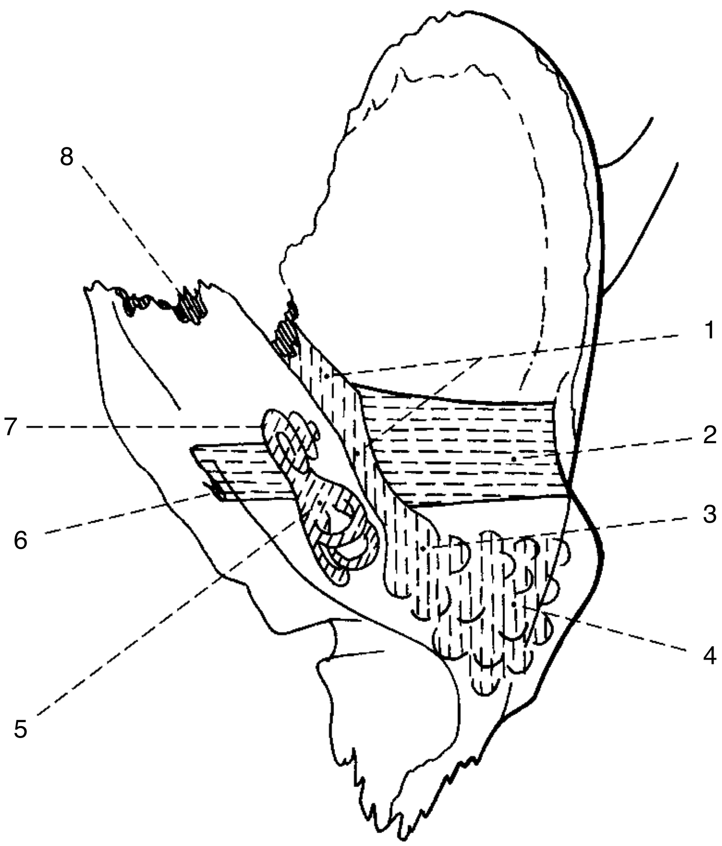

Fig. 8 **Projection of the bony labyrinth, middle ear cavities and meatus onto the anterior surface of the petrous part of the temporal bone, viewed from a superior aspect** (after Pernkopf)
1 – musculotubal canal, tympanic cavity, 2 – external acoustic meatus, 3 – mastoid antrum, 4 – mastoid cells, 5 – vestibule, semicircular canals, 6 – internal acoustic meatus, 7 – cochlea, 8 – carotid canal

External surface of the cranial base

1. The middle aspect of the anterior cranial fossa lies superior to the ceiling of the nasal cavity, separated by the cribiform plate. This narrow strip faces the continuation of the ethmoidal labyrinth from below, while the remainder of the fossa represents the ceiling of the orbit. In certain cases, this ceiling may be doubled (due to an enlarged frontal sinus) or contain a greater amount of openings (osteoporosis in the elderly), with the periorbita attaching to the dura mater.
2. The central part of the middle cranial fossa faces the relationship between the sphenoidal bone and the sphenoidal sinus, which extends into the anterior part of the base of occipital bone. It is also the point at which the ceiling of the pharynx projects from below.
   From the sides of the body of the sphenoidal bone, the pterygopalatine fossa extends to a small extent around the foramen rotundum, while the infratemporal fossa, tempomandibular joint, auditory tube and the parapharyngeal space extend laterally. The contents of these spaces will be discussed later.
   In the extent of the petrous part of temporal bone, the middle cranial fossa neighbors with the cavities of the middle and inner ear (Fig. 8), in a lateromedial direction: with the middle ear cavity and with the anterior semicircular canal (placed below the arcuate eminence), medially with the vestibule.
3. The atlanto-occipital joint projects in the posterior cranial fossa lateral to the foramen magnum, and the attachments of the suboccipital muscles constitute the remainder of the inferior surface of the cranial base.

The sulcus of the occipital artery passes medially along the origin of the posterior belly of digastric (which inserts at the mastoid notch).

Skull architecture demonstrating weakened and strengthened regions (Fig. 9)

Illumination of the skull internally can allow visible identification of the weakened regions against those areas of increased osseous thickening. Knowledge of these areas can help us understand not only the physical properties of the skull, but also assist in the analysis of fractures to the cranial base. Osseous thickening is amplified around the foramen magnum and from this point strong osseous strips tend to extend ventrally to the sides of the body of the sphenoidal bone. From this basic osseous origin, additional strips can be observed:

1. Extending dorsally from the foramen magnum to the internal occipital protuberance in an arch-like fashion along the midline to the glabella of the frontal bone.
2. Extending ventrolaterally along the lesser wings of the sphenoidal bone.
3. Extending dorsolaterally along the petrous part of the temporal bone.

Weakened areas are located between the amplified osseous strips and tend to contain numerous openings for blood vessels and nerves.

Blunt force trauma tends to result in so-called indirect fractures to the weakened areas of the cranial base. Fracture lines extend from the anterior cranial fossa through the ceiling of the nasal cavity to the optic canal; from here they extend into the middle cranial fossa to the foramen rotundum, ovale and spinosum; and then into the temporal squama, usually over the tegmen tympani. Fracture lines in the posterior cranial fossa generally run from the foramen rotundum through the hypoglossal canal to the jugular foramen, where they tend to continue through the internal acoustic meatus to the foramen spinosum. Fractures of the petrous part of temporal bone part frequently tend to reach the cavities of the inner ear.

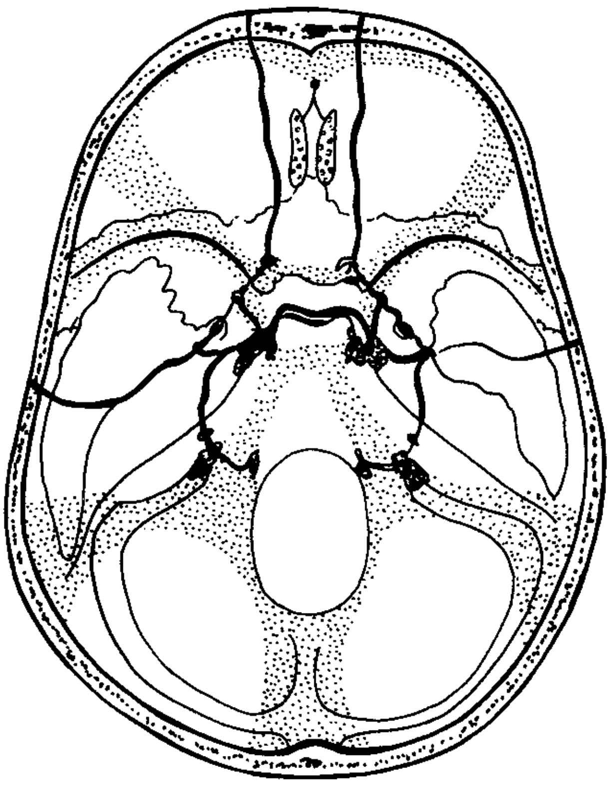

Fig. 9 **The amplified (dotted lines) areas where fractures of the cranial base occur most frequently (solid lines)** (after Weigner and Corning)

Infratemporal fossa

The borders and descriptions of this region differ with each author and its subdivision into various compartments varies with each textbook. As a result we will attempt to describe this region in the easiest and most relevant way possible.

The infratemporal fossa is located below the temporal fossa. Its lateral wall is formed by the ramus of the mandible, the medial wall by the pharynx and the anterior wall by the maxillary tuberosity. Ventrally and caudally below the maxillary tuberosity, the region travels seamlessly into the submandibular triangle, along the external surface of the buccinator where it continues to the facial region. The superior

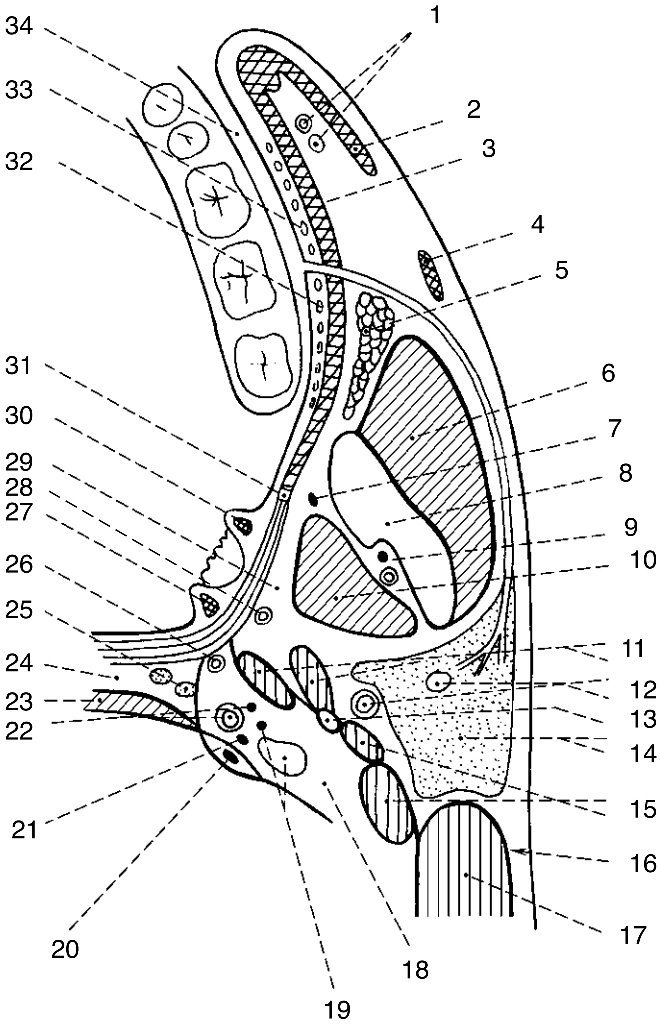

Fig. 10 **Horizontal section through the face and infratemporal region** (after Pernkopf)
1 – facial artery and vein, 2 – zygomaticus minor, 3 – buccinator, 4 – zygomaticus major, 5 – buccal fat pad, 6 – masseter, 7 – lingual nerve, 8 – ramus of the mandible, 9 – pterygomandibular space, 10 – medial pterygoid, 11 – stylopharyngeus and styloglossus, 12 – retromandibular vein and external carotid artery, 13 – styloid process, 14 – parotid gland, 15 – stylohyoid and posterior belly of the digastric, 16 – styloid septum, 17 – sternocleidomastoid, 18 – retrostyloid space, 19 – internal jugular vein and n. XII, 20 – sympathetic trunk, 21 – n. X, 22 – internal carotid artery and n. XI, 23 – longus colli, 24 – retropharyngeal space, 25 – retropharyngeal lymph nodes, 26 – ascending pharyngeal artery, 27 – palatopharyngeus, 28 – ascending palatine artery, 29 – prestyloid space, 30 – palatoglossus, 31 – pterygomandibular raphe, 32 – molar glands, 33 – bucal glands, 34 – oral vestibule