

učební texty Univerzity Karlovy v Praze

**TOPOGRAPHICAL  
ANATOMY** Jiří Valenta  
Pavel Fiala  
**WITH AUTOPSY GUIDE  
AND CLINICAL NOTES**

# Topographical Anatomy with Autopsy Guide and Clinical Notes

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Published by Charles University in Prague, Karolinum Press

as a teaching text for the Faculty of Medicine in Pilsen

Prague 2013

Typeset by DTP Karolinum Press

Second edition

© Charles University in Prague, 2013

Illustrations © Pavel Fiala, 2013

Text © Jiří Valenta, Pavel Fiala, 2013

The text has not been revised by the publisher

ISBN 978-80-246-2210-1

ISBN 978-80-246-2646-8 (online : pdf)



Charles University in Prague  
Karolinum Press 2014

<http://www.cupress.cuni.cz>



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# PREFACE

This short synopsis of topographical anatomy is intended for medical students who already have a good knowledge of systemic anatomy. The chapters follow the arrangement usual in anatomy coursebooks, i.e. according to the parts of the body: head, neck, chest, pelvis, back, and extremities. The text is accompanied by simplified drawings; however, for detailed information the student has to consult an anatomy atlas. In this second edition several new drawings were added, some chapters were revised and the clinical notes were extended. The short autopsy guide presents the most common approaches to anatomical dissection. As other approaches are also possible, the student has to follow the teacher's instructions in the autopsy room.

The authors hope that the students will find these lecture notes useful.

*Jiří Valenta, Pavel Fiala*





# 1 TOPOGRAPHY OF THE HEAD

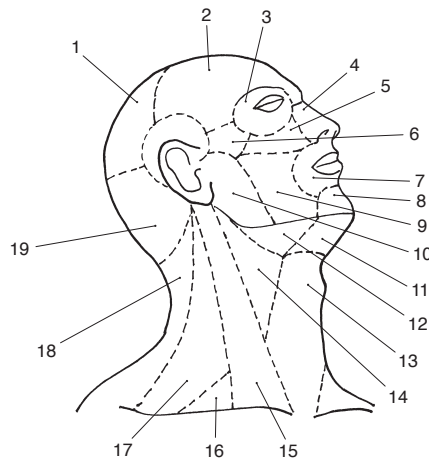
The head–neck boundaries are given by a line running from the external occipital protuberance to the external acoustic meatus and forward alongside the mandible to the chin.

**Cerebral part** and **facial part** are divided by a line going from the external acoustic meatus alongside the zygomatic arch and the upper border of the orbit.

## 1.1 Cerebral part of the head

### 1.1.1 Superficial regions of the head, cranium and cranial base

Superficial regions of the cerebral part correspond with the bones of the calvaria: frontal, parietal, temporal and occipital region (Fig. 1.1).



**Fig. 1.1 Regions of the face and neck**

1 – parietal region, 2 – frontal region, 3 – orbital region, 4 – nasal region, 5 – infraorbital region, 6 – zygomatic region, 7 – labial (oral) region, 8 – mental region, 9 – buccal region, 10 – parotidomasseteric region, 11 – submental region, 12 – submandibular region, 13 – anterior (muscular) region of the neck, 14 – carotid trigone, 15 – sternocleidomastoid region, 16 – omoclavicular region, 17 – omotrachezium region, 18 – posterior cervical region, 19 – occipital region

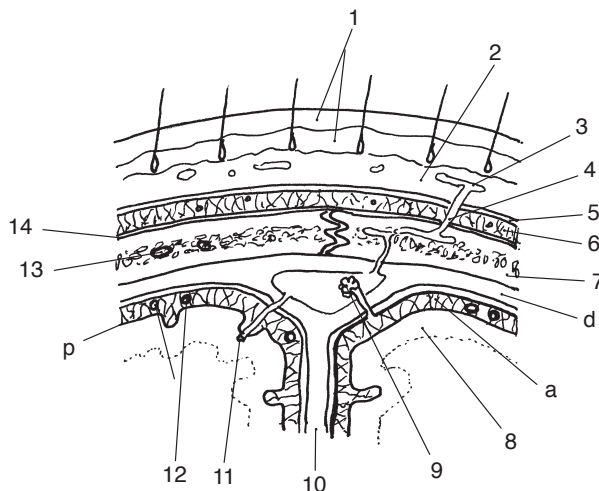
*Skin* is thick, in parietal, temporal and occipital regions covered by hair. Arterial supply is generous by supraorbital and supratrochlear artery (from the ophthalmic artery) and by superficial temporal and occipital artery (from the external carotid artery). Venous drainage of the orbital region is directed to the ophthalmic vein, otherwise to the retromandibular, internal and external jugular veins. Skin is innervated by the supraorbital and supratrochlear nerves (supraorbital foramen is the palpation point for CN V<sub>1</sub>), auriculotemporal nerve (CN V<sub>3</sub>), great auricular and lesser occipital nerves (cervical plexus), and greater occipital nerve (dorsal ramus C2). Lymphatics drain into the parotid, infraauricular, retroauricular and occipital lymph nodes.

*Epicranium muscle* under the skin consists of the anterior (frontal) and the posterior (occipital) belly and the tendinous galea aponeurotica. Into the galea inserts also the temporoparietalis muscle which originates from the auricular cartilage. Galea is firmly attached to the skin, under the galea is a thin layer of loose connective tissue enabling free movement (and scalpatation) against the pericranium

*Bone* has two parts – calvaria and basis.

*Calvaria* is formed by frontal, temporal, parietal and occipital bones. External and internal compact layers are covered by periosteum (external periosteum is called pericranium), between them is a spongy bone with many veins (diploe).

*Meninges*: Dura mater is attached to the periosteum. The meningeal vessels run in the potential *epidural space* between the periosteum and the dura mater. The most important is the middle meningeal artery (branch of the maxillary artery). In the folds of dura mater are the venous sinuses. Veins from the cerebral cortex cross through the *subdural space* mainly to the superior sagittal sinus. The next layer is the arachnoidea. The *subarachnoideal space*, between the arachnoidea and the pia mater, contains the cerebrospinal fluid (Fig. 1.2).

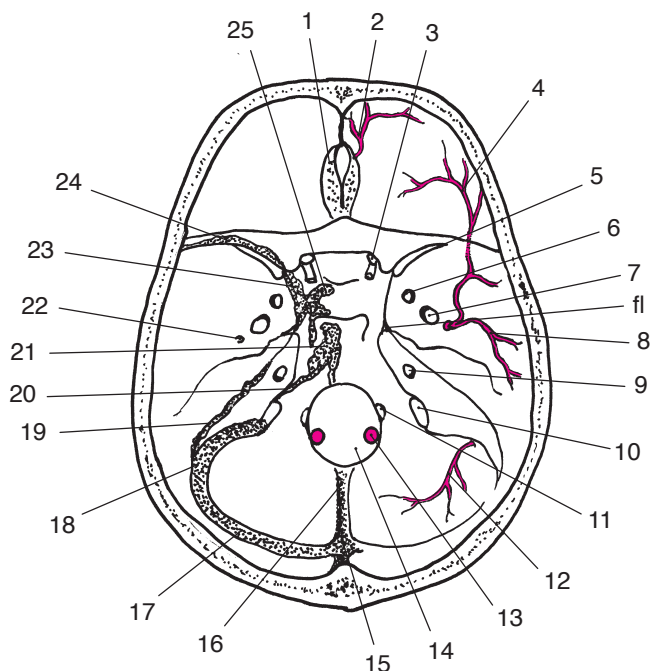


**Fig. 1.2 Section through the scalp, calvaria and underlying structures**

1 – skin, 2 – connective tissue, 3 – superficial vein, 4 – emissary vein, 5 – aponeurosis, 6 – loose connective tissue, 7 – bone of the skull, 8 – cerebral cortex, 9 – arachnoid granulation, 10 – falx cerebri, 11 – cerebral vein, 12 – cerebral arteries in the subarachnoideal space, 13 – diploic vein, 14 – pericranium, p – pia mater, d – dura mater, a – arachnoidea

**Internal cranial base** is divided into three cranial fossae (Fig. 1.3):

**Anterior cranial fossa** is formed by the frontal and the ethmoid bones. Through the cribriform plate of the ethmoid bone pass the fibres of the olfactory nerve (CN I) and the anterior meningeal artery (from the anterior ethmoidal artery). The posterior border of the anterior cerebral fossa is formed by the lesser wings of the sphenoid bone. In the basis of the wings is the optic canal, through which pass the optic nerve (CN II) and the ophthalmic artery (branch of internal carotid artery).

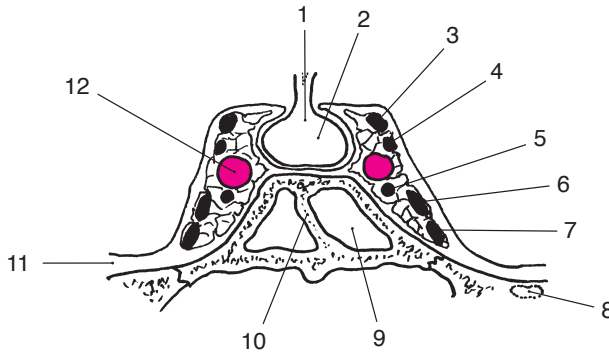


**Fig 1.3 Base of the cranial cavity. Foramina and arteries (right), dural venous sinuses (left)**

1 – cribriform plate with crista galli, 2 – anterior meningeal artery, 3 – optic canal, 4 – frontal branch of middle meningeal artery, 5 – superior orbital fissure, 6 – round foramen, 7 – oval foramen, 8 – occipital branch of middle meningeal artery, 9 – internal acoustic meatus, 10 – jugular foramen, 11 – hypoglossal canal, 12 – posterior meningeal artery, 13 – vertebral artery, 14 – great occipital foramen, 15 – confluens of sinuses, 16 – occipital sinus, 17 – transverse sinus, 18 – sigmoid sinus, 19 – superior petrosal sinus, 20 – inferior petrosal sinus, 21 – basilar plexus, 22 – spinous foramen, 23 – cavernous sinus, 24 – sphenoparietal sinus, 25 – anterior intercavernous sinus, fl – foramen lacerum

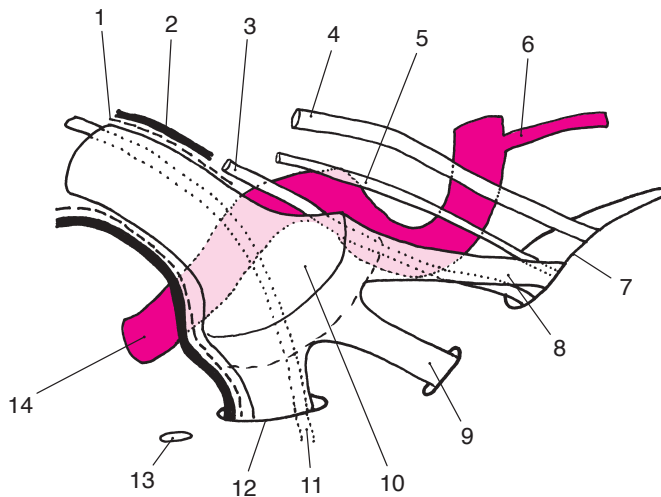
**Middle cranial fossa** is formed by the sphenoid bone and the temporal bone. In the middle is the sella turcica (Turkish saddle), which contains the hypophysis. Laterally lie the greater wings of the sphenoid bone and the petrous part of the temporal bone. Between the greater and the lesser wings is the superior orbital fissure, through which go the cranial nerves III (oculomotorius), IV (trochlearis), V<sub>1</sub> (ophthalmicus) and VI (abducens), and the superior ophthalmic vein. In the greater wings are the foramen rotundum for CN V<sub>2</sub>

(maxillary nerve), the foramen ovale for the CN V<sub>3</sub> (mandibular nerve) and venous plexus connecting the cavernous sinus with the pterygoid plexus, and the foramen spinosum for the middle meningeal artery and meningeal branch of the mandibular nerve. On both sides of the sella turcica is the cavernous sinus, both sides are connected anteriorly and posteriorly of the sella by the intercavernous sinuses. Laterally in the cavernous sinus are the cranial nerves oculomotorius, trochlearis, ophthalmicus and maxillaris, in the middle of the sinus run the abducent nerve and the internal carotid artery (Fig. 1.4). The superior ophthalmic vein,



**Fig. 1.4 Coronal section through the cavernous sinus**

1 – infundibulum of hypophysis, 2 – hypophysis cerebri (pituitary gland), 3 – oculomotor nerve, 4 – trochlear nerve, 5 – abducent nerve, 6 – ophthalmic nerve, 7 – maxillary nerve, 8 – mandibular nerve, 9 – sphenoid (paranasal) sinus, 10 – septum of sphenoid sinus, 11 – dura mater, 12 – internal carotid artery



**Fig. 1.5 Structures related to the trigeminal ganglion**

1 – arachnoid mater, 2 – dura mater, 3 – abducent nerve, 4 – oculomotor nerve, 5 – trochlear nerve, 6 – ophthalmic artery, 7 – superior orbital fissure, 8 – ophthalmic nerve, 9 – maxillary nerve in the round foramen, 10 – trigeminal ganglion, 11 – motor root of the trigeminal nerve, 12 – mandibular nerve in the oval foramen, 13 – foramen spinosum, 14 – internal carotid artery

the sphenoparietal sinus and the basilar plexus drain into the cavernous sinus. The cavernous sinus is connected by the superior and the inferior petrosal sinuses with the transverse sinus and the internal jugular vein. At the apex of the petrous bone is the opening of the carotid canal containing the internal carotid artery and the internal carotid venous plexus, connecting the cavernous sinus with the pterygoid plexus. In a pocket of dura mater (trigeminal cavity, Meckel's cavity) at the apex of the pyramid is the trigeminal, semilunar ganglion (Fig. 1.5). Between the greater wing of the sphenoid bone and the petrous bone is the sphenopetrous synchondrosis, through which go the greater and the lesser petrosal nerves.

**Posterior cranial fossa** is formed by the occipital bone and the posterior surface of the petrous bone. In the body of the occipital bone is the great occipital foramen, foramen magnum, through which the spinal cord enters the skull, accompanied by two vertebral arteries and the cervical root of the accessory nerve (CN XI). Posterolaterally to the foramen magnum is the hypoglossal canal for CN XII and a venous plexus, laterally is the condylar canal for an emissary vein. Between the occipital and the petrous bone is the jugular foramen through which CN IX, X, XI leave the skull and, more laterally, the sigmoid sinus opens into the superior bulb of the internal jugular vein. In the posterior surface of the petrous bone is the internal acoustic meatus into which enter the CN VII and VIII and the labyrinthine artery. On the upper and lower margins of the petrous bone are the venous superior and inferior petrosal sinuses, connecting the cavernous sinus with the transverse sinus and internal jugular vein. On the clivus is the basilar sinus connecting the cavernous sinus with the spinal venous plexuses, around the foramen magnum is the marginal sinus, which drains via the occipital sinus into the confluens sinuum. The confluence of sinuses is on the internal occipital protuberance. It receives the superior sagittal sinus, the straight sinus (into which drains the inferior sagittal sinus) and the occipital sinus, from the confluens goes the transverse sinus which continues as the sigmoid sinus into the internal jugular vein. Between the transverse sinus and the upper margin of the petrous bone is spread a dural sheet, tentorium cerebelli, separating the cerebellum from the occipital lobes of the brain. Through its notch pass the brain stem and the basilar artery.

### **External cranial base**

The anterior cranial fossa is connected by the cribriform plate with the nasal cavity, laterally are the ethmoidal cells and the orbit.

The middle cranial fossa opens through the superior orbital fissure into the orbit, the body of the sphenoid bone contains the sphenoid sinus, under it is the pharyngeal fornix. Laterally under the foramen rotundum is the pterygopalatine fossa, even more laterally is the parapharyngeal space, the infratemporal fossa with the openings of the foramen ovale and foramen spinosum, and the temporomandibular joint. The petrous bone contains the cavities of the inner and the middle ear. Behind the styloid process, between the the mastoid process and the jugular fossa, opens the stylomastoid foramen containing the facial nerve and the stylomastoid artery.

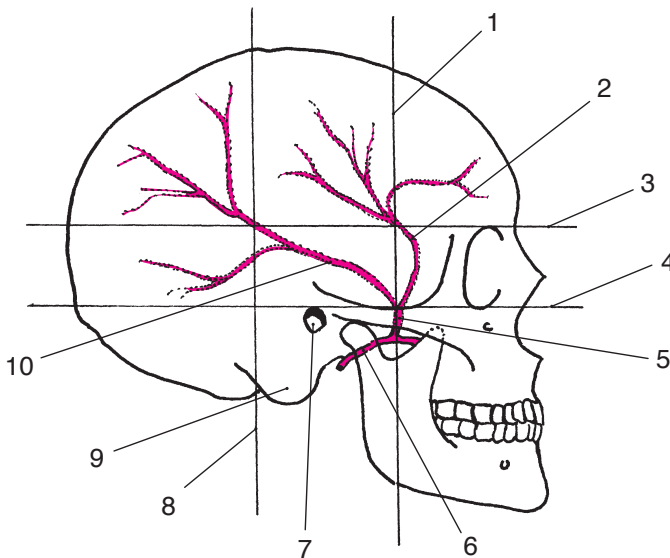
Under the posterior cranial fossa are, laterally to the foramen magnum, the atlantooccipital joints, and posteriorly the suboccipital muscles. Anteriorly is the jugular foramen, posteriorly are the openings of the hypoglossal canal and the condylar canal

The structure, vascular and nervous supply of the frontal, parietal and occipital region have already been described. The temporal region, however, requires more attention.

## Temporal region

The superior superficial boundary of the temporal region is given by the superior temporal line, the inferior boundary by the zygomatic arch. The osseous floor of the temporal fossa is formed by the squamous part of the temporal bone, the parietal bone and the lateral surface of the greater wing of the sphenoid. Skin is covered by hair, directly under the skin are the temporoparietalis muscle which inserts into the galea aponeurotica, and the muscles to the external ear – auricularis anterior and superior. The superficial temporal artery (one of the two terminal branches of the external carotid) runs subcutaneously accompanied by a vein and the auriculotemporal nerve (from CN V<sub>3</sub>). The zygomaticotemporal branch of the zygomatic nerve (from CN V<sub>2</sub>) comes to the anterior part of this region from the zygomaticotemporal foramen. The temporal fossa is filled with the temporalis muscle which is covered by a strong temporal fascia inserted to the zygomatic arch in two layers – to the external and internal surface of the arch. The muscle passes under the zygomatic arch to the coronoid process of mandible. Deep temporal arteries (from the maxillary artery) and nerves (from CN V<sub>3</sub>) run under the muscle and supply it.

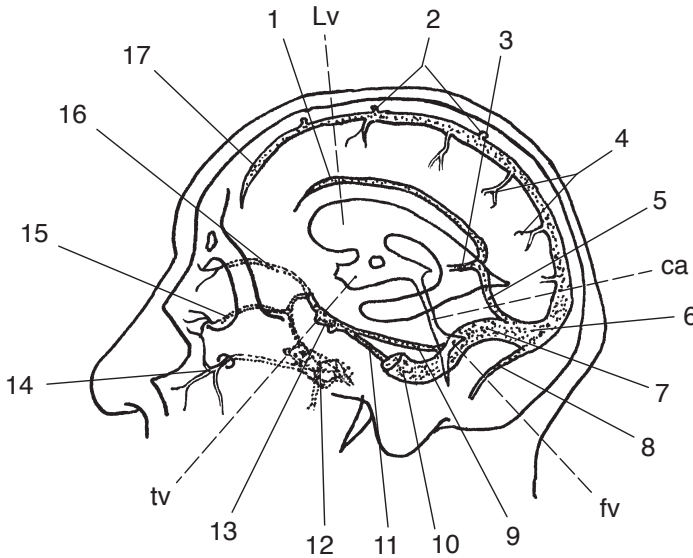
The intracranial course of the important middle meningeal artery and some structures of the brain can be projected to the temporal region (Fig. 1.6). A special pattern of lines is used, the *Kroenlein's projection*. It consists of two horizontal and two vertical lines. The first horizontal line, the auriculoorbital or frankfurter line, goes from the upper margin of the external acoustic meatus to the inferior margin of the orbit. The second horizontal line, the supra-orbital, is parallel to the first one and goes through the upper margin of the orbit. The vertical zygomatic line goes through the middle of the zygomatic arch and the vertical retromastoid line passes just behind the mastoid process. The stem of the middle meningeal



**Fig. 1.6 Middle meningeal artery, course and branches. Projection to the skull surface**

1 – anterior vertical (zygomatic) line, 2 – frontal branch, 3 – supraorbital line, 4 – auriculoorbital line, 5 – middle meningeal artery, 6 – maxillary artery, 7 – external acoustic meatus, 8 – posterior vertical (retromastoid) line, 9 – mastoid process, 10 – parietal branch

artery is at the point of intersection of the auriculoorbital and zygomatic lines, the anterior branch of the artery goes to the intersection of the supraorbital and zygomatic lines, the posterior branch to the intersection of the supraorbital and retromastoid lines. A line drawn from the point of intersection of the supraorbital and zygomatic lines to the point where the retromastoid line crosses the vertex of the skull indicates approximately the course of the cerebral central sulcus, and a line halving the angle between this line and the supraorbital line indicates the course of the lateral sulcus. Surface projection of cerebral venous sinuses and ventricles is shown in Fig. 1.7.



**Fig. 1.7 Scheme to show the intracranial venous sinuses and the ventricles of the brain**

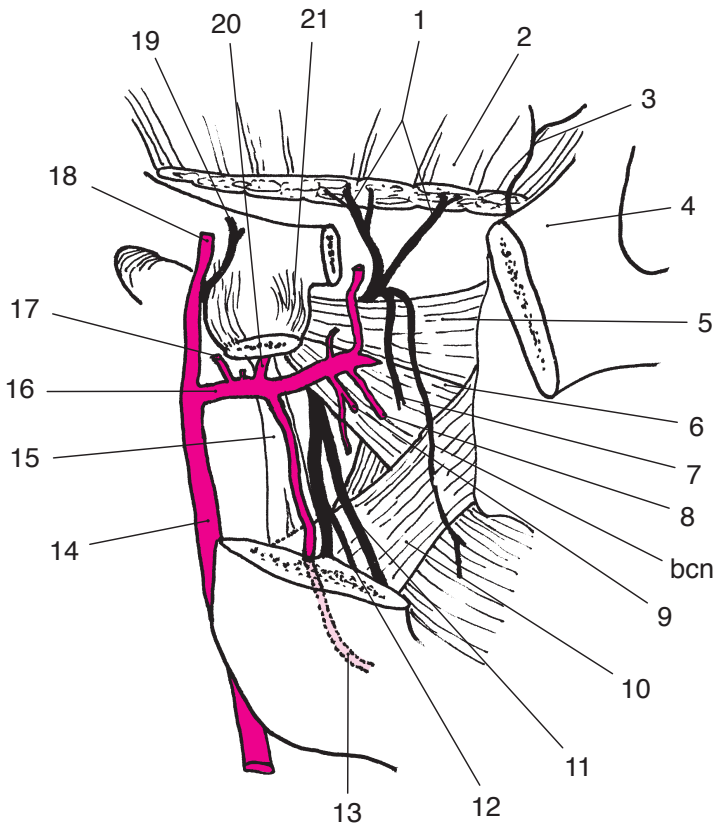
1 – inferior sagittal sinus, 2 – arachnoid granulations, 3 – great cerebral vein, 4 – superior cerebral veins, 5 – straight sinus, 6 – confluence of sinuses, 7 – transverse sinus, 8 – occipital sinus, 9 – superior petrosal sinus, 10 – sigmoid sinus, 11 – inferior petrosal sinus, 12 – pterygoid plexus, 13 – cavernous sinus, 14 – infraorbital vein, 15 – inferior ophthalmic vein, 16 – superior ophthalmic vein, 17 – superior sagittal sinus, Lv – lateral ventricle, ca – cerebral aqueduct, fv – fourth ventricle, tv – third ventricle

## 1.1.2 Infratemporal fossa and the deep regions of the head

### Infratemporal fossa

The infratemporal fossa is the space under the middle cranial fossa (Figs. 1.8, 1.9, Table 1.1). Its lateral wall is formed by the ramus of the mandible and the parotid gland, medially it extends to the pharynx, anteriorly it is marked off by the maxilla and posteriorly by the *styloid septum* (which is formed by the following muscles and their fascia: sternocleidomastoideus, posterior belly of the digastric muscle, stylohyoideus, styloglossus and stylopharyngeus). The roof is formed by the greater wing of the sphenoid bone with the foramen ovale and foramen spinosum, inferiorly the infratemporal fossa continues in the submandibular region.

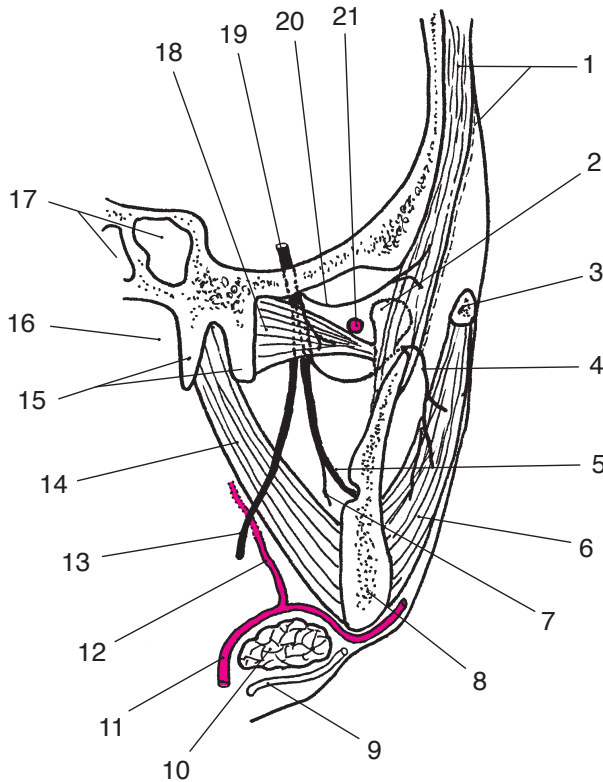
It contains the medial and the lateral pterygoid muscle, corpus adiposum buccae, venous plexus pterygoideus and part of the parotid gland. The mandibular nerve (CN V<sub>3</sub>) enters through the foramen ovale and gives off its main branches – auriculotemporal, lingual and inferior alveolar nerves, branches for the masticatory muscles and a meningeal branch, which returns to dura mater through the foramen spinosum. Through the foramen ovale also goes a venous plexus connecting the cavernous sinus with the plexus pterygoideus. Close to the mandibular nerve is the otic ganglion which receives its parasympathetic fibres by the lesser petrosal nerve (from CN IX). In this space the maxillary artery gives off its branches to the masticatory muscles and to the ear, the inferior alveolar artery, and the middle meningeal artery which enters the foramen spinosum.



**Fig. 1.8 Infratemporal fossa. Lateral view**

1 – deep temporal nerves, 2 – m. temporalis, 3 – zygomaticotemporal nerve, 4 – zygomatic bone, 5 – lateral pterygoid muscle (superior head), 6 – lateral pterygoid muscle (inferior head), 7 – masseteric branch of the mandibular nerve, 8 – buccal artery, 9 – muscular branches of the maxillary artery, 10 – medial pterygoid muscle, 11 – lingual nerve, 12 – mylohyoid nerve, 13 – inferior alveolar artery and nerve (in the mandibular canal), 14 – external carotid artery, 15 – sphenomandibular ligament, 16 – maxillary artery, 17 – deep auricular artery, 18 – superficial temporal artery, 19 – auriculotemporal nerve, 20 – middle meningeal artery, 21 – temporomandibular joint (capsule), bcn – buccal nerve





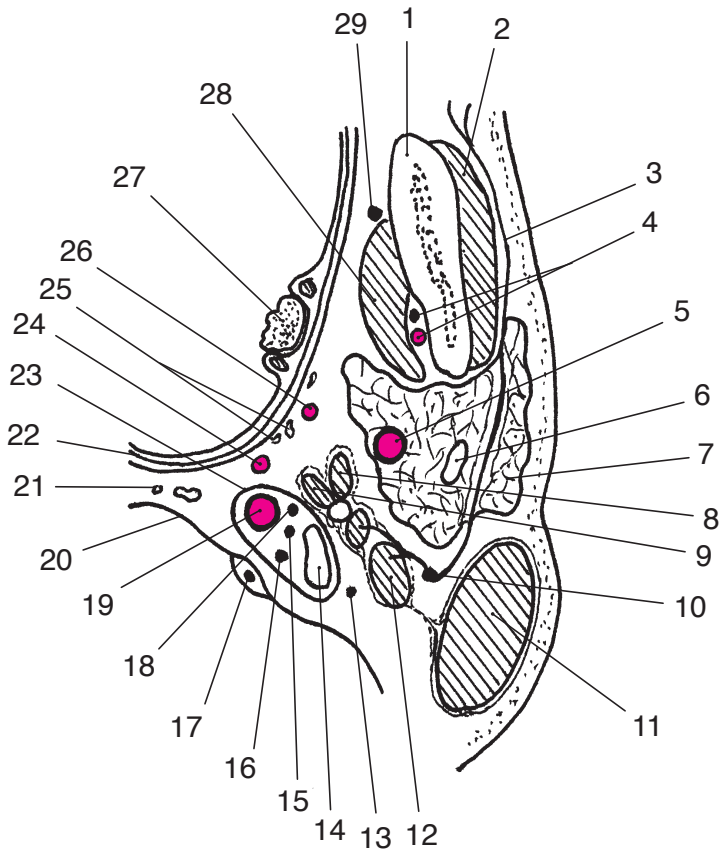
**Fig. 1.9 Infratemporal fossa. Coronal section**

1 – m. temporalis with temporal fascia, 2 – head of mandible, 3 – zygomatic arch, 4 – masseteric branch of CN V3, 5 – inferior alveolar nerve, 6 – m. masseter, 7 – n. mylohyoideus, 8 – angle of mandible, 9 – facial vein, 10 – submandibular gland, 11 – facial artery, 12 – tonsillar branch, 13 – lingual nerve, 14 – m. pterygoideus medialis, 15 – medial and lateral plate of pterygoid process, 16 – nasopharynx, 17 – sphenoid sinus, 18 – m. pterygoideus lateralis, 19 – mandibular nerve (CN V3), 20 – temporal branch of mandibular nerve, 21 – maxillary artery

A narrow space between the medial pterygoid muscle and the ramus of the mandible is called the **pterygomandibular space**. The posterior wall of this space is formed by the parotid gland, anteriorly it ends at the pharynx. In the anterior part of this space is the lingual nerve, posteriorly are the inferior alveolar artery and nerve before entering the mandibular canal. It is the place for injecting local anaesthetics for anaesthesia of the lower teeth.

Between the medial surface of the medial pterygoid muscle and the pharynx is the **praestyloid part of the parapharyngeal space** (Fig. 1.10). On the pharyngeal wall runs the ascending palatine artery (branch of the facial artery) which can be a cause of bleeding during tonsillectomy. This part of the parapharyngeal space is also called the **paratonsillar space**. In front of the external acoustic meatus from the confluence of the superficial temporal and maxillary veins arises the retromandibular vein, partly in the parenchyma of the parotid gland, between the parotid gland and the styloid septum is located the external

carotid artery before it divides into the superficial temporal artery and the maxillary artery. Between the pterygoid muscles and the temporalis muscle is the pterygoid plexus which collects veins corresponding with the branches of the maxillary artery, is connected with the cavernous sinus, and drains into the retromandibular vein through the maxillary veins.



**Fig. 1.10 Horizontal section through the parapharyngeal space and infratemporal fossa (right side, superior view)**

1 – mandible, 2 – m. masseter, 3, 10 – facial nerve, 4 – inferior alveolar artery and nerve (in the pterygopalatine space), 5 – external carotid artery, 6 – retromandibular vein, 7 – parotid gland, 8 – m. styloglossus, 9 – m. stylopharyngeus, 11 – m. sternocleidomastoideus, 12 – m. digastricus, 13 – accessory nerve, 14 – internal jugular vein, 15 – hypoglossal nerve, 16 – vagus nerve, 17 – sympathetic trunk, 18 – glossopharyngeal nerve, 19 – internal carotid artery, 20 – prevertebral fascia, 21 – lymph nodes (in retropharyngeal space), 22 – posterior pharyngeal wall, 23 – carotid sheath, 24 – ascending pharyngeal artery, 25 – pharyngeal veins, 26 – ascending palatine artery, 27 – palatine tonsil, 28 – m. pterygoideus medialis, 29 – lingual nerve

### **Pterygopalatine fossa**

The infratemporal fossa extends through the pterygomaxillary fissure medially into the pterygopalatine fossa which is a narrow space between the maxilla anteriorly, the pterygoid process of the sphenoid posteriorly and the perpendicular plate of the palatine bone medially. The roof is formed by the greater wing of the sphenoid bone, inferiorly it is opened into the palatine canal. Superiorly opens in this space the foramen rotundum through which enters the maxillary nerve (CN V<sub>2</sub>), which here divides into the zygomatic, the infraorbital and the superior alveolar nerves. The maxillary nerve is connected with the parasympathetic pterygopalatine ganglion by the pterygopalatine nerves. To this ganglion comes the parasympathetic greater petrosal nerve (from CN VII) together with the sympathetic deep petrosal nerve (from the plexus caroticus) through the pterygoid canal. From the ganglion go the nasal branches into the nasal cavity through the foramen sphenopalatinum. The greater and the lesser palatine nerves go inferiorly to the palate through the canals of the same name. The inferior orbital fissure with the orbital muscle opens into the pterygopalatine fossa anteriorly and superiorly. Through this fissure comes the inferior ophthalmic vein which drains into the pterygoid plexus, and the zygomatic and the infraorbital nerves and the infraorbital artery enter the orbit. The maxillary artery enters the pterygopalatine fossa from the infratemporal fossa and divides here into its final branches: sphenopalatine, infraorbital, superior posterior alveolar and descending palatine arteries which enter the nasal cavity, the orbit, the maxilla, the palatine canal, and also sends a small branch to the petrous canal.

### **Retrostyloid part of the parapharyngeal space**

This is a narrow space between the styloid septum and the praevertebral fascia, superiorly bounded by the inferior surface of the petrous temporal bone. The medial wall is formed by the pharynx and a thin fascia separating the retropharyngeal space, laterally is the sternocleidomastoid muscle and the posterior belly of the digastric muscle, the styloid septum continues anteriorly. Inferiorly this space opens into the carotid triangle. In the retrostyloid space is the internal carotid artery which finally enters the carotid canal, posterolaterally is the internal jugular vein originating in the jugular foramen. The carotid canal also contains a venous plexus connecting the cavernous sinus with the pterygoid sinus. The vagus nerve (CN X) descends posteriorly in the groove between the internal carotid artery and the internal jugular vein. Through this space also cross the accessory nerve (CN XI) to the sternocleidomastoid muscle and the glossopharyngeal nerve (CN IX) to the pharynx and to the tongue. These three nerves (CN IX, X, XI) enter the retrostyloid space through the jugular foramen. The hypoglossal nerve (CN XII) enters through the hypoglossal canal together with a venous plexus, forms an arch between the internal carotid artery and the internal jugular vein, and then passes through the carotid triangle before reaching the tongue. On the pharyngeal wall runs the ascending pharyngeal artery, branch of the external carotid. Under the praevertebral fascia lies the sympathetic chain with the superior cervical ganglion.

**Table 1.1**

<b>Synopsis of the deep regions of the head</b>	
<b>Fossa infratemporalis</b>	
<b>Spatium praestyloideum (pars praestyloidea spatii parapharyngealis)</b>	
boundaries:	ala major maxilla mandibula pharynx septum styloideum (mm. SCM, digastricus, stylohyoideus, styloglossus, stylopharyngeus) inferiorly it continues to the submandibular region
foramen ovale:	n. mandibularis plexus venosus
foramen spinosum:	a. meningea media r. meningeus n. V <sub>3</sub>
contents:	n. mandibularis and its branches ganglion oticum a. carotis externa – a. maxillaris and its branches a. palatina ascendens plexus pterygoideus v. retromandibularis gl. parotis mm. pterygoidei corpus adiposum buccae
<b>Spatium pterygomandibulare:</b>	
boundaries:	ramus mandibulae, m. pterygoideus medialis, gl. parotis, pharynx
contents:	n. lingualis a. et v. et n. alveolaris inferior
<b>Fossa pterygopalatina</b>	
boundaries:	ala major tuber maxillae processus pterygoideus lamina perpendicularis ossis palatini
contents:	n. maxillaris and its branches ganglion pterygopalatinum a. maxillaris and its branches plexus pterygoideus
foramen rotundum:	n. maxillaris
fissura orbitalis inf:	m. orbitalis v. ophthalmica inferior n. zygomaticus n. infraorbitalis a. infraorbitalis
foramen sphenopalatinum:	a. sphenopalatina rr. nasales ganglii pterygopalatini
canalis pterygoideus:	n. canalis pterygoidei (n. petrosus major, n. petrosus profundus) a. canalis pterygoidei
canalis palatinus major:	n. palatinus major a. palatina descendens