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Topographical anatomy and measurements of selected parameters of the rat temporal bone

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On the basis of dissection of 24 bones of 12 black rats a systematic anatomical description was made and measurements of selected size parameters of the temporal bone were taken. Besides the main air space in the middle ear, the tympanic bulla, there are also additional air cells, namely the anterior and posterior epitympanic recesses, containing the head of the malleus and the body of the incus. On the side of the epitympanic recesses the following are easily accessible: the malleus head and the core of the incus, the superior and lateral semicircular canals and the facial nerve. On the side of the ventral tympanic bulla it is easy access to both windows and the cochlea. The semicircular canals are relatively large, the lateral canal being the largest and the posterior the smallest. The length of the spiral canal of the cochlea does not exceed 11 mm. It is worth mentioning that both the vertical and horizontal dimensions of the scala vestibuli and scala tympani do not even exceed 0.7 mm in the basal turn, and are significantly decreased to tenths of a millimetre in further turns. This needs to be taken into consideration during all experiments requiring the introduction of examining instruments into the cochlear scala. (Folia Morphol 2008; 67: 111–119)

Key words: temporal bone, anatomy, measurements, rat

INTRODUCTION

The temporal bone containing the vestibulocochlear organ is significant in the pathology of humans and animals. Accurate anatomical description of the human ear with all its structures is found in every anatomy textbook and in specialist monographs. Analogical descriptions of the ear structures of animals, found in veterinary anatomy textbooks, are scarce, schematic and do not go beyond a rough enumeration of the structures, often with no data on topography and variability. The same applies to monographs devoted to particular species of laboratory animal [9, 10]. While experiments on the vestibulocochlear organ in laboratory animals, especially rodents, cover a wide spectrum of problems in the field of experimental and clinical medicine [1, 4, 6], there are only a few publications dealing with the anatomy of the rat ear [3, 5, 7].

The aim of undertaking this study has been to come up with a systematic anatomical description of the temporal bone, including the topographic aspects, in selected animal species for clinical purposes.

MATERIAL AND METHODS

Twenty four temporal bones (12 left and 12 right, 6 male and 6 female specimens) derived from 12 black rats (*Rattus rattus*, Linnaeus, 1758) and weighing 175–200 g were used for the study. The

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animals were obtained from the Drug Institute in Warsaw, Poland and were not deliberately deprived of life, but rather routinely euthanised after scientific experiments, and so it was not necessary to acquire permission from the Bioethics Committee.

The description was complemented by particular measurements of selected size and volume parameters of the temporal bone in order to provide indispensable data to scientists planning experiments on animals. The terminology applied is consistent with official veterinary anatomical nomenclature [8].

The investigation adopted traditional techniques for anatomical preparation, observation, photography and measurements. The bones were fixed in 10% formaldehyde solution. Next they were filled by injection with liquid latex as previously described [11] and then prepared under an operating microscope. Measurements were made using an eyepiece (ocular) with a 0.05 mm to 0.1 mm accuracy gauge (depending on the size of the objective), according to the schematic drawnings presented (Fig. 1, 2). The full length of the skull was measured as a distance between the opistocranion and prosthion points. The length of the neurocranial base was evaluated as a distance between the hormion and opisthion points. Student's t test was performed for evaluation of differences related to sex and body side.

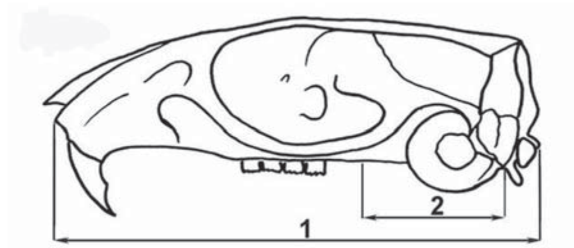

Figure 1. Scheme of measurements conducted on the whole skull of the rat; 1 — full length of the skull, 2 — length of the neurocranial base.

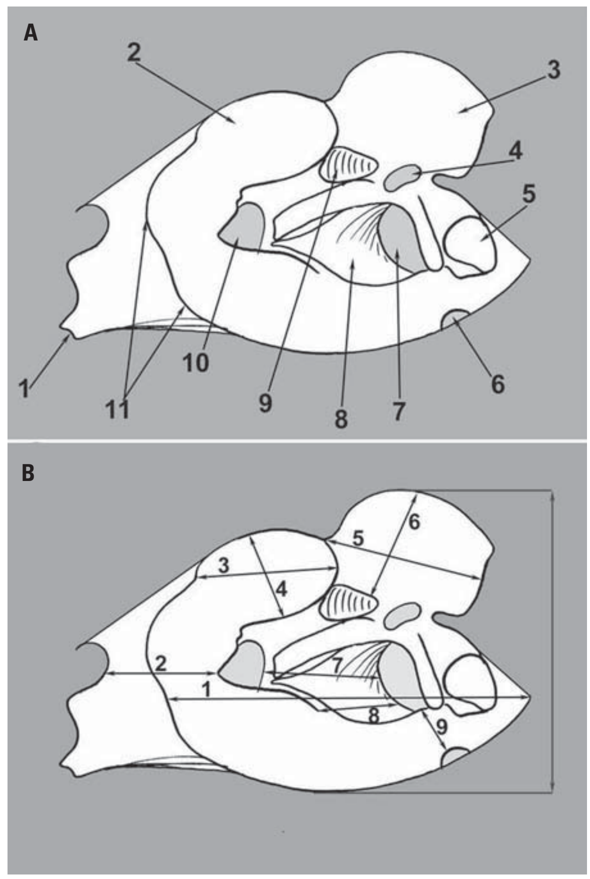

Figure 2. A. Scheme of arrangement of the structures of the tympanic cavity of the rat; 1 — muscular process of the tympanic bulla, 2 — anterior epitympanic recess, 3 — posterior epitympanic recess, 4 — oval window, 5 — separated air cell, 6 — jugular foramen, 7 — round window niche, 8 — promontory, 9 — cave for the tensor tympani muscle, 10 — internal orifice of the Eustachian tube, 11 — borders of the opened tympanic bulla; **B.** Scheme of measurements conducted on the tympanic cavity of the rat's ear; 1 — maximal length of the tympanic cavity, 2 — length of the semicanal of the Eustachian tube, 3 — length of the anterior epitympanic recess, 4 — height of the anterior epitympanic recess, 5 — length of the posterior epitympanic recess, 6 — height of the posterior epitympanic recess, 7 — minimal distance from the round window to the internal orifice of the Eustachian tube, 8 — minimal distance from the round window to the carotid canal, 9 — minimal distance from the round window to the jugular foramen.

RESULTS

The temporal bone and skull

The rat's temporal bone is an element of the lateral and ventral wall of the skull (Fig. 3–6). It consists of the squamous, tympanic, petrous and small mastoid. The first three parts are almost equal in size, although they obviously differ in external and internal topographical features. After maceration, the temporal bone falls apart into the three elements and therefore complete synostosis does not occur during life. There is then a temporal skull complex rather than a temporal bone.

The squamous part forms a considerable fragment of the lateral wall of the skull and joins the zygomatic bone, creating part of the zygomatic arch.

The tympanic part is much better developed and limits the lateral, inferior and small fragment of medial wall of the tympanic cavity. It consists of the tympanic ring and the tympanic bulla, and constitutes the ventro-latero-rostral part of the temporal bone. There is no isolated external acoustic meatus. The tympanic part bulges inferolaterally, where the

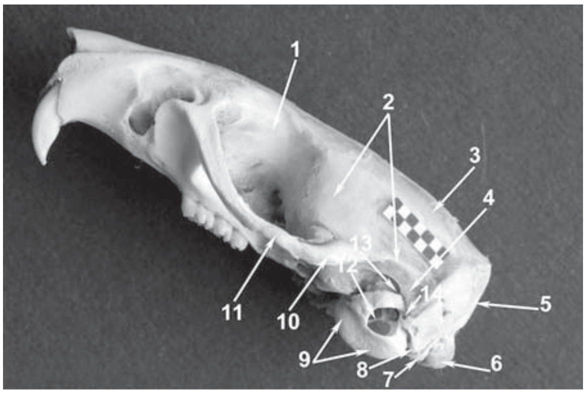

Figure 3. View of the left lateral wall of the rat skull. Scale bar 1 mm; 1 — frontal bone, 2 — squamous part of the temporal bone, 3 — parietal bone, 4 — occipital process of the squamous part, 5 — squamous part of the occipital bone, 6 — left occipital condyle, 7 — paracondylar process, 8 — mastoid process, 9 — auditory bulla, 10 — zygomatic process of the squamous part, 11 — zygomatic bone, 12 — handle of the malleus, 13 — postglenoid foramen, 14 — stylomastoid foramen.

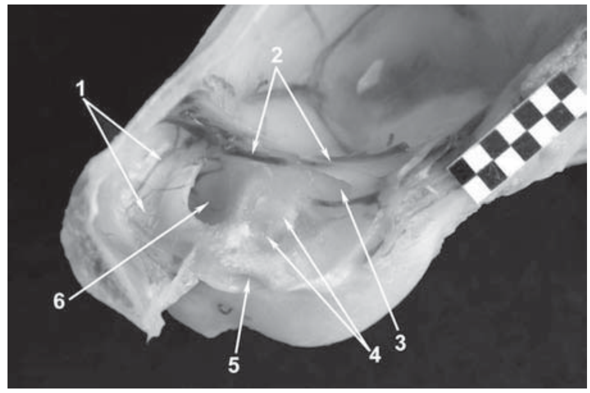

Figure 5. Specimen of rat head. View of the lateral supra and infratentorial cavity of the skull. Left side. Scale bar 0.5 mm; 1 — dura mater of the sigmoid sinus, 2 — dorsal petrous sinus, 3 — groove and canal of the trigeminal nerve, 4 — neural area, 5 — external opening of the cochlear canaliculus, 6 — subarcuate fossa.

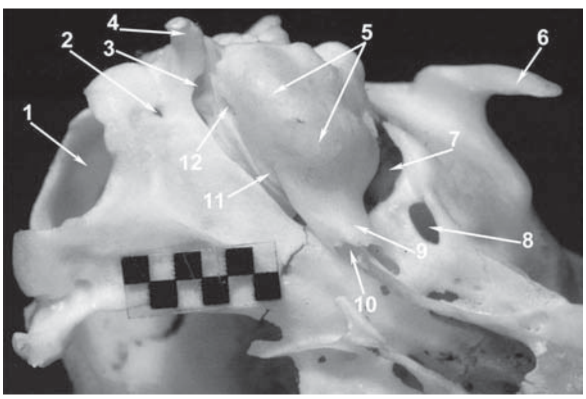

Figure 4. Ventral wall of the rat skull. Scale bar 1 mm; 1 — foramen magnum, 2 — hypoglossal nerve canal, 3 — jugular foramen, 4 — paracondylar process, 5 — auditory bulla, 6 — zygomatic process, 7 — middle lacerated foramen, 8 — oval foramen, 9 — muscular process, 10 — pharyngeal opening of the auditory tube, 11 — external opening of the internal carotid canal, 12 — opening of the tympanic canaliculus (external opening of the stapedial artery canal).

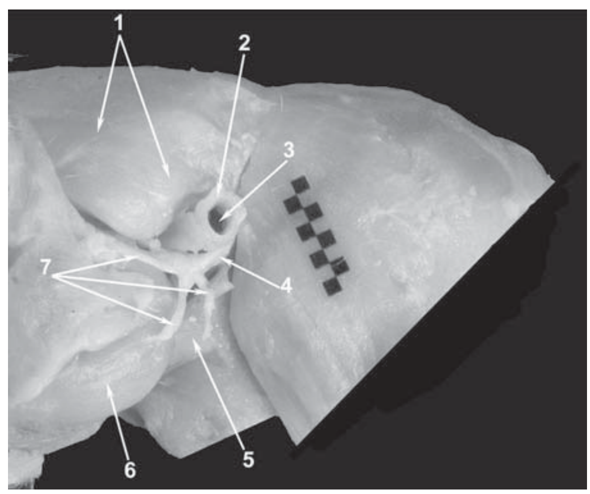

Figure 6. Specimen of rat head. Left side. Scale bar 0.5 mm; 1 — temporal muscle, 2 — external acoustic meatus, 3 — interior of the external acoustic meatus, 4 — facial nerve after leaving the canal, 5 — branches of the facial nerve, 6 — masseter muscle, 7 — digastric muscle.

tympanic membrane turns into the tympanic bulla with no distinct border line. Rostrally the bulla gradually narrows and turns into a short sharp muscular process, which is the attachment of the palate muscle. It is well developed in the medial part of the bulla, so that it forms an almost complete circumference of the auditory tube canal, complemented only by a small fragment of the petrous part.

The petrous part forms the middle and posterior cranial fossa and contains the inner ear. On the border of the squamous and petrous parts lies the temporal canal containing the petrosquamous sinus, which opens with the postglenoid foramen. The petrous part takes the form of a bony lamina with complicated external carving and internal structure. It does not have the shape of triparietal pyramid as observed in other mammal species but is rather similar to an irregular cuboid. In fact it is a flat lamina, which is only thickened in some areas, as the capsule of the labyrinth is particularly thin and delicate in rats. The medial wall of the petrous part forms the lateral wall of the infratentorial cavity of the skull and the anterior wall forms the ventral wall of the supratentorial cavity (Fig. 5).

The petrous part has four surfaces: anterior, ventral, medial, and lateral. The anterior and medial are the cerebral surfaces, as both spread towards the cranial cavity. The lateral is the tympanic surface, and the ventral spreads towards the base of the skull and pharynx. There is a groove for the dorsal petrous sinus on the border of the medial and anterior surfaces, and on the border of the medial and ventral is the groove for the ventral petrous sinus. The medial surface is richly carved. The central point of this surface is an area, which I propose to name the neural area, as it has neither an opening nor an internal acoustic meatus. The area is created by four openings: anterosuperior for the facial nerve, anteroinferior for the cochlear nerve and posterosuperior for the superior and posteroinferior for the inferior vestibular nerve. The largest is the inferior opening and the smallest is the superoposterior. Rostrally from the superoanterior opening spreads a gradually deepening groove for the trigeminal nerve. After a few millimetres this groove turns into an almost complete canal, although not closed from every side, and this runs to the apex of the temporal bone.

Caudally of the neural area lies a deep subarcuate fossa. The fossa is opened inferiorly. On the inferior surface of the petrous part usually lies a natural pore of 1 mm in diameter and a small branch of the stapedial artery runs through this. The external opening of the cochlear canaliculus and the external opening of the vestibular aqueduct are situated on the posterior surface, inferiorly from the external acoustic pore. The anterior semicircular canal runs in the posterosuperior and posteroinferior border of the entry to the subarcuate fossa.

The lateral surface of the petrous part forms the medial wall of the tympanic cavity and part of the posterior wall. The other walls belong to the tympanic part. Strong masseter muscles, neck muscles and suprahyoid muscles constitute the external vicinity of the temporal bone (Fig. 6).

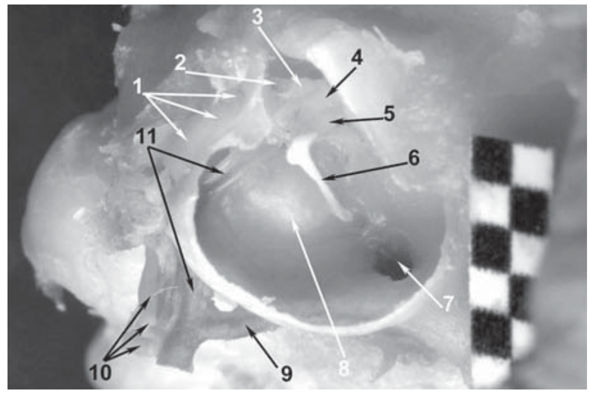

Figure 7. Interior of rat right tympanic cavity. Scale bar 0.5 mm; 1 — facial nerve in its extratemporal part, 2 — short limb of the incus, 3 — body of the incus, 4 — head of the malleus, 5 — anterior process of the malleus, 6 — handle of the malleus, 7 — tympanic opening of the auditory tube canal, 8 — promontory, 9 — internal carotid artery just before entering the canal in the temporal bone, 10 — nerves of the jugular foramen, 11 — stapedial artery in and out of the tympanic cavity.

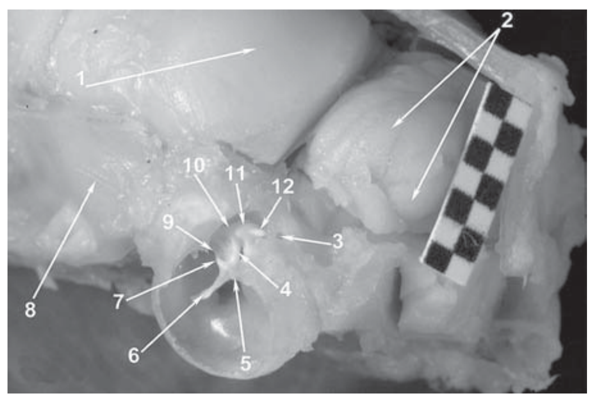

Figure 8. Fragment of rat head, showing the structures of the cranial cavity and of the middle and inner ear of the left temporal bone. Scale bar 0.5 mm; 1 — frontal lobe of the brain, 2 — cerebellum, 3 — opened superior semicircular canal, 4 — neck of the malleus, 5 — posterior part of the chorda tympani, 6 — handle of the malleus, 7 — anterior process of the malleus, 8 — temporal lobe of the brain, 9 — anterior part of the chorda tympani, 10 — head of the malleus, 11 — body of the incus, 12 — short limb of the incus.

The middle ear

The tympanic cavity in a rat consists of three poorly separated parts with auditory ossicles within it (Fig. 7–9): the inferior part of the tympanic bulla, which constitutes the hypotympanum, the middle part bordering with the tympanic membrane (mezotympanum) and the superior epitympanic part (the epitympanum). The walls of the tympanic bulla are smooth. Rostrally, the bulla turns into the auditory tube canal. The posteromedial wall of the bulla adjoins the nerves and vessels running in the jugular foramen (Fig. 7). Caudally of the bulla, below the stylomastoid foramen, runs the condylar canal opening into the jugular foramen.

The central eminence of the tympanic cavity is the promontory which is the prominence of the basal turn of the cochlea (Fig. 7). This prominence is not very elevated in the rat and therefore does not significantly

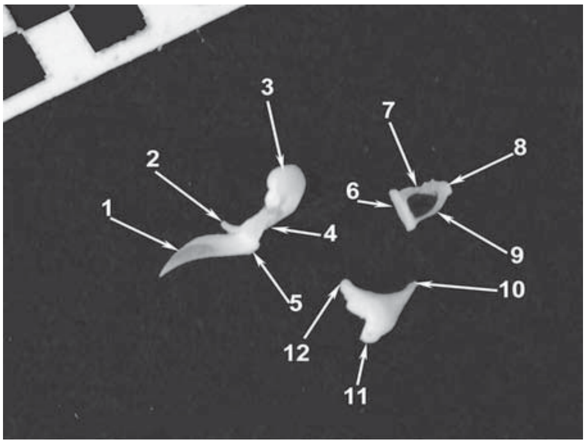

Figure 9. Isolated rat auditory ossicles. Scale bar 0.5 mm; 1 — handle of the malleus, 2 — muscular process of the malleus, 2 — head of the malleus, 3 — neck of the malleus, 4 — lateral process of the malleus, 5 — base of the stapes, 6 — anterior limb of the stapes, 7 — head of the stapes, 8 — posterior limb of the stapes, 9 — short limb of the incus, 10 — body of the incus, 11 — long limb of the incus, 12 — short limb of the incus.

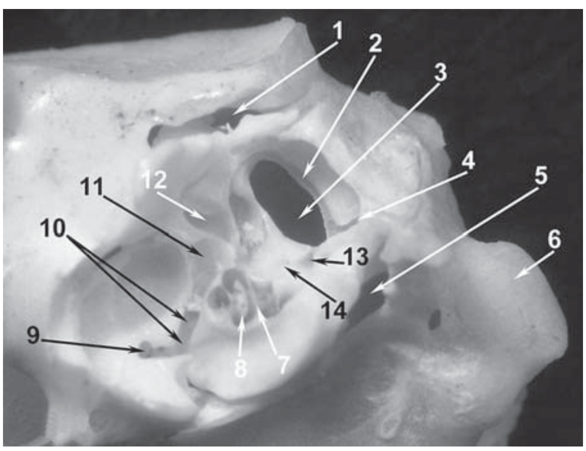

Figure 10. Fragment of rat skull, showing the structures of the middle and inner ear of the left temporal bone; 1 — temporal canal of the skull, 2 — opened superior semicircular canal, 3 — interior of the subarcuate fossa, 4 — opened posterior semicircular canal, 5 — jugular foramen, 6 — occipital condyle, 7 — contour lamina of the cochlea, 8 — spiral lamina of the cochlea, 9 — auditory tube canal, 10 — carotid artery canal, 11 — small cavity of the tensor tympani, 12 — arterior epitympanic recess, 13 — opened common limb of the superior and posterior semicircular canals, 14 — interior of the vestibule.

narrow the transverse dimension of the tympanic cavity. Rostrally from the promontory opens the canal of the bony part of the auditory tube.

Rostrally and dorsally from the promontory there is a small shallow oval cavity about 1 mm deep, which contains the venter of the tensor tympani muscle (Fig. 10). This small cavity is more distinctly limited posteriorly than anteriorly, as it flattens rostrally and ventrally, turning into a groove forming a semicanal and next the canal for the tendon of the tensor tympani. The cavity medially neighbours the facial nerve canal and the width of the lamina separating both structures is 0.15–0.25 mm (average 0.19 mm). Rostrally and dorsally the small cavity borders an extensive depression belonging to the epitympanum, which I propose to name the anterior epitympanic recess (Fig. 2, 7, 8, 10). Caudally it adjoins the stapedial artery canal (Fig. 7). Posteriorly and superiorly the cavity adheres to the posterior epitympanic recess.

The posterior epitympanic recess contains the head of the malleus and the body of the incus (Fig. 7, 8). This space constitutes the oval superior part of the tympanic cavity, which is quite well separated. The anterior epitympanic recess adjoins the middle cranial fossa caudally from the trigeminal ganglion and the posterior recess adjoins the subarcuate fossa. Therefore from here, it is possible to approach directly the subarcuate fossa, extending a little caudodorsally. The posterior recess forms a shallow fossa of the incus on the caudal wall, rostroventrally adjoining the small cavity of the tensor tympani but ventrally the facial nerve canal and, running below and parallel, the stapedial artery canal. The epitympanic recess may be approached from the side of the middle part of the tympanic cavity through a rather small opening, limited anteriorly by the neck of the malleus, medially by the long limb of the incus and laterally by a fragment of the lateral wall of the tympanic bulla.

Caudally from the promontory lies a vertical fissure 0.35–0.55 mm wide (average 0.42 mm), leading to the tympanic sinus, limited caudodorsally by the facial nerve canal and inferiorly turning into the hypotympanum. Dorsally runs a short bony lamina situated similarly to the promontory bridge on the human bone. It separates the tympanic sinus from the oval window niche. There is an approach from the tympanic sinus to the round window niche, which is deeply hidden and not accessible in observations from the side of the external acoustic meatus.

The stapedial muscle lies in a small cavity ventrally adjoining the facial nerve canal. Its tendon is about 0.25 mm long and penetrates the posterior limb of the stapes.

The facial canal originates on the medial wall of the petrous part of the temporal bone in the neural area described previously. In total it measures little more than 3 mm and runs arched caudally, superiorly and laterally. Farther, it enters the tympanic cavity. It lies in its own bony canal on the anterosuperior wall of the vestibule, over the oval window but caudally and medially from the tensor tympani. Here it also lies above the cochlea. It bends gently caudally and inferiorly, not creating a typical distinct geniculum, but returning the greater petrosal nerve. This nerve comes out of the facial nerve at an angle of almost 180°, as it extends superiorly and anteriorly and after 2–3 mm approaches the hiatus of the greater petrosal nerve canal. Together with the greater petrosal nerve runs the intracranial part of the stapedial artery, which enters the facial nerve canal from the inferior niche in the region of the superior border of the oval window. Next, after crossing the ampulla of the superior semicircular canal, the facial nerve runs obliquely posteroinferiorly, entering the temporal bone and appearing on the surface of the skull in the stylomastoid foramen, which lies slanting sharply to the surface of the skull 0.25–1.0 mm away from the posterior border of the external acoustic pore. After exiting, it divides into several trunks (Fig. 6). Before exiting, it returns the chorda tympani, which enters the tympanic cavity and runs between the handle of malleus and the long limb of the incus and leaves the tympanic cavity through the petrotympanic fissure (Fig. 8).

The carotid canal crosses the temporal bone from its caudoventral to its rostrodorsal part. The external opening of the canal lies on the ventral wall of the petrous part, directly anterior to the jugular foramen. The canal runs straight, rostrally from the cochlea, and, after crossing the auditory tube canal (Fig. 10), enters the cranial cavity through the internal opening, where the artery lies on the inferior wall of the ventral petrosal sinus and approaches the arterial circle of Willis. Before ending at the external opening it branches off the stapedial artery, entering its own bony canal, coming finally into the facial canal. The diameter of the internal carotid artery in the intrapetrosal part is about 0.5 mm, and that of the stapedial artery is about 0.25 mm.

The rat's auditory ossicles are slender and delicate (Fig. 9). The malleus has a distinctly developed oblong head mounted on a long neck and a slim handle, considerably thinner than the neck. The angle between the axis of the neck and the axis of the handle is about 120° and opened rostrally. Three processes grow out on the border between the neck and the handle. The long slender anterior process extends rostrally. The shorter and weaker processes, muscular and lateral, extend medially and laterally respectively. The anterior process lies in a plane perpendicular to the plane of the muscular and lateral processes. There is a thin bony lamina spreading between the head and neck of the malleus and the anterior process.

The incus resembles the human birooted molar tooth. It has a long and a short limb, the latter not much shorter than the former.

The stapes is of delicate structure and its limbs have excavations on the interior side. The posterior limb is a little longer than the anterior and less bent, which causes the head of the stapes to extend not only laterally but also a little rostrally. The stapedial artery runs between the limbs of the stapes.

The inner ear

The cochlea forms a $2^1/_2$ to $2^3/_4$ turn (Fig. 10). The long axis of the cochlea is arched against the curve of the column (modiolus), which extends inferiorly and laterally. This is caused by the structure of the cochlea, as the basal turn of the cochlea lies obliquely at about 45° in relation to the descriptive planes of the body (horizontal, vertical and sagittal), its base heading posteriorly, inferiorly and laterally, while the middle turn lies almost in the frontal plane, and the apical (incomplete) pointing caudally, superiorly and medially with its base. The length of the cochlear spiral canal, measured on a rubber mould in these investigations, was 9–11 mm (average 9.87 mm). The vestibular and tympanic scalae are very small, below 1.0 mm in width and in height (Fig. 11).

The vestibule has the shape of rotary ellipsoid with the following dimensions: anteroposterior — 1.1–1.25 mm (average 1.8 mm), superoinferior — 1.25–1.75 mm (average 1.43 mm). The longer dimension runs obliquely from the posterior, inferior and the side rostrally, anteriorly and medially. The vestibule is the entry to the cochlea from the inferior and to the semicircular canals from the superior.

The cochlear canaliculus comes out of the ventral wall of the scala tympani and approaches the cranial cavity. It runs at a distance of 2.05–2.65 mm (average 2.24 mm) between the internal acoustic meatus and the posterior semicircular canal.

The oval window is situated in the lateral wall of the vestibule. The anteroinferior wall leads to the scala vestibuli. The semicircular canals originate in the posterior and superior walls of the vestibule.

Three canals come out of the vestibule and two enter it. The superior and lateral semicircular canals lie in a nearly vertical plane and the posterior lies nearly horizontally. All three semicircular canals surround the subarcuate fossa: the superior canal posteriorly and

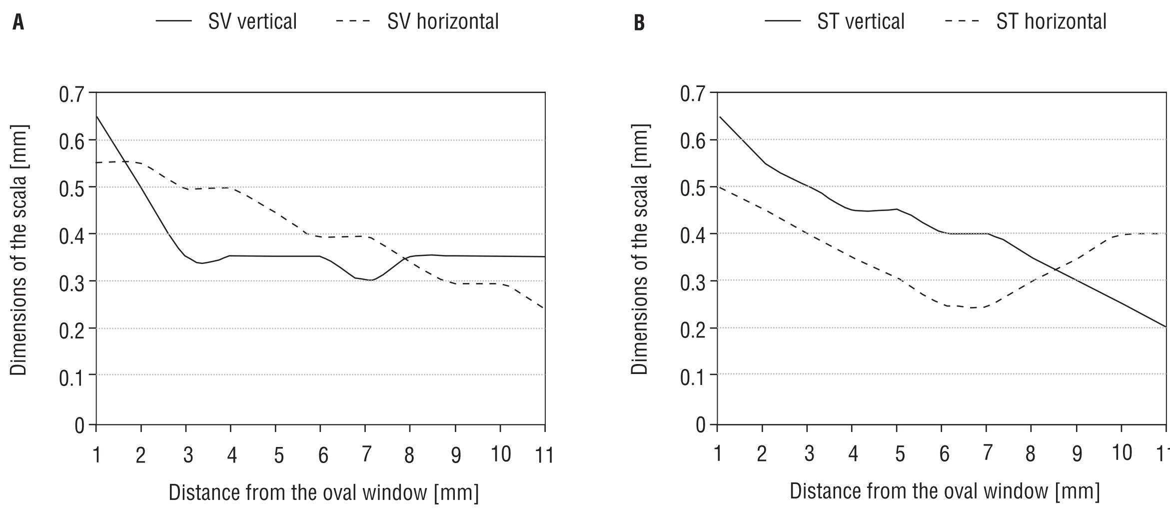

Figure 11. Dimensions of the vestibular **(A)** and tympanic **(B)** scale in the rat cochlea; ST — scala tympani, SV — scala vestibuli.

medially (i.e. from the side of cranial cavity), the lateral canal laterally (from the side of tympanic cavity) and the posterior canal inferiorly (Fig. 10).

The superior and lateral canals leave through separate openings in the posterosuperior wall of the vestibule. The superior canal extends posteriorly and next posterolaterally and, extending inferiorly, approaches the posterior canal. The posterior canal originates in the posteroinferior wall of the vestibule, runs caudally and next sharply superiorly, initially, as mentioned, parallel to the lateral canal and next strongly medially, thus becoming more distant from the lateral canal. It surrounds the inferior opening of the subarcuate fossa leading, as described, to the region of the jugular foramen and containing a small arterial branch. Next it runs rostrally and penetrates the common limb and runs together with the final part of the superior semicircular canal at a distance of 0.75–0.85 mm (average 0.81 mm). The posterior semicircular canal, in its most convex part extending caudally, lies in the vicinity of the petrooccipital suture along the condylar canal and the sigmoid sinus. The lateral canal runs caudally and inferiorly, forming a mild arch, hanging over the tympanic sinus and the small cavity of the stapedial muscle, with the convexity extending caudally. Farther, it bends sharply rostrally, runs horizontally, coming near the round window niche, and approaches its own opening in the posterior wall of the vestibule. This canal runs only about 0.05 mm from the posterior semicircular canal, which runs parallel and below.

The results of the remaining measurements of the temporal bone of the rat are presented in Tables 1–3. The acquired numerical values (data) are presented combined for males and females as well as for the right and left sides of the body, since no statistically significant differences depending on sex or side of the body were found among the mean values of the parameters measured.

Table 1. Results of measurements of selected parameters characterising the magnitude of the internal ear of the rat. All values are in millimetres. Arithmetical means with ranges in parentheses

Structure	Parameter	Value
Semicircular canals		
Superior	Vertical diameter	2.32 (2.1–2.55)
	Horizontal diameter	1.72 (1.35–2.25)
Posterior	Vertical diameter	1.72 (1.5–1.85)
	Horizontal diameter	1.62 (1.2–1.9)
Lateral	Vertical diameter	1.71 (1.5–2.05)
	Horizontal diameter	1.57 (1.25–2.0)
Cochlea	Diameter of the base	1.82 (1.55–2.15)
	Height	2.38 (1.55–2.65)
Oval window	Height	0.46 (0.35–0.5)
	Width	0.81 (0.65–1.05)
Round window	Height	0.72 (0.55–0.95)
	Width	0.68 (0.55–0.8)

DISCUSSION

Researchers involved in the anatomy of temporal bone in the rat confirm that the temporal bone

Table 2. Results of measurements of selected size parameters of the rat temporal bone. All values are in millimetres. Arithmetical means with ranges in parentheses

Structure	Parameter	Value
Whole skull	Full length of skull	41.91 (40.3–43.1)
	Full length of the neurocranial base	14.47 (13.8–15.2)
Whole bone	Full length of the bone	12.43 (12.1–14.3)
	Length of petrous part	7.91 (6.6–9.8)
	Height of petrous part	4.91 (3.75–5.8)
	Length of tympanic bulla	4.61 (4.1–5.6)
	Width of tympanic bulla	8.06 (7.0–9.4)
External auditory pore and its vicinity	Height	2.33 (1.8–2.6)
	Width	2.08 (1.6–2.8)
	Distance between external orifice of facial canal and posterior wall of external auditory meatus	0.52 (0.25–1.0)
	Distance between external orifice of temporal canal and upper wall of external auditory meatus	1.33 (1.0–2.1)
Internal auditory meatus	Height	1.71 (1.75–2.15)
	Width	1.16 (1.0–1.35)
	Distance between external opening of cochlear canaliculus and internal auditory pore	1.04 (0.75–1.25)
Subarcuate fossa	Height	2.22 (1.9–2.5)
	Width	1.32 (1.15–1.75)
	Depth	2.24 (1.25–2.65)

Table 3. Results of measurements of selected size parameters of tympanic cavity of the rat temporal bone. All values are in millimetres. Arithmetical means with the ranges in parentheses

Structure	Parameter	Value
Auditory ossicles	Malleus — full length	3.12 (2.75–3.55)
	Incus — full length	1.28 (1,2–1,35)
	Stapes — full length	0.98 (0,8–1,15)
Tympanic cavity	Full height of tympanic cavity	6.18 (5,4–7,3)
	Full length of tympanic cavity	6.28 (5.5–7.1)
	Height of anterior epitympanic recess	1.67 (1.1–2.55)
	Length of anterior epitympanic recess	2.87 (2.0–3.75)
	Height of posterior epitympanic recess	1.62 (1.25–2.0)
	Length of posterior epitympanic recess	2.58 (2.0–3.1)
	Distance between the round window and internal orifice of the Eustachian tube	4.21 (3.5–5.2)
	Distance between the round window and the internal carotid artery	3.31 (2.85–3.75)
	Distance between the round window and the jugular foramen	0.92 (0.75–1.25)
Eustachian tube	Full length of its bony part	2.27 (1.9–3.2)

in this animal is a complex of three bones: the "squamous bone", the "tympanic bulla" and the "aural capsule" [7]. Apart from the terminology used, this statement should be supported.

However, except for superficial descriptions, it is impossible to find more detailed data on the structure of the temporal bone. In Walker and Homberger's [10] textbook we find a rough description mainly in fact related to what we know about humans. Figures concerning the skull, without any data on the ear, are found only in the work of Popesco et al. [9]. Judkins and Hongyan [5], in their work on the surgical anatomy of the rat's inner ear, included a series of valuable illustrations, although the anatomical description is insufficient. They examined only five subjects and do not give any measurements. The figure showing the promontory demonstrates the presence of the stapedial artery but does not mention the carotid artery canal situated rostrally from the promontory. The authors state that "all structures described in human anatomy were found". Our studies show that there is no pyramidal eminence. Moreover, according to this publication [5], the rat's auditory ossicles "in comparison with human are small and are about a quarter of the size of human". The present study demonstrates that this may apply only to the incus and stapes and that the 3 mm long malleus is only about 2.5 times shorter than that in human. Next they state that "the grand opened air cell or bulla corresponds to the human mastoid process". This is patently untenable because the tympanic bulla derives from the tympanic part of the temporal bone, but the mastoid process develops from the petrous part.

According to the authors cited [5], the middle ear structures are difficult to approach from the side of the meatus. This is only partly true, as there is only a slight widening of the external acoustic meatus, while in fact the pore (because, the meatus is rudimentary) gives quite a good insight into the promontory region. Again, they state that the malleus has a short process, a long process and the body, which seems unclear. According to present observations and measurements the "long" process corresponds to the handle.

According to McClure and Daron [7], the subarcuate fossa is limited ventrally by the lateral semicircular canal. According to my own observations, the lateral semicircular canal is situated exactly laterally of the subarcuate fossa and the posterior canal is in its fundus. Therefore the posterior canal limits the subarcuate fossa ventrally. The author, it seems, has confused the lateral canal with the posterior, which is quite easy to do. Conclusive evidence for its being the lateral canal is that it emerges typically in the vicinity of the superior canal. Evidently it does not run in the horizontal plane, as in humans, but follows patterns of topography of the lateral canal regularly found in the majority of species. It has two independent openings to the vestibule and lies over the facial nerve and above the oval window. In fact the subarcuate fossa has three walls limited by the semicircular canals: anteromedial — the anterior canal, anterolateral – the lateral canal and inferior — the posterior canal. McClure and Daron [7] mentioned that the walls of the subarcuate fossa have vessel openings, which confirms the present observations.

The dimensions of the cochlea obtained are comparable with the results of other authors, where the height of the column (modiolus) is 2.45 mm in the Norwegian rat, and 1.75 in the Wistar strain [3]. The obtained value of 2.5 mm in fact refers to total height of the cochlea, which exceeds the height of the column (modiolus) and was not measured by Burda et al. [3]. The diameter of the basal turn as measured in our investigations is 1.75 mm, which perfectly corresponds to the value obtained by these authors (1.7 mm).

The system of large blood vessels in the rat ear is interesting. The system of cranial arteries in rodents most closely resembles the primitive, with well developed carotid and stapedial arteries [2]. The stapedial artery supplies the dura mater, the orbit and the eyeball, while the internal jugular artery supplies the brain (together with the vertebral artery) and has a major share in supplying the orbit (ethmoid, lacrimal and frontal branch) and maxilla. The external carotid artery takes over the supply of the masticatory organ.

In conclusion, it has to be stated that there is a wide easy approach to the tympanic cavity leading through the inferior and lateral wall of the tympanic bulla. In planning a procedure the proximity of large vessel trunks, such as the stapedial artery and the internal carotid artery, should be considered.

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