

Short communication

ISSN 2658-3518

LIMNOLOGY
FRESHWATER
BIOLOGY

www.limnolwbiol.com

The structure and blood supply to the Baikal seal's organ of hearing

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ABSTRACT. The article studies anatomical features of the structure and blood supply to the outer ear, the middle ear and the inner ear of the Baikal seal. The outer ear has no auricle. The long external auditory meatus has a slightly curved shape of various diameters and cartilaginous plates. The bone base of the middle ear is a triangular-shaped tympanic bubble. It has specific features in the topography of openings for the facial nerve and the bony auditory tube. The drum cavity is voluminous, repeats the contour of the tympanic bladder. It contains auditory ossicles (malleus, anvil, lenticular ossicles and stapes). The inner auditory meatus is deep; the entrance to the aqueduct is located medially on the rocky part of the inner ear. The main source of blood supply to the organ of hearing is the occipital (blood supply to the opening area of the bony auditory tube) and caudal ear deep temporal (blood supply to the area of the external auditory canal; they are formed from the external vascular network of tympanic membrane skin) arteries. They are branches of the external carotid artery, as well as the internal auditory (blood supply to the facial nerve and forms the internal vasculature) and rocky (blood supply to the vestibule, semicircular canals and cochlea) branches of the basilar artery.

Keywords: Baikal seal, hearing organ, blood supply

1. Introduction

All mammals have similar structures of the organ of hearing; however, depending on the environment during phylogenesis, the organ acquires anatomical features that help the mammals to adapt to their lifestyle. Pinnipeds are no exception. The seals spend most of their time in water rather than on land. Their auricle is reduced, and the auditory canal performs a protective function. When diving to a depth, their organ of hearing is subjected to significant changes in pressure (King, 1964; Bogoslovskaya and Solntseva 1979; Dehnhardt, 2002).

The Baikal seal is an endemic of Lake Baikal. Unlike their closest relatives, they live in fresh water. Anatomical features of the blood supply to the brain were studied by A.A. Molkova and N.I. Ryadinskaya (Molkova and Ryadinskaya, 2020). However, data on the structure and blood supply to the organ of hearing was not found in the literature. The present article aims to study this issue.

2. Material and methods

The organ of hearing of the Baikal seal aged from 5 months to 2 years ($n = 12$) was used as a research object. Anatomical features of the structure and blood

supply to the outer ear, the middle ear and the inner ear were studied using the method of anatomical preparation, both by infusing Invamat fire-fighting foam and without it. The results were processed biometrically in Statistics.

3. Results and discussion

The outer ear of the Baikal seal starts with an aperture of 6.7 ± 1.21 mm in diameter; it has no auricle. The external auditory meatus, 55.2 ± 0.77 mm long, is located under the skin; it starts from the external opening and ends with a cone in the tympanic ring of the tympanic vesicle whose base is the tympanic membrane. The canal has two weak bends in the cranial direction, with a deviation from the main axis of $12-15^\circ$ and $18-20^\circ$. Before entering the tympanic bubble, the canal deviates caudally by $5-6^\circ$. The diameter of the external auditory meatus is uneven: in the area of the first bend, it is 10.3 ± 0.11 it has a slight narrowing (8.5 ± 0.55); in the area of the second bend, it is 10.1 ± 0.14 mm; and in the narrowing area, before entering the tympanic cavity, it is 6.0 ± 0.36 mm. Cartilage plates were found at the narrowing base and the second bend. G.N. Solntseva and F. Ramprashad described four connected plates in the auditory canal, capable of changing the diameter and shape of the

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lumen of the auditory canal (Rampershad et al., 1973; Solntseva, 1973). J.E. King and S. Dehnhardt revealed a strong elongation and a S-shape of the auditory canal capable of changing the diameter under water pressure or muscle contraction (King, 1964; Dehnhardt, 2002).

A convex drum-shaped bubble of a triangular shape represents the middle ear, the base of the triangle is aboral, and the apex is rostral. Laterally on the tympanic bubble, there is an oval opening of the external auditory canal, 4.5 ± 0.54 mm in diameter; medially, there is an opening for the internal carotid artery. The opening is the beginning of the short carotid channel for the internal carotid artery to pass into the cranial cavity (it is not communicated with the tympanic cavity). The opening of the external auditory meatus is separated from the tympanic bladder by a bone crest. Between the base of the triangle of the tympanic vesicle and the mastoid part, there is a slit-like opening for the facial nerve. It is 6.1 ± 0.32 mm long and 1.8 ± 0.22 mm wide. A vascular groove 1.3 ± 0.11 mm wide passes to the opening along the medial corner of the base. In the region of the tympanic bladder triangle apex, the styloid process of the hyoid bone is attached. At its base, there is a slit-like opening of the bony auditory tube 5.2 ± 0.22 mm long and 1.6 ± 0.12 mm wide. Cranially from the opening, there are oval and wing openings. The drum cavity is wide enough and follows the contour of the tympanic bubble. It contains auditory ossicles (malleus, anvil, lenticular ossicles and stapes).

The inner ear of the Baikal seal is located in the rocky part of the stony bone, where there are semicircular canals, a vestibule and a cochlea. On the surface of the rocky part, in the internal auditory canal, there is a deep oval opening with a diameter of 5.0 ± 0.89 mm with three openings: for the facial, equilibrium and auditory nerves. Medially, there is an entrance to the aqueduct of the vestibule. Cranially, there is an entrance to the aqueduct of the cochlea.

Blood is supplied to the external auditory canal by two arteries from the caudal ear artery. The caudal ear artery is the second vessel of the external carotid artery. Through the branch with a diameter of 15.5 ± 1.11 mm, it gives the first artery with a diameter of 1.1 ± 0.21 mm to the narrowest part of the external auditory meatus in front of the tympanic cavity and anastomoses with the artery from the deep temporal artery. The second branch with a diameter of 1.3 ± 0.12 mm departs in the region of the first narrowing between the first and second bends. In addition, from the deep temporal artery to the opening for the facial nerve, an artery with a diameter of 0.9 ± 0.13 mm goes through the vascular canal, and another artery goes to the auditory canal in the opening of the external auditory canal, forming an external circulatory network of tympanic

membrane skin and anastomoses with branches of the caudal ear artery. A flex is formed in the mouth of the bony auditory tube from the occipital artery (the first branch of the external carotid artery). Small arteries go into the tympanic cavity from the flex.

The internal auditory artery with a diameter of 2.1 ± 0.11 mm departs from the basilar artery into the internal auditory meatus and enters the tympanic cavity through the facial canal, supplying the facial nerve and forming an internal circulatory network in the tympanic cavity that feeds the stapes muscle and the auditory ossicles. The rocky branch with a diameter of 1.2 ± 0.15 mm departs from the basilar artery and goes into the opening of the aqueduct in the vestibule of the inner ear.

4. Conclusions

Thus, the organ of hearing of the Baikal seal is represented by the outer ear lacking an auricle, the middle ear and the inner ear. The main source of blood supply to the organ of hearing is the occipital and caudal ear arteries - branches of the external carotid artery, as well as the internal auditory and rocky branches of the basilar artery

Acknowledgments

The research was conducted within the project financially supported by the Baikal Lake Project Support Fund for Applied Ecological Research and Development.

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