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Lambs' temporal bone anatomy under didactic aspects

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Abstract

Human temporal bones in teaching ear surgery are rare. The lamb's temporal bone might be a possible alternative.

Material and Methods: Temporal bones of the lamb were dissected with a typical temporal bone lab drilling program. We included a mastoidectomy, endaural approaches, but also analyzed the outer appearance, the external ear canal and the hypotympanon. Some steps differed from preparation done in humans. The morphometric results were compared to the known anatomy of human in order to verify the lambs` temporal bone for suitability in otosurgic training.

Results: The lambs' temporal bone appears smaller than the human one. We found a bullous extended hypotympanon located under the external ear canal. The tympanic membrane is very similar to the human one. The external ear canal is smaller and shorter. The ossicular chain shows analogies to human one.

Discussion: This study shows, that especially the middle ear, the tympanic membrane and the external ear canal are morphologically equal to the structures found in human temporal bones. The lamb seems feasible for teaching the anatomy of the ear. The smaller scales of some structures, especially the outer components of the temporal bone are a disadvantage.

Conclusions: The lamb seems to be an alternative in teaching ear surgery.

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INTRODUCTION

The use of human temporal bones is limited by their bad availability. The usual alternatives for teaching ear surgery are rare and consist of virtual temporal bones or models. Unfortunately they are not suitable for training chain reconstruction or preparatory work on the middle ear. Temporal bones retrieved from animals might help to reduce the need for human biologics[1-6] in teaching and research. In order to verify the feasibility of the lambs temporal bone for ENT-education we designed this morphometric study.

MATERIAL AND METHODS

Prearrangement

We retrieved 12 heads of lambs, aged between 8 to 11 months from a local slaughterhouse. No animal was killed for research purposes. The skin was removed, a sagittal separation of the heads was done and ventral parts of the heads were removed as well as the the brain. These probes were fixated in formaline solution of 3 % for 6 to 8 weeks. The appending soft tissue was removed from the fixated temporal bone in order to expose the mastoidal plane and the external ear canal.

Preparation

Before any manipulation on the temporal bones we examined and described the outer anatomy. As a first dissection step the bullous hypotymanon was opened. This allowed a good view from inferior into the middle ear.

Based on this approach we opened the external ear canal, leaving the fibrous anulus of the tympanic membrane untouched in order to get a view on the tympanic membrane and the external ear canal suitable for morphometric analysis.

The mastoidectomy was performed analogous to the one in humans, between the temporal line and the posterior wall of the external ear canal including the whole mastoidal plane. This procedure was done until the semicircular canals, the access to the middle ear,the facial nerve and the incus were visible.

As last step the ossicular chain was removed. This made morphometric studies on the promontory possible.

Measurement

The identified structures in all anatomical preparation were measured by an optical measurement procedure. The optical views were grabbed by a digital single lens reflex camera which had been adapted by a C-Mount to the microscope or a 0° degree endoscope. The light source was either the microscope itself or a standard surgical light fountain used in endoscopic surgery. We laid a small strip of foil containing units of 1 mm into the field of view. This strip was used as a reference for measurement calibration. The calibrating strip was positioned as near as possible to the measured structure.

The gauges were done with the help of the D-Cell Image analysis system which is a two-dimensional, pixel orientated software. After calibration of each single shot the anatomical parameters were acquired. It was imported to use views nearly perpendicular to the measured structure in order to avoid faulty results.

We determined the length and the smallest diameter as well as the diameter at the orifice of the external ear canal. The angles in two directions of the external meatus were measured. The tympanic membrane was gauged in length and height, as well as its nook to the external ear canal. In the middle ear spaces we quantified the length and sizes of all ossicules first in the middle ear and again isolated after chain removal in order to proof the measuring method.

On the promontory, the sizes of the oval and the round window and the distance of this structures were measured as well. The position of the cochlea was determined and described, but not quantified.

The structures found in mastoidectomy were described and partially measured. The acquired data was especially the angle of the short incus process to the lateral semicircular canal.

RESULTS

Outer appearance

Macroscopically the lamb's temporal bone appears smaller compared to human with a lot of similarities. The external ear canal is positioned humanlike and the mastoidal plane seems to have the same structural morphology.

The distance between temporal line and cranium was 1,71 cm on average. The atlanto-occipital joint is vectored backwards as well as the foramen magnum. A styloid process cannot be found. The mastoid strongly expands inferiorly.

We found a bullous structure consisting of a thin bony layer, later identified as the hypotympanon, which measured 11,4 mm in depth and 23,2 mm in length averaged (Figure 1).

External ear canal and tympanic membrane

The bony external ear canal is orientated on the same axis as in humans but it has smaller scales. Its length was 12,6 mm in the mean with a maximum of 15,7 mm and a minimum of 12,4 mm. The canals diameter was 2,9 mm on average (Figure 2).