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Ventilation and Gas exchange in middle ear (R716)

ID: 716.2

The role of the mastoid in middle ear pressure regulation

Presenting Author: **Michael Gaihede**

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Learning Objectives: Recent studies on the mastoid structure and function has pointed to an important role in middle ear physiology.

The normal function of the middle ear depends on regulation of its pressure relative to ambient pressure, and traditionally gas exchange between the middle ear mucosa and gas pocket has been focused on together with the function of the Eustachian tube. However, recent studies have also pointed to a role of the mastoid mucosa, where volumetric changes effected by changes in the blood vessels congestion may influence the pressure.

Physiological experiments have revealed two distinct patterns for pressure changes in the middle ear, where stepwise fast pressure equlibrations towards ambient pressure represent Eustachian tube openings, and where gradual slow pressure changes in both negative and positive directions represent other mechanisms. The congestion of the mucosa is likely to reflect these gradual changes, and loose connective tissue with abundant blood vessels favors such function together with the high surface area-to-volume ratio of the mastoid.

Recently micro-CT-scanning of temporal bones have revealed a high number of retroauricular microchannels, which represents a rich blood supply to the mastoid, as well as they have shown higher surface areas than previous CT studies. These observations point to a specific function of the mastoid structure. In addition, retroauricular injection of adrenaline has demonstrated a decrease the middle ear pressure, which can be explained by a direct drug transfer to the mastoid via the microchannels, and subsequently a vasoconstriction and shrinkage of the mucosa.

The mastoid mucosa has no cilia and goblet cells resulting in a relative susceptibility to infection in comparison with the tympanum. Repeated or chronic infections often lead to fibrosis, which may hamper the mucosa function. If the overall pressure regulation is represented by the complimentary actions of both the Eustachian tube and the mastoid mucosa, then an impaired function of both factors should be considered in the formation of middle ear underpressure.

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Ventilation and Gas exchange in middle ear (R716)

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A Formal Description of Middle Ear Pressure-Regulation

Presenting Author: **William Doyle**

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Introduction: Middle ear (ME) pressure-regulation (MEPR) is a homeostatic mechanism that maintains the ME-environment pressure-gradient (MEEPG) within a range optimized for "normal" hearing.

Objective: Describe MEPR using equations applicable to passive gas-exchange and determine if the predictions of that description include the increasing ME pressure observed under certain conditions and interpreted by some as evidencing gas-production by the ME mucosa.

Methods: MEPR was modeled as the combined effect of passive gas-exchanges between the ME and: perilymph via the round window membrane, the ambient environment via the tympanic membrane, the local blood via the ME mucosa and the NP during Eustachian tube openings. The first 3 of these exchanges are described at the species level using Fick's diffusion equation and the last as a bulk gas transfer governed by Poiseuille's equation. The model structure is a time-iteration of the state equation: $P^{ME}_{g(t=(i+1)\Delta t)} = \Sigma^{s}(P^{ME}_{s(t=i\Delta t)} + (1/(\beta^{ME}_{s}V^{ME})\Sigma^{P}(K^{P}_{s}(P^{C}_{s(t=(i\Delta t)}$-$P^{ME}_{s(t=(i\Delta t)}))$. There, $P^{ME}_{g(t=i\Delta t)}$ and $P^{ME}_{s(t=i\Delta t)}$ are the ME total and species-pressures at the indexed times, $P^{C}_{s(t=i\Delta t)}$ is the species-pressure for each exchange-compartment, $\beta^{ME}_{s}V^{ME}$ is the product of the ME species-capacitance and volume, K^{P}_{s} is the pathway species-conductance, and Σ^{S} and Σ^{P} are operators for summing the expression over all species or exchange pathways.

Results: When calibrated to know values, the model predicts the empirically measured species-pressures and the observed time-trajectories for total ME pressure and the MEEPG under physiologic, pathologic and non-physiologic conditions.

Conclusions: Passive inter-compartmental gas exchanges are sole and sufficient to describe MEPR and, by Occam's Razor, discount gas-production by the ME mucosa.

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Hearing Reconstruction: How I do it (2) (V717)

ID: 717.1

Ossiculoplasty techniques

Presenting Author: **Christopher Aldren**

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Learning Objectives: The video will show the use of the Dresden Partial Clip prosthesis, the KURZ Variac TORP with omega connector and the malleus replacement prosthesis. Results will be presented with surgical tips and time for questions.

The video session will demonstrate the use of various prosthesis that the author uses regularly. This includes the use of the Dresden partial clip prosthesis for use in the