

doi:10.1017/S0022215116002838

## 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**

Michael Gaihede  
Aalborg University Hospital

*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 equilibrations 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.

doi:10.1017/S002221511600284X

## Ventilation and Gas exchange in middle ear (R716)

ID: 716.3

### A Formal Description of Middle Ear Pressure-Regulation

Presenting Author: **William Doyle**

William Doyle

University of Pittsburgh

*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:  $P_{g(t=(i+1)\Delta t)}^{ME} = \sum^S (P_{s(t=i\Delta t)}^{ME} + (1/(\beta_s^{ME} V^{ME})) \sum^P (K_s^P (P_{s(t=i\Delta t)}^C - P_{s(t=i\Delta t)}^{ME})))$ . There,  $P_{g(t=i\Delta t)}^{ME}$  and  $P_{s(t=i\Delta t)}^{ME}$  are the ME total and species-pressures at the indexed times,  $P_{s(t=i\Delta t)}^C$  is the species-pressure for each exchange-compartment,  $\beta_s^{ME} V^{ME}$  is the product of the ME species-capacitance and volume,  $K_s^P$  is the pathway species-conductance, and  $\sum^S$  and  $\sum^P$  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.

doi:10.1017/S0022215116002851

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

ID: 717.1

### Ossiculoplasty techniques

Presenting Author: **Christopher Aldren**

Christopher Aldren  
Wexham Park Hospital

*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

presence of a mobile stapes and absent or deficient incus. The KURZ Variac total prosthesis for use when the stapes is absent will be demonstrated with the omega shoe connector. Malleus relocation combined with the Vincent ALTO prosthesis and the malleus replacement prosthesis will also be shown. Data on results will be discussed with time for questions.

doi:10.1017/S0022215116002863

### Middle ear function in normal and pathological ears (K723)

**ID: 723.1**

#### Middle Ear Function in Normal and Pathological Ears

Presenting Author: **John Rosowski**

John Rosowski

*Massachusetts Eye and Ear Infirmary*

*Learning Objectives:* - New measurements of TM motion tell us more about its function in normal and pathological ears. - Besides being of use in diagnosing the presence of middle-ear effusion, WBI can aid in the diagnosis of ossicular and other conductive disorders. - Normal 'third-window's affect the response of the inner-ear to non-ossicularly conducted sound.

*Introduction:* In recent years multiple technical and research developments expanded our understanding of the workings of the normal and pathological ear: New measurements of normal and pathological tympanic-membrane (TM) function, new ways to assess ossicular disorders, and an improved understanding of the effect of cochlear 'third-windows'.

*Methods:* The clinic-based techniques of Wide-Band acoustic Immittance (WBI) and Laser-Doppler Vibrometry (LDV) are described along with experimental techniques: Digital Opto-Electronic Holography (DOEH), Optical Coherence Tomography (OCT), and inner-ear sound pressure measurements.

*Results:* WBI and scanning LDV and OCT shed new light on the function of the TM. DOEH, without scanning, reveals the temporal response of over 100,000 points on the TM surface, and demonstrates the complex modal response of the TM surface in response to frequencies as high as 20 kHz. The TM motions induced by sound of a few kHz and less assess the presence of multiple conductive disorders, including ossicular fixations or interruptions, as well as the presence of several cochlear conductive disorders. Recent clinical and basic research led to a re-evaluation of the 'two-window' model of the inner ear, which occurred in the presence of evidence for pathological 'third windows' that result from abnormalities in the bone around the inner-ear fluids.

*Conclusions:* Advances in measurement tools increased our understanding of the workings of the normal and pathological middle ear. (1) Spatially uniform sound-induced TM motions dominate the response to sound, and TM motions near the ossicular attachment contributes most to

ossicular stimulation at high sound frequencies. (2) Multiple clinical techniques aid the pre-surgical diagnosis of ossicular and inner-ear conductive hearing disorders. (3) Normal inner-ear third windows explain multiple lines of evidence associated with non-ossicular stimulation of the inner ear.

doi:10.1017/S0022215116002875

### Balloon Tuboplasty (R731)

**ID: 731.1**

#### Site of Eustachian Tube Obstruction in COM

Presenting Author: **Muaaz Tarabichi**

Muaaz Tarabichi, Muaaz Tarabichi

*American Hospital Dubai*

*Learning Objectives:* 1-Understand the existence of obstructive pathology in COM. 2-Learn how to evaluate for the site of obstruction. 3-Consider options for addressing obstruction within the proximal Eustachian tube.

*Objective:* To assess the patency of the proximal and distal segments of the Eustachian tube in patients undergoing surgery for chronic ear disease.

*Study Design:* Case study with control group.

*Methods:* All consecutive patients presenting for surgery for chronic ear disease in our practice over 14 months underwent preoperative Valsalva computed tomography (CT) and an attempt was made intraoperatively using angled rigid scopes to evaluate obstruction of the protympanic segment of the Eustachian tube. Endoscopic examination of the same segment in 19 cadaver ears served as a control group.

*Results:* Preoperative Valsalva CT showed patency of the distal one-third of the Eustachian tube in 51 of 53 ears. Intraoperative endoscopy allowed visualization of the protympanic opening of the Eustachian tube in 31/53 ears; 21/31 ears showed obstruction of the protympanic opening of the Eustachian tube.

*Conclusion:* A clear obstruction was more likely to be present in the protympanic opening of the Eustachian tube in the patient population undergoing surgery for chronic ear disease than in the cadaver control group, and equally likely to be present in the distal cartilaginous tube in patients as in the control population.

doi:10.1017/S0022215116002887

### Balloon Tuboplasty (R731)

**ID: 731.2**

#### Defining disease and outcome measures

Presenting Author: **Mahmood Bhutta**