Is the 3D Sound-Induced Motion of the Tympanic Membrane Consistent With Thin-Shell Theory?

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During OM, genes encoding the protein substrates of the PI3K/PTEN/AKT pathway are upregulated just prior to the period of intense mucosal hyperplasia. Combined with growth reduction by pathway inhibitors, the data suggest that PI3K/PTEN/AKT signaling plays a significant role in regulating growth of the ME mucosa during OM.

The inflammasome adaptor ASC contributes to multiple innate immune processes in the resolution of otitis media

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The inflammasome complex and its activation of inflammatory cytokines by proteolytic cleavage play a crucial role in host defense and have been implicated in the pathogenesis of several inflammatory diseases. The current study was designed to understand the contribution of the inflammasome and IL-1β (interleukin-1β) activation in an animal model of otitis media (OM), a common pediatric disease.

Methods

We examined the middle ear (ME) response to Nontypeable Haemophilus influenzae (NTHi) in wild-type (WT) mice, using gene microarrays and our established murine model of acute OM. The expression of 45,000+ transcripts representing essentially all mouse genes were compared between NTHi-infected and sham MEs using Affymetrix gene chip. In addition, OM was induced by NTHi inoculation into the MEs of WT versus ASC-deficient mice.

Results

Expression of members of the NALP family of inflammasome receptor genes was significantly up-regulated early in NTHi infection of the ME, potentially resulting in the activation of specific down-stream regulatory cascades that contribute to the proliferative inflammatory response observed during OM. In addition, expression of the pro-forms of the inflammasome targets IL-1β and IL-18 were also up-regulated. To evaluate the role of inflammasome-mediated cytokine maturation, NTHi-induced Mice lacking the ASC gene showed near absence of IL-1β maturation in the ME and a reduction in leukocyte recruitment and infiltration to the cavity. In addition, macrophages from ASC-deficient mice exhibited reduced phagocytosis of NTHi. These inflammatory defects were linked to an increase in the degree and duration of mucosal epithelial hyperplasia in the ME of ASC-/- mice, as well as a delay in ME bacterial clearance.

Conclusion

These data demonstrate an important role for the inflammasome and cytokine processing in the course and resolution of OM. This is mediated by the participation of cleaved target molecules in multiple processes in the response to infection of the ME.
Fig. 1. Principal components of displacement along three orthogonal axes of the TM as obtained by application of our approach. TM was subjected to sound stimuli of 5730 Hz and sound pressure level of 101 dB: (a) 3-D view. (b) 2-D top view. The z axis corresponds to the lateral-medial direction with medial as positive, which was defined by the longitudinal axis of the illuminating and reflected laser beam. The x direction is approximate to the rostral (anterior)-caudal (posterior) axis with rostral positive. The y direction is approximate to the dorsal (superior)-ventral (inferior) direction with ventral positive. Displacements are in the unit of μm.

References


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A Three Dimensional Volumetric Study of the Epitympanum in Human Temporal Bones
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Background
The pathophysiology of chronic otitis media requires a proper understanding of the disease. Three-dimensional evaluation allows us to see the changes in ventilation pathways in pathologic conditions. Restoration of the ventilation will be the main focus of treatment in order to prevent any recurrences or residual problems. The aeration pathway from the Eustachian tube leads directly to the mesotympanic and hypotympanic space, whereas the epitympanum is away from the direct airstream and not aerated.

The epitympanic diaphragm consisting of the incus, malleus, and their folds, is described as the floor of the epitympanum, which is the dividing structure from the mesotympanum. It is believed that epitympanum and mastoid aeration occurs through the tympanic isthmus.

It has been suggested that a reduced volume of the bony boundaries of the epitympanum is related to a selective attic disventilation syndrome and chronic otitis media.

The purpose of this study is to compare the volume of the epitympanum between the groups of normal and chronic otitis media (COM).

Methods
Six children’s temporal bones that presented with chronic otitis media (COM group) and 3 normal children’s temporal bones as a control group from the human temporal bone (HTB) collections of the University of Minnesota were examined.

The epitympanum was divided into 5 different compartments: anterior area(A), lateral area(L), medial area(M), posterior area(P) and Malleus-Incus area(MI).

Three-dimensional models were generated from HTB histopathological slides with reconstruction software (Amira®). Measurements of the bony volumes of each compartment, total epitympanum (E) volume, and the ratio of the malleus and incus to the total epitympanum (MI/E) were taken.

Results
There were no differences of the bony volumes of each compartment or of the total epitympanum volume between the COM group and the control group. There were also no differences in MI/E between the two groups.

Conclusion
The evidence supports that no relationship exists between epitympanic volume and COM.

Further studies are necessary to clarify what kind of differences in anatomical features could be found between COM and the control groups.

Our next study will focus on the evaluation of the soft tissue blockage of the tympanic isthmus in cases with chronic otitis media.

<table>
<thead>
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<th>Anterior</th>
<th>Posterior</th>
<th>Lateral</th>
<th>Medial</th>
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<th>MI/total</th>
<th>total</th>
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(median)