2-mm pull). These are the first results to demonstrate that the delay through the human ME is altered by TM-shape changes caused by TT-tendon pulls that mimic muscle activation. The ~200-μs decrease in delay is about 25% of the maximum interaural time difference across the human head. This suggests that a role for TT muscle activity might be to modify sound-localization cues. [Work supported by grant R01-DC005960 from the NIDCD of the NIH.]

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Middle-ear Muscle Contractions Should Not Be Included in Damage-Risk Criteria

Heath Jones[1]; Stephen Tasko[2]; Gregory Flamme[3]; Kara McGregor[2]; Madeline Smith[2]; Kristy Deiters[3]; William Murphy[4]; Nathaniel T. Greene[5]; William Ahroon[1]
[1]U.S. Army Aeromedical Research Laboratory; [2]Western Michigan University; [3]Stephenson and Stephenson Research Consulting; [4]The National Institute for Occupational Safety and Health; [5]University of Colorado School of Medicine Department of Otolaryngology

Middle-ear muscle contractions (MEMCs) involve activation of the stapedius and/or tensor tympani muscles. MEMCs can be elicited by acoustic and non-acoustic stimuli, and can sometimes be engaged voluntarily. Responses typically increase the middle-ear impedance for low frequencies (95 % confidence of > 95% prevalence) within the population, and are of sufficient strength and duration to serve as a protective mechanism. These assumptions were addressed by determining (1) the prevalence of acoustic reflexes using clinical protocols, (2) the likelihood of observing an MEMC for short-duration acoustic and non-acoustic stimuli among people with clinically-measured acoustic reflexes, and (3) attempts to condition or train an anticipatory MEMC in laboratory environments. Studies varied in size from 26 to 15,106 participants. The largest study examined the prevalence of clinically-measured acoustic reflexes drawn from the U.S. National Health and Nutrition Examination Survey. The laboratory studies included 220 healthy adults with excellent hearing (*n*=194) or slight/mild hearing impairment (*n*=26). Reflexive MEMCs to short-duration acoustic and non-acoustic stimuli were assessed in all laboratory studies. Additionally, the presence of conditioned MEMCs was investigated using five different training tasks administered to subgroups chosen at random. No participant group exhibited pervasive MEMCs, which obviated the need for assessment of whether the observed responses had sufficient strength or duration. Results indicated the likelihood of observing an MEMC for short-duration acoustic stimuli was much lower than for non-acoustic stimuli and that voluntary eye closure produced the greatest likelihood of an MEMC. Conditioned MEMC responses were well below the 0.95 criterion necessary to consider the responses pervasive. Interestingly, participant attention greatly influenced the likelihood of observing an early, conditioned MEMC. Although clinical acoustic reflexes are often observed in a normal hearing population, clinical observations do not generalize to the stimuli and contexts relevant to DRC. Collectively, these studies indicate MEMCs should not be included as a protective factor in DRC for impulsive noises.

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Stapes Displacement in Response to Low-Frequency, High-Intensity Sounds: A Cross Species Study

John Peacock[1]; Mohamed Alhussaini[2]; Nathaniel T. Greene[3]; Daniel J. Tollin[4]
[1]University of Colorado School of Medicine, Department of Physiology and Biophysics; [2]Assiut university Egypt; [3]University of Colorado School of Medicine Department of Otolaryngology; [4]Department of Physiology & Biophysics, and Department of Otolaryngology, University of Colorado School of Medicine

Stapes displacement increases linearly with increasing ear canal sound pressure until it reaches its maximum, at which point it will act to attenuate the amount of energy entering the cochlea. If stapes displacement were to saturate at a lower applied sound pressure level, this could help to limit damage to the inner ear from exposure to high intensity sounds. Alternatively, if the stapes displacement were to saturate at a higher applied sound pressure level, this could make it easier for high intensity sounds to cause damage.

Stapes displacement will vary between species, and thus the potential for inner ear trauma due to blast exposure will also vary between species. Different animals will require exposure to different sound intensities before damage can occur. Some studies have suggested a peak to peak stapes displacement in rabbits and cats of around 30 μm, which is much smaller than the ~150 μm displacement that has been measured in humans.

The middle ear transfer function also varies between species. Different animals ears are tuned to different frequency ranges, thus the transfer function will vary across frequency. Blast energy is mostly concentrated at the lower frequencies, and thus different species may be more or less susceptible to hearing trauma, depending on how easily energy at lower frequencies is transmitted through the ear. These species differences are important

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