Optimal tympanic membrane reconstruction when using the Soundbridge hearing system

Matthias Bornitz, Christoph Müller, Thomas Zahnert
Technische Universität Dresden, Carl Gustav Carus Faculty of Medicine, Clinic of Otorhinolaryngology, Head and Neck Surgery

Introduction

The Soundbridge implant system is used for sensorineural and combined hearing loss. If the ossicular chain is interrupted, the actuator (VORP) can be coupled to the stapes. A reconstruction of the tympanic membrane (with connection to the actuator) is often also necessary. In case of chronic aeration disorder of the middle ear, a compromise between stability and good sound transmission must be found for tympanic membrane (TM) reconstruction.

Material & Methods

- Simulations with a Finite Element model of the human middle ear
- Experimental investigations on temporal bone specimen
- Artificial clamp for the tympanic membrane reconstruction for repeatable remeasurements
- Measurement of stapes footplate displacement with Laser Doppler Vibrometer (LDV)
- Sound pressure excitation in the (artificial) ear canal and excitation with the FMT/VORP

Results & Discussion

1. Underpressure in the tympanic cavity causes loss in sound transfer through the middle ear, due to stiffening of the annular ligament, which in turn is a result of the displacement of the (reconstructed) TM.
2. Sound transfer through the reconstructed middle ear is effected by underpressure the same way as in the normal middle ear; the thinner the cartilage the more attenuation in sound transfer. (cartilage 1 = thickest; 6 = thinnest)
3. Simulation results show, that a thicker cartilage reconstruction of the TM causes more loss in the performance of the VORP than a thinner one but it is much less effected by underpressure.
4. Measurement results do not show differences in VORP performance subject to cartilage thickness.
5. There is only a minor attenuation of VORP performance due to underpressure in the middle ear; independend of cartilage thickness.