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Optimizing the coupling load for the Otologics middle ear transducer MET: intra operative measurements

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Introduction: The appearance of novel implantable hearing devices represents a hopeful alternative for the therapy of sensorineural hearing loss. One of these is the MET ossicular stimulator (Otologics, LCC., Bolder, CO, USA), a semi-implantable hearing aid with an internal unit consisting of an electromagnetic transducer. This internal unit is coupled to the incus by a coupling rod that is inserted in a previously made whole and adjusted by a microadjustive screw to achieve an optimal static preload resulting in maximum footplate displacement. Determining the optimal preload by acoustical measurements is limited intraoperatively due to possible occlusion effects of the ear canal.

Material and Methods: Acoustical and mechanical measurements were done simultaneously three MET implantations. A probe microphone that was inserted into the subsequently sealed ear canal was used for the acoustical measurements. For the vibration measurements, the developed and subsequently optimized setup according to Rodriguez Jorge et al. [1] was used consisting of a laser Doppler vibrometer (LDV) that is coupled to an operation microscope. We stimulated the MET ossicular stimulator with 9 simultaneous pure tones (250 Hz, 500 Hz, 750 Hz, 1000 Hz, 1500 Hz, 2000 Hz, 3000 Hz, 4000 Hz and 6000 Hz) and the microadjustive screw was turned to obtain the maximum incus displacement amplitude. The incus vibration amplitude was measured twice while the laser beam was focused onto the incus body.

Results: The highest amplitudes (40 µm/V - 80 µm/V) were found with a screw rotation of 0° - 90° (0 to 0.0625 mm). If the microadjustive screw was rotated 180°, the amplitude decreased by 14 dB - 20 dB. Altogether, an optimal coupling was achieved with a rotation of 90° corresponding to a coupling rod advancement of 0.0625 mm.

Conclusions: 1. The described setup is a sensitive and precise technique for intraoperative measurements in the submicroscopic range. 2. We recommend a MET advancement lower than 0.0625 mm to avoid overloading.

[1]Rodriguez Jorge J, Zenner HP, Hemmert W, Burkhardt C, Gummer AW. Laser vibrometry. A middle ear and cochlear analyzer for noninvasive studies of middle and inner ear function disorders HNO: 1997 Dec;45(12):997-1007.