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Comparison of Indicators for Efficient Coupling of an Electromagnetic Transducer (Otologics MET™) to the Ossicles.

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Objectives: In implantable middle ear hearing devices, success and patient satisfaction crucially depend on the efficiency of sound transmission to the ossicles. Although laservibrometry of the ossicles is a Goldstandard for sound transfer it is inappropriate under intra-operative conditions or simply not available. In our study the appropriateness of electrical transducer impedance and ear canal sound pressure as indicators for optimal coupling of the electromagnetic Otologics LLC MET™ transducer were investigated.

Methods: 10 fresh (<48h) and 2 fresh frozen human temporal bones were implanted with the Otologics MET™ transducer. Laser Doppler vibrometry (Polytec HLV 1000 Vibrometer) was used to monitor ossicle vibration driven by the transducer (multi-tone signal, 100Hz-8 kHz, 4/Okt). In addition, sound pressure level in the ear canal (Etymotics, ER-10B+) and electrical transducer impedance were measured at different loading positions.

Results: During the loading procedure, both ear canal sound pressure level and MET transducer electrical impedance were sensitive indicators for initial contact between the transducer tip and the incus as well as overloading of the transducer or blockade of the ossicles. While LDV measurements are sensitive over the entire frequency range (100Hz to 10 kHz), the acoustic signal can be used at low frequencies (<1 kHz) and the transducer impedance is limited to frequencies around the resonance frequency (1.5 – 3.5 kHz). After contact is established, further optimization of the coupling efficiency is limited due to a broad plateau range.

Conclusions: Both, transducer impedance and probe microphone measurements are sensitive indicators for initial contact to the incus and overloading of the transducer. A broad plateau range between the two states contributes to uncritical adjustment properties and the robustness to external influences of the connection.

