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Experimental investigations on the functional effect of ossicular joint fixation

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Introduction: The protection and functional mechanism of the ossicular joints has been described in literature. The gliding ossicular joints reduce stapes displacement during atmospheric pressure changes in normal subjects. In cases of fixed ossicular joints unphysiological movements of the stapes can be assumed as static pressure is directly transferred towards the annular ligament. These movements could assumingly lead to disorders of the inner ear. Audiometric testing of ossicular joint fixation is difficult in clinical practise, therefore there is lack of knowledge about possible effects on static behaviour and acoustic transfer characteristics of the middle ear.

Materials and Methods: Experimental investigations were performed in 10 fresh temporal bone specimen. Dynamic measurements were performed using Laser-Doppler-Vibrometry (LDV) with determination of vibration amplitude of the stapes footplate before and after stepwise artificial fixation of the ossicular joints by cyanoacrylate glue. For static experiments standardized atmospheric pressure variations were applied through the sealed external ear canal while measuring stapes displacement using LDV.

Results: In cases of artificially fixed ossicular joints a shift of the resonance frequency was observed. Furthermore a decrease of the stapes vibration amplitude in the low frequency range of approximately 10 dB was evaluated whereas improvement of the transfer characteristics of up to 15 dB was demonstrable in the high frequency range. These findings were differently emphasized depending on the site of first fixation (incudo-stapedial vs. malleo-incudal joint). The stapes displacement evaluated an up to 5-fold increase compared to regular values after fixation of the ossicular joints under atmospheric pressure variations.

Conclusions: Ossicular fixation leads to significant changes in dynamic and static function of the middle ear. The amount of change, either from a dynamic as from a static point of view is depending on the specific ossicular joint involved. We conclude that ossicular joint fixation should be prevented during tympanoplasty, if possible.