

THE EFFECT OF COCHLEAR IMPLANTATION ON MIDDLE EAR TRANSFER FUNCTION

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Aim

The aim of this study is to investigate the impact of cochlear implant electrode insertion on middle ear low frequency transfer function.

Introduction

Preservation of residual low frequency hearing with the addition of electrical speech processing can substantially improve the speech perception abilities and hearing in noise of cochlear implant users.

To utilise the preserved low frequency hearing requires an intact middle ear conductive mechanism. Little is known about the effect of a cochlear implant electrode on the displacement pattern of the ossicles.

Methodology

Stapes displacement was measured in seven patients undergoing cochlear implantation. Intra-operative measurements were carried out before and after electrode insertion via the round window membrane. Sound was delivered into the ear canal via an ER-2 earphone and calibrated via an ER-7C probe microphone (Etymotic Research) approximately 3mm from the tympanic membrane.



Picture 1



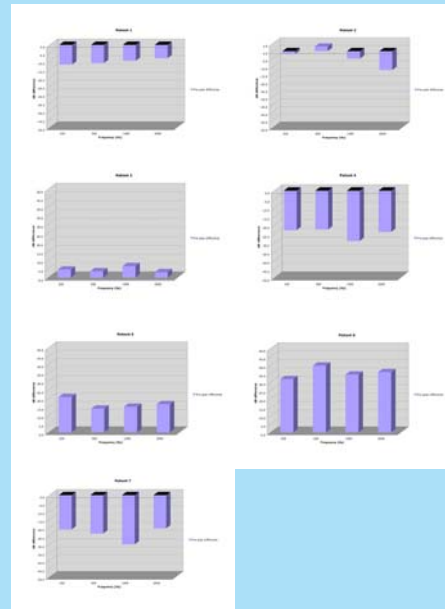
Picture 2



Picture 3

The speaker and probe microphone were integrated into an individually made ear mould (picture 1). Ossicular displacement to a multisine stimulus (Huber et al 2001) was measured at the head of the stapes via a posterior tympanotomy (picture 2) using an operating microscope mounted laser Doppler vibrometry system (picture 3).

Results



The results presented display the difference in dB between the displacement responses of the stapes before and after electrode insertion to the same stimuli for each patient. The responses fall into three categories of response, increased displacement (patients 5 & 6), decreased displacement (patients 1, 4 & 7) and no real change (patients 2 & 3). At 1kHz, the average decrease in stapes displacement in patients 1, 4 and 7 was 22.8 dB. In patients 5 and 6, the increase in displacement was 15.2 dB and 34.5 dB respectively.

Discussion

Aibara et al (2001) demonstrated that merely opening the inner ear has very little effect on transfer function. Research by Murkami et al (1998) has shown that an increase in inner ear pressure results in a reduced amplitude of stapes velocity, with greater effects at lower frequencies than higher frequencies. Temporal bone studies that have drained the cochlear have demonstrated varied stapes displacement with the largest effect being at frequencies greater than 1kHz (Gyo et al 1987, Lord et al 2001, Gan et al 2004)

The effect of cochlear implant insertion on cochlear impedance is unknown. The volume effect of a cochlear implant electrode is likely to increase cochlear impedance, while perilymph loss will reduce impedance. By increasing cochlear impedance one would expect a decrease in stapes displacement. In contrast, a reduction in cochlear impedance due to varying quantities of perilymph loss would reduce the stapes displacement accordingly. No two insertions will be identical and it is therefore possible that the discrepancy between the observed responses are a reflection of this. As a consequence of perilymph homeostasis, one would expect this effect to be short lived.

Conclusions

Insertion of a cochlear implant electrode alters stapes displacement. We speculate that the variation of the observed responses is due to the change in cochlear impedance caused by electrode insertion

References

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