The effect of changes in cerebrospinal fluid pressure on the labyrinth in terms of tympanic membrane displacement.

Tweed JJ, Marchbanks RJ and Martin AM.
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ABSTRACT

The objective of this study was to investigate the effects of changes in cochlear perilymphatic fluid pressure on the volume displacement of the tympanic membrane during acoustically induced reflex contractions of the stapedius muscle. These changes in perilymphatic pressure were induced by changing the body position of normal human subjects and thus varying the cerebrospinal fluid pressure at the head. The mechanisms by which changes in body posture affect cochlear fluid pressure have been investigated by a number of workers and this literature is also reviewed.

An experiment was carried out on 24 normal subjects in which the volume displacements of the tympanic membrane during stapedius muscle contraction were measured in three body positions at regular intervals over a 20-minutes period and compared to those measured in the sitting position.

The minute displacements of the tympanic membrane were recorded using computer-controlled instrumentation specially designed for the purpose. This measurement system has been developed for a number of clinical purposes, one of which is to investigate endolymphatic hydrops in patients with Meniere's Disease. A secondary purpose of the experiment was thus to evaluate the sensitivity of the measurement system in terms of these very small postural pressure changes, and to provide additional evidence that the direction of tympanic membrane displacement and its relationship with stimulus intensity are dependent upon cochlear fluid pressure.

CONCLUSIONS

The experimental work described in this report has shown that an estimated pressure change of only 30 mm saline in the perilymph fluid can be detected by the TMD measurement system in a group of subjects as a change in both the mean volume displacement and the maximum inward volume displacement of the tympanic membrane during contraction of the stapedius muscle. If the reflex TM response configuration has an inward component then it seems possible that an even smaller perilymphatic pressure change of approximately 15 mm saline can be detected.

With the majority of ears the change in perilymphatic pressure, as measured in terms of the reflex TMD, faithfully reflects the expected and well documented changes in CSF pressure brought about by controlled changes of posture. In these cases, a patent cochlear aqueduct would seem to be the most probable route for this pressure transfer from the CSF to the perilymph fluid to take. There are noteable exceptions to this, however, in that at least 12% of the ears tested showed no change in perilymphatic pressure with a change in CSF pressure. In this proportion of ears the cochlear aqueduct would not appear to be patent. This proportion of non-patency is probably particular to the age range of the subjects tested, 18 to 30 years, and according to histological studies will increase with age.

The experiment has shown that measurements of stapedial reflex induced displacement of the TM may be used to provide a sensitive measure of changes in perilymphatic pressure, and these results are in general agreement with previous mathematical models. The measurement technique therefore provides a means of detecting high intra-cochlear fluid pressures in patients with hydrops. This, together with the ability to detect cochlear aqueduct patency, is of great importance in the investigation of inner ear disorders which effect the labyrinthine fluid physiology. In particular the measurement technique may have a significant bearing on the investigation of the time-course of certain forms of paroxys mal vertigo such as Meniere's Syndrome.