THE EFFECT OF EAR CANAL PRESSURE ON PURE-TONE THRESHOLDS, ACOUSTIC CONDUCTANCE AND ACOUSTIC TRANSMITTANCE

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ABSTRACT

Changes in pure-tone thresholds induced by static pressures in the ear canal were estimated from shifts in acoustic transfer functions for 19 young adults with normal hearing. Pure-tone thresholds at 500 and 2000 Hz were measured at ambient pressure, and at ear canal pressures of -200 daPa using a 2 up 1 down-3AFC procedure. When averaged across pressure conditions, at 500 Hz the average change in threshold was 5.3 dB compared to 2.4 dB for conductance. These differences were significant for an alpha level of 0.05. Individual differences between behavioral and physiological measures showed high variability such that individual shifts in behavioral threshold could not be well predicted by shifts in conductance. The results of this study suggest that for the conditions of this study, average changes in middle-ear conductance and transmittance are generally in agreement with behavioral measures at 500 and 2000 Hz. However, individual threshold deviations could not be predicted from shifts in conductance or transmittance. Further studies are needed to explore the predictive value of these physiologic measures in ears with reversible hearing loss such as in otitis media with effusion.

INTRODUCTION

A number of studies have examined the effect of ear-canal pressure on middle-ear pressure on hearing thresholds (Loch, 1942; Finkelson et al., 1992; Raussman, 1940, 1991; Trunson, Bandy, & Snyder, 1978; Wyer et al., 1984) or middle-ear mechanics (Huttenbrink, 1988; Kringlebotn, 2000; Maruani, et al., 1997). Ear canal and middle-ear static pressures result in increased middle-ear impedance such that thresholds for frequencies below about 1000 Hz are elevated and there is a reduction in middle-ear energy absorption (e.g., reduced stimulus and e.m. vibrators).

New acoustic methods of assessing middle-ear function using wideband transfer functions have been successfully in predicting ears with conductive hearing loss (Kerle & Simmons, 2004; Finkelson et al., 1999). The purpose of the present study was to examine the relationship between the pure-tone elevation and changes in conductance and transmittance in human adults using ear canal pressure changes. Changes in conductance and transmittance on dB were compared to pure-tone threshold changes at 500 and 2000 Hz.

RESULTS

Subjects

Nineteen young adults, 13 women and 6 men, participated in this experiment (mean age = 24.6 yr). Each had a negative history of middle-ear disorder, normal audiograms, and a normal 226 Hertz admittance tympanogram with peak amplitudes of 0 to 10 daPa on the day of the test.

Procedure

- Subjects were seated in a sound-treated booth. A prototype Welch Allyn Diagnostic Middle Ear Analyzer (DME) was used to generate wideband click stimuli for the measurement of transmittance (1-energy reflectance) and conductance. The probe from the DME was inserted in the subject’s ear and remained in place for reflection testing. The probe was connected to the air pressure pump of a Grass Stimulus model G55-151 impedance instrument for ear canal pressure changes under computer control.
- For pure-tone threshold testing, 500 and 2000 Hz tones were digitally generated from a desktop PC using Tucker Davis Technologies (TDT) PsychoPhy software. The tones were routed through a TDT PA-4 programmable attenuator to an ER-3A earphone coupled to the ear with an impedance probe tip assembly. The probe tip was coupled to the air pressure pump of a Grass Stimulus model G55-151 impedance instrument for ear canal pressure changes under computer control.
- Thresholds were obtained using a 2 up 1 down-3AFC procedure. Thresholds, transmittance and conductance measurements were conducted at ambient pressure and with -200 daPa of pressure in the ear canal in random order. Subjects were trained in the psychometric procedure until stable performance was obtained prior to testing.
- The difference between ambient pressure and conductance pressure measurement was compared to changes in pure-tone threshold for those conditions.

METHOD

CONCLUSIONS

Consistent with previous studies, the change in threshold and middle ear function with negative ear canal pressure was greater at 500 Hz than at 2000 Hz. There was a small (+1.5 dB) but significant difference between the average elevation in threshold and the conductance shift at 500 and 2000 Hz when averaged across ear canal pressure conditions (Fig. 5). When positive and negative ear canal conditions were examined separately, there was no agreement between threshold and conductance shifts, especially for the 500 Hz condition for negative ear canal pressure (Fig. 6).

Further studies are needed to explore the predictive value of these physiologic measures in ears with reversible hearing loss such as in otitis media with effusion.

REFERENCES