International Journal of Pediatric Otorhinolaryngology (2006) **70**, 1063—1067

ELSEVIER

International Journal of Pediatric Otorhinolaryngology

www.elsevier.com/locate/ijporl

Relationship between transducer type and low-frequency hearing loss for patients with ventilation tubes

S. Tokar-Prejna [a,*], **J. Meinzen-Derr** [b,c]

[a] *Division of Audiology, 3333 Burnet Ave, ML 2002, Cincinnati, OH 45229-3039, USA*
[b] *Center for Epidemiology and Biostatistics, 3333 Burnet Ave., ML 2002, Cincinnati, OH 45229-3039, USA*
[c] *Hearing and Deafness Research Center, Division of Pediatric Otolaryngology, Cincinnati Children's Hospital Medical Center, OH 45229-3039, USA*

Received 23 May 2005; received in revised form 7 November 2005; accepted 17 November 2005

KEYWORDS
Ventilation tubes;
Insert earphones;
Headphones;
Pediatric audiology

Summary

Objective: To determine the relationship between the type of transducer used to perform pure-tone audiometry and the appearance of low-frequency hearing loss at 250 Hz and 500 Hz for patients with ventilation tubes.
Methods: Air conduction thresholds at 250 Hz and 500 Hz were measured using Telephonics TDH-49 supra-aural headphones and EARTONE 3-A insert earphones for patients with normal ears ($N = 16$) and patients with ventilation tubes ($N = 114$). Tympanometry was performed on each patient prior to audiometric testing. Audiometric test results obtained in normal ears were compared to results for patients with ventilation tubes. For analysis, the ventilation tube patients were separated into two groups, representative of ventilation tube type.
Results: Audiometric results obtained using the two transducer types at 250 Hz and 500 Hz revealed significant differences in threshold for patients with ventilation tubes. Thresholds obtained using insert earphones were generally worse than thresholds obtained using supra-aural headphones for this group. On average, difference in threshold was 14.15 dB worse with insert earphones at 250 Hz and 9.75 dB worse with insert earphones at 500 Hz for patients with Sheehy tubes. Average difference in threshold for patients with Donaldson tubes was 13.93 dB worse with insert earphones

* Corresponding author.
E-mail address: shayna_tokar@yahoo.com (S. Tokar-Prejna).

0165-5876/$ — see front matter
doi:10.1016/j.ijporl.2005.11.001

at 250 Hz and 8.93 dB worse with insert earphones at 500 Hz. In addition, thresholds were more variable for patients with ventilation tubes than normal ears at 500 Hz. There were no significant differences in threshold for normal ears using both transducers.

Conclusions: When performing pure-tone audiometry, choice of transducer can influence the accurate identification of a low-frequency hearing loss in patients with ventilation tubes. Low-frequency thresholds were generally worse using insert-style earphones to test subjects with tubes, resulting in the apparent identification of a hearing loss. However, with supra-aural headphones, no low-frequency hearing loss existed. There were no significant differences in threshold values using either transducer in normal ears.

1. Introduction

Use of insert-style earphones to perform pure-tone audiometry has become widespread. Advantages for using insert earphones include attenuation of low-frequency ambient noise, increased interaural attenuation, and solve the collapsing ear canal problem [1—3]. Studies have compared and contrasted audiometric thresholds using insert earphones and supra-aural headphones. Research has shown that there are no significant differences in pure-tone and speech audiometric thresholds using both transducers for normal and hearing-impaired subjects [4—6]. Also, intra-subject reliability is similar using both transducers and there is no evidence of increased test-retest variability with the use of insert earphones [7—10].

Conventional thought assumes that the small diameter of a ventilation tube should not interfere with conduction of sound. The placement of pressure-equalizing tubes has been reported to cause conductive hearing loss in certain cases [11]. Voss et al. conducted a study in which they made a comparison of ear-canal sound pressures using insert earphones and supra-aural headphones. Their findings indicate that tubes can reduce the ear-canal sound pressure from inserts in such a manner that an ear with a tube can appear to have a conductive loss, consistent with findings reported by Estrem and Batra [11]. With the insert earphone, sound pressures at frequencies below 1000 Hz were always smaller in ears with tubes and perforations than in ears with intact eardrums. With the supra-aural headphone, sound pressures in ears with tubes and perforations differed from normal ears by less than 5 dB at 500 Hz and above [12]. Factors that can impact pure-tone audiometry and sound pressures generated by audiologic transducers include volume of the middle ear, diameter of the tube lumen, and position of the tube on the tympanic membrane [11,12]. Although Voss et al. described smaller differences in thresholds when using supra-aural headphones, their study subjects comprised of a small sample of adults with tubes (five ears total with tubes). Therefore, the objective of this study is to investigate the difference in thresholds between supra-aural headphones and insert headphones among children.

2. Methods

2.1. Patient selection

Audiological information on children who were seen through the Division of Audiology between March 23, 2004 and October 15, 2004, was obtained from a retrospective chart review. Children were deemed eligible for this retrospective analysis if an otologic examination revealed tube was in place and patent prior to audiologic examination. Children were excluded from this analysis if they had a history of more than one ventilation tube surgery. Whether or not the child had received a ventilation tube was noted, along with the type of tube.

2.2. Instrumentation

A Madsen Zodiac 901 Middle Ear Analyzer was used to perform tympanometry on all subjects. The Madsen Zodiac 901 was calibrated according to ANSI immittance specifications [13]. A Madsen Orbiter 922 Clinical Audiometer was used for pure-tone audiometry. The Madsen Orbiter 922 was calibrated according to ANSI audiometer specifications [14]. Telephonics TDH-49 supra-aural headphones and EARTONE 3-A insert earphones were connected to the audiometer.

2.3. Procedure

All subjects with ventilation tubes received pure-tone audiometry and tympanometry as part of their post-surgical audiologic evaluation. Subjects in the normal ear group had no history of either conductive