Validation of the Lexie Lumen in-situ audiometry

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INTRODUCTION

Most modern hearing aids have the ability to present brief pure tones through the use of an on-board signal generator. As a result, some hearing aid manufacturers have used this in order to obtain in-situ, pure tone audiometry results (Ludvigsen & Topholm, 1997; Bostock et al., 2004). To obtain these in-situ audiometry pure tone thresholds, the hearing aid receiver is used as the transducer for the delivery of sound (Brien, Keidser, Yeend, Hartley, & Dillon, 2010). Previous literature has found that thresholds obtained through in-situ audiometry are equivalent to the results obtained through conventional audiometry (Smith-Olinde et al., 2006; Winter & Kuk, 1998).

Due to the advantages offered by in-situ audiometry, this method of determining pure tone thresholds is becoming increasingly popular. One such advantage being potential cost saving due to the fact that less equipment is needed in comparison to traditional audiometric procedures (Brien et al., 2010). This may allow for accessibility of hearing healthcare services in areas where equipment and resources are limited. In addition, this form of testing may be more time efficient for hearing healthcare professionals whilst at the same time reducing potential errors that may occur when transferring audiometric test results between different test modules (Brien et al., 2010).

In-situ audiometry is not without its challenges. Many individuals who present with mild to moderate sensorineural hearing loss are fitted with hearing aids with open domes in order to prevent the occlusion effect from occurring. However, open domes can allow low frequency sound from escaping the ear canal whilst allowing low ambient low-frequency noise to enter directly into the ear canal (Dillion, 2001). This may affect the in-situ audiometry results, particularly at low frequencies.

OBJECTIVE

To determine the validity and reliability of the pure tone in-situ audiometry thresholds obtained through the Lexie Lumen hearing aid. This was done by comparing the pure tone results obtained through in-situ audiometry in comparison to a reference standard audiometer with insert earphones.

METHODS

Ten participants took part in the current study (five females, five males) aged 40 to 80 years (mean = 65.10, SD = 12.14). Each participant presented with pure tone thresholds >15 dB HL. Hearing thresholds obtained for participants ranged from normal hearing to profound hearing loss. If no response was obtained from a participant at the maximum intensity of the Lexie Lumen hearing aid, this specific frequency was excluded from the study.

Equipment

Testing took place in a double-walled soundproof booth compliant with the standards required by SANS 10182 (2012) in order to eliminate background noise so that accurate results could be obtained. The Lexie Lumen hearing aid was used to conduct an in-situ audiometry pure tone test. Pure tones were generated by the hearing aid, through the use of a mobile based application. A standard reference audiometer, namely the hearTest (hearTest version: heartest-release-v6005-beta4-vc10003) with IP30 insert earphones, calibrated according to ISO/SANS standards, was used to conduct a pure tone audiometry test in order to compare to the pure tone in-situ audiometry results obtained with the Lexie Lumen hearing aid. To ensure consistency, the same hearing aid was used for all participants for both the left and right ear. Each hearing aid was assembled with a size 2B slim tube and a tulip dome.

Procedures

Each participant was seated in a comfortable chair in a sound treated room in order to ensure accurate results by minimising the interference of background noise, ambient noise and visual distractions. A pure tone audiometry test was conducted using a reference standard audiometer as well as via in-situ audiometry through the Lexie Lumen hearing aid.

The pure tone air conduction thresholds (dB HL) were obtained for the following frequencies: 250, 500, 1000, 1500, 2000, 3000, 4000, and 6000 Hz. The Hughson-Westlake technique was used in order to obtain these thresholds (Katz, 2015). In order to counterbalance testing, participants alternated between which test they commenced with. The maximum dB level that can be presented by the Lexie Lumen hearing aid is 80 dB HL. If a participant did not respond at this maximum level, that specific threshold at the relevant frequency was excluded from the results.

RESULTS

The pure tone audiology thresholds obtained with the reference standard audiometer were compared to the in-situ audiological results obtained through the Lexie Lumen hearing aid for both the left and right ear (Figure 1). Thresholds from reference standard and Lexie Lumen in-situ audiometry were highly correlated (r = 0.957 and 0.928 for right and left ears respectively). 78.4% of the thresholds obtained with the Lexie Lumen hearing aid and the reference standard audiometer were within +/- 5 dB of each other. 93.2% of the thresholds obtained with the Lexie Lumen hearing aid and the reference standard audiometer were within +/- 10 dB of each other. Previous research found that in-situ audiometry thresholds have varied from thresholds obtained from conventional audiometric procedures by between -10 dB to +10 dB when averaged between participants (Smith-Olinde, Nicholson, Chivers & Highly, 2007; Further, Winter & Kuk, 1998). Therefore, the results obtained for the current study are in agreement with previous literature. Only 6.8% of the thresholds obtained with the Lexie Lumen hearing aid and the reference standard audiometer were not within +/- 10 dB of each other. This could be due to the fact that greater variability was seen in the low frequencies which may have resulted due to the seal created by the tulip dome as it is possible for low frequency noise to enter directly into the ear canal and allow low frequency sound to escape. This may affect the threshold level obtained, especially for low frequencies (Durisala, 2015).

Right Ear

Left Ear

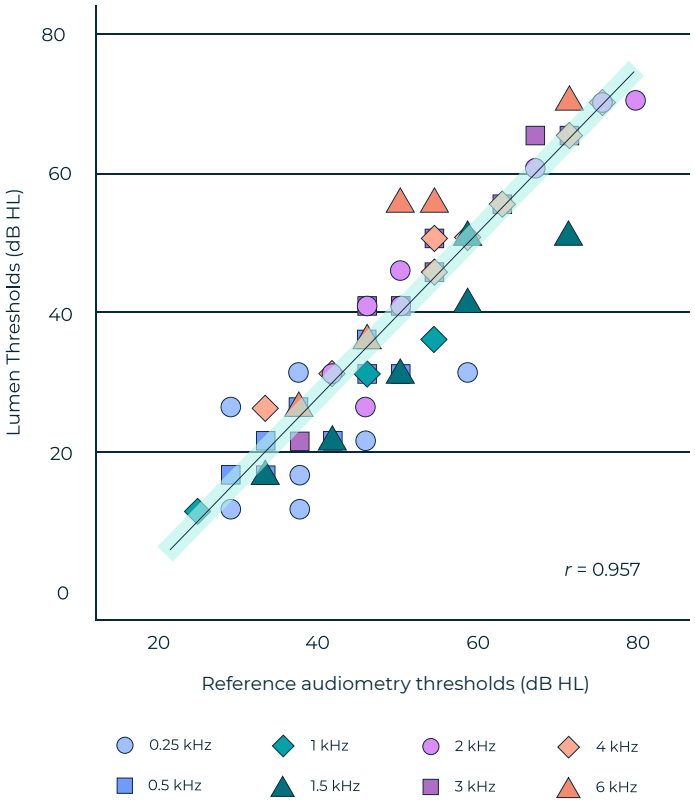

Figure 1. Pure tone audiological thresholds obtained with a reference standard audiometer in comparison to the Lexie Lumen hearing aid.

CONCLUSION

The results from the current study indicate that the in-situ audiometry pure tone test performed through the Lexie Lumen hearing aid is a reliable test that can be used to successfully determine accurate pure tone audiometry thresholds.

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