ORIGINAL ARTICLE

Objective comparison between perforation and hearing loss∗,∗∗

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Abstract
Introduction: There appears to be no relationship between the size of tympanic perforations and hearing loss. Some studies in the literature have assessed this connection, with conflicting data and without proper methodology, especially concerning the measurement of the size of the perforation, which was performed in a subjective manner.
Objective: To evaluate the size of tympanic perforations and to relate them to hearing loss in four different sound frequencies through the use of an objective method.
Methods: Transversal retrospective study. The present study evaluated 187 perforations through digital imaging, calculated the percentages of the tympanic membrane that was perforated using ImageScope software version 11.1.2.760 and correlated perforations' size with hearing loss at four frequencies.
Results: Data were statistically analyzed using Pearson's correlation test.
Conclusion: There was no significant relationship between the size of tympanic perforations and hearing loss in the four analyzed frequencies.

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Introduction

This was a longitudinal retrospective cohort study. It is clear that there appears to be no direct relationship between the size of the tympanic membrane in simple chronic otitis media and hearing loss assessed by pure tone audiometry. This suspicion has been studied and evaluated, but by using subjective methods to measure the size of the perforations. With the advent of modern computer programs, the percentage of these perforations in relation to the total area of the membrane can be objectively evaluated. These more accurate data can be used to compare more reliably this finding with each audiometry frequency. Few similar studies were retrieved in the literature. This study aimed to analyze the correlation between the percentual size of the perforation and hearing loss in four frequencies.

Methods

This was a retrospective cohort trial conducted at the Department of Otorhinolaryngology of a medical teaching institution, approved by the Research Ethics Committee under N° 9228. Images of the tympanic membrane were acquired using a 3 mm diameter rigid fiber optic telescope coupled to a digital camera and with computer digital capture.

Only pictures of simple chronic otitis media (dry perforations as sequelae of necrotizing otitis) were selected, with more than six months without otorrhea reported by the patients. Hearing loss in four frequencies (500 Hz, 1 kHz, 2 kHz, and 4 kHz), with any degree of conductive hearing loss, was considered. The audiometries were performed by phonoaudiologists, using the Katz technique.

ImageScope, version 11.1.2.760 by Aperio Technologies®, was used. The selected images were evaluated by circumscripting (by tracking with a mouse) the total area of the tympanic membrane, which was then measured by pixel counting (Fig. 1). The same procedure was applied to the area of the perforation. Both measures were transported to an Excel® (Microsoft) spreadsheet. Since the determination of the area of perforation was then calculated as a percentage of the area of the tympanic membrane, there was no distortion because of the angle of view or the proximity of...
the image capture. These measurements were performed by two examiners, at different times, and only those that coincided with an error factor of >5% were considered.

The inclusion and exclusion criteria of the study were as follows:

- Inclusion - images of tympanic membrane perforation without evidence of inflammation or otitis media.
- Exclusion - evaluation of the perforation size by two examiners presenting a difference >5%.

The audiograms were evaluated only with respect to their conductive hearing loss, i.e. the air-bone gap that characterized the tympanic involvement (membrane or ossicular chain). The following frequencies were used: 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz.

Data obtained from the perforations of the tympanic membranes were correlated with the air-bone gap in each of the frequencies analyzed by Pearson’s correlation test.

Results

The study included 187 ears that presented simple chronic otitis media. The age of patients analyzed ranged from 4 to 75 years. The right ear was involved in 79 patients, while 108 exhibited the problem in left ear. The correlation between the size of the perforation and the frequencies is listed in Table 1.

The correlation between the percentage of perforation of the tympanic membrane and the air-bone gap that exists in each of the evaluated frequencies is shown in Figs. 2-5.

Fig. 2 illustrates the correlation between the percentage of perforation of the tympanic membrane and the air-bone gap observed at a frequency of 500 Hz.

Fig. 3 shows the correlation between the percentage of perforation of the tympanic membrane and the air-bone gap observed at a frequency of 1000 Hz.

In Fig. 4, a correlation between the percentage of perforation of the tympanic membrane and the air-bone gap observed in the frequency of 2000 Hz is shown.

Finally, in Fig. 5, the correlation between the percentage of perforation of the tympanic membrane and the air-bone gap observed at a frequency of 4000 Hz is shown.

Discussion

The linear correlation between the size of the tympanic perforation in patients with simple chronic otitis media and hearing loss in four different frequencies was investigated. Pearson’s correlation coefficient for the frequencies of 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz was, respectively, 0.415, 0.372, 0.282 and 0.325, demonstrating that there is a strong linear correlation between the variables studied.
The correlation for the frequency of 500 Hz was found to be moderately significant for the issue examined, while the correlations observed for the other frequencies proved to be of little significance.

In the literature, Pannu et al. reported different results, demonstrating an increase in hearing loss with increasing sizes of the tympanic perforation in 100 patients who also had perforations without signs of active inflammation or secretion. Importantly, in that study, the perforation size was estimated by measuring their greater vertical (R1) and greater horizontal (R2) diameters with a 1-mm wire, inserting the values into the formula: perforation area = \( \pi \times R1 \times R2 \).

Ibekwe et al. analyzed 67 patients with a total of 77 perforations. Using the Pearson correlation: \( p = 0.01, r = 0.05 \), they concluded that the larger the tympanic membrane perforation, the greater the loss in sound perception.

The article by Ahmad and Ramani is in agreement with the studies previously mentioned. In that study, 70 patients with dry central perforation were analyzed. The patients were divided into four groups according to the size, expressed as a percentage, of the observed perforation. These authors analyzed the hearing loss in each frequency in each of their groups, and concluded that the hearing loss increased with the size of perforation.

Therefore, the present study, with a larger number of patients and using a more modern methodology, contradicts the literature and leads to the conclusion that factors, other than the size of perforation (e.g., disjunctions or fixations of the ossicular chain), compromise the auditory acuity in patients with simple chronic otitis media.

**Conclusion**

There was no correlation between the size of tympanic membrane perforations in simple chronic otitis media and hearing loss at 500 Hz; 1000 Hz; 2000 Hz and 4000 Hz.

**Conflicts of interest**

The authors declare no conflicts of interest.

**References**