LETTER TO THE EDITOR

Oman Medical Journal [2016], Vol. 31, No. 1: 83–84

Is the Degree of Hearing Loss Truly Dependent on the Site of Tympanic Membrane Perforation?

Mohd Zakaria*, Nik Othman and Aw Cheu Lih

Universiti Sains, Malaysia Kubang Kerian, Kelantan, Malaysia

ARTICLE INFO

Article history:
Received: 6 November 2015
Accepted: 8 November 2015

Online:
DOI 10.5001/omj.2016.17

Dear Editor,

We wish to highlight the relationship between the site of tympanic membrane (TM) perforation and the degree of hearing loss. We feel that this issue is worthy of consideration as there is a need to revise the related popular belief, as well as enhance the clinical knowledge among otorhinolaryngologists and relevant medical candidates.

When the TM is perforated, due to the long wavelength, low-frequency sounds can bend and escape via the hole, resulting in less force on the intact part of the TM. This leads to less effective movements of the TM and ossicles, and low-frequency conductive hearing loss. When the size of the TM perforation increases, more hearing loss at low frequencies is expected as more low-frequency sounds can escape through the bigger perforation. Additionally, high-frequency hearing loss could also occur as the bigger hole would now permit high-frequency sounds to escape.

Early studies in the 1970's revealed that perforation in the posterior quadrant of the TM caused more hearing loss than the anterior part.[1,2] This notion has been widely accepted by many otorhinolaryngologists ever since. However, more recent studies have found that the site of TM perforation has no effect on the degree of hearing loss.[3–6] In fact, apart from perforation size, middle ear volume is another influencing factor. That is, larger air-bone gaps are seen in patients with smaller middle ear volumes.[4,6] From a physics perspective, these later findings are more logical. In sound transmission, two pathways are involved: ossicular coupling and acoustic coupling. If the middle ear is healthy, ossicular coupling serves as the main pathway. On the other hand, acoustic coupling (where the sound energy is transferred directly to oval and round windows) is about 60 dB less effective than the ossicular coupling, making it almost negligible in transmitting sounds.[7] When the TM is perforated, acoustic coupling is improved by around 10–20 dB.[7] These values, however, are still much lower than the gain provided by the ossicular coupling. In this regard, the dominance of ossicular coupling in sound transmission is still preserved. Due to insufficient involvement of acoustic coupling, the influence of site of TM perforation on the degree of hearing loss is, therefore, negligible.

The influence of middle ear volume on the degree of hearing loss is also expected. A reduced middle ear volume would enhance the middle ear stiffness leading to low frequency hearing loss.[4] Hence, more loss at low frequencies is expected if a perforated TM is coupled with small middle ear volume.[6] One of the possible reasons why the outcomes of earlier studies[1,2] are different from the later ones[4,6] is that the middle ear volume was not taken into consideration in the study procedures. When the middle ear volume was controlled, no significant differences in air-bone gaps were found between the anterior and posterior parts of the TM.[4]

In the presence of an intact middle ear system, we support the notion that the degree of hearing loss is affected only by the size of the TM perforation (more hearing loss with bigger perforation size) and middle ear volume (more hearing loss with smaller middle ear volume). By considering the

*Corresponding author: ✉mdnorman@usm.my

existing literature, the site of TM perforation has no influence on the degree of hearing loss. This information should be widely disseminated among practicing otorhinolaryngologists and regarded as a "revision" to the popular belief that more hearing loss would occur when the posterior part of the TM is perforated. This revised issue has at least two clinical implications. Firstly, it is possible to have a milder degree of hearing loss in cases of TM perforation involving the posterior part. In this regard, the outcomes are possibly genuine, and the validity of a pure tone audiometric result may not be an issue. Secondly, in line with the statement by Park et al,[6] it is also possible for patients with small TM perforation size to have bigger hearing losses or vice versa as the middle ear volume also plays an important role in this matter.

Disclosure
No conflicts of interest, financial or otherwise, were declared by the author.

REFERENCES

1. Anthony WP, Harrison CW. Tympanic membrane perforation. Effect on audiogram. Arch Otolaryngol 1972 Jun;95(6):506–510.
2. Ahmad SW, Ramani GV. Hearing loss in perforations of the tympanic membrane. J Laryngol Otol 1979 Nov;93(11):1091–1098.
3. Voss SE, Rosowski JJ, Merchant SN, Peake WT. How do tympanic-membrane perforations affect human middle-ear sound transmission? Acta Otolaryngol 2001 Jan;121(2):169–173.
4. Mehta RP, Rosowski JJ, Voss SE, O'Neil E, Merchant SN. Determinants of hearing loss in perforations of the tympanic membrane. Otol Neurotol 2006 Feb;27(2):136–143.
5. Saliba I, Abela A, Arcand P. Tympanic membrane perforation: size, site and hearing evaluation. Int J Pediatr Otorhinolaryngol 2011 Apr;75(4):527–531.
6. Park H, Hong SN, Kim HS, Han JJ, Chung J, Seo MW, et al. Determinants of conductive hearing loss in tympanic membrane perforation. Clin Exp Otorhinolaryngol 2015 Jun;8(2):92–96.
7. Peake WT, Rosowski JJ, Lynch TJ III. Middle-ear transmission: acoustic versus ossicular coupling in cat and human. Hear Res 1992 Jan;57(2):245–268.