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Tympanic membrane perforation: correlation of hearing loss with its site and size

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ABSTRACT

Background: The objectives of the study were correlation of hearing loss with size and site of tympanic membrane perforation.
Methods: A cross-sectional prospective study of 100 patients of both sex and age between 11-60 years with perforated tympanic membrane was conducted in the department of Otorhinolaryngology (ENT). Size and site of TM perforation was assessed using otoscope and otomicroscope. Size of perforation was measured with 1 mm thin wire loop and vernier caliper. Patients were divided into three groups according to size; Group I (0-9 mm), Group II (9-30 mm), Group III (>30 mm). The tympanic membrane was divided into five segments anterosuperior, posterosuperior, anteroinferior, posteroinferior and central for the localization of the site of perforation. Data thus collected was statistically analysed.
Results: Patients with Group I perforation had an average hearing loss of 31.42±7.15 decibel. Group II had an average hearing loss of 39.42±8.97 decibel. Group III had an average hearing loss of 48.91±7.38 decibel. Maximum hearing loss was noted in patients with central perforation with an average hearing loss of 39.34±9.47 decibel. Average hearing loss was found higher in posterior perforations than anterior quadrant perforations. This difference was however not statistically significant with 'p' value of '0.689'.
Conclusions: Linear correlation was found between size of tympanic membrane perforation and degree of hearing loss. No linear correlation between site of tympanic membrane perforation and hearing loss was found. We found no correlation between duration of disease and size of tympanic membrane perforation with degree of hearing loss.

Keywords: Tympanic membrane, Perforation, Hearing loss

INTRODUCTION

Tympanic membrane(TM) lies at the medial end of the external auditory meatus and forms the majority of the lateral wall of tympanic cavity. It is slightly oval in shape, being broader above than below, forming an angle of about 55 degree with the floor of meatus. Its longest diameter from posterosuperior to anteroinferior is 9-10 mm, while perpendicular to this the shortest diameter is 8-9 mm. Both the pars tensa and pars flaccida comprise three layers. There is an outer epithelial layer, middle fibrous layer, and inner mucosal layer.[1] Apart from conduction of sound across the middle ear, tympanic membrane also has a protective role on middle ear cleft and round window niche. Intact tympanic membrane has a protective role for middle ear cleft from infections and shields round window from direct sound waves which referred at as round window baffle.[2] Perforation of tympanic membrane is common in an otologic practice and can result from acute otitis media, chronic otitis media (COM), trauma.[3] Tympanic membrane perforation represents a hole in the eardrum, establishing a communication between the middle and external ear.[4] Perforation occur as a result of the disease process in

chronic otitis media, which affects at least 0.5% of the population.[5] Chronic otitis media implies a permanent abnormality of the pars tensa or pars flaccida, most likely a result of earlier acute otitis media, negative middle ear pressure or otitis media with effusion. However, the distinction remains between active COM, where there is inflammation and production of pus, and inactive COM, where this is not the case though there is the potential for the ear to become active at some time. Chronic otitis media usually classified in to following types. Healed COM, inactive (mucosal) COM, inactive (squamous) COM, active (mucosal) COM, active (squamous) COM. In inactive COM there is permanent perforation of the pars tensa, but the middle ear and mastoid is not inflamed.[6]

A perforation of tympanic membrane decreases the surface area of tympanic membrane available for sound transmission and allows sound to fall directly on middle ear. As a result, the pressure gradient between the 'inner' and 'outer' surfaces of the tympanic membrane virtually becomes insignificant. The effectiveness with which the tympanic membrane transmits the sound waves to the ossicular chain is thus hampered along with the level of hearing.[7]

It has been a general view that the hearing loss increase with the size of the perforation, more so if it is in the posteroinferior quadrant. It was found that the maximum average loss occurred at 250 Hz. The hearing loss is less in small perforations (less than 2 mm diameter) than in larger ones; less in perforations touching the manubrium than in those away from it, and also less in perforations of the anteroinferior quadrant than in those on posteroinferior quadrant. A normally functioning Eustachian tube is also an essential physiologic requirement for a healthy middle ear and normal hearing.[8] Posterior quadrant perforations have more hearing loss than anterior quadrant perforation, may be because of round window exposure and a higher incidence of ossicular fixation. Posteroinferior perforations abolish the sound protection of the round window and hence, they will cause more hearing loss than perforations in other quadrant.[9]

To sum up, because of the high incidence of conductive hearing loss caused by central perforations of tympanic membrane, the conflicting reports regarding the effect of perforations on hearing loss, this project has been under taken to study the effects of site and size of tympanic membrane perforation on degree of hearing loss.

METHODS

The present study was a cross-sectional and prospective study conducted in the outpatient department of ENT at Sri Guru Ram Das institute of medical sciences and research vallah Sri Amritsar. The present study included 100 patients between 11-60 years of age with perforated TM.

Inclusion criteria

All patients between 11-60 years of age with tympanic membrane perforation.

Exclusion criteria

Exclusion criteria were age below 11 years and above 60 years of age; patients having sensorineural or mixed hearing loss; patients with atticoantral disease; patients with myringosclerosis; patients with attic/ postero-superior quadrant perforation.

These patients was subjected to clinical, audiological, radiological and laboratory investigations.

The pattern of examination followed was:

Informed consent was obtained. Detailed history of the patient. Local and systemic examination. Detailed evaluation of the patient including complete ear, nose, throat examination. Ear examination using bulls eye lamp, Welch Allyn otoscope, Microscope (Moller wedel), Tuning fork test (256, 512, 1024 Hz). The tympanic membrane was divided into five segments anterosuperior, posterosuperior, anteroinferior, posteroinferior and central for the localization of the site of perforation. Site of perforation was assessed using Otoscope and Otomicroscope. To estimate size of perforation a 1 mm thin wire loop was taken. Readings were taken under microscope. Two diameters were taken for each perforation, one maximum vertical and one maximum horizontal area were calculated as:

Area of perforation: pR1R2

Whereas p is the 3.14159 constant, R1 is the radius along vertical axis and R2 is the radius along the horizontal axis.

Depending upon the area, perforation was divided into 3 groups:

Group I: small perforation (0-9 mm^2)
Group II: medium perforation (9-30 mm^2)
Group II: large perforation (>30 mm^2)

The average surface area of intact tympanic membrane was taken as (64.3 mm^2).

Assessment of hearing was done using pure tone audiometer (Arphi proton sx-5) with proper masking in sound treated room. X-ray mastoid (Schuller's view) was taken in all cases. Data was collected in the constructed proforma.

RESULTS

A total of 100 patients were enrolled in this prospective study to evaluate the "Tympanic membrane perforation:

correlation of hearing loss with size and site of perforation"

In our study 24% patients were in age group 11-20 years. 33% patients were in age group 21-30 years, 22% patients were in age group 31-40 years, 14% in age group 41-50 years and seven percent in age group 51-60 years. The mean age was found to be 31.73 years. The Range of age was between 11-60 years. There were 63 females and 37 males in the present study with female to male ratio 1.7:1. Ninety one patients had unilateral ear involvements while 9 patients had bilateral ear disease. Only one ear was evaluated in patient with bilateral disease resulting in 100 ears for evaluation in 100 patients. The left and right ear was evaluated in 51 and 49 patients respectively. The commonest symptoms at presentation were otorrhoea and impaired hearing seen in 98 and 97 patients respectively. This was followed by itching, tinnitus and otalgia seen in 55, 25 and 19 patients respectively. Only four patients complained of vertigo. In our study we divided patients in to three groups according to duration of disease. Group A (<1 year), Group B (>1-5 years), Group C (>5 years). Twenty three patients belonged to Group A, 49 to Group B and 28 patients belonged to Group C. Of the 100 patients nearly all (97%) were following otitis media due to infection, while 3% were following Trauma.

Table 1: Showing correlation of hearing loss with size of perforation.

Comparison of average hearing loss of all groups according to size of perforation					
Group (I, II, III)	**No. of patients**	**Avg. hearing loss (dB)**	**Standard deviation**	**Minimal hearing loss (dB)**	**Maximum hearing loss (dB)**
Group I (0-9 mm^2)	26	31.42	7.151	15	50
Group II (9-30 mm^2)	63	39.24	8.969	25	60
Group III (>30 mm^2)	11	48.91	7.382	40	65

Table 2: Showing correlation of hearing loss with site of perforation.

Correlation of site of perforation with average hearing loss					
Site of perforation	**No. of patients**	**Avg. hearing loss (dB)**	**Standard deviation**	**Minimum hearing loss (dB)**	**Maximum hearing loss (dB)**
Central (C)	80	39.34	9.47	25	65
Posteroinferior (PI)	11	34.82	10.79	25	60
Anteroinferior (AI)	8	35.25	6.042	28	48
Anterosuperior (AS)	1	15	0	15	15

Table 3: Showing comparison of hearing loss between anterior and posterior perforation.

Site of perforation	No. of patients	Mean hearing loss (dB)	Standard deviation	Minimum hearing loss (dB)	Maximum hearing loss (dB)
PI	11	34.82dB	10.787	25	60
AI+AS	9	33 dB	8.803	15	48

Area of perforation

The patients were divided into 3 categories depending on the area of tympanic membrane perforation as follows:

Group I: 0-9 mm^2
Group II: 9-30 mm^2
Group III: >30 mm^2

Among the 100 patients, 26 patients belonged to group I, 63 patients in Group II and 11 patients were in Group III.

Site of perforation

The Tympanic Membrane perforations were classified depending on the quadrant of tmypanic membrane involved into anterosuperior, anteroinferior, postero-superior and posteroinferior, while peforation involving all 4 quadrants were labelled as central peforation. Of the 100 patients 80 were central, 11 posteroinferior, 8 anteroinferior and 1 was anterosuerior. There was no posterosuperior perforation.

Correlation of hearing loss according to area of peforation

An increase in the degree of hearing loss was noted with an increase in the area of tympanic membrane perforation. Patients with Group I perforation had an average hearing loss of 31.42±7.15 decibel, maximum hearing loss up to 50 decibel was found in Group I. Group II had an average hearing loss of 39.42±8.97 decibel, maximum hearing loss of 60 decibel was found in Group II. Group III had an average hearing loss of 48.91±7.38 decibel with maximum hearing loss of 65 decibel. This difference was statistically significant with 'p' value of '0.0' which is highly significant.

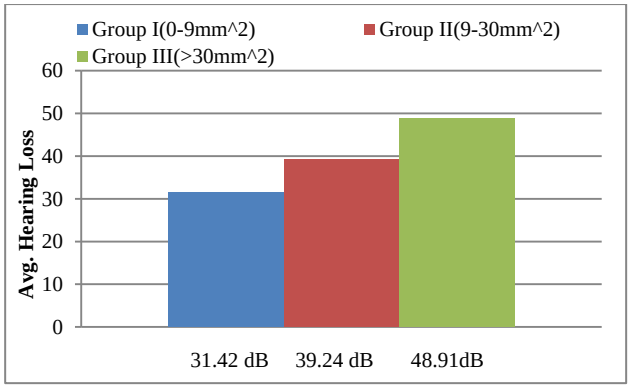

Figure 1: Showing correlation of avg. hearing loss with size of perforation (Group I, II, III).

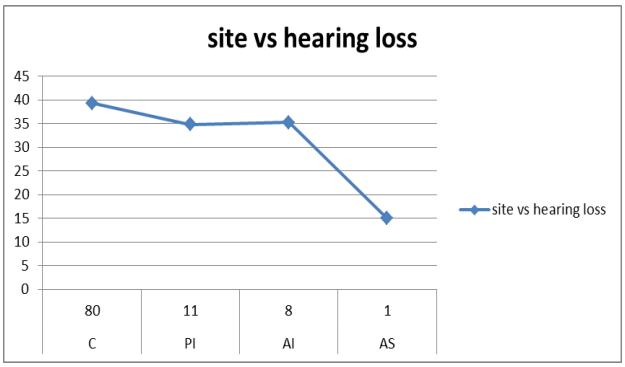

Figure 2: Showing correlation of hearing loss with site of perforation.

Figure 3: Endoscopic view of right ear perforation showing anteroinferior quadrant perforation.

Correlation of hearing loss with site of perforation

Maximum hearing loss was noted in patients with central perforation with an average hearing loss of 39.34±9.47 decibel and a maximum hearing loss upto 65 decibel. Patients with posteroinferior perforations had an average hearing loss of 34.82±10.79 decibel. Anterosuperior perforations had average hearing loss of 15 decibel. Anteroinferior perforations had average hearing loss of 35.25±6.042 decibel with a maximum hearing loss of 48 decibel. Maximum hearing loss was found 60 decibel in posteroinferior perforations which was higher than anterior perforations. After combining anteroinferior and anterosuperior perforations average hearing loss found to be 33 decibel. So, average hearing loss was found higher in posterior perforations than anterior quadrant perforations. This difference was however not statistically significant with 'p' value of '0.689' that is insignificant.

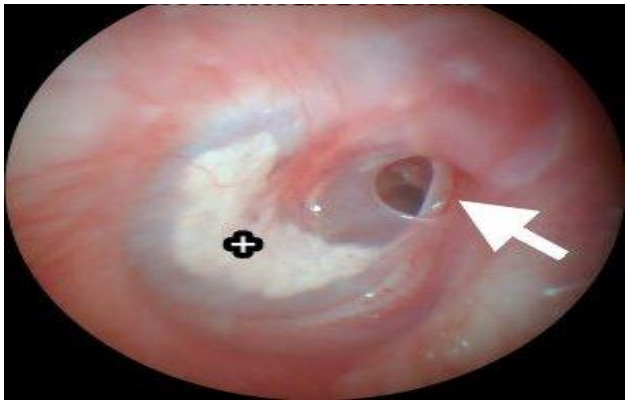

Figure 4: Endoscopic image of right ear showing anterosuperior perforation.

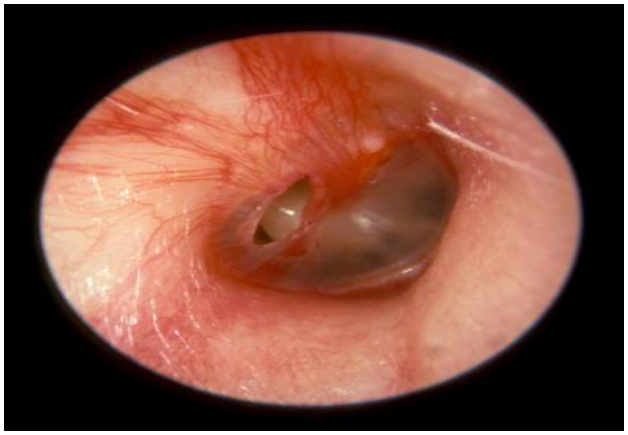

Figure 5: Endoscopic view of right ear showing posteroinferior quadrant perforation.

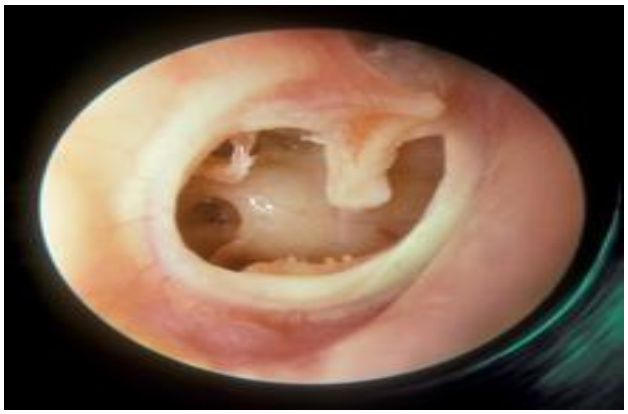

Figure 6: Endoscopic view of right ear showing subtotal perforation involving all the quadrants.

DISCUSSION

The present study was conducted among 100 patients in 100 ears in the outpatient department of ENT at Sri Guru Ram Das Institute of Medical Science & Research Vallah, Sri Amritsar, Punjab. In our case study we examined 100 ears in 100 patients. After taking history we examined the ears with bull's eye lamp, and otoscope. Tuning fork tests were done in all patients. After that hearing loss assessed by pure tone audiometry. Site of perforation was assessed during examination by otoscope. Size of perforation measured by placing 1mm thin wire loop over the perforation and adjusted according to size and shape of perforation. After that two maximum diameters along horizontal and vertical diameters measured from wire loop by vernier's caliper. The most common age group affected is 21-30 years. As people in this age group are more concerned about their health. The mean age of presentation is 31.73 years. The range is between 11–60 years. In our study we found female ratio more than males. There were 63 females and 37 males. Female to Male ratio found to be 1.7:1. This is in contrary to most of the studies which shows a higher incidence of males as compared to females. Out of 100 patients 97 cases were due to COM and only 3 cases were due to trauma. So COM is the most common cause of tympanic membrane perforation. Chandra et al also showed the distribution of the cause of perforation in tympanic membrane as follows, CSOM: 20, trauma: 06, post myringoplasty: 8.[10] The most common symptoms were otorrhoea in 98%, followed by impaired hearing in 97%, itching in 55%, tinnitus in 25%, otalgia in 19% and vertigo in 4% patients. Gulati et al in their study reported that main symptoms were hearing loss and discharge.[11]

Size of perforation with hearing loss

The present study showed a significant linear association between size of the tympanic membrane perforation and the degree of hearing loss with 'p' value of '0.0'. Similar results were obtained by the Maharjan et al on 119 tympanic membrane perforation.[12] They found patients with larger perforations involving all four quadrants with greater hearing loss and larger air–bone gap, with a strong trend for hearing loss to increase as the perforation size increased. The same findings were also shown by Pannu et al and Nepal et al in their respective studies who found perforation size to be the most important determinant of hearing loss.[13,14] This can be explained as the larger perforation size result in greater loss of middle ear and mastoid volume, a significant predictor of hearing loss and also decreases the phase effect due to the direct exposure of round window to the sound pressure. However in a contradictory study, Ribeiro et al evaluated 187 perforations and found no significant relationship between the size of tympanic membrane perforation and hearing loss at 500 Hz, 100Hz, 2000 Hz and 4000 Hz.[15]

Site of perforation with hearing loss

In our study we did not find any significant difference in the degree of hearing loss between anterior and posterior perforations. According to site of perforation we found 80 cases of central perforation, 11 cases of posteroinferior perforation, 8 cases of anteroinferior perforation and only 1 case of anterosuperior perforation. In central perforations mean hearing loss was found 39.34dB, in posteroinferior perforations mean hearing loss was found 34.82dB, in anteroinferior perforations mean hearing loss was found 35.25 dB and in anterosuperior perforations mean hearing loss was found 15 dB.

After combining anteroinferior and anterosuperior groups of perforations we found mean hearing loss 33 dB. While comparing posterior and anterior groups of perforations, we did not find significant 'p' value. 'p' value was found to be '0.689' that is highly insignificant

Site has been conventionally thought to be a major factor influencing the degree of hearing loss in patients with tympanic membrane perforation. Berger et al in their study on 120 patients found that perforations involving the posteroinferior quadrant were associated with the largest air – bone gap. Similar results were also shown by Nepal et al and Maharjan et al who showed a statistically significant relation between site of the perforation and degree of hearing loss with posteriorly placed perforations having the maximum hearing loss.[12,14] Pannu et al in their study on 100 patients of tympanic membrane perforation also developed a relation between posterior perforations and hearing loss at all frequencies, though not statistically significant.[13] This can be explained on the basis that perforations over the posterior tympanic membrane expose the round window resulting in a sound pressure which diminishes cochlear response by a 'phase cancellation effect'. However in a contrasting report Ibekwe et al did a cross sectional prospective study on 62 consecutive adult patients with perforated tympanic membrane concluded that the location of tympanic membrane perforation has no effect on the degree of hearing loss in acute perforations, while it is significant in chronic ones.[17]

Correlation of duration and hearing loss

Not many studies have evaluated the relationship between duration and the degree of hearing loss. In our study, we did not find any significant correlation between either duration and size of tympanic membrane perforation or between duration and the degree of hearing loss. Maharjan et al in their study however found a strong correlation between duration of ear discharge and degree of hearing loss.[12] The relation between duration of ear discharge and degree of hearing loss was statistically significant with P value 0.023.

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