ORIGINAL RESEARCH

Association of Hearing Loss with Tympanic Membrane Perforation

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ABSTRACT

Background – Tympanic membrane play an important role in the conduction of sound through middle ear. Its perforation cause hearing loss of varying degree on the basis of size of perforation.

Aim & objective – To evaluate and analyse the degree of deafness in tympanic membrane perforation on the basis of size of perforation.

Method – a prospective cross-sectional study was done on 80 patients of both the sex, with dry tympanic membrane perforation along with reduced hearing.Size of tympanic membrane perforation was evaluated under operating microscope. Patients were divided into three groups according to size of perforation; Group I (small), Group II (medium), Group III (large). Hearing loss was measured in each case with tuning fork test and pure tone audiometry.

Result – Out of 80 patients 47% had small perforation, 34% had medium perforation and 19% had large tympanic membrane perforation. Deafness increased as the perforation size increased. [I vs. II ($p < 0.001$), I vs. III ($p < 0.001$) and II vs. III ($p < 0.001$)

Conclusion – There is a strong association between size of tympanic membrane perforation and degree of deafness as deafness increase with size of perforation increase.

Key words– Perforation, Deafness (Hearing loss), Tympanic membrane.

Introduction

Tympanic membrane is a membranous partition separating the external auditory meatus from the middle ear. Its vertical diameter is 9-10 mm and horizontal is 8-9 mm. It helps in transmission of sound wave from external to middle ear.[1]

Apart from conduction of sound waves across the middle ear, it alsoserves a protective function to the middle ear cleft and round window niche. Intact tympanic membrane protects the middle ear cleft from infections and shields the round window from direct sound waves which is referred to as 'round window baffle.[2]

Tympanic membrane perforation is results by various causes. The most common being trauma and middle ear infections. Trauma (Barotrauma, temporal bone fracture), Infections (Acute otitis media, chronic otitis media, TB), Intragenic (ventilation tubes).

Tympanic membrane perforation leads to conductive deafness. A perforation on the tympanic membrane reduces the surface area of the membrane available for sound pressure transmission and allows sound to pass directly into the middle ear without amplification. As a result, the pressure gradient between the 'inner' and 'outer' surfaces of the membrane virtually becomes insignificant. The effectiveness with which the tympanic membrane transmits motion to the ossicular chain is thus impaired along with the level of hearing.it seems that larger perforation leads to higher degree of hearing loss. A total absence of the tympanic membrane would lead to a loss in the transformer action of the middle ear.[3]

Hearing loss is a national health problem which causes significant physical and psychosocial problem. So, it is important to diagnose and treat tympanic membrane perforation as early as possible because tympanic membrane perforation leads to anatomical changes in middle ear which will further lead to destructive changes, thus adding to further hearing loss.[4]

In general, larger the perforation, the greater is the hearing impairment, but this relationship is not constant and consistent in clinical practice.[5]

The purpose of this study is to investigate the relationship between the Size of tympanic membrane perforation and the magnitude of hearing loss in our patients.

Material and method– This were the cross-sectional prospectivestudy which was done on 80 patients who came to ENT OPD at tertiary care centre with dry tympanic membrane perforation and reduced hearing from September 2022 to march 2023 of both sex and age of 15 years and above. Detailed history and complete detailed otorhinolaryngological examination were done in all patients.

Inclusion Criteria: patients presenting with dry clean perforations of tympanic membrane due to chronic otitis media-tubotympanic, post residual perforations acute otitis media and simple traumatic perforations with no history of active middle ear disease, unilateral or bilateral, were selected.

Exclusion criteria: patients with Perforations due to pre-existing or congenital hearing loss and sensory neural hearing loss were not taken up for the study. Similarly, those with atticoantral diseases and actively discharging ears were excluded from study. Age criteria were put from 15 year and above because younger children may not be able to understand the instruction during hearing assessment and in older group, presbyacusis itself may affect the exact assessment of hearing loss, hence excluded in the study. Patients with co-morbidities like diabetes, hypertension or any other chronic diseases were excluded.

Detailed history was taken in each case, followed by detailed examination and investigations. Then, the evaluation of hearing loss was done in each case of dry tympanic membrane perforation with no history of active middle ear disease at the time of presentation, depending on the size of perforation.

Diameter of perforation was measured by 1 mm thin wire hook. Readings were taken under microscope. Two diameters were taken for each perforation, one maximum vertical and the other maximum horizontal.

Area of perforation was calculated with the help of formula of $\pi r1r2$ where π is constant of value is 3.14159 and r1 and r2 are radius of perforation along vertical and horizontal axis respectively.

Depending upon the area, perforations were divided into 3 groups:

Group I = Small perforation: 0–9 mm^2

Group II = Medium sized perforation:9–30 mm^2.

Group III = Large perforation: >30 mm^2.

The location of each perforation was determined anterior or posterior with respect to an imaginary line drawn across the tympanic membrane at the level of manubrium.

Routine Investigations like Blood investigations and X-ray were performed.

X-ray both mastoids lateral/oblique view was done in every case to know the involvement of mastoid air cell system The type, degree and frequency of hearing loss was determined by Tuning fork test and Pure tone audiometry.The association of degree of hearing loss was matched with the characteristics of perforation and result thus obtained was evaluated.

Tuning fork tests (Weber's and Rinne's) were carried out with 512 Hz forks in most instances which gives Rinne negative in conductive deafness of > than 25dB. Tuning fork of 1024 and 256Hz were used wherever necessary. Weber test was done to detect the better hearing cochlea or the side where there is conductive component of hearing loss.[6]

Similarly Pure Tone Audiometry (PTA) was carried out in each case to confirm that the hearing loss was of conductive type and to determine its extent.

Level of hearing can be divided into normal to hearing impairment in progressive order into slight, mild, moderate, moderately severe, severe and profound hearing loss.[7]

The association of degree of hearing loss was matched with the characteristics of perforation and result thus obtained was evaluated.

Result

The study comprised of 80 patients in which 44 patients (55%) were male and 36 patients (45%) were female.

Out of 80 cases, 25 patients had right ear involved, 40 were with left side ear involvement and 15 patients had both side ear involvement. So total number of ears involved in our study were 95.

The most common symptoms in all patients were hearing loss of varying degree on the basis of surface area of tympanic membrane involved, 90 % patients present with hearing loss whereas 82% patients present with on and off ear discharge in the past.

All the ears with perforation were divided into three groups. Maximum number of patients were found in group I that is 45 (47%) and followed by 32 (34%) in group II. Minimum number of patients were found in group III, that is 18 (19%).

Table 1: Distribution of patients according to type of perforation

Type of perforation	No of patients	%
Group 1(Small)	45	47%
Group 2 (Medium)	32	34%
Group 3 (Large)	18	19%
Total	95 ear	100%

Table 2: Avg. Hearing loss according to size of perforations

Group	Avg hearing loss in dB
Group I (small perforation) (n= 45)	12.01- 61.82
Group 2 (medium perforation) (n= 32)	15.03- 48.39
Group 3 (large perforation) (n=18)	30.67 – 56.76

Table 3: Association between groups

Group	P value	Significance
1 vs 2	< 0.001	Highly Significance
2vs 3	< 0.001	Highly Significance
1vs 3	< 0.001	Highly Significance

This trend shows that people are becoming aware of their health-related issues as with long standing disease the perforation size increases which will make life more difficult.Based on the site of perforation, they were divided into anterior, posterior and involving multiple quadrants.

Tuning Fork Test - Rinne's test was negative in all diseased ears 95 (100%) cases. Weber's test was lateralised to worse ear in 84 (89%) cases while, 11 (11%) cases had indeterminate Weber's. This is because in those cases both ears were having almost equal degree of hearing loss.

X-Ray Findings - X-ray mastoid's lateral oblique view of 80 patients revealed sclerosis in 50 patients (62%) and cellular mastoid in 30 patients (38%). Sclerosis of mastoid air cells could be due to congenital or the result of longstanding otitis media. Nevertheless, the process of sclerosis is more pronounced in a diseased ear than a healthy ear. Hence, the cases with sclerosed mastoid air cells outnumbered the cellular mastoid air cell system in our study.

In our results hearing loss increased with size of perforation at each frequency. In group I (small) the mean hearing loss at 250 Hz was 18.67 and at 4000 Hz was 8.87db. In group II (medium), the mean hearing loss at 250 Hz was 29.23 and as the frequency increased hearing loss declined. In group III (large), the mean hearing loss at 250 Hz was 39.65 and 21.02 at 4000 Hz.

On comparing the average hearing loss of one group with the other difference was found to be significant statistically as shown in Table. Average hearing loss increased as the perforation size increased.

Discussion

The tympanic membrane (TM) serves as a key component of the tympano-ossicular system for sound transmission. Perforation of the TM is common in an otologic practice and can result from various causes such as trauma and chronic otitis media. Perforations of the TM can result in a hearing loss (HL) that ranges from negligible to 50 dB. [8]

This study includes 80 patients. 15 cases had involvement of both ears, so total number of ears involved in this study was 95.

The age of patient ranged from 15–50 years, the mean age of presentation being 25.27 ± 11.50. while CayeThomasen et al. reported 13.3 years as a mean age. [9] Incidence of tympanic membrane perforation was found maximum in the age group of 11–25 years. The reason for it because patients in this age group may be attributed to the patients becoming more cautious socially about their hearing at this age and because of professional necessities or due to marriageable age group.

In our study out of 80 patients in which 44 (55%) were male and 36 patients (45%) were female. Kurian also reported closer findings with 55% of his patients as male.[10]

Majority of the patients in our study were belonging to rural areas. This difference was due to illiteracy, poor sanitary conditions, poor personal hygiene and overcrowding in rural population leading to more incidence of disease in rural people. Bansal et al also reported that majority of the patients having chronic suppurative otitis media were from rural areas.[11]

Out of 80 cases, 25 patients had right ear involvement, 40 were with left ear involvement and 15 patients had bilateral ear involvement.

Chronic otitis media was found to be the most common cause and trauma being the 2nd commonest cause of tympanic membrane perforation. Chopra and Chopra found the cause of perforation was infection and Eustachian tube dysfunction in 62% cases while trauma in 28% cases and cholesteatoma in 10% cases.[12]

In our study hearing loss was the most common symptoms in study population. Gulati et al found in their study that main symptoms were hearing loss and discharge.[13]

In our study hearing loss increased with increase in size of perforation at each frequency. On comparing the average hearing loss of one group with the other difference was found to be statistically significant. Average hearing loss increased as the perforation size increased.

In the study of Mehta et al reported that deafness is greater in the lower frequencies in small perforation while increasing in the size of the perforation the hearing impairment was also increased and affecting the high frequencies as well.[14]

They also mention that the hydraulic action developing from the difference in area of TM and of the stapedial footplate is the major factor in impedance matching. When the surface area is decreased, there will be decrease in amplification and deafness will be equal to size of perforation.[15]

In the study of Voss et al, he also observed that hearing loss increased as the perforation size increases.[16]

Conclusion

This study represent that the hearing deficit is major health problem in our population and the aetiology of this was the tympanic membrane perforation either by the diseased process or the trauma which is common in younger's. In our study we have found that the degree of deafness increased statistically as the perforation size increased which was statically significant. So, ear drum repair should be done in every perforation case to improve social status of patient.

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