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A study on correlation of size and site of tympanic membrane perforation with degree of conductive hearing loss in chronic otitis media

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ABSTRACT

Background: The objective of the study was to evaluate the size and site of tympanic membrane perforation, to assess hearing loss in patients with dry tympanic membrane perforation and to correlate the relationship between degree of conductive hearing loss with the size and site of tympanic membrane perforation.
Methods: Study (n=150) done to correlate the site and size of tympanic membrane perforations and conductive hearing loss in cases of inactive tubotympanic COM from October 2013 to December 2015. Size of the tympanic membrane perforation was assessed under microscope using a measuring template. Patients were divided into four groups according to size; based on the site: anterior group, posterior group, combined group and divided in to three groups based on the duration of the disease.
Results: Anterior perforations were most common 74 (49.3%). Hearing loss increased as the size of the perforation increased IV>III>II>I [(46.97±6.59)>(38.69±2.63)>(35.13±2.98)>(27.67±1.85) p<0.0001)]. Statistical significance for hearing loss at combined site (41.37±5.9) was higher compared to Posterior (35.21±4.6, p=0.0001) and Anterior (31.7±5.7, p=0.0001). There was statistically significant difference in hearing loss between all three groups (p=0.0001). Degree of hearing loss increased as the duration of the disease increased.
Conclusions: Hearing loss is directly proportional to the size of perforation; more for the posterior quadrant perforations when compared to the anterior quadrant perforations of same size; also, hearing loss increases as the duration of the disease process increases.

Keywords: Hearing loss, Perforation, Tympanic membrane

INTRODUCTION

Chronic otitis media (COM) is an inflammatory process in middle-ear space that results in long-term, more often, permanent changes in the tympanic membrane including atlectasis, dimer formation, perforation, tympanosclerosis, retraction pocket development, or cholesteatoma.[1] COM is one of the main cause of hearing impairment seen especially in developing countries. If not treated properly, it can give rise to various extra cranial and intra cranial complications which can be fatal also.

Middle-ear sound transmission mechanism getting affected by TM perforations of various sizes is not well characterized, mainly because ears with perforation typically have additional pathological changes as mentioned above. A better description of perforation effects on middle-ear function is needed so that clinicians know what magnitude and frequency of hearing loss to

expect with perforations of various sizes. With such information available, clinicians will be able to assess whether hearing loss is solely the result of a perforation or if additional pathologies are contributing to the hearing loss. This will help the surgeons to be better prepared in the management of cases.

There are various school of thought regarding the site of perforation and its effect on hearing. While some consider site of perofartion having effect on hearing loss; some studies[2-5] say that hearing loss does not depend on the site of perforation. Therefore, the present study is conducted to correlate the site and size of tympanic membrane perforation with pure conductive hearing loss in patients having inactive tubotympanic chronic otitis media. This study also aims to correlate magnitude of hearing loss with disease duration.

METHODS

This was a Cross sectional study conducted at the ENT department attached to Bangalore Medical college and Research Institute within the time period of two and a half years (from November 2015 to May 2017). 150 patients with in the age group 15–45 years with inactive tubotympanic disease were included in this study. Only the patients with inactive tubotympanic disease with pure conductive hearing loss were included in the study. Patients below 14 years and above 45 years of age, those with inactive COM who had multiple perforations, those with active ear discharge, those with tympanosclerosis, those who had undergone priormyringoplasty, those with mixed or sensorineural hearing loss, attico-antral type COM cases, those with ossicular chain fixation or disruption were excluded from the study.

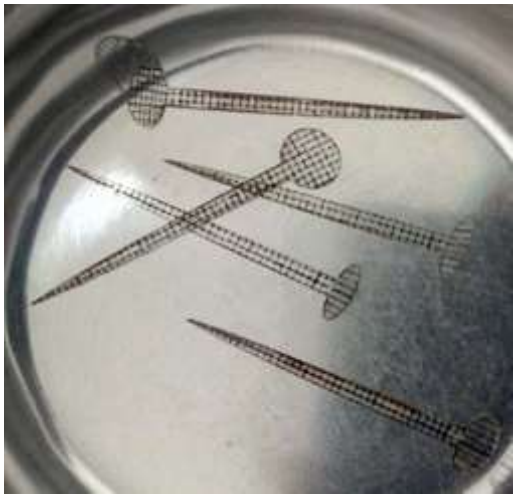

Figure 1: Measuring templates.

In all cases a detailed history was taken which was followed by general examination and ENT examination. Relevant details were noted in all cases. All patients were subjected to specific evaluation, which included hearing evaluation, by Tuning fork tests, Pure Tone Audiometry,

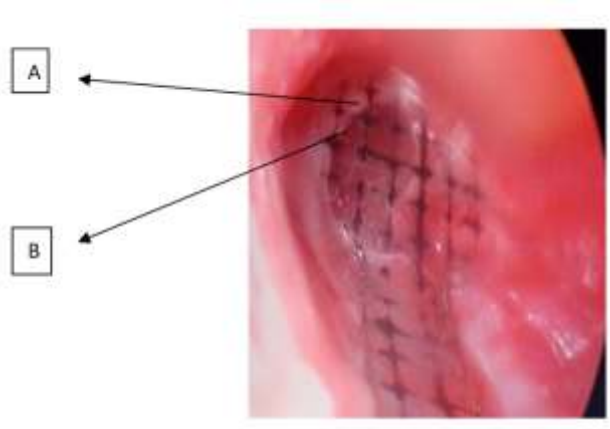

Figure 2: Measuring templates placed over perforation. 'A' will not be counted whereas 'B' will be counted as one square.

examination of tympanic membrane (TM) by means of Oto endoscopy, and examination under microscope under appropriate sedation or localanaesthesia. Audiometric assessment was performed using a clinical audiometer calibrated according to ISO standard in a sound treated room. A pure tone audiometry was determined at the frequencies of 250, 500, 1000, 2000, 4000 and 8000 Hz.

To measure the size of tympanic membrane perforation, a measuring template was prepared by imprinting a graph grid measuring 1mm x 1mm square over a transparent OHP sheet and cut in to an oval shape measuring approximately 9 mm x 8 mm pieces and sterilised in formalin chamber (Figure 1). A smaller template of 6 mm x 5 mm was also prepared for narrow ear canal.

The external auditory canal was anaesthetized by applying five drops of 4% xylocaine drops in to the canal and left for half an hour. Under operating microscope, the sterile measuring template was placed over the tympanic membrane. The number of squares overlying the perforation was directly counted. Half or more of any square within the margins of the perforation was taken as 1 square, less than half of a square within the margins of the perforation was not counted. (Figure 2). Average surface area of an intact TM was taken as 64.3sqmm.[43]

Percentage of Surface area involvement by the perforation was calculated by:

$$(\text{Number of squares with in the margins of the perforation})/64.3 \times 100$$

The patients were further divided into three groups based on the site involved. The site was determined by assuming an imaginary vertical line along the long axis of handle of malleus. Perforations predominantly anterior to the handle of malleus were taken as anterior perforations; posterior to the handle of malleus were taken as posterior perforations. Third group was combined i.e., those

perforations which were involving both anterior and posterior quadrants equally.

Based on the duration of the disease, patients were further divided in to three groups: Group A- <1 year, Group B- 1–5 years and Group C- >5 years and the hearing loss in each group were assessed.

The association of degree of hearing loss was matched with the characteristics of perforation and results thus obtained were evaluated statistically using SPSS software version 20.0.

RESULTS

The study comprised of 150 patients who presented with inactive tubo tympanic disease with pure conductive hearing loss after considering all exclusion criteria as mentioned above.

Age and sex distribution

In our study males (n=88) were predominant than females (n=62), male to female ratio 1.42:1. Majority of patients, n=62 (41.3%) were in the 25-35 years age group. This was followed by patients from the age group 15–25 years (n=47) and 35–45 years age (n=41).

Duration of disease

42 patients (28%) had disease for less than 1 year. 62 (41.3%) patients had disease in the range of 1–5 years, and 46 (30.67%) patients had disease for more than 5 years.

Size of perforation

Maximum number of patients were found in-group 2 (10-20%) and group 3 (20-40%), which comprised of 44 patients (29.3%) each followed by 40 patients (26.67 %) in group 1. Minimum numbers of patients were in-group 4, which was 22 (14.67%). In our study, it is observed that the size of perforation was larger in patients with long term ear disease.

Site of the perforation

In this study, most of the patients had anterior perforation- 74 patients (49.3%), followed by combined perforation- 48 patients (32%). Posterior perforation was the least common type- 28 patients (18.67%).

Tuning fork test

Rinne's test was negative in all diseased ears 150 (100%) cases. Weber's test was lateralized to the worse ear in 148 (98.67%) cases while, 2 cases had indeterminate Weber's. This is because in those cases both ears were having almost equal degree of hearing loss.

Hearing loss according to site of perforation

Isolated posterior quadrant perforations had more hearing loss compared to isolated anterior quadrant perforations (Table 1).

Table 1: Relationship between hearing loss and the site of perforation.

Groups	Average hearing loss (mean ±SD)
Anterior (n=59)	31.7±5.7
Posterior (n=29)	35.21±4.6
Combined (n=62)	41.37±5.9

There was a statistically significant difference between groups as determined by one-way ANOVA ($F(2,147)=45.714$, $p<0.001$). A Bonferroni's post hoc test revealed that hearing loss was statistically significantly higher at combined site (41.37±5.9) compared to posterior (35.21±4.6, $p<0.0001$) and anterior (31.7±5.7, $p<0.0001$). There was statistically significant difference between all three groups ($p<0.0001$) (Table 2).

Hearing loss according to size of perforation

A linear relationship was found between hearing loss and the size of the perforation in our study. As the size of perforation increased, hearing loss was also found to be increased.

A Bonferroni's post hoc test (Table 3) revealed a higher statistically significant value of hearing loss in group IV (46.97±6.59) compared to group III (38.69±2.63, $p<0.0001$), group II (35.13±2.98, $p<0.0001$), group I (27.67±1.85, $p<0.0001$). There was statistically significant difference between all four groups ($p<0.0001$) Average hearing loss with respect to size of the perforation (Table 4). There was a strong positive correlation between hearing loss and size ($r_s(148)=0.33$, $p<0.001$).

Hearing loss according to duration of disease

It was found that hearing loss increased as the duration of disease increased at all the frequencies. Comparison of average hearing loss in all the three groups showed that average hearing loss increased, statistically as the duration of disease increased as shown in Table 5. The perforations were divided into three groups according to duration of disease and hearing loss at each frequency was noted in all the three groups. Hearing loss was more in group C, followed by group B and group A in decreasing order (Table 5 and 6).

Table 2: Average hearing loss for each frequency.

Frequencies Hearing loss (Db)	250	500	1000	2000	4000	8000	Average
Anterior	39.5	35.4	32.7	30.8	27.6	24.2	31.7
Posterior	43.2	39.3	36.2	33.2	31.2	28.2	35.21
Combined	52.4	49.1	47.2	43.5	41	39	45.37

Table 3: Correlation between hearing loss and the size of the perforation.

Groups	Average hearing loss (range in db)	Mean (db)	SD
Group I (0-10) (n=35)	25.7–33	27.67	±1.85
Group II (11-20) (n=45)	29–41	35.13	±2.98
Group III (21-40) (n=46)	35.7–45	38.69	±2.63
Group IV (>40) (n=24)	26.2–51.5	46.97	±6.59
Groups	**Z value**	**P value**	**Significance**
I vs II	-7.42	0.0001	Significant
I vs III	-11.01	0.0001	Significant
I vs IV	-19.29	0.0001	Significant
II vs III	-3.55	0.0001	Significant
II vs IV	-11.83	0.0001	Significant
III vs IV	-8.28	0.0001	Significant

Table 4: Average hearing loss with respect to size of the perforation.

Frequencies Hearing loss (Db)	250	500	1000	2000	4000	8000	Average
Group I	33.02	31	29	24	19	18	25.67
Group II	44.2	42	38.1	33	30.08	28	35.13
Group III	46.1	44.3	40	35.7	33	31	38.69
Group IV	53.2	50.4	48.2	45.7	40.1	38.3	46.97

Table 5: Comparison of average hearing loss of all the groups (according to duration of disease).

Groups	Average hearing loss
A. <1 yr (n=42)	28.33±2.52
B. 1–5 yr (n=62)	32. 27±2.67
C. >5yr (n=46)	42.56±5. 03

Table 6: Comparison of hearing loss with respect to duration of the disease.

Groups	F value	P value	Significance
A vs B	-8.86	0.043	Significant
A vs C	-13.75	0.0001	Significant
B vs C	4.88	0.0001	Significant

DISCUSSION

In our study age of the patients ranged from 15–45 years, the mean age of presentation being 30.6±7.8 years. Majority of the patients (n=62) were found to be in the age group of 26–35 years. The reason for this may be attributed to the patients becoming more cautious socially about their hearing at this age and because of professional necessities. In a study by Caye-Thomasen et al on 26 patients, the mean age was 13.3 years.[6] In our study of 150 patients, 88 patients were male and 62 were female with male to female ratio as 1.42:1. This could be due to

the male gender being more aware of their disease and the incapacity produced because of the disease affecting their daily activities. In the study conducted by Kurian et al on 120 patients, the percentage of male and female were 55% and 45% respectively.[7]

Various methods were used by various authors to determine the size of perforation. In our study we used measuring templates to measure the size of the perforation, which was comparatively a simpler and safer method to directly assess the size of the perforation. We noticed that the average hearing loss increased as the size of the perforation increased. A linear relationship was observed between the hearing loss and the size of tympanic membrane perforation at each frequency. Ahmad et al in their similar study on 70 patients with dry central perforations stated that the hydraulic action arising from the difference inthe area of TM and of the stapedial footplate is the most important factor in impedance matching.[8] When the effective surface area of the tympanic membrane decreases, there will be a decrease in amplification and hearing loss will be proportionate to size of perforation. Similar findings were observed by Voss et al, Gulati et al, Lerut et al, Bhusal et al who also noted a linear relation between size of the perforation and the amount of hearing loss.[5,9,10,11]

Several studies state that location of perforation has no effect on the degree of hearing loss.[4,5] However, in our study we observed that posterior quadrant perforation had more hearing loss when compared to the anterior perforation of same size. The mechanism behind the increased hearing loss in the posterior perforation of the tympanic membrane could be due to the reduction in the effective area of membrane in contact with the sound waves. There is a reduction of pressure difference across the tympanic membrane and depending on the position of tympanic membrane perforation, there is a reduction in mechanical coupling between the remaining intact portion of membrane and the malleus. Several studies have indicated that small and moderate perforations had far more severe effect when placed on posterior and superior margins of the tympanic membrane than placed on anterior and inferior margins, due to the changes in the coupling.[12] Similar findings were observed by Maharajan et al, NishanthKumar et al who concluded that the hearing loss increases as the size of perforation increases and that site of perforation also have significant effect on the magnitude of hearing loss i.e., posterior placed perforations seem to have larger hearing loss when compared to anterior ones.[3,13]

The findings in our study was also supported by the study conducted by Kulwantkaurpunnu et al who observed that hearing loss is directly proportional to size of the perforation, posterior quadrant perforation has more hearing loss than anterior quadrant ones and also as the duration of disease increases, hearing loss also increases.[2] In addition, hearing loss also increased as the duration of disease increased. The findings in this study are comparable with the findings in our study.

CONCLUSION

Hearing loss is directly related to the size of perforation. As the size of perforation increases, conductive hearing loss also increases. Location of perforation also affects amount of hearing loss. Hearing loss is more for posterior quadrant perforations when compared to anterior quadrant perforations of same size. As the duration of disease process increases, hearing loss also increases. The magnitude of hearing loss had no correlation with age or gender factors.

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