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EVALUATION OF HEARING LOSS IN RELATION TO TYMPANIC MEMBRANE PERFORATIONS

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ABSTRACT Hearing impairment is the most frequent sensory deficit in human populations, affecting more than 250 million people in the world. WHO estimated that between 65 and 330 million individuals suffer from chronic suppurative otitis media (CSOM), in which, 60% experience hearing impairment [1]. We have conducted a prospective study on 100 patients with tympanic membrane perforations who attended our ENT opd at Mahatma Gandhi mission medical college and hospital, Kamothe, Navi Mumbai during the period from November 2012 to May 2014. The study group consisted of randomly selected patients of both sex falling in the age group between 10-50 years, with dry perforation of tympanic membrane unilateral or bilateral with no active middle ear disease. Each perforation was studied for parameters of size, site and relation to handle of malleus. Hearing loss in each perforation was determined by pure tone audiometry (PTA). The hearing loss was found to be frequency dependent with greatest loss occurring at lowest frequencies.

We found a linear relationship between size of perforation and conductive hearing loss. Involvement of umbo at the perforation margin worsens the hearing. Site of perforation is also an important factor as posterior pars tensa perforation has greater hearing loss than anterior quadrant perforation.

KEYWORDS : conductive hearing loss, tympanic membrane perforation, pure tone audiometry

INTRODUCTION

Conductive deafness due to tympanic membrane perforation is a very important problem in our community. It distorts the physical and emotional integrity of the affected individual, and impairs the working ability [2]. It important to diagnose and treat tympanic membrane perforations as early as possible, because if untreated it leads to ongoing destructive changes in middle ear, thus adding to further hearing loss. Although tympanic membrane perforations are common, there have been few systematic studies of the structural features determining the magnitude of the resulting conductive hearing loss [3]. Tympanic membrane (TM) protects the middle ear cleft from the infection and shields the round window from direct sound waves. This shield is necessary to create a phase differential so that the sound wave does not impact on the oval and round window simultaneously [4]. It separates external auditory meatus from tympanic cavity, measuring 9 to 10 mm vertically and 8 to 9 mm horizontally [5]. Thus TM plays a major role in the middle ear mechanism. When the sound waves transmit from TM to oval window, the force of vibration is increased, but the amplitude is decreased proportionally. The TM transmits the vibrations to the oval window preferentially through the ossicular chain, but at the same time affords protection to the round window. This is responsible for the reciprocal mobility of both the windows. This middle ear mechanism essentially consisting of middle ear transformer and protection of the round window, is the crux for transforming sound waves to the inner ear after impedance matching.

MATERIALS AND METHOD

100 patients in age group of 10-50 years of either sex with dry perforation of TM of unilateral or bilateral ear with no history of active middle ear disease were selected by simple random sampling technique. The prospective observational clinical study was carried out on patients who attended ENT opd in a period between November 2012 and May 2014.

Method of collecting data included

1) Informed written and well understood consent
2) Detailed history from patient selected with inclusion and exclusion criteria
3) General and systemic examination
4) ENT examination
5) Ear microscopy
6) Tuning fork test (TFT), free field audiometry (FFA) and pure tone audiometry (PTA)

The parameters considered in the study were as follows
1) Site of perforation of tympanic membrane perforation: anterior/ posterior/ both
2) Size of perforation of tympanic membrane: this was measured by using a calibrated 1 mm thin wire hook, graduated in 0.5 mm steps. 2 diameters were taken for each perforation 1 maximum vertical and other maximum horizontal.

Area was calculated as:

Area of perforation $=\pi$ R1 R2

Where π is 3.14159, R1 is the radius along vertical axis, while R2 is the radius along the horizontal axis.

Grouping of perforations were considered on the basis of area of perforation [5]

Group 1- 'Small' perforations - perforation with area 1-9 sq mm
Group 2- 'Moderate' perforations - perforation with area 9-30 sq mm
Group 3- 'Large' perforations - perforation with area >30 sq mm
Relation of perforation with handle of malleus
Perforations were divided into [6]
Malleolar perforation, touching the handle of malleus
Non-malleolar perforation, not touching the handle of malleus [7]
Degree of hearing loss was assessed by TFT, FFA, and PTA

OBSERVATION AND RESULT

1) Maximum patients were seen in the age group 31-40 years (40%), second highest (31%) group was seen between 21-30 years. The lowest number of cases (3%) were seen in the age group 41-50 years.
2) The number of males and female patients were 37% and 63% respectively. The male to female ratio was 1:1.7.
3) Out of hundred patients, 15 cases were due to trauma to ear. In remaining 85 cases etiology was CSOM
4) Average hearing loss for all perforations

Table 1: Average hearing loss (dB)

Frequencies (Hz)	Small perforation (n=19)	Moderate perforation (n=41)	Large perforation (n=67)	All perforation (n=127)	(F-Stat, p value)**
250	20	27	34	31	32.56
500	15	21	31	28	33.12
1000	12	17	24	24	27.13
2000	8	12	20	19	26.49
4000	5	10	14	17	19.39
8000	2	6	10	14	29.79

**:p<0.01 (significant at 1% level of significance)

a) The highest hearing loss in all perforations was at 250Hz (31dB) and gradually decreasing to a minimum of 14dB at 8000Hz. The hearing loss was found to be fairly uniform between 1000Hz and 2000Hz.

b) For small perforation i.e. area of perforation <9 sq mm, (n=19) the maximum of 20dB hearing loss was seen over 250Hz and minimum of 2dB at 8kHz. The hearing loss was approximately uniform between 2000 to 4000Hz.

For moderate perforation i.e. area of perforation 9-30 sq mm (n=67), the maximum of 27dB hearing loss was seen over 250 Hz and minimum of 6dB at 8 kHz. The hearing loss was approximately uniform between 2000 to 4000Hz.

For large perforation i.e. having area of perforation >30 sq mm (n=58), the maximum of 34dB hearing loss was seen over 250Hz and minimum of 10dB at 8 kHz. The hearing loss was approximately uniform between 2000 to 4000Hz.

The hearing loss was seen more in lower frequencies in all type of perforations (small, moderate, large).

A strong relation between size of perforation and degree of hearing was observed. The average hearing loss was significantly different among small, moderate and large perforations (p<0.01). The larger the perforation, the more was hearing loss.

5) Hearing loss – malleolar perforations

In this study, in small malleolar perforations (n=16) maximum hearing loss was 19 dB at 250 Hz and minimum was 3 dB at 8 kHz frequency. Maximum hearing loss was at 250 Hz of 25dB and a minimum of 5dB at 8 kHz frequency in moderate perforations (n=24). Large malleolar perforations (n=34) caused maximum hearing loss of 34 dB at 250Hz and minimum of 12dB at 8 kHz frequency. The statistical analysis indicates that there was a significant difference in the average hearing loss at all frequencies (<0.01). At each sound frequency the hearing loss was maximum in large malleolar perforations and minimum in small malleolar perforations

Table 2: Average hearing loss for malleolar perforation

Frequencies (Hz)	Small Malleolar perforation (N=16)	Moderate Malleolar perforation (N=24)	Large Malleolar perforation (N=34)	(F-Stat, pvalue)**
250	19	25	34	23.18
500	18	24	31	12.42
1000	11	19	26	17.48
2000	9	12	22	10.56
4000	6	9	18	1415.50
8000	3	5	12	14.48

**: p <0.01 (significant at 1% level of significance)

6) Hearing loss – non-malleolar perforations

In this study, large non-malleolar perforations (n=13) caused hearing loss of 27dBat 250 Hz and gradually decreasing to 7dB at 8 kHZ. In moderate non-malleolar perforations (n=17) hearing loss at 250 Hz was 23 dB and at 8 kHz it was 6 dB. In small non-malleolar perforations (n=23) hearing loss at 250 Hz was 19 dB and at 8 kHz, it was 2 dB.

Hearing loss in large non-malleolar perforations was significantly higher (p>0.05) as compared to small non-malleolar perforations.

The hearing loss was found to be more in lower frequencies than higher frequencies, in all small, moderate and large non-malleolar perforations.

Table:3 Average hearing loss for nonmalleolar perforation

Frequencies (Hz)	Small Non-Malleolar perforations (n=23)	Moderate Non-Malleolar perforations (n=17)	Large Non-Malleolar perforations (n=13)	(F-Statistic p value)
250	19	23	27	19.23**
500	16	18	23	13.67**
1000	9	14	15	9.49*
2000	8	9	13	5.89*
4000	6	9	9	2.69
8000	2	6	7	10.46**

*:Significant at 5% level, ** : significant at 1% level of significance

7) Hearing loss – malleolar/ non-malleolar perforations

Table no 4 shows the comparative hearing loss in all malleolar perforations (n=74) and non malleolar perforations (n=53).

In this study, non-malleolar perforations showed an average hearing loss of 22 dB at 250 Hz and an average loss of 5 dB at 8 kHz. The malleolar perforations showed an average hearing loss of 30 dB at 250 Hz and an average hearing loss of 9 dB at 8 kHz. At all frequencies, the hearing loss in malleolar perforations was significantly high as compared to non-malleolar perforation (p<0.01).

Table 4: Average hearing loss (comparison) non-malleolar & malleolar

FREQUENCIES(Hz)	All Non-malleolar perforations (N-53)	All malleolar perforations (N-74)	F stastistic; p value **
250	22	30	19.29
1000	13	23	21.60
1500	10	21	16.59
2000	9	19	16.21
4000	7	15	21.02
8000	5	9	10.32

**: significant at 1% level of significance

8) Table 5 : Average hearing loss(dB) small perforations (comparison)

FREQUENCIES(Hz)	Small Non-malleolar perforations (N- 23)	Small malleolar perforations (N-16)	ANOVA one way (F statistic, p value)
250	18	19	1.43
500	15	16	1.39
1000	9	10	0.89
2000	7	10	0.49
4000	5	6	0.69
8000	2	3	3.49

9) Table 6: Average hearing loss (dB) moderate perforations (comparison)

FREQUENCIES (Hz)	Moderate Non-malleolar perforations (N- 23)	Moderate malleolar perforations (N-16)	ANOVA one way (F statistic, p value)
250	23	25	2.34
500	18	24	3.19
1000	14	19	3.49
2000	9	12	2.38
4000	9	9	0
8000	6	5	1.97

10) Table 7 : Hearing loss (dB)large perforation (comparison)

FREQUENCIES(Hz)	Large Non-malleolar perforations (N- 22)	Large malleolar perforations (N-46)	ANOVA one way (F statistic, p value)
250	25	35	10.87
500	22	30	10.98
1000	17	26	11.39
2000	14	20	8.97
4000	8	17	20.36
8000	6	11	7.31

11) Hearing loss in relation to site of perforation

This study indicates that, in average perforations, the maximum hearing loss of 19dB was at 250Hz and minimum hearing loss of 3 dB was at 8 kHz. Similarly, in posterior perforations, the maximum hearing loss of 31 dB was observed at 250 Hz and minimum hearing loss of 7dB was observed at 8KHz. In perforations involving both the quadrants, the maximum hearing loss 36 dB was observed at 250Hz and a minimum hearing loss of 13dB was observed at 8KHz.

Table 8 : Hearing loss (dB) site of perforation

Frequencies (Hz)	Anterior (n-33)	Posterior (n-26)	Both (n-34)	F statistic p value **
250	19	31	36	17.21
500	18	27	34	19.52
1000	16	24	30	16.06
2000	11	18	26	18.67
4000	7	12	20	12.49
8000	3	7	13	27.99

**: significant at 1% level

DISCUSSION

The present study 'Evaluation of hearing loss in tympanic membrane perforations' is carried out to assess different clinical scales of tympanic membrane perforation size, to evaluate the effect of size, site and malleolar involvement of perforation on the hearing level and in the hearing frequencies.

In our study, the mean age was 28.64 years with standard deviation of 8.5. The male to female ratio was 1:1.7. Out of 100, 15 patients had traumatic etiology and 85 patients had CSOM as etiology of perforation. In the present study, the average hearing loss caused by tympanic membrane perforation in all frequencies was 22 dB

In the present study, small perforations resulted in HL of 17dB at low frequency (<1 kHz), 7dB at middle frequencies (1-4 kHz) and 3db at high frequency (>4 kHz). Moderate perforations caused HL of 24 dB at low frequencies, 13 dB at middle frequencies and 6 dB at high frequencies. Large perforations caused average HL of 33 dB in lower frequency, 19 dB in middle frequencies and 10 dB at high frequencies. The difference in HL in small and large perforations was statistically significant ($p<0.05$).

In the present study it was noticed that HL varies between 26 dB to 6 dB in low to high frequency in malleolar perforations as compared to range of 16 dB to 10 dB in non malleolar perforations. The average HL in malleolar perforations in our study was 19 dB and in non malleolar perforations it was 10.5 dB, which is statistically significant.

In the present study, small malleolar perforations caused 16 dB average HL at lower frequencies and 6 dB HL at higher frequencies, moderate malleolar perforations caused HL of 23 dB at lower frequencies and 9 dB at higher frequencies, and large malleolar perforations caused HL of 30 dB at lower frequencies and 17 dB at higher frequencies. In case of non-malleolar perforation average HL at low frequencies was 15 dB for small, 18 dB for moderate and 21 dB for large perforations. Average HL at high frequencies it was 5 dB for small, 8 dB for moderate and 9 dB for large perforations.

In the present study, the average HL of all anterior perforation was 12dB, for all posterior perforations it was 20 dB and in case of perforation involving both the quadrants it was 27 dB.

At low frequencies average HL for anterior perforations were 18 dB, 27 dB for posterior perforation and 33 dB for perforation involving both the quadrants. At high frequencies HL was 7 dB in anterior perforation, 12 dB for posterior perforation and 20 dB for multiple perforations.

SUMMARY

The study 'Evaluation of hearing loss in tympanic membrane perforations' was conducted in MGM hospital, Kamothe, Navi mumbai in 100 patients.

The observation findings were summarized as:

1) The mean age was 28.6 years.
   The highest number of patients belonging to age group 31-40 years (40%)
2) The male to female ratio was 1:1.7
3) 15% of the perforations had traumatic etiology and 85% perforations had CSOM as etiology.
4) The average HL as on PTA in dry TM perforations ranged from 2 dB to 33 dB. All TM perforations caused average HL of 22 dB at all frequencies.
5) The conductive HL was frequency dependant, with the greatest loss occurring at the lowest frequency.
6) The average hearing loss for all small perforations was 10.33 dB, for all moderate perforations were 15.5 dB and for large perforations it was 22.1 dB. The difference in HL in small, moderate and large perforations was statistically significant ($p<0.01$).
   Thus hearing loss increased with increase in size of TM perforations.
7) The average HL in all malleolar perforations was 19 and in all non malleolar perforations it was 10.5. The difference was statistically significant ($p<0.01$).
8) The average HL in small malleolar perforations was 10.66 dB, and in non malleolar perforations it was 9.33 dB. The difference was statistically significant ($p<0.05$).
9) The average HL in all moderate malleolar perforations was 15.66 dB, and in all moderate non malleolar perforations it was 13.1 dB. The difference was statistically significant ($p<0.05$). The average HL in large malleolar perforations was 23.16 dB, while in large non malleolar perforations it was 15.5 dB. The difference was statistically significant ($p<0.05$).
   Malleolar perforations revealed greater HL as compared to non malleolar perforations.
10) The larger malleolar perforations caused statistically significant more HL than small malleolar perforations ($p<0.05$). Similarly larger non malleolar perforations caused statistically more significant HL than small non malleolar perforations ($p<0.05$)
11) The average HL for anterior perforations was 12 dB, for all posterior perforations was 20 dB and for perforations involving both the quadrants it was 27 dB. The difference between anterior and posterior perforations was statistically significant. Posterior perforations showed greater HL as compared to anterior quadrant.
12) Larger perforations produced higher HL than smaller perforations in each location.

CONCLUSION

This prospective clinical study of TM perforations showed that young and middle aged populations are the most common sufferers of CSOM. The hearing loss is frequency dependent with greatest loss occurring at lowest frequency.

A linear relations ship exists between size of perforation and conductive HL as a general rule.

Involvement of umbo at the perforation margin worsens the hearing.

Site of perforation is also an important factor as posterior quadrant pars tensa perforations have greater hearing loss than anterior quadrant perforations.

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