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ORIGINALRESEARCH

A Study To Assess The Effect Of Size Of The Perforation On The Degree Of Hearing Loss

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Abstract

Introduction: Tympanic membrane is a membranous partition separating the external auditory meatus from the tympanic cavity. It is important to diagnose and treat the tympanic membrane perforation as early as possible as untreated tympanic membrane perforations leads to further hearing loss. Thus, the present study was undertaken to study the effect of site and size and shape of the perforation on the degree of hearing loss.

Material and Methods: The present study was conducted on 200 patients of either sex and of age 15 years and above presenting with hearing loss due to tympanic membrane perforation attending the outdoor and indoor of ENT Department of GGS Medical College & Hospital, Faridkot. CT Scan of patients whenever necessary were done. Pure Tone Audiometric examination was conducted in sound treated room of ENT outpatient department. All the results were recorded and analysed by SPSS software. T- test was used for evaluation of level of significance.

Results: Incidence of tympanic membrane perforation was found to be maximum 121(60.5%) in the age group of 11-30 years. On the basis of size of perforation, the overall mean hearing loss of all the groups was maximum at 250 Hz 39.49±12.74 and it was minimum at 4000 Hz 28.57±10.79. The mean hearing loss in group I at 250 Hz was 30.21±10.54 and at 4000 Hz was 23.50±10.71. The mean hearing loss in group II at 250 Hz was 41.10±11.00 and 29.59±10.57 at 4000Hz. The mean hearing loss in group III at 250 Hz was 48.33±11.56 and 33.04±8.72 at 4000 Hz.

Conclusion: On the basis of size of perforation, the overall mean hearing loss of all the groups was maximum at 250 Hz and it was minimum at 4000 Hz. All the patients were given proper counseling for requisite treatment depending upon the size of perforation and degree of hearing loss.

Keywords: Ear; Hearing loss; Tympanic membrane;

Introduction

Tympanic membrane (TM) is semitransparent and elliptical in shape[1]which is set into vibratory motion by sound waves.[2]It is a key component of the tympano-ossicular system for sound transmission. It measures 9 to 10 mm vertically and 8 to 9 mm horizontally. The average thickness of the tympanic membrane is 0.074 mm.[3]

Perforation of the TM is common in an otologic practice and can result from various causes such as trauma and chronic otitis media.[4] Movement of TM are more at the periphery than at the centre where malleus handle is attached. This is curved membrane effect. The movement takes place at the periphery of the tympanic membrane, the central portion moving in and out like a plunger.[5] Sound waves are transmitted to the oval window by the ossicular chain with a hydraulic effect

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i.e., there is difference in areas of the tympanic membrane and the stapes foot plate which results in a transformer action by hydraulic principle. Helmholtz measured the areas and he gave 64.3 mm^2 for the tympanic membrane and 3.2 mm^2 for the foot plate. The areal ratio is 20:1.[6]
Integrity of tympanic membrane is must for proper sound transmission and so is the integrity of the other portion of the conducting mechanism like patent eustachian tube, air in the middle ear at atmospheric pressure and condition of the cochlea and central connection.[7] Thus, the present study was undertaken to study the effect of size of the perforation on the degree of hearing loss.

Material and Methods

The present study was conducted on 200 patients of either sex and of age 15 years and above presenting with hearing loss due to tympanic membrane perforation attending the outdoor and indoor of ENT Department of GGS Medical College & Hospital, Faridkot. 40 patients had bilateral tympanic membrane perforation so number of ears involved was 240. Patients with dry perforations of tympanic membrane, unilateral or bilateral, were selected at random from the Department.
A thorough history according to the proforma was taken in each case, followed by detailed examination and investigations. Each patient was subjected to clinical examination and routine laboratory tests such as Hb, BT, CT, TLC, DLC, complete urine examination. Radiological examination such as X-ray mastoid (oblique lateral view) was undertaken. CT Scan of patients whenever necessary were done. Pure Tone Audiometric examination was conducted in sound treated room of ENT outpatient department. The observations, thus made were analysed in the light of accessible literature and patients were advised accordingly to prevent further hearing loss.
Then, the evaluation of hearing loss was done in each case of dry tympanic membrane perforation, depending on the size of perforation.
To estimate the diameter of perforation a 1 mm thin wire hook was taken. Readings were taken under microscope. Two diameters were taken for each perforation one maximum vertical and other maximum horizontal. Area was calculated as area of perforation $=\pi R1R2$, where $\pi=3.14159$ (constant), $R_1$is radius along the vertical axis and $R_2$is radius along the horizontal axis. Depending upon the area, perforation will be divided into 3 groups where group I comprised of small perforation i.e., 0-9 mm^2 , group II comprised medium sized perforation i.e., 9-30mm^2 and group III comprised of large sized perforation i.e.,>30 mm^2. The average surface area of intact tympanic membrane will be taken as 64.3 mm^2. All the results were recorded and analysed by SPSS software. T- test was used for evaluation of level of significance.

Table I :Distribution Of Patients (Ears Involved) According To Size Of Perforation

Surface area of TM involved	No. of patients (ears involved)	%age
Group I (0-9 mm^2)	120	50.0
Group II (9-30 mm^2)	72	30.0
Group III (>30 mm^2)	48	20.0
Total	240	100.0

On the basis of surface area of tympanic membrane involved. All the ears with perforation had been divided into three groups. Maximum number of patients was found in group I that is 120 (50%). In group II, 72(30%). Minimum number of patients was in group III, that is 48(20%). This trend shows that people are becoming more aware of their health related problems and so they seek the medical advice as early as possible. As with long standing disease the perforation size increases.

ISSN:0975-3583,0976-2833 VOL13,ISSUE 02,2022

Table II: Comparison Of Hearing Loss Of Group I (0-9 Mm^2) At Different Frequencies

Frequencies (in hertz)	Range (in db)	Mean (in db)	±SD
250	10-60	30.21	10.54
500	15-50	28.79	9.45
1000	15-55	25	8.42
2000	10-40	24.71	7.55
4000	5-55	23.50	10.71

In group I (0-9 mm^2) the mean hearing loss at 250 Hz was 30.21±10.54 and at 4000 Hz was 23.50±10.71. The overall range of hearing loss in Group I was 10-65.

Table III: Comparison Of Hearing Loss Of Group Ii (9-30mm^2) At Different Frequencies

Frequencies (in hertz)	Range (in db)	Mean (in db)	±SD
250	15-60	41.10	11.00
500	15-60	38.58	8.92
1000	15-55	32.44	8.52
2000	10-60	31.42	9.65
4000	10-55	29.59	10.57

In group II (9-30 mm^2), the mean hearing loss at 250 Hz was 41.10±11.00 and as the frequency increased hearing loss declined to 29.59±10.57. The overall range of hearing loss of group II was 10-60.

Table IV: Comparison Of Hearing Loss Of Group III ($\geq$30 Mm^2) At Different Frequencies

Frequencies (in hertz)	Range (in db)	Mean (in db)	±SD
250	20-60	48.33	11.56
500	20-60	44.80	9.84
1000	20-55	41.57	8.97
2000	15-55	38.04	8.72
4000	10-50	33.04	8.72

In group III ($\geq$30 mm^2), the mean hearing loss at 250 Hz was 48.33±11.56 and 33.04±8.72 at 4000Hz. The overall range of hearing loss was 20-70 dB.

Table V:Comparison Of Average Hearing Loss Of All The Groups (According To Size Of Perforation)

Groups	**Average hearing loss (Range in db)**	**Mean (in db)**	**±SD**
Group I (0-9 mm^2) (n=120)	11.67-61.67	25.50	7.35
Group II (9-30 mm^2) (n=72)	15.00-48.33	34.15	7.62
Group III ($\geq$30 mm^2) (n=48)	31.67-56.67	41.47	8.09
Groups	**'t' value**	**'p' value**	**Significance**
I v/s II	4.23	<0.001	Highly significant
I v/s III	11.68	<0.001	Highly significant
II v/s III	8.19	<0.001	Highly significant

Above table V clearly shows that when average hearing loss of patients in group I was compared with average hearing loss of group II, it was found to be statistically significant ($p<0.001$), similarly when average hearing loss in group I was compared with group III and group II was compared with group III respectively, both were found to be highly significant that is $p<0.001$. So, above table I shows that average hearing loss increases statistically significantly as the

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perforation size increases.

Table VI:Comparison Of Hearing Loss Of All The Groups (According To Size Of Perforation)

Groups (according to size of perforation)	Total No. of ears	Average hearing loss	No. of patient in each group	%age
0-9 mm^2	120	≤25 db	84	70
		25-40 db	24	20
		≥40 db	12	10
9-30 mm^2	72	≤25 db	12	16.66
		25-40 db	48	66.66
		≥40 db	10	13.88
>30 mm^2	48	≤25 db	-	-
		25-40 db	14	29.16
		≥40 db	34	70.83

The above table VI shows that in group I maximum patients 84 (70%) were having hearing loss ≤25 db. Only 12(10%) patients were having hearing loss ≥40 db. Most of these patients had traumatic perforation with sharp instrument. Case No. 89 had perforation in PS quadrant and case No.4 had noise induced hearing loss. Maximum patients in Group II were having hearing loss in the range of 25-40 db. Only 10 (13.8%) patients out of 72 had hearing loss ≥40 db. Most of these patients had either malleolar perforation or had long standing disease.
In group III, 34 (70.83%) patients out of 48 had hearing loss ≥40 db.

Discussion

The tympanic membrane is a crucial component for sound transmission from external world to inner ear. Perforation of the tympanic membrane is common in an otologic clinic and can result from various causes such as chronic otitis media and trauma. Perforation of the tympanic membrane can result in conductive hearing loss that ranges from negligible to 50db.[8]
The present study was conducted on 200 patients of either sex and age, 15 years or above who presented with tympanic membrane perforation, unilateral or bilateral. Hearing loss was evaluated in each case. Relation of hearing loss to site, size, shape and duration of disease was sought out. The data was analysed statistically.
On the basis of surface area of tympanic membrane involved, all the perforations were divided into three groups in our study.
Group I (0-9 mm^2) 120 (50%)
Group II (9-30 mm^2) 72 (30%)
Group III (≥30 mm^2) 48 (20%)
This trend shows that people are becoming more and more aware of their health related problems and so they seek the medical advice as early as possible. With long standing disease the perforation size increases.
All the perforations were placed in four groups depending upon their surface area involved by Ahmad and Ramani.
Group A (<10%) of tympanic membrane surface area
Group B (10-20%) of tympanic membrane surface area
Group C (20-40%) of tympanic membrane surface area
Group D (>40%) of tympanic membrane surface area
Ears were divided into three subgroups on the basis of area of perforation by Mehta et al.[6]
Small perforation 0-8 mm^2 = 30
Medium sized perforation 9-30 mm^2 = 25
Large perforation > 30 mm^2 = 7

ISSN:0975-3583,0976-2833 VOL13,ISSUE 02,2022

In our study hearing loss increased with increase in size of perforation, at each frequency. Moreover, in each group hearing loss was more at lower frequency and it decreased as the frequency increased. On comparing the average hearing loss of one group with the other difference was found to be significant statistically. Average hearing loss increased as the perforation size increased. Ahmad et al[9] said that the hydraulic action arising from the difference in area of TM and of the stapedial footplate is the most important factor in impedance matching. When the surface area is decreased, there will be decrease in amplification and hearing loss will be proportionate to size of perforation. Voss et al[10]studied that hearing loss increased as the perforation size increases. Gulatiet al[11] ina study of 21 patients with safe otitis media reported a linear relation between size of perforation and amount of hearing loss.
Shambaugh[12] stated that perforations cause a loss that depends on frequency and perforation size. Perforation size is an important determinant of the loss. Large perforation result in larger hearing loss. Shah et al[13]in his study seen that average hearing loss was 23 dB in perforation involving <25% of effective vibrating tympanic membrane-surface area, 27 dB in perforations involving 25-50% and 41 dB in perforations involving 50-75% of effective vibratory tympanic membrane surface area. Thus it was seen that large sized perforations had greater hearing loss than small sized perforations. Mehta et al[6] in their study of 56 patients (62 ears) showed that perforation induced hearing losses were generally greater at the lowest frequencies and decreased as the frequency increased. Larger perforations resulted in greater hearing loss, an effect that was present at all audiometric frequencies. So our study is consistent with the study conducted by above authors.

Conclusion

The mean hearing loss increased as the size of perforation increased and the difference was significant statistically.On the basis of size of perforation, the overall mean hearing loss of all the groups was maximum at 250 Hz and it was minimum at 4000 Hz. All the patients were given proper counseling for requisite treatment depending upon the size of perforation and degree of hearing loss.

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