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Hearing Loss and Size and Type of Perforation of Tympanic Membrane in Chronic Otitis Media Patients: An Observational Study in North Eastern India

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A B S T R A C T

Objective*:** The study of correlation between sizes and type of tympanic membrane perforations with degree of hearing loss.Study Design***: Cross sectional observational study.***Setting***: E. N. T OPD, at AGMC & GBP Hospital, Tripura.***Materials and Methods***: 110 patients (118 ears) of COM (safe type)were selected from Dec 2020 to June 2022. Instruments used for data collection/processing included questionnaires, oto-endoscopy (hand held portable) and microscopy, Pure tone audiometer and image J software.***Results***: 110 patients (56-males, 54-females), aged 15-60 years (mean age 41.00 years ± 13.99 years) with 118 perforated eardrums were studied. 8(7.3%) had bilateral TM perforations, 53(48.2%) right unilateral and 49(44.5%) left unilateral. The various sizes of perforation and their hearing loss were as follows: Group I (total perforation) no. of ear=3. Group II (subtotal perforation) no. of ear=19. Group III (central perforation) no. of ear = 96. Based on size of perforation GROUP 1 (<20 mm sq.) 41 examined ears, GROUP 2 (20- 40mm sq) 59 examined ears, GROUP 3 (>40mm sq.) 18 examined ears.Amongst the central perforation 19 ears had HL < 35db and 73 ears have mean hearing loss 35 - 55 db and 4ears have HL >55db. Amongst the subtotal perforation11 ears have mean hearing loss 35-55db & 8 ears have HL >55db. Amongst the total perforation 1 ear have HL 35-55db and 2 ears have mean hearing loss > 55db and Difference was significant, P value<0.001.***Conclusion****:* A linear relationship existed between sizes and type of tympanic membrane perforation with degree of hearing loss.

Keywords: Tympanic membrane perforations, Hearing loss, COM (safe type), Oto-endoscopy, Pure tone audiometer, Image J software, Bilateral TM perforations, Unilateral TM perforations, Perforation size, degree of Hearing loss.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is a chronic inflammation of the middle ear and mastoid cavity, characterized by recurrent otorrhoea through a tympanic perforation [1]. Tympanic membrane is a membranous partition separating external auditory canal from the middle ear, measuring 8-9mm horizontally and 9-10 mm vertically. The large effective surface area of an intact and normally vibrating tympanic membrane plays a major role in middle ear transformer mechanism [2]. The severity of hearing loss can vary depending on several factors, and one potential contributing factor is the size of the perforation. The relationship between the size and type of tympanic membrane perforation and the degree of hearing loss in COM patients has been a subject of extensive research studies have shown that larger perforations generally results in more significant hearing impairment [3]. The tympanic membrane, also known as the eardrum, is a thin oval, semi-transparent structure that separates the external auditory canal from the middle ear. It measures approximately 8-9 mm horizontally and 9-10 mm vertically. The large effective surface area of an intact and normally vibrating tympanic membrane plays a crucial role in the middle ear transformer mechanism, facilitating sound transmission from the outer ear to the auditory ossicles [4]. Perforation of the tympanic membrane can result from a variety of causes, with infections and trauma being the most common. Infections such as acute otitis media, chronic otitis media, and tuberculosis, as well as trauma including barotraumas and temporal bone fractures, are frequent culprits. Iatrogenic causes, such as the insertion of ventilation tubes, also contribute to tympanic membrane perforations. These

perforations lead to varying degrees of conductive hearing loss, which is a significant national health issue with notable physical andpsychosocial impacts. Early diagnosis and treatment of tympanic membrane perforations are crucial, as untreated perforations can cause ongoing destructive changes in the middle ear, exacerbating hearing loss. Accurate assessment of the type and size of the perforation and its relationship with hearing loss is essential for clinicians to provide optimal care. The incidence of otitis media and tympanic membrane perforation is particularly high in developing countries like India, especially in rural areas [5, 6].

The aims of this study are to explore the correlation between the size and type of tympanic membrane perforation and the degree of hearing loss in patients with chronic otitis media.

By understanding these relationships, clinicians can better predict the auditory outcomes of COM patients and tailor their treatment strategies accordingly. This study will also contribute to the existing body of knowledge, providing insights that may inform future therapeutic approaches and improve patient care.

Aims & Objectives of the Study

1) To study the various types and sizes of perforation in patients of safe chronic otitismedia.
2) To correlate the size and type of the tympanic membrane perforation with hearing loss as evidenced by PTA.

Materials and Methods

A prospective observational study was done on Patients attending the outpatient department in a Tertiary Care Hospital AGMC AND GBP HOSPITAL, TRIPURA, during the study period from Dec 2020 to June 2022 who had a perforation in tympanic membrane. A sample size of 110 patients with perforated Tympanic membrane of patients of safe CSOM were included in the study. Study tools:

All patients underwent following investigations:

1. Otoscopy (Heine mini 3000)
2. Examination under microscope (EUM)
3. Tuning Fork Tests using 256hz, 512hz and 1024hz
4. Pure Tone Audiometery (PTA) (ALPS AD 2100)
5. Image J software
6. Examination of ear with a portable otoendoscope (Beebird R1)
7. HRCT Temporal bone imaging &xray mastoid (ifrequired).

Inclusion Criteria:

1. Subjects with central tympanic membrane perforationdue to tubotympanic disease
2. Subjects with an intact ossicular chain
3. Subjects aged between 15 to 60 years.

Exclusion Criteria:

1. Patients suffering from COM squamosal disease (atticoantral disease).
2. Active chronic suppurativeotitis media tubotympanictype.
3. Patients with ossicular chain pathology.
4. Patients who could not give a valid and consistent puretone audiogram response.
5. Patients with Sensorineural hearing loss (SNHL) ormixed hearing loss.
6. Patients with complications of CSOM
7. Patients not willing to give written and informed consent
8. Acute suppurative otitis media.
9. Traumatic perforation.
10. Previously operated ears.

METHODOLOGY

A written informed consent was taken from the patients who were included in the study. Photographs of the perforated tympanic membrane were taken using portable otoendoscope. The type of perforation was noted anterior or posterior to handle of malleus. The images were analysed using 'IMAGE J' software, free down load software available on the internet. The size of the perforation and the total size of the tympanic membrane were measured in terms of pixels.

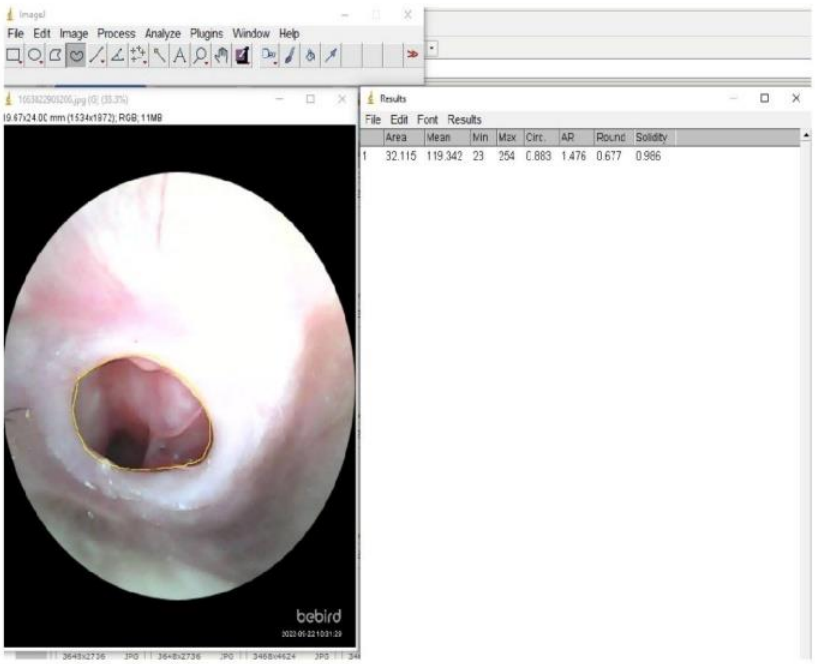

Image 1: Measurement of perforation with image J software

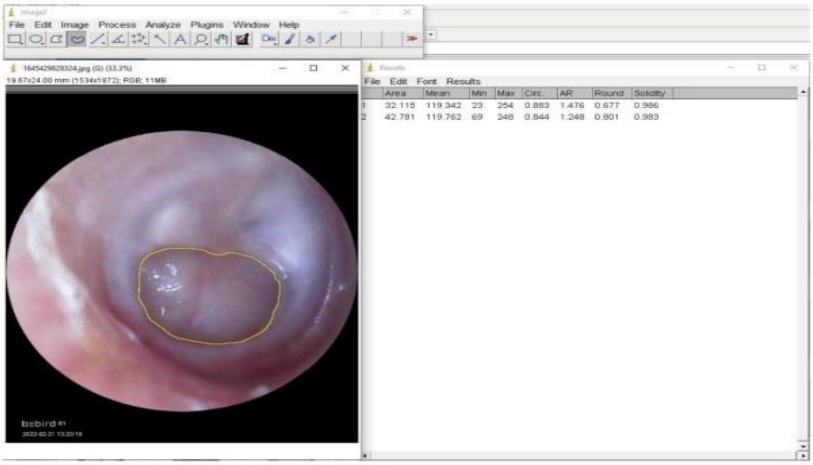

Image 2:Measurement of TM perforation with image J software

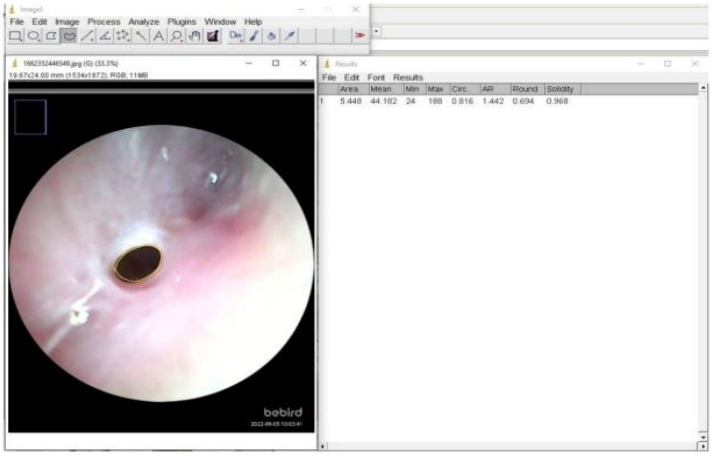

Image 3: Measurement of TM perforation with image J software

Image 4: Photo of portable otoendoscope

RESULTS

Table 1: Showing the number of gender enrolled in the study

Gender	No. of Patients	%
Female	54	49.1%
Male	56	50.9
Total	110	100.0

Table 2: Shows the types of perforation and its frequency in the study sample

Perforation type	No. of Patients	%
Total perforation	3	2.5
Subtotal	19	16.1
Central	96	81.4
Total	118	100.0

Table 3: Shows the sizes of perforation and its range in the study sample

Size of perforation (mm2)	No. of Patients	%
<20	41	34.7
20- 40	59	50.0
>40	18	15.3
Total	118	100.0

Mean ±SD:27,33 ±13.75

Table 4: Shows the side of ear involved in the patients

which side ear	No. of Patients	%
Bilateral	8	7.3
Left only	49	44.5
Right only	53	48.2
Total	110	100.0

Table 5: Shows the different levels of hearing loss occurring in the three groups of perforation

Perforation type	Hearing Loss in decibel			Total
	< 35 db	35-55db	>55db	
Total Type	0(0%)	1(1.3%)	2(7.7%)	3(2.5%)
Subtotal type	0(0%)	11(11.3%)	8(61.5%)	19(16.1%)
Central type	19(100%)	73(87.5%)	4(30.8%)	96(81.4%)
Total ears	19(100%)	85(100%)	14(100%)	118(100%)

Table 6:Showing the correlation between the different ranges of hearing loss with the mean of perforation size

Variables	Hearing Loss in decibel			p- value
	< 35 db	35-55db	>55db	
Hearing Loss (db)	34.13± 8.21	43.48 ± 5.75	57.54 ± 8.60	<0.001**
size of perforation (in mm)	12.84 ± 6.40	26.52 ± 10.60	49.44± 10.17	<0.001**

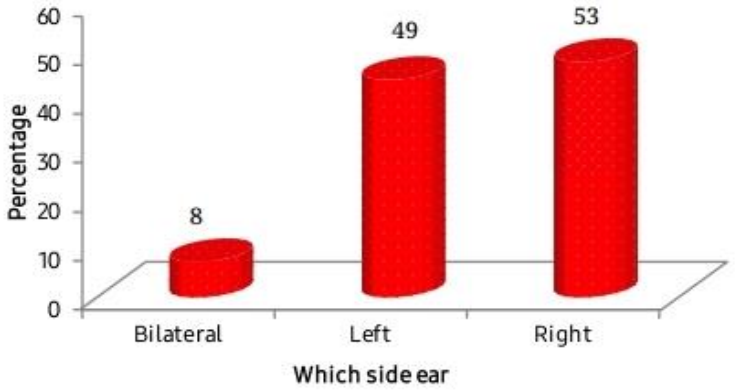

Figure 1: Shows which side ear is more affected

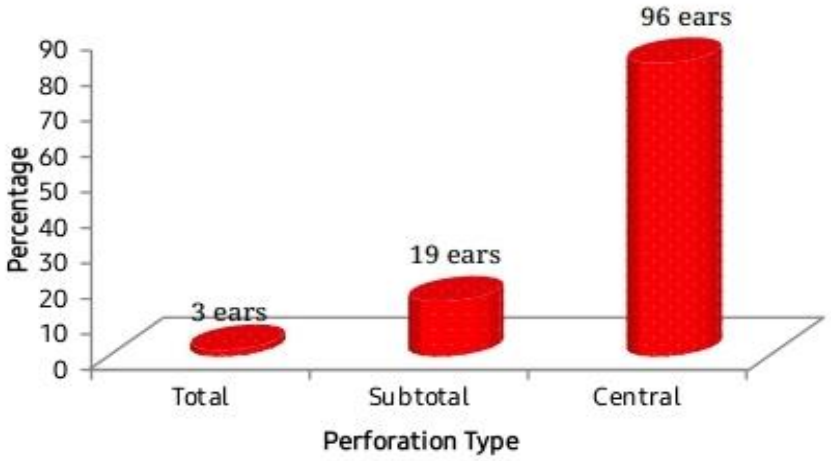

Figure 2: Showing the frequency of 3 different subtypes

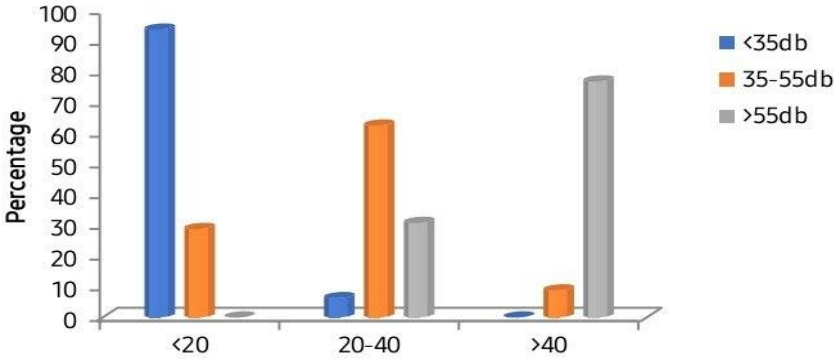

Figure 3: Shows the hearing loss range and number of examinedears

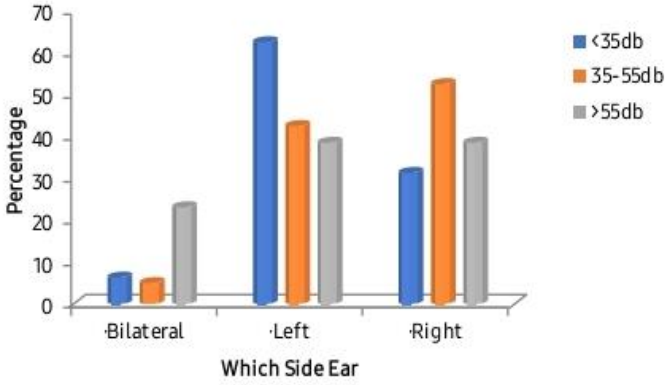

Figure 4: Showing the range of hearing loss in different sides of test ear

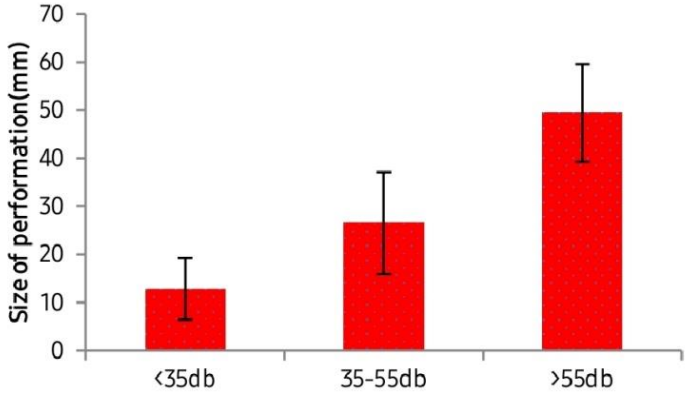

Figure 5: Showing the correlation between the mean of perforation and mean of hearing loss

DISCUSSION

Perforation of tympanic membrane is a common otological problem. It leads to varying degree of conductive hearing loss. The study attempts to find the degree of hearing loss occurred in with the size and type of tympanic membrane perforations assessed by pure tone audiometry.

The present study was conducted in 110 patients (118 perforated ears) in the outpatient department of ENT. Methodology was similar to that used in Ibekwe TS *et al*., [7] study. After taking detailed history and a clinical examination, video otoscopy of all ears was done with a portable hand held otoendoscope (beebird R1) and images were recorded in a computer. Area of perforation (P) and area of entire tympanic membrane (Q) were calculated and percentage of area of perforation (P/Q×100) for every ear was obtained by using IMAGE J software.

Matsuda Y *et al*., [8] have also used image analysis equipment (WIN ROOF version 5.5 software, mitani corporation, Tokyo, Japan) to study the effect of perforation of tympanic membrane on middle ear transmission. Hsu CY *et al*., [9] used a computer program which was designed by them. In their study, they concluded that size of perforation calculation using computer program and visual estimation showed a larger differences. The variations were large for different individuals even experienced otologists. In our study the most common affected age group was 20-35 years. People of this age group are more concerned about their health. In our study females are more than males. Most of the cases were due to chronic otitis media. Therefore we conclude that chronic otitis media is the most common cause of perforation of tympanic membrane. Most common symptoms were hearing loss and discharge. Pure tone audiogram was done for all patients. Ajith U [10] and Bhat VK [11] have done patch test, similar to our study to exclude the ears with ossicular pathology. Bhusal *et al*., [12] measured the diameter of perforation and classified perforation into categories based on the area of tympanic membrane affected by perforation. Relation of Size of Perforation and Hearing Loss. Our study showed a significant linear association between the degree of hearing loss and size of perforation of tympanic membrane, with p value 0.002. As the 'p' value is less than 0.05 it implies that the average hearing loss increased with

increase in size of perforation. It was also stated that hearing loss due to perforation was more at low frequencies than at high frequencies.

Johnson Edialeet *al*., [13] in 2018 conducted a study on148 patients, in which he proved the severity of hearing loss increased with an increase in size of perforation of tympanic membrane. Similar results were obtained in study done by Sood As *et al*., [14], Maharajan *et al*., [15]. They found that patients with subtotal, total perforations showed larger air-bone gap with more hearing loss. Size of the perforation is the most important determinant of hearing loss, was also proved by Pannu *et al*., [16] and Nepal *et al*., [17]. Matsuda Y *et al*., [8] in their study stated that conduction disturbance in the low frequency range increases due to inflammatory changes in middle ear. In such cases, due to tympanosclerosis or sclerotic changes of the ossicles tympanic compliance may decrease which leads to conduction disturbance in low frequency range. Even in cases of traumatic perforation of the tympanic membrane it is difficult to determine whether the observed conduction disturbance is only due to perforation. Type of Perforation with Hearing Loss The ears being examined with 200mm lens carl zeismicroscope and also with portable otoendoscope.

Type of perforation classified as:

1) Grade 1- central <25%
2) Grade 2-subtotal
3) Grade 3-Total
4) Grade 4- multiquadrant 25-50%.

Kumar UA *et al*., [18] in their study found that site of perforation does not depend upon degree of hearing loss except in the anterio-superior quadrant.

Anthony and Harrison [19] in their study showed that posterior inferior quadrant perforation caused more hearing loss than anterior inferior perforation at 250Hz, equal loss at 4000Hz and lesser loss at intermediate frequencies.

Based on the above studies, there is no consensus on the site of perforation and its relation on hearing loss. This requires further study. Our study includes only 8patients with purely posterior quadrant perforation, which is not sufficient to arrive at a conclusion.

CONCLUSION

Chronic otitis media is the chronic inflammation of the muco-periosteal lining of the middle ear cleft with hearing impairment. Chronic otitis media is the most common ontological problem encountered in developing countries due to poor nutrition, poor socioeconomic status, lack of health education and poor hygiene habits. It is one of the major causes of deafness in India.

In the present study following observations are made:

1) The most commonly affected age group is between 20 to 35 years.
2) The tubotympanic type of chronic otitis media is more common in females.
3) Chronic otitis media is more common in low socioeconomic group due to lack of advanced medical care especially in rural areas.

The following conclusions are made from the present study:

1) The magnitude of hearing loss increased with increase in size of the perforation of tympanic membrane.
2) The degree of hearing loss is related to different types of perforation small Central perforations have lesser hearing loss Compared to larger subtotal and total perforations

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