

## Tympanic Membrane Perforation And It's Correlation With Hearing Loss And Frequencies Affected

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

### Abstract

Chronic otitis media is a long standing infection of a part or whole of the middle ear cleft characterized by ear discharge and a permanent perforation with or without hearing loss. Considering the high incidence and prevalence of COM in our country and it being a common cause of preventable hearing loss, this institutional based prospective observational study was conducted in Department of Otorhinolaryngology and Head & Neck Surgery, J.L.N Hospital and Research Centre, Bhilai (Chhattisgarh) for a period of 1 year from 10 February 2020 to May 2022. Here, we studied the pure tone audiometry in 50 patients (male and female) from the ages 18 to 80, who came to out patient department (OPD) with complaints of hearing loss and history of ear discharge in the past. The patients with Tympanic Membrane perforation on otoscopic examination with hearing loss on tuning fork tests underwent otoendoscopy. The otoendoscopic photos of the perforation were used to determine size and site of the perforation. Tympanic membrane perforations were classified into 3 groups according to size and 10 groups on the basis of site. WHO classification was used for grading of hearing loss. It was concluded that large central perforations caused the maximum hearing loss and the loss was more at higher frequencies by statistical analysis of the obtained data.

**Keywords:** CSOM, frequency loss, hearing loss, PTA, TM perforation

### Introduction

COM implies an abnormality of the pars tensa or pars flaccida, most likely a result of earlier AOM, negative middle ear pressure or OME.[1] Incidence of this disease is more in developing nations (3% to 5.7%) than developed nations (0.5% to 2%). Prevalence is higher in poor socioeconomic status. Affects both sexes and all age groups. It is a leading cause of hearing impairment in rural areas (46/1000) [2].

There are various types of COM. Inactive mucosal COM is a defect of the pars tensa but the middle ear mucosa is not inflamed. Active mucosal COM is

defect of the pars tensa with an inflamed middle ear mucosa which produces mucopurulent discharge. In Inactive squamous type there is retraction of the pars tensa or pars flaccida which has the potential to become active with retained debris. Active squamous COM shows retraction of pars flaccida or tensa that has retained squamous epithelial debris and is associated with inflammation and production of pus, often from adjacent mucosa. [1]

The effect of the enhanced ratio of the surface area of the tympanic membrane to that of the oval window increases the sound pressure by 27 (dB) whereas the

lever action of ossicles contributes about 3 dB. A perforation of tympanic membrane decreases the surface area of tympanic membrane available for sound transmission and sound falls directly on middle ear. Hence, the pressure gradient across the surfaces of the tympanic membrane is insignificant which hampers the effectiveness of TM and causes hearing loss. [3]

Pure tone audiometry gives an idea about the type and degree of hearing loss. The type of hearing loss is determined by comparing the amount of hearing loss for AC and BC thresholds at the same frequency. Conductive hearing loss is described by the air–bone gap which has a maximum of about 65 dB and needs to exceed 10 dB before it is considered significant. A sensoryneural hearing loss has an equal amount of loss for AC and BC thresholds. A mixed hearing loss has an air–bone gap and the thresholds for BC fall outside the range of normal hearing. Classification for hearing loss is based on the average AC thresholds for three frequencies 500, 1,000, and 2,000 Hz, often referred to as the three-frequency pure tone average [2].

According to WHO hearing loss is classified as-

1. Normal hearing -  $< / = 25$  dB
2. Mild – 26 – 40 dB
3. Moderate - 41- 60 dB
4. Severe – 61 – 80 dB
5. Profound -  $> 81$  dB [4]

Though most of the studies have shown a linear relationship between size of perforation and degree of loss, variation with site of perforation could not be established. Very few studies have been conducted to show the affected frequencies in TM perforation, results of which remained inconclusive. Because of these varying reports this project was under taken to fill lacunae of scientific research in this area. This information helps to provide more insight into the sound transmission mechanism by tympanic membrane and helps in better determination of post operative prognosis which can be explained to the patient during counselling.

## Materials And Methods-

Study design: Prospective observational study

Study period: February 2020 to May 2021 (1 year 3 months)

Sampling design: Patients coming to Jawahar Lal Nehru Hospital and Research Centre, OPD ENT & Head & Neck Surgery with hearing loss and previous history of ear discharge showing tympanic membrane perforation on otoscopic examination.

Sample size: 50 Patients

Calculation - The prevalence of perforation size  $>30$  mm<sup>2</sup> = 11% = 0.11  $1.96 = z$  value for 5% confidence level

$e =$  Allowable error = 10%

Minimum sample size =  $N = 1.96^2 * P * (1-P) / e^2 = (3.8416 * 0.11 * 0.89) / (0.10)^2 = 38$

To increase the reliability and power of the study and to avoid loss of data, 50 samples are taken.

## Inclusion Criteria:

1. Patients willing to take part and give informed Consent
2. Unilateral/bilateral COM inactive mucosal type
3. Age  $> 18$  years

## Exclusion Criteria:

1. Not willing
2. Active Discharge with complications
3. active squamous & mucosal, inactive squamous disease.
4. Traumatic perforations.
5. Intact TM with hearing loss

Method : The patients who attended ENT & Head and Neck Department of JLNHRC, Bhilai with the complaints of hearing loss and history of ear discharge are selected as the subjects of the study. Informed consent is taken. Detailed history of these patients is taken. Patients are subjected to thorough systemic and ear examination with a Welsch Allyn Otolaryngoscope. Patients found to have perforation on otoscopic examination undergo Pure tone audiometry using ELKON 3N3 Multi Pure Tone Audiometer. Otoendoscopic images of the patients with tympanic membrane perforation are taken using Kurl Shortz 0-degree endoscope. The ratio of the perforation to the entire tympanic membrane area was calculated using the 'Image meter app'

## Methodology:

Ethical clearance to conduct the research is sought and obtained from ethical review committee (ERC)

as per national ethical guidelines. Those patients >18 years presenting in OPD with unilateral/bilateral COM inactive mucosal type with dry ear for at least 6 weeks are selected.

Prior to starting the study, all recruits are explained the nature of the study and informed consent is taken. Detailed history of the patient about the onset, duration and progression of the disease is taken along the lines of the preformed questionnaire. Systemic examination of the patient is done. Ear is examined carefully with the help of an otoscope to determine the size, site of perforation, type of COM, presence of discharge. Otoendoscopy is performed for calculation of exact size and determine site of tympanic membrane perforation in mm<sup>2</sup>. Pure tone audiometry is performed. Analysis of data and evaluation of hearing loss is done.

### Classifications Of Perforation -

Classification of perforation on the basis of size: [5]

1. Group I (small) - area in range of 0-8 mm<sup>2</sup>
2. Group II (medium) - area in range of 8.1-30 mm<sup>2</sup>
3. Group III (large) - area in the range  $\geq 30.1$  mm<sup>2</sup>

Calculation of Percentage of perforation =  $P/T \times 100\%$ ,

(Where P is the area (in cm<sup>2</sup>) of the TM perforation and T is the total area (in cm<sup>2</sup>) for the entire TM (including the perforation) calculated by image meter app.

Assuming the total area of the TM to be 90 mm<sup>2</sup>

Area of perforation in mm<sup>2</sup> =  $90 \times \text{percentage perforation}/100$ .

Classification of perforation on the basis of site: [5]

Anterior – perforations occupying area only anterior to the handle of malleus on the pars tensa

Posterior – perforations occupying area only posterior to the handle of malleus on the pars tensa

Central – perforations occupying area on either side of the handle of malleus on the pars tensa.

WHO Classification of hearing loss- [4]

1. No hearing loss -  $\leq 25$  dB
2. Mild – 26 – 40 dB
3. Moderate - 41- 60 dB
4. Severe – 61 – 80 dB

5. Profound -  $> 81$  dB

### Results –

1. Age distribution- Ranges from 19-79 years with a mean age of 51.18 years. Commonest age group was 51-60 years (12 cases)
2. Sex distribution - 15 cases were male and 35 cases were female (1:2.33)
3. Laterality - Right ear was affected in 22 cases, left ear in 15 cases while bilateral disease was seen in 13 cases
4. Symptoms - The most common history given by our patients were non- foul smelling ear discharge present in all the cases (43 mucoid and 7 mucopurulent) followed by hearing loss in 45. Discharge was moderate in case of 43 patients and remaining had profuse discharge. Patients complaining of hearing loss were classified into mild, moderate and severe according to their inability to hear whispers, normal conversations and loud voice. We had maximum patients who had severe hearing loss (18 cases).
5. Laterality of hearing loss - 12 patients had exclusive right sided hearing loss, 20 patients had left ear hearing loss and 13 patients had bilateral hearing loss.
6. Site of perforation - Most of the patients had central perforation (19 cases), followed by Anterior (15 cases) Anterior perforation = Lies anterior to Handle of malleus (AI, AS, AI+AS) Posterior perforation = Lies posterior to Handle of malleus (PS, PI, PS+PI) Central perforation = Lies both anterior and posterior to Handle of malleus (AI+PI, AS+AI+PI, AI+PS+PI, Subtotal)
7. Size of perforation - In our study, most patients were found to have moderate size of perforation with 27 cases followed by large sized perforation with 15 cases. Group I – Size of perforation  $< 8$  mm<sup>2</sup> Group II – Size of perforation 8-30 mm<sup>2</sup> Group III – Size of perforation  $> 30$  mm<sup>2</sup>
8. Tuning fork tests - Negative Rinne's was found in all the cases. Weber's test was found to be lateralized towards Left side in 28 cases.
9. Size of perforation & mean hearing loss- The mean hearing loss was maximum in Grade III i.e., Large Perforation which is 33.86 dB followed by moderate (23 dB) and then small perforation. This finding is along the lines of previous studies where loss of hearing is proportional to the increase in size of perforation. (Table 1)

TABLE 1 – SIZE OF PERFORATION WITH PURE TONE THRESHOLD AND A-B GAP		
SIZE OF PERFORATION	MEAN THRESHOLD	MEAN A-B GAP
I	35.3	15.375
II	51.3	23
III	63.7	33.86

1. Group I – Size of perforation <8mm<sup>2</sup>
2. Group II – Size of perforation 8-30 mm<sup>2</sup>
3. Group III – Size of perforation >30mm<sup>2</sup>

Size of perforation and frequency loss - In our study, the loss was minimum at 2kHz whereas maximum loss was at higher frequencies. This is expected due to fundamental frequency of vibration of the human Tympanic membrane which is 2000 Hz. (Table 2)

TABLE 2– SIZE OF PERFORATION WITH FREQUENCY OF HL					
FREQUENCY	250 Hz	500 Hz	1kHz	2kHz	4kHz
GRADE OF PERFORATION					
I	15	13.1	13.125	13.75	21.85
II	21.85	21.66	24.44	20.55	29.29
III	34	34	33	28	39.66

1. Group I – Size of perforation <8mm<sup>2</sup>
2. Group II – Size of perforation 8-30 mm<sup>2</sup>
3. Group III – Size of perforation >30mm<sup>2</sup>

Site of perforation mean hearing loss - The AB gap was largest in central perforation (31.89) as compared to anterior (21.187) and posterior perforations (20.4). (Table 3)

TABLE 3 – SITE OF PERFORATION & MEAN HL		
SITE	THRESHOLD	A-B GAP
CENTRAL	62.74	31.89
POSTERIOR	49.184	20.4
ANTERIOR	43.45	21.187

Site of perforation with frequency of hl - A-B gap was minimum at 2 kHz and greater in higher frequencies. (Table 4).

TABLE 4– SITE OF PERFORATION WITH FREQUENCY LOSS
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FREQUENCIES	250 Hz	500 Hz	1kHz	2kHz	4kHz
SITE					
CENTRAL	31.57	31.57	32.10	27.89	36.31
POSTERIOR	19.68	19.37	20.93	19.06	26.87
ANTERIOR	20.33	19.33	21	17.33	24

Anterior perforation = Lies anterior to Handle of malleus (AI, AS, AI+AS) Posterior perforation = Lies posterior to Handle of malleus (PS, PI, PS+PI)

Central perforation = Lies both anterior and posterior to Handle of malleus (AI+PI, AS+AI+PI, AI+PS+PI, Subtotal)

Type of hearing loss – Only 2 patients have pure conductive hearing loss and 48 patients had mixed hearing loss. The sensorineural component appears to be due to large number of elderly patients included in our study most likely suffering from presbycusis.

Intensity of hearing loss - Hearing loss ranged from 15-42 dB in our study. According to WHO classification, most patients (18 cases) had mild HL and followed by severe HL.

## Discussion

The main focus of this study was to determine the hearing loss caused by the type of perforation of tympanic membrane in COM inactive mucosal disease without complications. 50 patients (age 18-80) were subjected to detailed clinical examination. The size and site of the perforation was mentioned via otoendoscopic examination. The pure tone audiometry was performed in all patients to determine Pure Tone Threshold and A-B Gap. This study was used to determine which frequencies showed the maximum loss due to the perforation.

The most common age group affected was 51-60 years but most of the studies (e.g. Ali AH et al) found that most common age group presenting with COM are 21-30 years of age [6]. Handi et al who found most of their cases concentrated in age group 11-20 years [7] likely due to the fact that we have patients with elderly age groups (50 -78 years) derived from retired population of township created by the steel manufacturing company related to our hospital.

The distribution of patient population according to the sex in our study was female predominant (1:2.33). Similar results were obtained by Bhusal et al where females (19 cases) were more than males (16 cases) [8]. According to the study conducted by Promod Kharadi et al, there is male predominance [9]

Left ear was found to be affected the most followed by right side ear and bilateral disease. Ibekwe et al showed similar results with most cases having left ear disease, followed by right & bilateral [10]. However, Ediale et al showed preponderance to Right ear disease [11]

The most common history in our study was ear discharge followed by hearing loss. Patients who presented with ear pain, giddiness, facial weakness or tinnitus were not included. It is very similar to study by Nahata et al where all the patients had history of ear discharge [5] whereas in study conducted by Pannu et al, hearing loss was the most common symptom. [12]

Rinne's was negative and Weber's was lateralized in all the cases. These findings are similar to those of Rafique et al where Rinne's was negative in all cases and Weber's lateralized in as many as 90% cases and undefined Weber's in 10% cases [13]. Nepal et al found the Rinne's test to be negative in all cases with hearing loss >25 dB. [14]

Only 2 patients have pure conductive hearing loss and the rest mixed hearing loss. The sensori- neural component of these 48 patients may be due to long standing disease causing insult to cochlea due to bacterial toxins or presbycusis.

Most of the cases belong to the Group II i.e; Moderate size perforation. These findings were very much similar to the study conducted by Raghujii et al, where they found the maximum cases in the Group II [15]



Regarding the variation of hearing loss with size of perforation, our study produced similar conclusion as the most of the studies that degree of hearing loss is directly proportional to the size of tympanic membrane perforation. We found a loss of 33.86 dB for Group III (Large perforation) followed by a 23 dB loss in Moderate size perforation (Group II) and 15.375 dB loss in small perforation. Nahata et al, Herkel et al, Kumar et al, Pannu et al all provided similar results of linear relationship. [5,16,19,20]

In our study, most of the cases had central perforation whereas in the study conducted by Vaidya et al majority of cases are seen in AI site of tympanic membrane (22 cases), then PI with 19 cases. [21]

Variation with frequency Loss – In our study we found that hearing loss was lowest in 2 kHz for all sites of perforations whereas loss was more at higher frequencies i.e at 4kHz. Also hearing loss was more in central perforation than anterior and followed by posterior perforation. Unlike ours, in the study conducted by John et al, loss was more at lower frequencies for all three sites – anterior, posterior and central perforation. [22]. Similarly in the study done by Dawood et al, the lower frequencies were affected more than higher.

Aneesa M et al [23] concluded that the hearing loss increased with size of perforation & posterior location of the perforation. Iziki O showed that the locations of TM perforation has no correlation with the magnitude of hearing loss but is dependent on the size of the perforation [24]. Park et al showed that the mean A-B gap increased as the size of perforation increased [25] Dessai et al found that maximum loss was in large central perforation and minimum loss in pin hole type [26] Alsarhan et al concluded the hearing loss increased with size of perforation and more in posteroinferior quadrant. [27] Lerut et al concluded that a linear relationship exists between size of perforation and conductive hearing loss. Involvement of umbo at the perforation margin worsens hearing by 5-6 dB, whereas site itself doesnot play a role. [28] Anil HT et al concluded that most of the patients had low frequency conductive hearing loss directly related to the size of perforation. Posterior quadrant perforations have more loss. [29] Bianca N et al [30] showed that, higher losses being recorded on lower frequencies and increase with the

increase of perforation size in case of perforations affecting more than 10% of TM surface.

## Conclusion

COM inactive mucosal disease was found to be more common in females and in 51-60 years of age group. Left ear disease was more common than Bilateral and Right disease. History of Otorrhoea was the most common symptom found among these patients.. Most of the cases had moderate size perforation. The range of hearing loss was about 15 to 42 dB. Maximum loss of hearing was seen in Large (Group III) perforation followed by Moderate size (Group II) and Small (Grade I) perforation in that order. Central perforations are more common and showed greater hearing loss than anterior/posterior perforation. For all three grades of perforation maximum loss is seen at 4 kHz and minimum at 2 kHz.

## Conflict

We wish to confirm that there are no known conflicts of interest associated with this publication.

## Acknowledgement

I'm grateful to Dr. Neeta Sharma for valuable guidance given to me during this work. I express my gratitude towards her enthusiastic support and meticulous supervision. I would like to thank Dr. Prachi Mene & Dr. Ashwin A. Jaiswal for supervising, and giving cooperation despite their busy schedule. I'm thankful to all the OT and library staff for their support. I'm thankful to my parents for their unconditional support. I bow before almighty God for his blessings. I'm thankful to all the researchers for providing with the very valuable literature.

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