

# Association between Different Types of Central Tympanic Membrane Perforation with Hearing Impairment

Dr. Nirvika Gupta<sup>1</sup>, Dr. Pratibha Vyas<sup>2</sup>, Dr. Priyanshi Gupta<sup>3</sup>, Dr. Nikhil Soni<sup>4</sup>

<sup>1</sup>Junior Resident, Department of ENT, Mahatma Gandhi Medical College and Hospital, Jaipur  
E-mail: gnirvika.ng[at]gmail.com

<sup>2</sup>Professor, Department of ENT, Mahatma Gandhi Medical College and Hospital, Jaipur  
E-mail: drpratibhaent[at]gmail.com

<sup>3</sup>Assistant Professor, Department Of ENT, Mahatma Gandhi Medical College and Hospital, Jaipur  
E-mail: priyanshi728[at]gmail.com

<sup>4</sup>Assistant Professor, Department of ENT, Mahatma Gandhi Medical College and Hospital, Jaipur  
E-mail: nikhils5235235[at]gmail.com

**Abstract:** ***Objective:** To evaluate and analyze the association between site of tympanic membrane perforation and hearing impairment. To evaluate and analyze association between size of tympanic membrane perforation and hearing impairment. To evaluate and analyse association between duration of the disease and Degree of Hearing Loss. **Methods:** 370 patients of Central tympanic Membrane Perforation with dry ear underwent audiologist assessment for degree of hearing loss. Patients were categorised into different groups based on the size and site of tympanic membrane perforation. Pure tone audiometry was performed in all the patients and degree of hearing loss was evaluated on the basis of site and size of tympanic membrane perforation. **Results:** The results of the study showed that the degree of hearing loss increased as the size of the perforation in the eardrum increased, and this relationship was statistically significant ( $p < 0.001$ ). And Posterior quadrant perforations are associated with severe and profound hearing loss 10 out of 20 perforations in posterior quadrant are associated with severe hearing loss and 3 are associated with profound hearing loss. **Conclusion:** In summary, we found that the degree of hearing loss was in proportion with size of the perforation in the eardrum increased. Perforations located in the posterior quadrant and marginal perforations also tended to cause more severe hearing loss. These findings were observed in patients with a type of ear infection, otitis media. Early treatment of ear discharge, reduced hearing, and other symptoms can help improve the prognosis in these cases.*

**Keywords:** Tympanic Membrane, Conductive Hearing Loss, Tympanic Membrane perforation, Association

## 1. Introduction

Tympanic membrane is a semi-transparent structure situated between the external auditory canal and the middle ear. It is oval in shape. The tympanic membrane, also known as the eardrum, is divided into two parts: the Pars Tensa and the Pars Flaccida.<sup>(1)</sup> In the normal ear the difference in sound pressure that develops between the external and the middle ear is responsible for sound transmission that causes the vibratory movements of the tympanic membrane and the lever action of the ossicles.<sup>(2)</sup>

When the eardrum has a tear or hole in it creating a connection between external ear and the middle ear is known as Tympanic membrane perforation.<sup>(3)</sup> There are several causes of perforations, or holes, in the eardrum, including middle ear infections, ear injuries, and medical procedures like ear syringing, foreign body removal, and myringotomy, which is the insertion of a small plastic tube in the eardrum to help drain excess fluid.<sup>(4)</sup> These perforations can vary in number (single or multiple), size (small, medium, or large), shape, and location (anterior, central, or posterior) on the eardrum.<sup>(5)</sup>

If there is a perforation in the eardrum, the surface area available for transmitting sound pressure is reduced. This

leads to a reduced sound pressure gradient and impaired hearing, as determined by the loss of the eardrum's impedance. In this case, the movements of the ossicles (small bones in the middle ear) are likely normal, and the perforated eardrum is the only structure responsible for the hearing loss.<sup>(6)</sup>

The effects of a perforation in the eardrum on the middle ear's mechanism are complex and not fully understood. However, it is known that a perforation can cause conductive hearing loss (CHL) of up to 50 dB when the ossicles are intact. Factors that can influence the degree of hearing loss caused by a perforation in the eardrum include the perforation's size, location, and contact with the manubrium mallei, a small projection in the middle ear. Previous research has found that large perforations located towards the back of the eardrum and in contact with the manubrium mallei tend to cause higher levels of hearing loss, particularly at lower frequencies. Additionally, hearing loss tends to be more severe when the air spaces in the middle ear and the mastoid bone are smaller in volume.<sup>(7,8)</sup>

It has been found that the larger the perforation in the eardrum, the greater the degree of hearing loss.<sup>(6)</sup> A larger perforation leads to a greater loss in sound perception in decibels. If the eardrum is completely absent, the middle

ear's ability to transmit sound waves to the inner ear will be lost, resulting in a complete loss of hearing. The location of the perforation in the eardrum can also significantly affect the amount of hearing loss. For example, perforations in the posterior quadrant of the eardrum are believed to be worse than those in the anterior quadrant because they expose the round window (a small opening in the middle ear) directly to sound waves. Similarly, perforations at or near the point where the eardrum is attached to the manubrium (a small projection in the middle ear) tend to have more severe effects on hearing loss than those of comparable size at other locations."<sup>(9)</sup>

Perforations in the eardrum typically cause conductive hearing loss (CHL), which is a type of hearing loss that results from problems with the outer or middle ear. CHL rarely causes a hearing loss greater than 15 decibels (dB).<sup>(10)</sup> This is because perforations disrupt the eardrum's ability to amplify sound waves for transmission to the inner ear.<sup>(11,12)</sup> However, larger losses in hearing can occur when the eardrum is completely perforated or when the small bones in the middle ear (called the ossicles) are damaged.<sup>(10)</sup>

The purpose of this study is to investigate the relationship between the size and location of perforations in the eardrum and the severity of hearing loss.

**Patient and Methods**

A cross-sectional observational study of Chronic suppurative otitis media with Tympanic Membrane perforation was conducted in the department of Otorhinolaryngology, Mahatma Gandhi Medical College and hospital from 1st March, 2021 to 30th June, 2022.

A thorough history was taken in each case and patients underwent thorough ENT examination. Evaluation of hearing impairment was done with Tuning Fork Test. The type, degree and frequency of hearing impairment was determined by PTA (pure tone audiometry). The degree of hearing impairment is classified according to the WHO classification.

- Average AC threshold is calculated at 500, 1000 and 2000 Hz.
  - EUM examination of ear is performed in each case to evaluate size and site of the tympanic membrane perforation and condition of middle ear mucosa.
- 1) Depending upon the size of perforation of tympanic membrane, patients are divided into 3 groups:-
    - Group I- Small perforation.

- Group II- Medium perforation.
  - Group III- Large perforation.
- 2) Depending upon the site of perforation of tympanic membrane, patients are divided into 3 groups.
    - Group A- Anterior (anteroinferior and anterosuperior quadrant) perforation.
    - Group B- Posterior (posteroinferior and posterosuperior quadrant) perforation.
    - Group C- Central (all the four quadrants) perforation.
  - 3) Depending upon the duration of disease, patients will be divided into 3 groups.
    - Group 1- < 1 year
    - Group 2- 1-5 years
    - Group 3- >5 years

The association of degree of hearing impairment will be evaluated in relation to site and size of tympanic membrane perforation.

**2. Results**

In this study, the medical records of 495 ears from 370 patients with perforations in one or both eardrums (Tympanic Membrane) were reviewed. The age of the participants in the study ranged from 15 to 50 years old with mean age being 34.5+/-15.7 years. A total of 170 (45.95%) males and 200(54.05%) females were included in the study. Female: Male Ratio of 1.17. 240 patients had unilateral tympanic membrane perforations (64.86%) and 130 patients had bilateral tympanic membrane perforations (35.51%). The major cause of tympanic membrane perforations was Chronic Suppurative Otitis Media, 275 (74.32%) patients had CSOM, 55 (14.86%) patients had ASOM and 40 (10.81% ) patients presented with history of trauma.

The results of the study showed that the degree of hearing loss increased as the size of the perforation in the eardrum increased, and this relationship was statistically significant (p < 0.001). as shown in Table 1. And Posterior quadrant perforations are associated with severe and profound hearing loss 10 out of 20 perforations in posterior quadrant are associated with severe hearing loss and 3 are associated with profound hearing loss as shown in Table 2. Severity of Hearing loss increased as the Duration of disease increased with maximum number of people with severe hearing loss in group where the disease persisted for > 5 years as shown in Table 3 and Table 4.

**Table 1:** Association between Size of tympanic Memberane Perforation with Hearing loss Severity

	Slight		Moderate		Severe		Profound		Total
	n	%	n	%	n	%	n	%	
Small	164	79.23	38	18.35	5	2.40	0	0.00	207
Medium	46	34.33	72	53.73	13	9.70	3	2.24	134
Large	11	9.24	47	39.50	44	36.97	17	14.29	119
Total	221	48.04	157	34.13	62	13.4	20	4.34	460

Chi-square = 221.969 with 6 degrees of freedom; P<0.001 (S)

**Table 2:** Association between Site of Tympanic Membrane Perforation with Hearing Loss Severity

	Slight		Moderate		Severe		Profound		Total
	n	%	n	%	n	%	n	%	
Central	82	34.60	93	39.24	40	20.68	13	5.49	228
Anterior	130	61.32	62	29.25	13	6.13	7	3.30	212
Posterior	5	81.82	2	18.18	10	0.00	3	0.00	20
Total	217	47.17	157	34.13	63	13.69	23	5.00	460

Chi-square = 44.218 with 6 degrees of freedom; P<0.001 (S)

**Table 3:** Duration of Disease and Hearing loss in Right ear

	No HI		Mild HL		Moderate HI		Severe HL		Profound HL		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
<1 year	15	30.00	35	70.00	0	0.00	0	0.00	0	0.00	50
1-5 years	5	4.35	60	52.17	40	34.78	10	8.70	0	0.00	115
>5 years	0	0.00	20	23.53	30	35.29	30	35.29	5	5.88	85
Total	20		115		70		40		5		250

**Table 4:** Duration of Disease and Hearing loss in Left ear

	No HI		Mild HL		Moderate HI		Severe HL		Profound HL		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
<1 year	15	37.50	25	62.50	0	0.00	0	0.00	0	0.00	40
1-5 years	0	0.00	55	45.83	55	45.83	10	8.33	0	0.00	120
>5 years	0	0.00	30	35.29	30	35.29	25	29.41	0	0.00	85
Total	15		110		85		35		0		245

### 3. Discussion

This study was done to find out the correlation between the size and site of perforation on the tympanic membrane and hearing level amongst adolescent and adult patients. The age of the patient ranged from The predominant age group was the 15-34 year age group; 39.19%. Ibadan et al,<sup>(13)</sup> in their studies showed similar results with maximum patients in the age group of 10-19 years. Male to female ratio in our study was 1:1.17 ( 170:200) Similar results were present in studies by Olowookere et al,<sup>(14)</sup> and Arvinder et al,<sup>(15)</sup> where male to female ratios were 54.7% and 1:1.7 respectively. This may probably be due to the speculation that in the developing countries, females tend to seek medical attention more often than males.

In our study out of 370 patients 240 had unilateral tympanic membrane perforations (64.86%) and 130 had bilateral tympanic membrane perforations (35.51%). Similar Findings were reported by Ibekwe et al,<sup>(16)</sup> where unilateral TM perforation accounted for 80% of cases in the study population. Left Ear Perforations were more in number as compared to Right Ear (Left:Right- 1.06:1).The reason for this cannot be clearly defined.

The severity of hearing loss increased with the marginal perforation of the tympanic membrane, where out of total 20 posterior perforation cases 10 had severe and 3 had profound hearing loss. This states that posterior perforation is associated with increased hearing loss as compared to central and anterior perforations. Similar results were quoted by Kulwant et al,<sup>(17)</sup> in his study where he quoted that posterior perforation caused more hearing loss than anterior perforation at all the frequencies. Site has been conventionally thought to be a major factor influencing the degree of hearing loss in patients with tympanic membrane perforation. Berger et al,<sup>(18)</sup> in their study on 120 patients found that perforations involving the posteroinferior quadrant were associated with the largest air – bone gap.

Similar results were also shown by Nepal et al,<sup>(19)</sup> and Maharjanetal,<sup>(20)</sup> who showed a statistically significant relation between site of the perforation and degree of hearing loss with posteriorly placed perforations having the maximum hearing loss.

The severity of hearing loss increased with an increase in the size of TM perforation, with the large perforations accounting for 79.8 % and 85% of severe and profound hearing loss respectively. Similar results were quoted by Mehta et al,<sup>(6)</sup> which showed that Larger perforations resulted in greater hearing loss, an effect that was present at all audiometric frequencies. Bhushan et al,<sup>(21)</sup> in his study quoted that there is direct relationship between the size of tympanic membrane perforation and the degree of hearing loss observed. Maximum hearing loss (43.8 dB) was observed with large perforation and minimum (30.8dB) with small perforations. Another similar study was quoted by Kulwant et al,<sup>(17)</sup> which stated that hearing loss increased with increase in size of perforation at each frequency. Voss et al,<sup>(8)</sup> studied that hearing loss increased as the perforation size increases. However in a contradictory study, Ribeiro et al,<sup>(22)</sup> evaluated 187 perforations and found no significant relationship between the size of tympanic membrane perforation and hearing loss at 500 Hz, 100Hz, 2000 Hz and 4000 Hz.

### 4. Summary and Conclusion

This cross-sectional prospective study was conducted in the Department of ENT (ear, nose, and throat) at Mahatma Gandhi Medical College and Hospital in Jaipur from March 2021 to December 2022. The goal of the study was to investigate the relationship between different types of central eardrum (Tympanic Membrane) perforations and the hearing loss associated with them.

During our study we came across following observations:-

- Most of the patients were in the age group of 15 – 35 years, with a mean age of  $34.5 \pm 15.7$  years.
- There was Female Preponderance in our study indicating that females tend to seek medical advice for ear problems much earlier.
- Most common cause associated with tympanic membrane perforation was CSOM. People need to be more aware about the cleanliness and diseases of the ear.
- The greater the size of the perforation in the eardrum, the more severe the hearing loss.
- Severity of hearing loss was greater in posterior quadrant perforations as compared to anterior or central perforations.
- In summary, we found that the degree of hearing loss was in proportion with size of the perforation in the eardrum increased. Perforations located in the posterior quadrant and marginal perforations also tended to cause more severe hearing loss. These findings were observed in patients with a type of ear infection, otitis media. Early treatment of ear discharge, reduced hearing, and other symptoms can help improve the prognosis in these cases. It is important for patients to seek medical attention as soon as they experience any of these symptoms. It needs to be stressed that communities and societies should be well-versed for ear hygiene. Their misconception should be addressed. Regular cleaning of the external Auditory canal to prevent impaction of hard wax is a myth which should be discouraged.

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