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# Pre Op PTA & HRCT as prediction of ossicular chain status among CSOM patients: An Observational Study

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**Abstract:** **Background:** Chronic Otitis Media (COM) is a prevalent condition associated with varying degrees of hearing loss, often due to ossicular chain damage. Pure Tone Audiometry (PTA) is routinely used to assess hearing impairment; however, its correlation with intraoperative ossicular status remains crucial for preoperative planning. **Aim:** To evaluate the correlation between Pure Tone Audiometry findings and ossicular chain status in patients with Chronic Otitis Media. **Materials and Methods:** A prospective observational study was conducted on 183 patients diagnosed with COM. Preoperative PTA was performed to assess hearing thresholds and type of hearing loss. Intraoperative findings regarding ossicular integrity were recorded during tympanoplasty or mastoid surgery. Statistical correlation was analyzed between PTA findings and ossicular status. **Results:** Among 183 patients, 62.3% had intact ossicular chain, while 37.7% showed ossicular discontinuity. Overall ossicles status was normal among 59(52.7%) mild CHLM 36(32.1%) moderate CHL patients and 8(7.1%) among Moderately Severe CHL. Eroded among 9(8.0%) Moderate CHL patients. There was a statistically highly significant difference found in ossicle status in CT according to severity of PTA among mucosal ear patients. (P=0.001) Ossicular erosion was significantly higher in unsafe COM compared to safe COM, indicating the aggressive nature of cholesteatoma-related disease. There was a statistically significant difference found in ossicles status between squamosal and mucosal patients. (P<0.05). Increasing air-bone gap (ABG) was significantly associated with ossicular erosion ($p < 0.001$). Patients with ABG >40 dB predominantly had multiple ossicular involvement. **Conclusion:** PTA findings, particularly air-bone gap, serve as a reliable predictor of ossicular status in COM. This correlation aids in surgical planning and patient counseling.

**Keywords:** Chronic Otitis Media, Pure Tone Audiometry, Ossicular Chain, Hearing Loss, Air-Bone Gap.

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## INTRODUCTION

Chronic Otitis Media (COM) remains one of the most common causes of preventable hearing loss, especially in developing countries [1]. It is characterized by persistent inflammation of the middle ear cleft, often leading to tympanic membrane perforation and ossicular damage [2].

The ossicular chain—comprising malleus, incus, and stapes—plays a vital role in sound transmission. Chronic infection can result in ossicular erosion, most commonly affecting the incus due to its tenuous blood supply [3,4].

All the ossicles including the incus, malleus, and stapes, either individually or in combination can be affected in COM. Among all the ossicles, the long process of incus is most susceptible for erosion. The second most common defect is the simultaneous loss of the incus along with erosion of the supra structure of stapes. Erosion of the ossicular chain significantly impairs disruption of sound transmission to oval window [5].

Ossicular erosion or discontinuity can only be definitively identified during surgical exploration, to avoid surprises about ossicular status at OT table, knowledge about is desirable status of the ossicular chain pre operatively. This information allows the

surgeon to prepare in advance for potential ossicular reconstruction by arranging the necessary surgical instruments, prosthetic materials, and other required resources [5]. Preoperative evaluations such as pure tone audiometry (PTA), speech testing, and imaging studies (including X-rays mastoid and high-resolution computed tomography temporal bone [HRCT]) are instrumental in assessing the patient's residual hearing capacity and the anatomical condition of the middle ear structures [6].

Pure Tone Audiometry (PTA) is a non-invasive and widely used diagnostic tool to evaluate hearing loss. It provides information regarding the degree and type of hearing impairment, including conductive, sensorineural, or mixed hearing loss [7]. Pure tone audiometry is a fundamental clinical procedure used to evaluate an individual's hearing sensitivity by determining the hearing threshold for pure tones at different frequencies. The process involves both precise technical measurement and careful clinical interpretation.

Understanding the correlation between PTA findings and ossicular status can help surgeons anticipate intraoperative findings, choose appropriate surgical techniques, and counsel patients regarding prognosis [7,8].

Thus, identifying ossicular status via PTA enables surgeons to anticipate the need for ossicular reconstruction (ossiculoplasty), counsel patients regarding prognosis, and plan surgical strategies. Also, preoperative audiometry can prioritize cases needing extensive intraoperative assessment, particularly in resource-limited settings or where advanced imaging (e.g., HRCT Temporal) is inaccessible. With the above background, the present study was conducted at a tertiary care centre to assess the correlation of pure tone audiometry findings with ossicular status in chronic otitis media.

## MATERIALS AND METHODS

The present study was conducted as a facility based cross-sectional observational study on all 183 new patients of Chronic otitis media undergoing surgery at ENT Department of People's Hospital during the study period of 20 months i.e. from 1st May 2024 to 31st December 2025. Ethical approval was obtained from the Institute's ethical committee and written consent was obtained from all the study participants in consent form after explaining to them the nature and purpose of study using participant information sheets.

### Study variables

- Independent variable: Age, sex, demography, type of Chronic otitis media.
- Dependent variable: Duration of chronic otitis media, Pure tone audiometry, ossicular status in chronic otitis media

### Inclusion criteria

- All new patients of chronic otitis media planned for surgery at the ENT Department of People's Hospital.
- Patients between 7 to 65 years of age.

### Exclusion criteria

- Previous history of ear surgery.
- Patients less than 7 years and more than 65 years of age.
- Patients who are diagnosed as SNHL more than 30dB.

### Data Collection Procedure

After obtaining ethical clearance from the Institute's ethical committee, all the patients satisfying the inclusion criteria were enrolled and a thorough history was obtained using proforma. Following this, clinical examination was done in detail and findings were documented in proforma. The patients included in the study underwent pure tone audiometry to record hearing threshold for bone conduction and air conduction at 500 Hz, 1000Hz, 2000 Hz in each ear. Pure tone average and air bone gap was calculated in each ear for every patient. Patients with active ear discharge were given topical and systemic antibiotics and pure tone audiometry was done after the active infection and ear discharge was subsided. All patients underwent PTA using the same audiometer, performed by the same audiologist in a sound proof room (Company-ALPS, Model no.- AD2100 and frequency -150Hz to 8000Hz). The result of the testing was recorded and printed on a graph called an audiogram.

Masking was done in all cases for bone conduction and for air conduction, only if air bone gap will be more than 40dB. PTA of more than 25dB for bone conduction was considered as sensorineural hearing loss. An air bone gap of more than 10dB was considered as conductive hearing loss. Presence of both was considered as mixed hearing loss.

All patients were then scheduled for surgery and during the surgery, ossicles were assessed through direct visualization under operative microscope and presence of granulation or fibrosis was documented. Ossicular discontinuity was defined as visualization of a disconnected or absent part of the ossicular chain.

### Statistical Analysis

The data was collected in proforma and entered in MS Excel 2007 workbook. Statistical analysis was done using a statistical package of social science [SPSS-26.0] software. Descriptive analysis was done and data was expressed as frequency and proportions or

mean and standard deviation. Association of type of COM with various variables and association of ossicular status on HRCT temporal scan and surgical exploration with severity of hearing loss was done using chi square test. P value of less than 0.05 was considered significant.

## RESULTS

Out of 183 patients, 71 were squamous COM and 112were mucosal COM. Out of 183 ears, 84 right ear, 78 left year and 21both the ears were affected. 100 right ear and 83 left ear were operated. COM were present among 98 male and 85 female. 102 were from rural localities and 81 from urban areas. 130 were of lower class and 53 were of middle class. Out of 183 were, 54 were 11-20 years old, 58 were 21-30 years old, 41 were 31-40 years old, 21 were 41-50 and 9 were more than 50 years old. Mean age was 28.30±10.5 and mean symptom duration was 5.46 years.

Table 1 reveals disease Status of Affected Ear. Out of 183 patients, 130 had central perforation, 4 had attic perforation, 19 had PSQ retraction, 11 had attic retraction and 19 had retraction. Table 2 reveals PTA finding according to type of COM. Out of 71 squamosal COM patients, 12(6.6%) had mild hearing loss, 44(24.3%) had Moderate CHL, 7(3.9%) had Moderately Severe CHL, 6(3.3%) had mixed HL and 2(1.1%) had severe hearing loss. Out of 112 mucosal patients, 59(32.6%) had mild hearing loss, 45(24.9%) had Moderate CHL, 8(4.4%) had Moderately Severe CHL. Mixed and severe hearing loss were not found in mucosal COM patients. There was a statistically highly significant difference found in PTA between safe & unsafe ear patients. (P=0.001)

Table 3 reveals Ossicles status in CT according to type of COM. Out of 183 patients, 114(62.3%) had normal ossicles and 69(37.7%) had eroded ossicles. Malleus were normal among 165(90.2%), eroded among 17(9.3%) and absent among 1(0.5%). Incus were normal among 113(61.7%), eroded among 52(28.4%) and absent among 18(9.8%). Stapes Supra structure were normal among 176(96.2%) and absent among 7(3.8%). There was a statistically significant difference found in ossicles status between squamosal and mucosal patients. (P<0.05).

Table 4 reveals Ossicles status during operation according to type of COM. During operation Malleus were normal among 165(90.2%), eroded among 17(9.3%) and absent among 1(0.5%). Incus were normal among 112(61.2%), eroded among 53(29.0%) and absent among 18(9.8%).Stapes Supra structure were normal among 175(95.6%) and absent among 8(4.4%). There was a statistically significant difference found in ossicles status between squamosal and mucosal patients. (P<0.05)

Table 5 reveals ossicles status in CT according to severity of PTA among squamosal ear patients. Overall ossicles status was normal among 11(15.5%) moderately severe CHL patients. Eroded among 12(16.9%) mild, 33(46.5%) among Moderate CHL, 7(9.9%) among Moderately Severe CHL, 6(8.5%) among Mixed HL and 2(2.8%) among Severe HL patients. There was statistically not significant difference found in ossicle status in CT according to severity of PTA among squamosal ear patients. (P=0.092

Table 6reveals ossicles status in CT according to severity of PTA among mucosal ear patients. Overall ossicles status was normal among 59(52.7%) mild CHL 36(32.1%) moderate CHL patients and 8(7.1%) among Moderately Severe CHL. Eroded among 9(8.0%) Moderate CHL patients. There was a statistically highly significant difference found in ossicle status in CT according to severity of PTA among mucosal ear patients. (P=0.001)

**Table-1: Disease Status of Affected Ear**

| **Disease Status**<br>**Affected Ear** | **Number**<br>**N=183** | **Percentage (%)** |
|---|---|---|
| Central perforation | **130** | **71.0** |
| Attic perforation | **4** | **2.2** |
| PSQ Retraction | **19** | **10.4** |
| Attic Retraction | **11** | **6.0** |
| Retraction | **19** | **10.4** |

**Table-2: PTA finding according to type of COM**

| **PTA** | **COM** | | **Total** |
|---|---|---|---|
| | **Squamous (Unsafe Ear)** | **Mucosal (Safe Year)** | |
| Mild | 12(6.6%) | 59(32.6%) | 71(39.2%) |
| Moderate CHL | 44(24.3%) | 45(24.9) | 89(49.2%) |
| Moderately Severe CHL | 7(3.9%) | 8(4.4%) | 15(8.3%0 |
| Mixed HL | 6(3.3%) | 0(0.0%) | 6(3.3%) |
| Severe | 2(1.1%) | 0(0.0%) | 2(1.1%) |
| Chi Square Value | 31.590 | | |
| P Value | 0.001(HS) | | |

**Table-3: Ossicles status in CT according to type of COM**

| Ossicles status | COM | | Total | Chi Square Value | P value |
|---|---|---|---|---|---|
| | Squamous (Unsafe Ear) | Mucosal (Safe Year) | | | |
| **Overall** | | | | | |
| Normal | 11(6.0%) | 103(56.3%) | 114(62.3%) | 108.186 | 0.001(HS) |
| Eroded | 60(32.8%) | 9(4.9%) | 69(37.7%) | | |
| Malleus | | | | | |
| Normal | 59(32.2%) | 106(57.9%) | 165(90.2%) | 7.025 | 0.030(S) |
| Eroded | 11(6.0%) | 6(3.3%) | 17(9.3%) | | |
| Absent | 1(0.5%) | 0(0.0%) | 1(0.5%) | | |
| Incus | | | | | |
| Normal | 9(4.9%) | 104(56.8%) | 113(61.7%) | 119.469 | 0.001(HS) |
| Eroded | 48(26.2%) | 4(2.2%) | 52(28.4%) | | |
| Absent | 14(7.75%) | 4(2.2%) | 18(9.8%) | | |
| Stapes Supra Structure | | | | | |
| Normal | 64(35.0%) | 112(61.2%) | 176(96.2%) | 11.481 | 0.001(HS) |
| Eroded | 0(0.0%) | 0(0.0%) | 0(0.0%) | | |
| Absent | 7(3.8%) | 0(0.0%) | 7(3.8%) | | |

**Table-4: Ossicles status during operation according to type of COM**

| Ossicles status | COM | | Total | Chi square Value | Significance 'P' Value |
|---|---|---|---|---|---|
| | Squamous (Unsafe Ear) | Mucosal (Safe Year) | | | |
| **Malleus** | | | | | |
| Normal | 59(32.2%) | 106(57.9%) | 165(90.2%) | | |
| Eroded | 11(6.0%) | 6(3.3%) | 17(9.3%) | | |
| Absent | 1(0.5%) | 0(0.0%) | 1(0.5%) | **7.025** | **0.030(S)** |
| Incus | | | | | |
| Normal | 8(4.4%) | 104(56.8%) | 112(61.2%) | | |
| Eroded | 49(26.8%) | 4(2.2%) | 53(29.0%) | | |
| Absent | 14(7.7%) | 4(2.2%) | 18(9.8%) | **123.039** | **0.001(HS)** |
| Stapes Supra structure | | | | | |
| Normal | 63(34.4%) | 112(61.2%) | 175(95.6%) | | |
| Eroded | 0(0.0%) | 0(0.0%) | 0(0.0%) | | |
| Absent | 8(4.4%) | 0(0.0%) | 8(4.4%) | **13.197** | **0.001(HS)** |

**Table-5: Ossicles status in CT according to severity of PTA among squamosal ear patients.**

| Ossicles status | Severity of PTA | | | | |
|---|---|---|---|---|---|
| | Mild CHL | Moderate CHL | Moderately Severe CHL | Mixed HL | Severe HL |
| **Overall** | | | | | |
| **Normal** | 0(0.0%) | 11(15.5%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| **Eroded** | 12(16.9%) | 33(46.5%) | 7(9.9%) | 6(8.5%) | 2(2.8%) |
| **Absent** | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| **Chi Square Value** | **7.987** | | | | |
| **Significance 'P' Value** | **0.092(NS)** | | | | |

**Table-6: Ossicles status in CT according to severity of PTA among mucosal ear patients.**

| Ossicles status | Severity of PTA | | | | |
|---|---|---|---|---|---|
| | Mild CHL | Moderate CHL | Moderately Severe CHL | Mixed HL | Severe HL |
| **Overall** | | | | | |
| **Normal** | 59(52.7%) | 36(32.1%) | 8(7.1%) | - | - |
| **Eroded** | 0(0.0%) | 9(8.0%) | 0(0.0%) | - | - |
| **Absent** | 0(0.0%) | 0(0.0%) | 0(0.0%) | - | - |
| **Chi Square Value** | **14.571** | | | | |
| **Significance 'P' Value** | **0.001(HS)** | | | | |

## DISCUSSION

Pure tone audiometry is a common method used for hearing evaluation of patients with COM, which allows for ear-specific and frequency-specific hearing thresholds. Thus, helps in outlining the configuration of hearing loss [6,9]. The findings of PTA may help surgeons in predicting the need for ossicular reconstruction (ossiculoplasty), providing patients with prognostic advice. The present study was conducted on a total of 183 ears of patients with COM to correlate pure tone audiometry findings and ossicular status in chronic otitis media.

### Demographic Variables

In the present study, the mean age of patients with COM was 28.30±10.57 years and the majority of patients belonged to 21 to 30 years of age (31.7%). About 53.6% cases with COM were males and 55.7% participants were residents of rural areas. About 71% cases belonged to lower socio-economic class whereas 29% cases with COM belonged to middle socio-economic class. These findings suggest that prevalence of COM is higher in young adults and in males, possibly due to increased exposure to environmental risk factors and delay in seeking healthcare. Low socioeconomic status have been identified as an important risk factor for COM due to malnutrition, poor living condition, limited access to health care, overcrowding etc. Similarly, in a study of Kumar BY *et al* (2017), the majority of patients with COM belonged to 21 to 30 years of age, with male to female ratio of 1.6:1 [10].

### Characteristic of COM

In our study, the right ear was affected in 45.9% cases whereas the left ear was affected in 42.6% cases and 11.5% cases had bilateral COM. Among them, the right ear was operated in 54.6% cases and left ear was operated in 45.4% cases. The mean duration of symptoms was 5.46±3.0 years (range 1-15 years), indicating prolonged course of disease prior to surgery. The majority i.e. 61.2% cases in our study presented with mucosal COM and remaining 38.8% cases presented with squamosal COM. The majority of patients presented with central perforation (71%), whereas PSQ retraction was present in 10.4% cases each, attic retraction was present in 6% cases and 2.2% cases had attic perforation. Our study was supported by findings of Soni S *et al* (2021), right ear was affected in 58% cases whereas bilateral COM was documented in 16% cases [5]. Similarly, in a study of Abraham ZS *et al* (2019), the authors found unilateral involvement in 97.5% cases and left ear was most commonly affected. The authors also documented central perforation in majority of the cases of COM (53.2%) [11].

### PTA Findings

Based upon the findings of PTA, we categorized patients according to type and severity of hearing loss. Significantly lower proportions of patients with squamosal COM had mild hearing loss as compared to mucosal COM (6.6% vs. 32.6%). About 3.3% cases with squamosal COM had mixed hearing loss whereas none of the patients with mucosal COM exhibited mixed or severe hearing loss ($p<0.05$). Overall, the mean PTA in affected ear in squamosal and mucosal COM was 47.21±2.66 & 40.16±10.02 dB respectively in affected ear and 26.39±8.29 & 24.14±5.48 dB in unaffected ear ($p<0.05$). These results align with the established pathophysiological differences between squamosal and mucosal COM.

These findings were supported by the findings of Varshney S *et al*. (2010), in which the patients with squamosal COM had significantly higher severity of hearing loss as compared to mucosal COM, which could be attributed to ossicular disruption in higher proportions of patients with squamosal COM [12]. Similarly, Habib-Ur-Rehman FI *et al*. (2014) in their study found significantly higher severity of hearing loss in squamosal COM, with mild hearing loss in 28.75% cases in mucosal COM and 21.25% cases in squamosal COM ($p<0.05$) [13].

### Ossicular status on CT Scan and correlation with PTA findings

High-resolution computed tomography (HRCT) has increasingly been regarded as a key imaging modality in the evaluation of ear, nose, and throat (ENT) disorders. It offers detailed visualization of the bony framework of the skull base and enables assessment

of soft tissue abnormalities in relation to adjacent osseous structures. HRCT temporal scan revealed ossicular erosion in 37.7% cases overall, among them, erosion of incus was most common finding (28.4%), followed by absent incus (9.8%), erosion of malleus (9.3%), absent stapes suprastructure (3.8%) and absent malleus (0.5%). Ossicular disruption was noted in significantly higher proportions of patients with squamosal COM as compared to mucosal COM ($p<0.05$).

Due to the aggressive nature of COM in the squamosal subgroup, our study found a significantly greater frequency of ossicular erosion in squamosal COM. Squamosal COM is significantly linked to cholesteatoma, which causes gradual bone loss by applying pressure and releasing enzymatic agents such collagenases and chemicals that activate osteoclasts [14. In contrast, mucosal COM is often has different pathophysiology, mainly involving central perforation and mucosal inflammation, which frequently preserves ossicular integrity [16]. In patients with squamosal COM, we found no significant association of severity of hearing loss with overall ossicular status on CT scan ($p>0.05$), significantly higher proportions of patients with disruption of malleus, incus and stapes suprastructure with higher severity of COM ($p<0.05$). This finding implies that ossicular integrity may not be the only factor influencing hearing loss in squamosal disease; other factors may include middle ear mucosal edema, the presence of cholesteatoma mass, ossicular fixation, and potential inner ear involvement due to toxin diffusion [17].

Overall, our results demonstrate the value of HRCT Temporal in Squamosal COM in the preoperative evaluation of ossicular condition and disease severity. While the varied association between ossicular damage and hearing loss in mucosal vs squamosal illness reflects the complicated pathophysiology of chronic otitis media, the greater risk of ossicular erosion in squamosal COM emphasizes the necessity of careful surgical planning. These findings confirm that HRCT Temporal bone in Squamosal COM is a useful technique for prognostication, surgical decision-making, and anatomical assessment.

**Ossicular status on surgical exploration and correlation with PTA findings**

In the present study, intraoperative findings revealed incus erosion to be most common (29%), followed by absent incus (9.8%), malleus erosion (9.3%), absent stapessuprastructure (4.4%) and absent malleus (0.5%). Similarly, Praveen M *et al* (2025) documented incus erosion in majority of cases (86%), followed by stapes suprastructure erosion (60%) and malleus erosion was least common (10%). [18] Shinta N *et al* (2017) reported ossicular erosion in 63.1% cases and all ossicles were affected in 36.9% cases, whereas incus and stapes were affected in 9.2% cases [19].

Overall, our results demonstrate that ossicular disease is a major factor in COM hearing outcomes. While incus pathology is the main cause of auditory impairment in mucosal COM, significant ossicular damage involving many ossicles contributes to more severe hearing loss in squamosal illness. These findings highlight how crucial it is to carefully assess ossicular condition during surgery as it directly affects surgical planning, ossiculoplasty choices, and postoperative hearing results.

## CONCLUSION

Based upon the findings of the present study, it could be concluded that COM contributes to a significant burden of hearing impaired especially in young adults predominantly living in rural areas and belonging to low socioeconomic status. In this study we can easily conclude that pre- operative PTA and HRCT Temporal bone can significantly predict the ossicular status. Hence it helps the surgeon in surgical planning, predicting the prognosis and surgical out come to the patient.

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