Original Article

# Endoscopic Assessment of Anterior and Posterior Tympanic Isthmus Status in Chronic Otitis Media: A Descriptive Cross-Sectional Study

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## Abstract

**Background:** The tympanic isthmus represents a critical anatomical structure governing middle ear ventilation, connecting the mesotympanum to the epitympanum. Obstruction of the anterior and posterior tympanic isthmus in chronic otitis media may contribute to disease persistence and surgical failure. Endoscopic ear surgery provides superior visualization of these narrow anatomical corridors compared to conventional microscopy. This study aimed to evaluate the status of the anterior and posterior tympanic isthmus in patients with chronic otitis media using intraoperative endoscopic assessment. **Material and Methods:** This descriptive cross-sectional study was conducted at a tertiary care hospital over one year. Twenty-six patients with chronic otitis media undergoing tympanoplasty were enrolled. Intraoperative endoscopic assessment of the anterior tympanic isthmus and posterior tympanic isthmus was performed using rigid endoscopes and calibrated cannulae of varying diameters to determine patency and size. Statistical analysis included descriptive statistics, Wilcoxon Mann Whitney U test, Spearman's correlation, and chi-square test. **Results:** The mean age was 29.8 ± 12.4 years, with female predominance (69.2%). The anterior tympanic isthmus was blocked in 73.1% of cases, while the posterior tympanic isthmus was blocked in 69.2%. Mean anterior isthmus size (1.06 ± 0.53 mm) was significantly larger than posterior isthmus size (0.80 ± 0.71 mm; $p = 0.005$). Strong negative correlations were observed between isthmus size and symptom duration for both anterior ($r = -0.804$, $p = 0.001$) and posterior isthmus ($r = -0.851$, $p = 0.001$). Patients with blocked isthmi had significantly longer symptom duration compared to those with patent isthmi ($p < 0.01$). **Conclusion:** Tympanic isthmus blockage is highly prevalent in chronic otitis media and correlates with disease chronicity. Endoscopic assessment provides excellent visualization for evaluating these critical ventilation pathways, potentially guiding surgical intervention and improving outcomes.

**Keywords:** Chronic otitis media, tympanic isthmus, endoscopic ear surgery, middle ear ventilation, tympanoplasty, epitympanum.

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## Introduction

Chronic otitis media (COM) represents a significant global health burden, affecting an estimated 65– 330 million individuals worldwide, with approximately 50% experiencing associated hearing impairment.[1] The pathophysiology of COM involves complex interactions between Eustachian tube dysfunction, mucosal inflammation, and impaired middle ear ventilation, ultimately leading to tympanic membrane perforation and persistent otorrhea.[2] Understanding the anatomical factors contributing to disease persistence is essential for optimizing surgical outcomes and reducing recurrence rates.

The middle ear cleft functions as an interconnected pneumatic system wherein adequate ventilation is paramount for maintaining mucosal health and preventing disease progression.[3] While the Eustachian tube directly aerates the mesotympanum and hypotympanum, the epitympanum and mastoid compartments receive ventilation exclusively through the tympanic isthmus.[4] Proctor's seminal anatomical studies identified the tympanic isthmus as comprising anterior and posterior components, located between the tensor tympani tendon anteriorly and the stapes posteriorly.[5]

The anterior tympanic isthmus (ATI) and posterior tympanic isthmus (PTI) serve as the primary conduits for air exchange between the lower and upper compartments of the middle ear cleft.[6]

The anterior tympanic isthmus, a critical ventilation passage in the middle ear, is bounded anteriorly by the tensor tympani tendon, posteriorly by the posterior incudal ligament, medially by the attic bone (medial wall), and laterally by the head of the malleus and body/short process of the incus. Posterior tympanic isthmus is a narrow inconsistent space between the stapedius muscle and short process of incus. It communicates the

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epitympanum, the mesotympanum, and the airway through incudal fossa.

Obstruction of these narrow passageways by inflammatory tissue, mucosal edema, adhesions, or granulation tissue may result in selective epitympanic dysventilation, predisposing to negative pressure accumulation, retraction pocket formation, and potentially cholesteatoma development.[7] Several investigations have demonstrated that isthmus blockage correlates with poor mastoid pneumatization and increased disease severity.[8]

Conventional microscopic examination has inherent limitations in visualizing the tympanic isthmus due to its recessed anatomical position and the narrow confines of the external auditory canal.[9] The advent of endoscopic ear surgery has revolutionized otological practice by providing wide-angle, magnified visualization of previously inaccessible middle ear regions.[10] Marchioni and colleagues pioneered the endoscopic assessment of middle ear ventilation pathways, demonstrating superior identification of isthmus obstruction compared to microscopic techniques.[11]

Despite growing recognition of the tympanic isthmus's importance in COM pathophysiology, systematic endoscopic evaluation of isthmus status remains underexplored, particularly in the Indian subcontinent. Furthermore, the correlation between isthmus dimensions, patency status, and clinical parameters such as disease duration requires further elucidation. This study aimed to endoscopically assess the status of the anterior and posterior tympanic isthmus in patients with chronic otitis media and to investigate associations between isthmus characteristics and disease chronicity.

## Materials and Methods

This descriptive cross-sectional study was conducted in the Department of Otorhinolaryngology at a tertiary care teaching hospital in New Delhi, India, over a period of one year. The study protocol received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrolment.

**Study Population:** Patients aged 18 years and above diagnosed with chronic otitis media and scheduled for tympanoplasty were consecutively enrolled. The diagnosis of COM was established based on clinical history of persistent ear discharge exceeding three months duration, otoscopic evidence of tympanic membrane perforation, and pure tone audiometry findings.

**Sample Size Calculation:** Based on previous literature reporting tympanic isthmus status variation of 16%, with a margin of error of 3.2% at 5% significance level, the minimum required sample size was calculated as 50 patients. However, due to time constraints and the study period limitations, a minimum of 26 patients were enrolled.

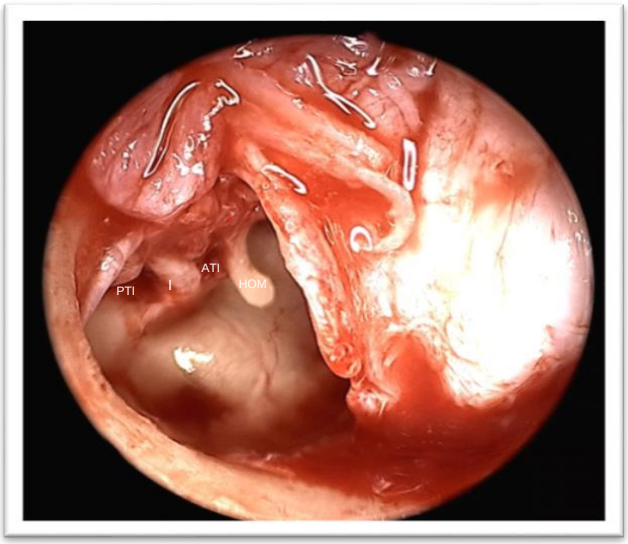
**Inclusion and Exclusion Criteria**

Inclusion criteria comprised patients above 18 years with chronic otitis media of the mucosal type presenting for surgical management. Exclusion criteria included patients with previous ear surgery, or squamosal disease or frank cholesteatoma.

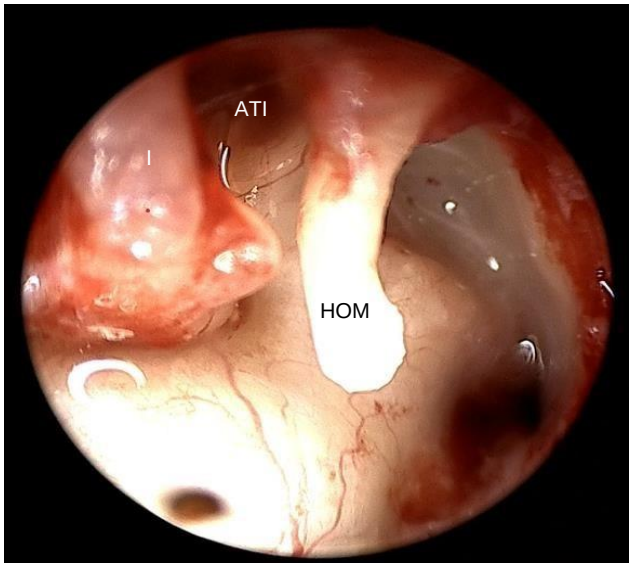
**Surgical Procedure and Endoscopic Assessment**

All patients underwent endoscopic tympanoplasty under local anaesthesia with sedation. Following standard preparation, a 0-degree and 30-degree rigid endoscope (4 mm diameter) was introduced through the external auditory canal. After elevation of the tympanomeatal flap and visualization of the middle ear cavity, systematic assessment of the anterior and posterior tympanic isthmus was performed.

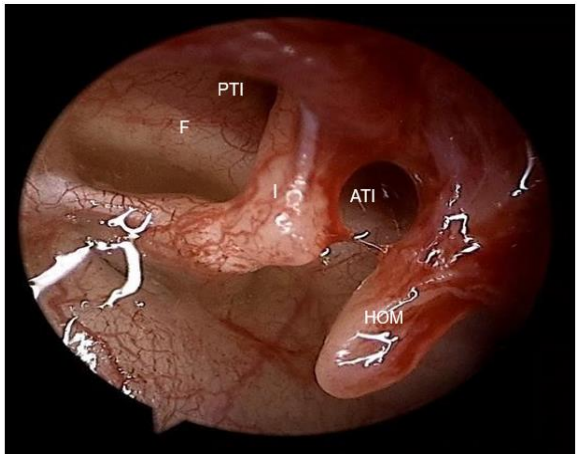
Isthmus patency was determined by direct visualization and probing using calibrated cannulae of varying diameters (0.9 mm, 1.1 mm, 1.3 mm, and 1.7 mm). The cannula tips were bent at 45 degrees to facilitate access to the isthmus region. The largest cannula that could be passed through the isthmus without resistance was recorded as the isthmus size. Complete obstruction was documented when no cannula could traverse the isthmus.




**Blocked Anterior Tympanic isthmus**




**Anterior tympanic isthmus patency established**




I- Incus
ATI- Anterior Tympanic Isthmus
PTI - Posterior Tympanic Isthmus I
HOM- Handle of Malleus
F - Facial nerve
Patent anterior and posterior tympanic isthmus

**Data Collection:** Demographic data including age and sex were recorded. Clinical parameters including duration of symptoms (in years), type of tympanic membrane perforation, and intraoperative findings were documented. The patency status (patent versus blocked) and size (in millimetres) of both anterior and posterior tympanic isthmus were recorded.

## Results

A total of 26 patients with chronic otitis media were enrolled in this study. The demographic distribution is presented in Table 1. The mean age of participants was 29.8 ± 12.4 years, with the majority (42.3%) belonging to the 15–25 years age group. Female patients constituted 69.2% (n = 18) of the study population, while males represented 30.8% (n = 8).

**Table 1: Demographic Characteristics of Study Population (N = 26)**

| Parameter | Category | Frequency (n) Percentage (%) | |
|---|---|---|---|
| Age (years) | 15–25 | 11 | 42.3 |
| | 26–35 | 6 | 23.1 |
| | 36–45 | 4 | 15.4 |
| | >45 | 5 | 19.2 |
| | Mean ± SD | 29.8 ± 12.4 | — |
| Sex | Female | 18 | 69.2 |
| | Male | 8 | 30.8 |
| Duration of symptoms (years) Mean ± SD | | 9.2 ± 11.8 | — |
| Median (IQR) 4.5 (0.5–18.0) — | | | |

**Tympanic Isthmus Patency Status:** Endoscopic assessment revealed that the anterior tympanic isthmus was blocked in 19 patients (73.1%) and patent in 7 patients (26.9%). Similarly, the posterior tympanic isthmus was blocked in 18 patients (69.2%) and patent in 8 patients (30.8%). The distribution of isthmus patency and size is presented in Table 2.

**Table 2: Anterior and Posterior Tympanic Isthmus Characteristics**

| Parameter | Anterior Isthmus | Posterior Isthmus | p-value |
|---|---|---|---|
| Patency Status | | | |
| Blocked, n (%) | 19 (73.1) | 18 (69.2) | 0.762 |
| Patent, n (%) | 7 (26.9) | 8 (30.8) | |
| Size (mm) | | | |
| Mean ± SD | 1.06 ± 0.53 | 0.80 ± 0.71 | 0.005* |
| Median (IQR) | 1.10 (0.80–1.70) | 0.80 (0–1.70) | |
| Range | 0–1.70 | 0–1.70 | |

*Wilcoxon Signed Rank Test; $p < 0.05$ considered significant

The mean anterior tympanic isthmus size (1.06 ± 0.53 mm) was significantly larger than the mean posterior tympanic isthmus size (0.80 ± 0.71 mm), with a statistically significant difference (W = 2.78, p = 0.005).

**Correlation Between Isthmus Status and Symptom Duration**

A strong negative correlation was observed between isthmus size and duration of symptoms for both the anterior tympanic isthmus (Spearman's r = -0.804, p = 0.001) and posterior tympanic isthmus (Spearman's r = -0.851, p = 0.001). Patients with blocked anterior isthmus had significantly longer symptom duration (mean 12.1 ± 13.2 years) compared to those with patent anterior isthmus (mean 0.77 ± 0.55 years; p = 0.005). Similarly, patients with blocked posterior isthmus demonstrated longer symptom duration (mean 12.4 ± 13.5 years) compared to those with patent posterior isthmus (mean 1.48 ± 2.64 years; p = 0.003). These findings are summarized in [Table 3].

**Table 3: Association Between Isthmus Patency and Duration of Symptoms**

| Isthmus Status | n | Mean ± SD (years) | Median (IQR) (years) | p-value |
|---|---|---|---|---|
| Anterior Isthmus | | | | |
| Blocked | 19 | 12.1 ± 13.2 | 7.0 (1.5–21.0) | |
| Patent | 7 | 0.77 ± 0.55 | 0.55 (0.50–0.71) | |

| | | | | |
|---|---|---|---|---|
| Posterior Isthmus | | | | |
| Blocked | 18 | 12.4 ± 13.5 | 7.0 (2.0–22.0) | |
| Patent | 8 | 1.48 ± 2.64 | 0.50 (0.49–0.69) | |

*Wilcoxon-Mann-Whitney U Test; $p < 0.05$ considered significant

Chi-square analysis revealed a significant association between anterior and posterior isthmus sizes ($\chi^2 = 32.79$, $p = 0.008$), indicating that smaller anterior isthmus size was frequently associated with smaller posterior isthmus size.

## Discussion

This study demonstrates the utility of intraoperative endoscopic assessment in evaluating the tympanic isthmus status in patients with chronic otitis media. Our findings reveal a high prevalence of isthmus blockage, with 73.1% of anterior and 69.2% of posterior tympanic isthmi being obstructed, consistent with previous reports by Marchioni and colleagues who emphasized the significance of isthmus obstruction in middle ear pathology.[12]

The tympanic isthmus serves as the exclusive ventilation pathway between the mesotympanum and epitympanum, and its obstruction has been implicated in the pathogenesis of epitympanic disease.[13] Our observation that the anterior tympanic isthmus is significantly larger than the posterior isthmus (1.06 ± 0.53 mm versus 0.80 ± 0.71 mm, $p = 0.005$) aligns with anatomical studies by Palva and Ramsay, who described the anterior isthmus as the primary ventilation route.[14] This anatomical distinction has important surgical implications, as the larger anterior isthmus may be more amenable to surgical restoration of patency.

A particularly noteworthy finding is the strong negative correlation between isthmus size and symptom duration.

Patients with blocked isthmi demonstrated significantly longer disease duration (exceeding 12 years on average) compared to those with patent isthmi (less than 2 years). This correlation suggests that isthmus obstruction may either contribute to disease chronicity or develop progressively as a consequence of prolonged inflammation.[15] Shirai and colleagues similarly reported that chronic inflammation leads to fibrotic narrowing of the tympanic isthmus, establishing a selfperpetuating cycle of dysventilation and mucosal disease.[16]

The significant association between anterior and posterior isthmus sizes ($p = 0.008$) suggests that pathological processes affecting one isthmus frequently involve the other, reflecting the shared anatomical and mucosal environment of the epitympanic region.[17] This finding underscores the importance of comprehensive assessment of both ventilation pathways during surgical intervention.

Endoscopic ear surgery has emerged as a transformative approach in otology, offering unparalleled visualization of hidden recesses including the tympanic isthmus, sinus tympani, and facial recess.[18] The wide-angle view provided by rigid endoscopes overcomes the limitations imposed by the narrow external auditory canal, enabling identification of subtle mucosal changes and anatomical variations that may escape microscopic detection.[19] Tarabichi and colleagues demonstrated that endoscopic techniques facilitate more complete disease clearance while preserving ossicular chain integrity.[20]

The clinical implications of our findings are significant. Preoperative recognition of isthmus obstruction may guide surgical planning, prompting interventions aimed at restoring epitympanic ventilation. Intraoperative assessment and clearance of blocked isthmi during tympanoplasty may improve postoperative middle ear aeration and reduce recurrence rates.[21] Furthermore, understanding the relationship between isthmus status and disease duration may assist in prognosticating surgical outcomes.

This study has several limitations. The relatively small sample size limits generalizability, and the crosssectional design precludes establishment of causal relationships between isthmus obstruction and disease progression. Future prospective studies with larger cohorts and long-term followup are warranted to validate these findings and assess the impact of isthmus restoration on surgical success rates.

## Conclusion

This study demonstrates that tympanic isthmus blockage is highly prevalent in patients with chronic otitis media, affecting over 70% of cases. The anterior tympanic isthmus is significantly larger than the posterior isthmus, and both structures show strong negative correlation between size and disease duration. These findings suggest that isthmus obstruction plays an important role in disease chronicity and may represent a modifiable factor in surgical management. Endoscopic assessment provides excellent visualization of these critical ventilation pathways, offering advantages over conventional microscopic techniques. Routine intraoperative evaluation and restoration of isthmus patency during tympanoplasty may improve middle ear ventilation and enhance surgical outcomes. Further multicentre studies with larger sample sizes and longitudinal follow-up are recommended to establish definitive guidelines for managing tympanic isthmus obstruction in chronic otitis media.

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### Conflicts of interest

There are no conflicts of interest.

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