

Incidence of Mastoid Sclerosis Using Plain Radiography (Schuller's View) in Patients with Uncomplicated Chronic Suppurative Otitis Media and its Effect on Graft Uptake

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Abstract

Background: Chronic otitis media is long term infection of middle ear cleft characterized by persistent or recurrent episodes of ear discharge, hearing impairment with tympanic membrane perforation. Persistent infection and mucosal edema within the middle ear cleft lead to obstruction of the aditus ad antrum, producing chronic hypoxia leading to osteoblastic remodeling, progressively replacing the pneumatized air cell system with dense, avascular bone-a process termed mastoid sclerosis. Additionally, critical anatomical variations when present in a sclerotic mastoid, significantly heighten the risk of iatrogenic injury during mastoidectomy. Plain radiography using Schuller's view remains an accessible and valuable tool for pre-operative assessment.

Aims and Objectives: To determine the incidence of mastoid sclerosis in patients with mucosal type COM using plain X-ray mastoid (Schuller's view); to classify mastoid pneumatization patterns into well pneumatized, partially sclerosed, and fully sclerosed types; and to evaluate the effect of the degree of mastoid sclerosis on tympanoplasty graft uptake outcomes.

Methodology: A hospital-based retrospective observational study was conducted using 180 patient records with mucosal type CSOM undergoing surgical management. Pre-operative X-ray mastoid (Schuller's view) reports were retrieved and analyzed. Mastoid patterns were classified as well pneumatized, partially sclerosed, or fully sclerosed. Anatomical variations including low-lying tegmen and anteposed sigmoid sinus were recorded. Statistical analysis was performed using SPSS software.

Results: Of 180 patients with mucosal COM, 54 (30%) were male and 126 (70%) were female. A total of 180 ears had classified radiological findings. Among these, 80% demonstrated mastoid sclerosis (55.56% partially sclerosed; 24.44% fully sclerosed), with only 20% being well pneumatized. Out of 180 patients, 22 (12.22%) showed a low-lying tegmen antri and 6/180 showed Anteposed sigmoid sinus (3.33%). A total of 63/180 patients (35%) required cortical mastoidectomy and 117/180(65%) required tympanoplasty alone. The overall graft uptake rate was evaluated at 12 weeks, out of 180 total patients, 174(96.67%) had a well healed neotympanum while 6 patients (3.33%) had a residual perforation.

Conclusion: Mucosal type CSOM is associated with a high incidence of mastoid sclerosis (80%), challenging the notion that it represents "simple" ear surgery. A substantial proportion of patients demonstrate a low-lying tegmen, a critical anatomical hazard during mastoidectomy. These findings strongly support routine pre-operative radiological screening even in mucosal disease and advocate for meticulous surgical planning to prevent catastrophic iatrogenic complications.

Keywords: Chronic Suppurative Otitis Media, Mastoid Sclerosis, Mastoid Pneumatization, Low-Lying Tegmen, Anteposed Sigmoid Sinus, Plain Radiograph, Schuller's View.

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Introduction

Chronic suppurative otitis media is long term infection of middle ear cleft characterized by persistent or recurrent episodes of ear discharge, hearing impairment with tympanic membrane perforation.[1] COM is significant public health concern in most of the developing countries. The traditional designation of mucosal CSOM as "safe" ear disease pertains to the absence of cholesteatoma and the lower risk of intracranial spread. However, this nomenclature belies the significant structural and anatomical changes that the chronic inflammatory state inflicts upon the temporal bone. Persistent infection and mucosal edema within the middle ear cleft lead to obstruction of the aditus ad antrum, producing chronic hypoxia. This hypoxic environment activates osteoblastic remodeling, progressively replacing the pneumatized air cell system with dense, avascular bone—a process termed mastoid sclerosis. [2-4] A sclerotic mastoid lacks the defining "honeycomb" architecture of air cells that normally guide the surgeon during mastoidectomy. In its absence, surgical navigation becomes significantly more demanding, as the reliable anatomical landmarks are obliterated. This challenge is compounded when concurrent developmental anatomical variations are present—specifically, a low-lying tegmen antri or anteposed sigmoid sinus. [5,6] In a well-pneumatized mastoid, these structures are held at a safe distance from the surgical corridor. In a sclerotic mastoid, however, they encroach upon the narrow MacEwen's triangle, dramatically narrowing the safe zone for the high-speed drill.

Failure to anticipate these variations can result in catastrophic iatrogenic injuries, including inadvertent dural exposure causing CSF rhinorrhea or meningocele, and accidental puncture of the sigmoid sinus resulting in life-threatening hemorrhage. In this resource limited setting, plain radiography of the mastoid in Schuller's view continues to serve as a valuable, cost-effective, and widely available first-line screening tool.[7] Despite the clinical importance of these findings, published data specifically examining the association of mastoid sclerosis with critical anatomical variations in mucosal CSOM remains sparse, particularly from the Indian subcontinent.

The present study was therefore undertaken to determine the prevalence of mastoid sclerosis, low-lying tegmen and anteriorly positioned sigmoid sinus on plain radiography in a surgical cohort of mucosal CSOM patients, and to correlate these

findings with the intraoperative findings and operative procedures performed.

Aims and Objectives

Primary Objective: To determine the incidence of mastoid sclerosis using plain radiography (Schuller's view) in patients clinically diagnosed with mucosal type CSOM.

Secondary Objectives

1. To determine the relation between mastoid pneumatization and graft uptake following tympanoplasty.
2. To assess the association of age, sex, the laterality of disease and the duration of disease with the mastoid pneumatization pattern in patients with uncomplicated CSOM

Materials And Methods

This was a hospital-based retrospective cross-sectional observational study conducted over a period of 6 months, from January 2025 to June 2025, in the Department of Otorhinolaryngology in a teaching hospital in India. Patient records undergoing tympanoplasty with or without cortical mastoidectomy during this period were retrieved from the surgical registry.

A total of 195 such records were identified from the surgical registry. X-rays of 15 patients could not be found in hospital database, so had to be excluded and only 180 patients were included in the study.

Inclusion Criteria

1. Clinically diagnosed mucosal type COM with central perforation of tympanic membrane.
2. Availability of pre-operative X-ray Mastoid (Schuller's view) in the clinical records.

Exclusion Criteria

1. Attico-antral disease (squamosal/unsafe type CSOM) including cholesteatoma.
2. Revision surgical cases.
3. Patients with non-otological primary diagnoses or incomplete clinical records.

Radiological Assessment: Pre-operative plain X-ray mastoid films in Schuller's view were retrieved and analyzed. The mastoid air cell system was classified into three categories based on established radiological criteria:

1. Well Pneumatized: normal honeycomb pattern of air cells extending into all regions of mastoid.

2. Partial sclerosed: reduced pneumatization with evidence of bony sclerosis involving portions of the mastoid.
3. Fully Sclerosed: complete replacement of air cells by dense bone, with no identifiable pneumatization.

In addition, the Schuller's view was evaluated for the following critical anatomical variations:

1. Low-Lying Tegmen Antri — defined as inferior displacement of the tegmen tympani plate towards the level of the external auditory canal.
2. Anteposed Sigmoid Sinus — defined as anterior displacement of the sigmoid sinus resulting in reduced retrosigmoid space.
- Surgical Categorization: The operative procedures were categorized as: Tympanoplasty alone, Cortical Mastoidectomy with Tympanoplasty.

- Statistical Analysis: Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) software. Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as mean $\pm$ standard deviation (SD) with range. Chi-square test was used to determine associations between mastoid pneumatization pattern and surgical procedure type. A p-value of <0.05 was considered statistically significant.

Results

Demographic Profile: A total of 180 patients with mucosal type CSOM were enrolled in the study. The demographic characteristics are summarized in Table 1.

Table 1: Demographic profile of study participants (n=180)

Variable	Category	Number (n)	Percentage (%)
Total Patients	—	180	100%
Gender	Male	54	30%
	Female	126	70%
Age Groups	< 20 years	37	20.56%
	20 – 29 years	64	35.56%
	30 – 39 years	44	24.44%
	40 – 49 years	23	12.78%
	$\geq$ 50 years	12	6.67%
Ear Involved	Right	75	41.67%
	Left	75	41.67%
	Bilateral	30	16.67%

The study cohort comprised 54 males (30%) and 126 females (70%), with a female preponderance. Out of 180 patients, the largest proportion (64 patients, 35.56%) were in the 20–29-year age group, reflecting the disease burden in young productive adults.

Regarding ear involvement, binaural hearing burden as we observed perfect symmetry between right

(41.67%) and left (41.6%) ear involvement, suggesting no particular laterality in pathogenesis of COM.

Radiological Classification of Mastoid Pneumatization: X-ray mastoid (Schuller's view) findings were available and classifiable in 180 ears across the study cohort. The distribution of mastoid patterns is detailed in Table 2.

Table 2: Radiological classification of mastoid pneumatization patterns (n=180 classified ears)

Mastoid X-Ray Pattern	Left ear operated	Right ear operated	Combined total
Well Pneumatized	18(20.22%)	18(19.78%)	36(20%)
Partially Sclerosed	44(49.44%)	56(61.54%)	100(55.56%)
Fully Sclerosed	27(30.34%)	17(18.68%)	44(24.44%)
Total Classified Ears	89	91	180

Among the 180 ears with classifiable X-ray data, mastoid sclerosis (either partial or full) was present in 80% of all operated ear (144 out of 180). Partial sclerosed mastoids was the most common pattern (55.56%), followed by fully sclerosed 55(24.44%). While both sides show similar rate of well pneumatized mastoids (20%), left operated ears demonstrate a higher rate of fully sclerosed air systems (30.34% vs 18.68% in right operated ear).

Conversely, right operated ear shows a higher proportion of partially sclerosed system (61.54% vs 49.44% in left operated ears).

Surgical Procedures Performed: The distribution of operative procedures performed is shown in Table 3. Of the 180 patients, 63 (35%) required cortical mastoidectomy in addition to tympanoplasty. Type I Tympanoplasty was the most frequently performed procedure, accounting for 117 cases (65%),

reflecting predominance of cases requiring tympanic membrane repair with or without reconstruction of ossicular chain.

Table 3: Distribution of surgical procedures performed (n=180)

Surgical Procedure	Number of Patients (n)	Percentage (%)
Tympanoplasty alone	117	65%
Cortical Mastoidectomy + Tympanoplasty	63	35%
Total	180	100%

Critical Anatomical Variations: The presence of low-lying tegmen antri and anteposed sigmoid sinus was recorded where available in the operative notes and pre-operative radiology reports.

Table 4: Prevalence of critical anatomical variations out of patient (among patients with documented data)

Anatomical Variation	Present (n)	Present (%)	Absent (n)	Absent (%)
Low-Lying Tegmen Antri	22	12.22%	158	87.78%
Anteposed Sigmoid Sinus	6	3.33%	174	96.67%

A low lying tegmen dura is most common anatomical variation found in this surgical population, affecting 12.22% of cases (22 out of 180 patients). This variation is highly relevant during tympanoplasty and mastoidectomy. Anteposed sigmoid sinus is less frequent, presenting in only 3.33% of cases (6 out of 180 patients). The patient anatomical variation could be correlated with surgical variation among 63 patient who underwent cortical mastoidectomy.

Graft Outcome: The overall graft uptake rate was evaluated at 12 weeks. Out of 180 total patients, 174(96.67%) had a well healed neotympanum while 6 patients (3.33%) had a residual perforation. The difference in graft outcomes was statistically significant ($p < 0.0001$), indicating proportion of patients with an intact graft was significantly higher than with graft perforation.

Table 5: Graft outcome at follow-up among study participant at 3 months(n=180)

Mastoid X-Ray Pattern	Graft uptake	Graft failure	Statistical significance
Well Pneumatized	36(100%)	0(0%)	P=0.0424
Partially Sclerosed	98(98.00%)	2(2%)	P= 0.0955
Fully Sclerosed	40(90.91%)	4(9.09%)	P= 0.2107
Combined total	174(96.67%)	6(3.33%)	

The graft success rate demonstrates a clear physiological correlation with the degree of mastoid pneumatization: Well Pneumatized systems achieved a 100% graft success rate (36/36). Partially Sclerosed systems achieved a 98% graft success rate (98/100). Fully Sclerosed systems dropped to a 90.91% graft success rate (40/44).



Figure 1: A. Moderate central perforation in left ear. B. Plain x ray mastoid schuller's view with partial pneumatized mastoid air cells. C. Otoendoscopic picture of neotympanum at 3rd month of follow up

Discussion

This present study evaluated 180 patients with mucosal type chronic otitis media (COM) to assess their clinico-demographic profile, radiological mastoid air cell patterns, clinically relevant anatomical variations, and surgical outcomes.

The demographic analysis demonstrated female preponderance, with females accounting for 70.0% ($n = 126$) of the cohort compared to 30.0% ($n = 54$) males. This presentation is consistent with several studies in developing countries. Subramanya and Lohith et al. observed 56.7% female involvement [8], while Verma and Paudel noted 72.0% female cases [9]. This observed gender distribution may

reflect differences in healthcare-seeking behaviors in low-resource environments [10]. The majority of patients belonged to 20–29 years age group, accounting 35.56% (n = 64) of patients, followed by the 30–39 years group at 24.44% (n = 44). The predominance of COM predominantly impacts young, active populations, causing significant conductive hearing loss during productive decades [11].

Unilateral disease was more common than bilateral disease. Right and left ears involved in 41.67% (n = 75) each, while bilateral involvement was noted in 16.67% (n = 30) of patients. This distribution is broadly comparable with patterns reported in other clinical studies [12].

Preoperative radiographic evaluation of the operated ear showed that 20.0% (n = 36) were well-pneumatized, 55.56% (n = 100) were partially sclerosed, and 24.44% (n = 44) were fully sclerosed. This indicates that 80.0% of our patients exhibited some form of mastoid sclerosis. Mastoid sclerosis is a recognized radiological finding associated with chronic middle ear inflammation, where long-standing mucosal disease triggers reactive osteitis that obliterates the air cell system [11]. Sharma et al. reported a similarly incidence of mastoid sclerosis in 75.0% of cases on radiographic evaluation [12] which is comparable with the high prevalence observed in the present study.

In the present study, 65.0% (n = 117) of patients underwent Type I Tympanoplasty alone, while 35.0% (n = 63) underwent Cortical Mastoidectomy + Tympanoplasty. Proponents of combined surgery suggest that removal of diseased mastoid air cells and opening of adequate antrum may improve ventilation of middle ear cleft and facilitate clearance of occult disease [2, 5]. Indeed, Verma and Paudel observed better graft uptake (96.0%) in their tympano-mastoidectomy group compared to tympanoplasty alone (84.0%) [9]. Similarly, Sharma et al. achieved 100.0% graft uptake with combined surgery versus 95.0% with tympanoplasty alone [12].

Conversely, Shahid Rasool et al. evaluated sclerotic mastoids and reported no additional benefit of mastoidectomy in terms of graft uptake (84.0% combined vs. 80.0% tympanoplasty alone) [11]. They proposed that drilling of dense sclerotic bone create an artificial cavity lined by bone rather than functioning, gas-exchanging mucosa there by limiting the proposed physiological benefits of mastoidectomy. In the present study, an overall graft uptake success rate of 96.67% (n = 174) was achieved, with only 3.33% (n = 6) graft failure, confirming that excellent outcomes are achievable using both techniques when patients are selected carefully.

Identification of clinically significant anatomical variations was another key aspect of our study. A low-lying tegmen antri was identified in 12.22% (n = 22) of patients, and an anteposed sigmoid sinus was present in 3.33% (n = 6). These findings highlight the value of detailed preoperative assessment of mastoid anatomy, particularly when mastoid surgery is contemplated. A low lying tegmen may increase the risk of inadvertent intracranial injury during drilling, while an anteposed sigmoid sinus may reduce available space for surgery leading to increased risk of vascular injury. Therefore, awareness of anatomical variations is essential for safe drilling and intraoperative orientation. [10, 14].

Furthermore, overall graft success rate (96.67%) is highly comparable to modern series. Patel and Panchal achieved successful tympanic membrane graft closure in 94.0% of cases using cartilage grafts, noting that cartilage's structural rigidity provides excellent resistance to retraction [15]. Atishkumar B. Gujrathi et al. reported a 98.0% graft uptake rate with transcanal endoscopic tympanoplasty compared to 90.0% with microscopic underlay tympanoplasty [16]. Meticulous margin freshening, coupled with appropriate graft selection, ensures high anatomical and functional success [8, 16]. Appropriate preoperative radiological assessment, careful evaluation of mastoid pneumatization, awareness of potentially hazardous anatomical variations can therefore contribute to safer and more effective surgical management.

Conclusion

The present study of 180 patients with mucosal-type chronic otitis media (COM) demonstrated a female predominance, with young adults being most commonly affected. Also, our radiological findings confirm that mastoid sclerosis is the predominant anatomical state in chronic middle ear disease, with 80.0% of operated ears showing partial or full sclerosis on Schuller's view. This high rate of sclerosis underscores the chronic inflammatory burden on the middle ear cleft, leading to a low-volume and poorly aerated mastoid system. Excellent surgical outcomes were achieved, with an overall graft uptake rate of 96.67% and graft failure in 3.33% of cases. Both tympanoplasty alone and tympanoplasty with cortical mastoidectomy yielded favorable outcomes in appropriately selected patients; however, the present study does not establish superiority of either technique. The identification of low-lying tegmen antri (12.22%) and anteposed sigmoid sinus (3.33%) emphasizes the importance of careful preoperative assessment of mastoid anatomy and meticulous surgical planning. Further prospective comparative studies are warranted to clarify the role of mastoidectomy in mucosal-type CSOM.

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