



Original Article

## Corelation between pre-operative Findings of High-Resolution Computed Tomography (HRCT) of Temporal Bone and Intra-operative Findings of Squamous Type of Chronic Otitis Media - An Ambispective Study

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### ABSTRACT

This ambispective study evaluated the correlation between preoperative HRCT temporal bone findings and intraoperative observations in squamous chronic otitis media. HRCT showed high accuracy for certain structures, serving as a reliable surgical planning tool. However, limitations exist in assessing delicate structures, emphasizing its role as a complementary, structure-specific modality.

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### INTRODUCTION

Chronic otitis media (COM) is a recognised cause of preventable hearing loss, especially in developing countries where delayed diagnosis and limited access to specialised investigations & treatment often impede effective management. Chronic otitis media (COM) comprises of various diseases; however, the squamous variant or unsafe type, associated with cholesteatoma formation, poses the highest risk of adverse sequelae. [1]

Extensive research has been conducted on the pathophysiology of cholesteatoma in squamous type chronic otitis media. It is an eroding process that puts vital structures like the ossicular chain, facial nerve canal, tegmen tympani, and lateral semicircular canal at risk. This shows how important it is to find and evaluate the disease early. [2]

In the past few decades, imaging techniques for middle ear diseases have improved significantly. Conventional radiography provided limited structural details; however, High-Resolution Computed Tomography (HRCT) has completely transformed temporal bone imaging.[3] HRCT enables a complete evaluation of the middle ear, ossicles, mastoid air cells, and nearby neurovascular structures because it has detailed bony structures and can show multiple planes. HRCT is the best tool for investigating at cholesteatoma before surgery. [4] High-resolution computed tomography (HRCT) is necessary for examining bony erosions, a hallmark of cholesteatoma, and for evaluating ossicular chain erosion, dural plate thinning, facial nerve dehiscence, and lateral sinus exposure. Surgeons can be prepared for the challenging nature of surgery by identifying these features before the procedure and changing their plans as needed. [5] HRCT has some exceptional points, but it also has a few poor facets. Researches demonstrate varying degrees of concordance between HRCT findings and actual intra-operative observations in cholesteatoma cases.

The primary aim of this study is to correlate the relationship between preoperative HRCT results of the temporal bone and intra-operative results in patients undergoing surgery for squamous type chronic otitis media (COM). The objective of this research is to find out if HRCT is a reliable tool to predict intra-operative pathology by systematically comparing imaging results to intra-operative surgical observations. The study also aims to assess the utility of HRCT in preoperative surgical decision making, elucidating its function as a diagnostic and surgical planning tool in modern otologic practice.

## **METHODOLOGY**

### **1. Study Design**

This was a diagnostic analytical study to assess the accuracy of preoperative High-Resolution Computed Tomography (HRCT) of the temporal bone in predicting surgical outcomes in patients with squamous chronic otitis media (COM). The research utilized an ambispective methodology, combining retrospective data analysis from previously operated cases with prospective data-collection from patients undergoing surgery during the study period.

### **2. Study Setting**

The study was done at the Department of Otorhinolaryngology, Zydus Medical College and Hospital, Dahod, India, with help from the Department of Radiodiagnosis. The surgeries were performed by experienced ENT surgeons and intraoperative data was recorded. The study worked with the radiology department to make sure that HRCT scans were always done and read by senior radiologists.

### **3. Study Duration**

The study was intended to run from October 2023 to September 2025, or 15 months.

### **4. Participants**

#### **Inclusion Criteria:**

- Patients diagnosed with squamous type COM.
- Patients presenting with foul-smelling ear discharge, cholesteatoma, granulation tissue, or posterosuperior/attic retraction pocket.
- All patients planned for surgery (tympanomastoidectomy – canal wall down or reconstruction of attic defects using tragal/conchal cartilage)
- Patients from all age groups and either sexes.
- Patients providing written informed consent.

#### **Exclusion Criteria:**

- Patients with mucosal type CSOM.
- Patients with residual or recurrent cholesteatoma following prior surgery.
- Patients with no follow-up post-surgery.
- Patients unwilling to consent for HRCT or surgery.
- Patients with contraindications to CT scanning (e.g., pregnancy).
- Patients unfit for general anesthesia or surgery due to severe comorbidities

### **5. Study Sampling**

The sampling followed a consecutive sampling technique, wherein all eligible squamous CSOM patients presenting to the ENT OPD during the recruitment period were included in the study after obtaining the consent.

### **6. Study Sample Size**

The planned sample size for this study was set at 50 patients diagnosed with squamous type chronic otitis media (CSOM), presenting to Zydus Medical College and Hospital, Dahod, India, over the study period, the sample was pragmatically estimated based on the average number of squamous CSOM patients undergoing surgery per month at the study center. On average, 3 to 4 cases of squamous CSOM requiring surgery were identified per month during the hospital's routine surgical audit, allowing for the inclusion of 50 patients over a 12-month recruitment period.

### **7. Study Procedure**

Every patient underwent a thorough evaluation, including a detailed ear, nose and throat examination and history-taking to understand the nature and duration of symptoms like discharge and hearing loss, as well as other complaints.

HRCT scans of the temporal bone were then carried out on all patients using a SOMATOM 16-slice CT scanner (Siemens AG, Erlangen, Germany) with 1 mm axial and coronal cuts. The resulting HRCT images were evaluated by experienced radiologist.

During the surgical procedures, careful observation and documentation of intraoperative findings were conducted for each patient. The surgeries were conducted under strict sterile conditions and under general anesthesia.

A comprehensive comparative analysis was then performed, juxtaposing the findings from HRCT temporal bone scans with the observations made during surgery to assess the correlation between the radiological and surgical findings.

### 8. Data-Collection

Data-collection followed a structured protocol using a comprehensive proforma designed specifically for the study. All details were also directly entered into a Microsoft Excel master sheet. This ensured real-time accuracy. The data-collection phase continued until the target sample size was achieved. Each patient was assigned a unique study ID to ensure anonymity.

### 9. Data Analysis

Data analysis was performed using SPSS version 23. Preoperative HRCT findings were cross-tabulated with intra-operative findings, allowing calculation of: Sensitivity (true positive rate), Specificity (true negative rate), Positive Predictive Value (PPV), Negative Predictive Value (NPV). Kappa statistics were used to quantify agreement between HRCT and intraoperative findings.

### 10. Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before starting the study. Patients were provided with a detailed information sheet explaining the study purpose, risks, and benefits in their local language. Written informed consent was obtained from all participants. All patient data were handled confidentially, stored using anonymized identifiers. Only study investigators had access to identifiable data.

A total of 50 patients were recruited in the study, three in five participants were  $\leq 30$  years, followed by 30-40 years (18%). Children  $<10$  years accounted for 10%, while  $\geq 40$  years comprised 14%. Males formed nearly two-thirds of the cohort (64%), with females comprising 36%. Unilateral squamosal COM dominated (R - 40%; L - 48%), with bilateral disease present in 12%. Hearing loss was predominantly unilateral moderate conductive: Left 36% and Right 34%. Bilateral moderate CHL accounted for 16%. Severe categories were less frequent 8 % Mild CHL occurrences were sparse at 2 %.

The sensitivity, specificity, PPV, NPV, and accuracy of HRCT in detecting various pathologies were calculated. It was observed that HRCT had a perfect sensitivity in detecting scutum erosion, mastoid sclerosis, and abnormalities in the tympanic membrane. Additionally, HRCT demonstrated a perfect specificity in detecting sinus plate erosion, lateral semicircular canal (SCC) erosion. The overall accuracy of HRCT was above 60% in detecting almost all pathologies, except for erosion of the stapes.

It was observed that there was a perfect or near-perfect agreement between the HRCT and the intraoperative findings in detecting sinus plate erosion, mastoid sclerosis, scutum erosion, and abnormalities in the tympanic membrane. Fair agreement was found in detecting LSCC erosion, Stapes erosion, and facial canal erosion, sinus plate erosion, moderate agreement in detecting incus and tegmen erosion.

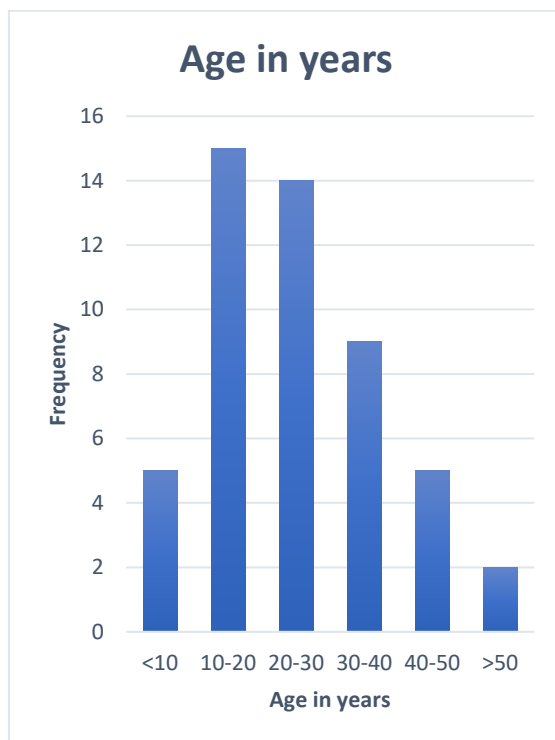


Chart 1 : Age Distribution in cases of Squamous type of CSOM

## DISCUSSION

The study cohort demonstrated a clear predominance of younger individuals, with 60% aged  $\leq 30$  years (10–20 years: 30%; 20–30 years: 28%), followed by 30–40 years: 18% and  $\geq 40$  years: 14% (40–50 years: 10%;  $>50$  years: 4%). This distribution reflects a late-childhood to young-adult dominance, consistent with the natural history of pars flaccida retraction pockets progressing to cholesteatoma, thereby concentrating unsafe ears within surgical populations.

Comparable trends have been reported in prior studies. Rai (2014) described a surgically enriched chronic otitis media (COM) cohort with frequent HRCT detection of advanced attic disease and bony erosions, paralleling our findings of universal scutum erosion (100%) and near-universal incus involvement (96%) [6]. Similarly, Kanotra et al. (2015) (n=47) and Sreedhar et al. (2015) (n=25) reported cohorts skewed toward active squamosal disease requiring surgical management [7,8]. More recent studies by Bhagat et al. (2022) (n=60) and Swami et al. (2023) (n=50) further support these observations, demonstrating strong HRCT–surgical concordance in younger, referral-based populations [9,10].

In contrast, studies with a higher proportion of older individuals tend to demonstrate more heterogeneous tympanomastoid disease patterns and fewer frank attic erosions, which may reduce HRCT sensitivity for subtle bony abnormalities. Our findings, however, reflect a high-prevalence unsafe COM spectrum, enhancing the detectability of scutum and ossicular pathology.

Overall, the observed age distribution supports age-based stratification ( $\leq 30$  vs  $>30$  years) to further evaluate its influence on HRCT–surgical concordance, particularly for delicate structures such as the facial canal and stapes.

This study demonstrated a male predominance (64% vs 36%) with a disease profile dominated by unilateral active squamosal chronic otitis media (right 38%, left 36%, bilateral 10%). Complications were relatively infrequent but clinically significant, including mastoid abscess (6%), intracranial abscess (4%), aural polyp (4%), and post-aural fistula (2%).

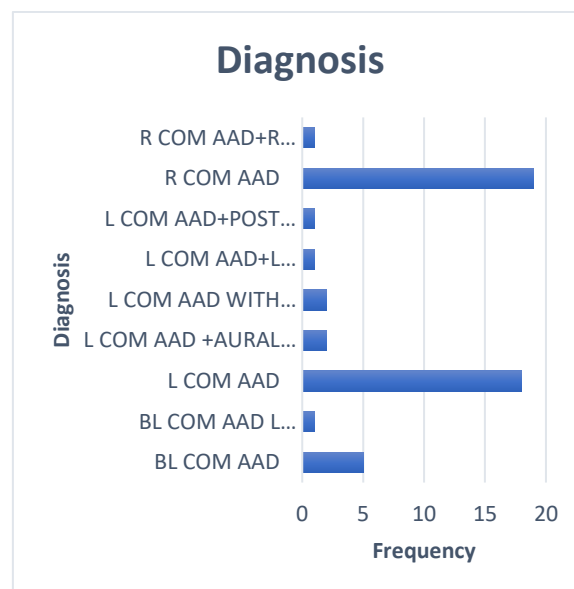


Chart 2 : Diagnoses of various varieties of COM

Audiologically, the cohort was characterized by predominantly moderate conductive hearing loss, with left MOD CHL 36%, right MOD CHL 34%, and bilateral MOD CHL 16%, while severe categories were uncommon (left severe CHL 4%, right severe MHL 4%). Intra-operatively, disease was advanced, with universal scutum erosion (100%), sclerotic mastoids (100%), and near-universal incus involvement (96%), reflecting an unsafe, attic-dominant disease spectrum.

Table 1: PTA findings in cases of Squamous type of CSOM

PTA		
	Frequency	Percent
BL MOD CHL	8	16.0
L MILD CHL	1	2.0
L MOD CHL	18	36.0
L SEV CHL	2	4.0
MILD CHL	1	2.0
R MOD CHL	17	34.0
R SEV MHL	2	4.0
Total	50	100.0

HRCT demonstrated variable diagnostic performance across anatomical subsites. For the tegmen tympani, sensitivity was 66.7%, specificity 82.9%, PPV 46.2%, NPV 91.9%, and accuracy 80% ( $\kappa \approx 0.42$ ;  $p=0.002$ ), supporting a rule-out role. The sigmoid sinus plate showed perfect specificity and PPV (100%) but low sensitivity (30%), while the lateral semicircular canal (LSCC) similarly demonstrated 100% specificity/PPV with low sensitivity (25%), establishing both as rule-in parameters.

Evaluation of the facial canal was limited, with sensitivity 42.9%, specificity 75.9%, and accuracy 62% ( $\kappa \approx 0.18$ ;  $p=0.161$ ), indicating unreliable exclusion of dehiscence. Ossicular assessment revealed that HRCT detected presence of disease more reliably than severity. Malleus erosion was 84% intra-operatively, though partial erosions were undercalled radiologically. Incus involvement was 96%, with 44% exact grading agreement ( $\chi^2=10.587$ ,  $p=0.032$ ). The stapes was frequently overcalled, with sensitivity 75% but low specificity (56%) and PPV (19%), although NPV remained high (95%).

Additional findings included Koerner's septum absence in 100% and uniform "system" labeling for the tympanic membrane field (100%), limiting analytical contribution. Posterior superior quadrant pathology predominated, with PSQ + granulations (18%) and PSQ + cholesteatoma (16%), consistent with attic-driven disease.

Overall, HRCT proved highly valuable for pre-operative mapping in unsafe COM, functioning as a rule-out test for tegmen defects and a rule-in test for sinus plate and LSCC involvement, while demonstrating limitations in evaluating delicate structures such as the facial canal and stapes. These findings reinforce the role of HRCT as a target-specific surgical planning tool rather than a definitive diagnostic modality

## CONCLUSION

This ambispective correlation study demonstrates that HRCT temporal bone is best interpreted in a structure-specific manner, enabling precise surgical anticipation rather than binary accuracy assessment. The cohort was predominantly young (60%  $\leq 30$  years) with male predominance (64%), and showed an unsafe disease profile with scutum erosion (100%), sclerotic mastoid (100%), and incus involvement (96%). Audiometry reflected this pathology, with moderate conductive hearing loss predominating (left 36%, right 34%, bilateral 16%).

HRCT performance varied by structure. The tegmen tympani showed 80% accuracy and high NPV (91.9%), supporting a rule-out role. In contrast, the sigmoid sinus plate (sensitivity 30%, specificity/PPV 100%) and LSCC (sensitivity 25%, specificity/PPV 100%) functioned as rule-in parameters, where positive findings are definitive but negatives do not exclude disease. The facial canal demonstrated limited reliability (sensitivity 42.9%, accuracy 62%), necessitating cautious intra-operative handling regardless of imaging.

Ossicular assessment showed that HRCT reliably detects presence of incus erosion (96%), but grading is limited (44% agreement). The stapes was frequently overcalled, with low PPV (19%) despite high NPV (95%), indicating that negative findings are more dependable than positive ones.

Overall, HRCT serves as a target-specific surgical planning tool, with a practical diagnostic framework: rule-out for tegmen, rule-in for sinus/LSCC, cautious interpretation for facial canal, presence-not-severity for incus, and overestimation for stapes. This approach enhances surgical planning, risk anticipation, and patient counselling without overstating imaging accuracy

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