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Research Article

Analytical Cross-Sectional Study: The Correlation of HRCT Temporal Bone Findings and Intraoperative Findings in Chronic Otitis Media of Squamosal Type

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ABSTRACT

Background: Cholesteatoma (Johannes Muller 1838) is a benign keratinizing epithelial lined cystic structure found in the middle ear cavity and mastoid. It can cause destruction of the local structures like ossicular chain and otic capsule, thereby leading to complications such as hearing loss, vestibular dysfunction, facial paralysis and intracranial complications like meningitis and brain abscess. Accurate preoperative assessment is crucial for surgical planning. High-Resolution Computed Tomography (HRCT) of the temporal bone plays a vital role in evaluating disease extent and involvement of critical structures.

Aim: To assess the correlation between HRCT temporal bone findings and intraoperative observations in patients with squamosal-type COM.

Methodology: This study was conducted on patients diagnosed with squamosal-type COM who underwent HRCT imaging followed by surgical intervention. HRCT findings regarding ossicular erosion, scutum, tegmen, sinus plate, posterior canal wall, facial nerve canal, and soft tissue densities were compared with intraoperative findings. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of HRCT were calculated. Statistical analysis was performed using the Chi-square test.

Results: HRCT showed high sensitivity for detecting ossicular erosion (95.08%), scutum erosion (100%), and posterior canal wall erosion (100%), with posterior canal wall erosion also demonstrating a 100% NPV. HRCT findings closely matched intraoperative results for tegmen plate erosion (sensitivity 92.3%, specificity 98.2%) and sinus plate erosion. Minor discrepancies were noted in incus and stapes erosion detection. HRCT was 100% accurate in identifying middle ear soft tissue densities.

Conclusion: HRCT of the temporal bone is a highly reliable tool in preoperative assessment of squamosal-type COM. While not a substitute for surgical evaluation, it significantly aids in identifying disease extent, planning surgery, and reducing intraoperative surprises.

Keywords*: HRCT Temporal Bone, Chronic Otitis Media, Ossicular Erosion, Cholesteatoma, Middle Ear Surgery.*

INTRODUCTION

Chronic Otitis Media (COM), particularly attic antral disease involving cholesteatoma, remains a significant global health concern, especially in developing countries. The disease is notable not only for its high prevalence but also for the economic burden and potential for serious complications, including hearing loss and intracranial sequelae.[1] COM continues to be a common presentation in the outpatient departments of otorhinolaryngology, particularly among individuals from lower socioeconomic strata.[1,2] However, the disease can affect individuals across all economic backgrounds. The persistent challenge in developing countries like India is amplified by factors such as lack of awareness, inadequate healthcare access, and delayed medical attention. Many patients, particularly in rural settings, seek treatment only when the disease is significantly advanced, contributing to higher rates of complications and chronicity.[2,3]

The World Health Organization (WHO) estimates that 65 to 330 million individuals globally suffer from chronic otitis media, with approximately half experiencing some degree of hearing impairment. Moreover, about 28,000 deaths each year are attributed to complications of otitis media.[1] The burden is particularly severe in regions such as Oceania, with an incidence of 9.37 per 1,000 individuals, and the highest rate occurring in the first year of life. The global prevalence of COM-related hearing impairment is reported to be 30.8 per 10,000 population.[4] In India, the prevalence of cholesteatoma, a destructive form of COM, is among the highest in the world, exceeding 4%, which underscores the urgent need for effective diagnosis and management strategies.[4] Cholesteatoma has an incidence rate of 3 per 100,000 in children and 9 per 100,000 in adults. Due to its invasive nature and propensity to cause intracranial complications, it contributes substantially to morbidity and occasional mortality.[4,5]

COM of the active squamous type is particularly aggressive and necessitates surgical management in almost all cases. Despite being curable, the disease's complexity due to the anatomical intricacies of the temporal bone poses a major challenge. The surgical management of cholesteatoma is generally classified into two categories: canal wall up (CWU) and canal wall down (CWD) procedures. The choice of surgical approach is dictated by the extent and location of the disease. Radiological imaging plays a pivotal role in preoperative assessment, enabling the surgeon to visualize the extent of the disease and plan the appropriate surgical intervention. [6]

A significant advancement in the diagnostic workup of COM is the advent of High-Resolution Computed Tomography (HRCT) of the temporal bone. HRCT provides exceptional visualization of the complex osseous anatomy of the temporal bone, with a spatial resolution of 0.45–0.65 mm.[7] It allows for detailed evaluation of cholesteatoma involvement, including erosion of ossicles, scutum, facial canal, tegmen tympani, and sigmoid sinus, as well as the presence of complications like labyrinthine fistula or auto mastoidectomy.[8,9] HRCT can also identify anatomical variations such as a high-riding jugular bulb or dehiscent facial canal that may influence surgical risk and technique.[10]

This study is undertaken to evaluate the role of HRCT of the temporal bone in the diagnosis and preoperative assessment of cholesteatoma. The objective is to determine whether HRCT can reliably delineate disease extent and involvement of adjacent structures and assist in surgical planning. A correlation between HRCT findings and intraoperative observations will be established to assess the diagnostic accuracy and clinical utility of HRCT. The broader aim is to advocate for HRCT as a standard preoperative imaging modality in patients with COM with suspected cholesteatoma, thereby improving surgical outcomes and minimizing complications.

AIM & OBJECTIVES

To assess the correlation between HRCT temporal bone findings and intraoperative observations in patients with squamosal-type COM.

METHODOLOGY

The present work was undertaken to study the radiological findings of HRCT temporal bone findings in patients with COM of Active Squamosal type and intraoperative findings at Tertiary Health care centre in Northern Maharashtra in the department of Otorhinolaryngology, between August 2022 to August 2024.

Sample size: 70 patients

Inclusion Criteria:

Patients of all age groups clinically diagnosed with active squamosal type of chronic otitis media (COM), presenting with unsafe COM features such as purulent/foul-smelling/blood-stained otorrhea, progressive hearing loss, tinnitus, vertigo, headache, giddiness, or other otogenic complications including facial nerve palsy or periauricular swelling, and who are willing to undergo HRCT and surgery.

Exclusion Criteria:

Patients with contraindications to HRCT, prior history of ear surgery for COM, history of trauma, those unfit for anaesthesia, or with temporal bone malignancies were excluded from the study.

Methodology:

A total of 70 patients with clinically diagnosed active squamosal type COM attending the ENT outpatient department at a tertiary healthcare centre in Northern Maharashtra were included. Detailed history, ENT examination, tuning fork tests, audiometry, radiological (X-ray Schuller's view), and HRCT of the temporal bone (performed on a GE 16-slice machine) were done preoperatively. Surgical intervention with mastoid exploration was performed after informed consent and preoperative evaluation. Intraoperative findings were recorded and correlated with preoperative HRCT findings.

Statistical Analysis:

All data were entered in Microsoft Excel and analyzed using appropriate statistical tests. A p-value less than 0.05 was considered statistically significant.

RESULT & OBSERVATIONS

Chronic Otitis Media (COM) of squamosal type, often associated with cholesteatoma, poses a significant risk of complications due to its destructive nature. High-Resolution Computed Tomography (HRCT) of the temporal bone has become a crucial preoperative diagnostic tool to assess the extent, location, and involvement of surrounding structures. All enrolled patients underwent a thorough ENT examination, which included otoscopic evaluation under a microscope, tuning fork tests, pure tone audiometry, X-ray mastoid (Schuller's view), and required laboratory investigations. HRCT of the temporal bone was performed using a GE Healthcare 16-slice scanner prior to surgery.

Among the 70 patients, 28 (40%) were under 25 years of age, another 28 (40%) were between 26–40 years, and 14 (20%) were above 40 years. The gender distribution included 32 (45.7%) males and 38 (54.3%) females**. (Refer Table 1)**

Table 1 – Age & Gender distribution

Age Groups	Number	Percentage
<25 Year	28	40.0%
26-40 Year	28	40.0%
>40 year	14	20.0%
Gender		
Male	32	45.7%
Female	38	54.3%
Total	70	100.0%

Ossicles were identified in 63 (90.0%) patients on HRCT, while intraoperatively they were seen in 61 (87.1%) cases. HRCT showed high sensitivity (95.08%) and a positive predictive value (92.1%) for detecting ossicles. However, specificity was relatively low at 44.4%, with a negative predictive value of 57.1%.There was no statistically significant difference between HRCT and intraoperative findings in the evaluation of ossicles (P = 0.595), supporting the reliability of HRCT as a preoperative diagnostic tool.

Malleus erosion was seen in 34 patients (48.6%) on HRCT and in 32 patients (45.7%) intraoperatively. HRCT showed 75.0% sensitivity and 73.6% specificity. The PPV was 70.6% and NPV was 77.8%. There was no significant difference between HRCT and surgery (P = 0.735). HRCT is useful in identifying malleus erosion preoperatively.

Incus erosion was detected in 36 patients (51.4%) on HRCT and in 44 patients (62.9%) intraoperatively. HRCT had 70.4% sensitivity and 80.7% specificity. The PPV was 86.1% and NPV was 61.8%. No significant difference was found (P = 0.172). HRCT is reliable for detecting incus erosion before surgery.

Stapes erosion was detected in 22 patients (31.4%) on HRCT and in 19 patients (27.1%) during surgery. HRCT showed a sensitivity of 73.6% and specificity of 84.3%. The positive predictive value (PPV) was 63.6%, and the negative predictive value (NPV) was 89.6%. There was no statistically significant difference between HRCT and intraoperative findings (P = 0.577). Thus, HRCT is useful in identifying stapes erosion preoperatively.

Tegmen plate erosion was seen in 13 patients (18.6%) both on HRCT and intraoperatively. HRCT showed high sensitivity (92.3%) and specificity (98.2%). The PPV was 92.3% and the NPV was 98.2%. There was no statistically significant difference (P = 1.000). This indicates that HRCT is a reliable tool for detecting tegmen plate erosion before surgery.

Sinus plate erosion was found in 4 patients (5.7%) on HRCT, matching the intraoperative findings. HRCT demonstrated a sensitivity of 75.0% and specificity of 98.4%. The PPV was 75.0%, and the NPV was 98.5%. No statistically significant difference was observed (P = 1.000). Hence, HRCT is effective in preoperative identification of sinus plate erosion.

Lateral semicircular canal dehiscence was seen in 4 patients (5.7%) on HRCT, matching the intraoperative findings. HRCT showed a sensitivity of 75.0% and specificity of 98.4%. The positive predictive value (PPV) was 75.0%, and the negative predictive value (NPV) was 98.5%. There was no statistically significant difference between HRCT and

intraoperative findings (P = 1.000). Therefore, HRCT is useful for preoperative identification of lateral semicircular canal dehiscence.

Scutum erosion was detected in 33 patients (47.1%) on HRCT, whereas it was confirmed in 25 patients (35.7%) intraoperatively. HRCT had a sensitivity of 100% and specificity of 82.2%. The PPV was 75.8%, and the NPV was 100.0%. No statistically significant difference was observed between HRCT and surgical findings (P = 0.170). Hence, HRCT proves to be helpful in detecting scutum erosion prior to surgery.

Facial nerve canal effacement was noted in 6 patients (8.6%) on HRCT and in 4 patients (5.7%) during surgery. HRCT demonstrated a sensitivity of 75.0% and specificity of 95.4%. The PPV was 50.0%, and the NPV was 98.4%. There was no statistically significant difference between HRCT and intraoperative results (P = 0.512). Thus, HRCT can be considered useful in identifying facial nerve canal effacement before surgery.

Posterior canal wall erosion was seen in 5 patients (7.1%) on HRCT and in 4 patients (5.7%) intraoperatively. HRCT showed a sensitivity of 100.0% and specificity of 98.4%. The PPV was 80.0%, and the NPV was 100.0%. There was no statistically significant difference between HRCT and surgical findings (P = 0.730). Therefore, HRCT can aid in the preoperative detection of posterior canal wall erosion.

Soft tissue density was detected in all 70 patients (100%) using both HRCT and intraoperative methods, showing complete agreement between the two modalities.

HRCT detected ossicle abnormalities in 63 cases, closely matching intraoperative findings in 61 cases. This highlights the strong diagnostic value of HRCT in evaluating ossicular pathologies.

Malleus erosion was seen in 34 cases on HRCT and 32 cases intraoperatively, indicating good agreement. Incus erosion was more commonly detected during surgery (44 cases) than on HRCT (36 cases), suggesting a slight underestimation by HRCT. Stapes erosion findings were comparable, with 22 cases on HRCT and 19 surgically. Tegmen plate erosion (13 cases) and sinus plate erosion (4 cases) were equally detected by both methods, showing excellent consistency. Lateral semicircular canal dehiscence was identified in 2 patients on both HRCT and intraoperative evaluation. Scutum erosion appeared more frequently on HRCT (33 cases) than intraoperatively (25 cases), hinting at HRCT's greater sensitivity. Facial nerve canal effacement was slightly more frequent on HRCT, showing moderate correlation. Posterior canal wall erosion also showed close alignment, being marginally higher on HRCT.**(Ref Fig 1)**

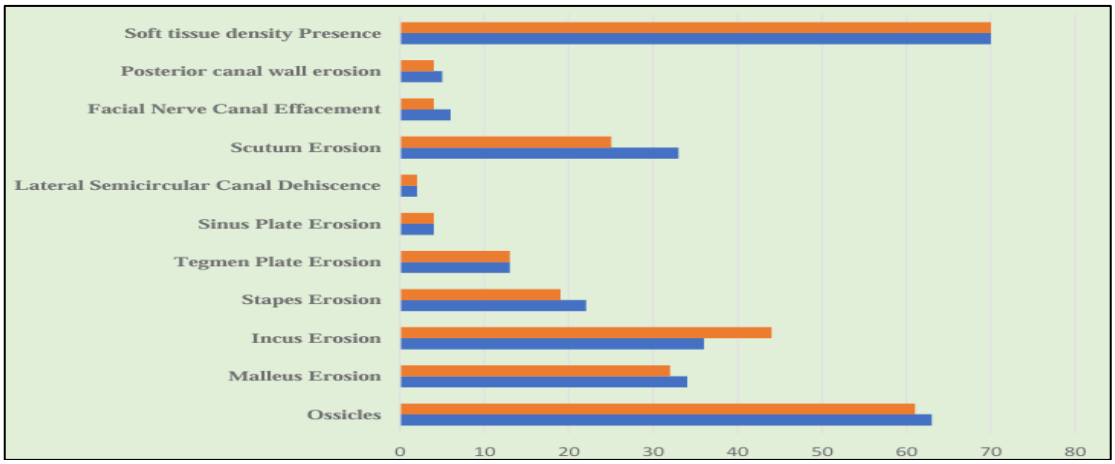

Figure 1 - Comparative evaluation of HRCT & Intraoperative findings

HRCT demonstrated high sensitivity (95.08%) but lower specificity (44.4%) for detecting ossicular abnormalities, with a PPV of 92.1% and NPV of 57.1%, making it better at confirming than excluding disease. For individual structures, malleus erosion had moderate sensitivity (75%) and specificity (73.6%), while incus and stapes erosion showed similar sensitivities (70.4% and 73.6%) with incus having a higher PPV (86.1%). Tegmen and sinus plate erosion showed excellent specificity (98.2% and 98.4%) and high NPV, making HRCT highly reliable for ruling out these conditions. Lateral semicircular canal dehiscence had lower sensitivity (50%) but very high specificity (98.5%). Scutum and posterior canal wall erosions had perfect sensitivity (100%) and high specificity, while facial nerve canal effacement demonstrated moderate sensitivity (75%) and high specificity (95.4%), affirming HRCT's utility in preoperative assessment. **(Refer Table 2)**

Findings	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Ossicles	95.08%	44.4%	92.1%	57.1%
Malleus Erosion	75.0%	73.6%	70.6%	77.8%
Incus Erosion	70.4%	80.7%	86.1%	61.8%
Stapes Erosion	73.6%	84.3%	63.6%	89.6%
Tegmen Plate Erosion	92.3%	98.2%	92.3%	98.2%
Sinus Plate Erosion	75.0%	98.4%	75.0%	98.5%
Lateral Semicircular Canal Dehiscence	50.0%	98.5%	50.0%	98.5%
Scutum Erosion	100.0%	82.2%	75.8%	100.0%
Facial Nerve Canal Effacement	75.0%	95.4%	50.0%	98.4%
Posterior canal wall erosion	100.0%	98.4%	80.0%	100.0%

DISCUSSION

In the present analytical cross-sectional study titled *"The Correlation of HRCT Temporal Bone Findings and Intraoperative Findings in Chronic Otitis Media of Squamosal Type,"* 70 patients were evaluated to determine the role of HRCT in assessing the extent and involvement of adjacent structures by cholesteatoma. The majority of patients were under 40 years (80%), and there was a slight female predominance (54.3%). Compared to **Kanotra S et al. (2015),** who reported a male predominance (57.44%) with a mean age of 36.38 years, the current study showed a more balanced gender distribution and younger age group.[11]**Aljehani M (2019)** also observed a higher percentage of females (64.1%) and a younger mean age of 28 years, aligning more closely with our findings.[12] In contrast, **Sagar NJ et al.** (2017) reported a male predominance (65%) and a higher concentration in the 31–40 age group. Thus, the present study features a relatively younger and more gender-balanced population compared to prior studies.[13]

The ossicular status assessed via HRCT and intraoperatively showed ossicles present in 90.0% and 87.1% of cases, respectively. HRCT demonstrated a high sensitivity (95.08%) but low specificity (44.4%). These findings align with **Dutta et al.** who reported 89% sensitivity and 85% accuracy, and contrast with **Agarwal et al. (2022)** and **Malashetti S. (2018),** who observed higher rates of ossicular erosion intraoperatively. The relatively lower specificity in the present study may be due to challenges in differentiating between true erosion and soft tissue envelopment, especially of the stapes, emphasizing the complementary role of intraoperative findings.[14-16]

Regarding malleus erosion, HRCT detected it in 48.6% of cases versus 45.7% intraoperatively, with a sensitivity of 75.0% and specificity of 73.6%. These results show moderate correlation and are comparable to findings by **Agarwal et al. (2022),** who reported 81.3% sensitivity. Similarly, Sagar NJ et al. (2017) found a sensitivity of 68.75%, while Gerami et al. noted lower sensitivity for malleus erosion compared to other ossicles.[15]

HRCT detected incus erosion in 51.4% of cases, while intraoperative findings confirmed it in 62.9%. The sensitivity and specificity were 70.4% and 80.7%, respectively, with a PPV of 86.1%. Compared to **Matta et al. (2017),** who reported lower HRCT detection (26%–62%) and similar intraoperative findings (30%–66%), the current study shows slightly higher HRCT detection.[17]**Thukral et al. (2015)** reported higher sensitivity (86%) and PPV (100%) than the present study. [18]

In the current study, HRCT identified stapes erosion in 31.4% of cases, with intraoperative confirmation in 27.1%. Sensitivity was 73.6%, specificity 84.3%, PPV 63.6%, and NPV 89.6%. **Mehrdad et al. (2017)** reported lower agreement for stapes (k = 0.27), while **Gerami et al. (2009)** showed higher kappa values (0.62). [19.20]

Tegmen plate erosion showed complete agreement between HRCT and intraoperative findings, with 13 cases (18.6%) identified by both methods. HRCT demonstrated excellent diagnostic performance with a sensitivity and PPV of 92.3%, and specificity and NPV of 98.2%. These results are superior to those reported by **Chatterjee P et al. (2015),** who found 66% sensitivity, but are consistent with **Dutta et al.** (2014) who reported 100% sensitivity and specificity.[21,14]

For sinus plate erosion, HRCT and surgery agreed in 4 cases (5.7%) and excluded it in 66 cases (94.3%), showing perfect concordance. The sensitivity was 75.0% and specificity 98.4%, aligning with findings by **Zia Hui Ng et al. (2014),** who

noted moderate agreement (k=0.76).[22] Although slightly lower than the 100% sensitivity reported by **Agarwal R et al. (2022),** the present study reaffirms HRCT's high reliability in detecting and especially ruling out sinus plate erosion.[15]

Lateral semicircular canal dehiscence was noted in 2 cases (2.9%) both on HRCT and intraoperatively, with perfect agreement (p=1.000). HRCT showed a sensitivity of 50.0% and specificity of 98.5%. These findings are consistent with **Thukral CL (2015),** who reported low sensitivity (33.33%) but high specificity (97.5%) for HRCT in detecting similar dehiscence.[18]**Datta G et al. (2014)** also reported comparable results.[14]

HRCT detected scutum erosion in 33 cases (47.1%), while intraoperative findings confirmed 25 cases (35.7%), with no significant statistical difference (p=0.170). Sensitivity and NPV were 100%, while specificity was 82.2%. These results align with **Gerami H et al. (2009),** both of whom reported high accuracy and specificity. **Sagar NJ et al. (2017)** also reported over 90% accuracy.[20, 13]

Facial nerve canal effacement was seen in 6 cases on HRCT and 4 intraoperatively, with a non-significant difference (p=0.512). HRCT sensitivity was 75.0%, specificity 95.4%, and NPV 98.4%, though PPV was low (50.0%). This reflects similar findings by **Thukral CL (2015)** and **Datta G et al. (2014),** both reporting low sensitivity (33.33%) and high specificity.[18,14]

In the present study, posterior canal wall erosion was detected in 5 cases (7.1%) on HRCT and 4 cases (5.7%) intraoperatively. With a Chi-square value of 0.119 (p = 0.730), there was no statistically significant difference. HRCT showed 100% sensitivity, 98.4% specificity, 80% PPV, and 100% NPV, confirming its high diagnostic accuracy. These findings align with studies by **Sagar NJ et al. (2017),Gerami H et al. (2009),** and **Khavasi P et al. (2018),** which also reported high sensitivity and specificity for detecting bony erosions with HRCT.[13,20,23]

There was complete agreement (100%) between HRCT and intraoperative findings in detecting soft tissue density in the middle ear, confirming HRCT's accuracy. Similar results were reported by **Sagar NJ et al. (2017), Gerami H et al. (2009),** and **Khavasi P et al. (2018),** emphasizing HRCT's role in preoperative planning.[13,20,23]

HRCT and intraoperative findings were closely matched in most parameters. HRCT slightly overestimated scutum and incus erosions and underestimated some ossicular erosions. Nonetheless, high concordance was seen in detecting tegmen and sinus plate erosion, lateral semicircular canal dehiscence, and soft tissue presence. These observations are consistent with studies by **Sagar NJ et al. (2017)** and **Khavasi P et al. (2018),** though as noted by **Gerami H et al. (2009),** HRCT may miss subtle erosions.[13,20,23]

HRCT showed excellent sensitivity for scutum and posterior canal wall erosions (100%) and high specificity for tegmen (98.2%) and sinus plate erosions (98.4%). Moderate sensitivity but high specificity was noted for incus and stapes erosions. HRCT was less sensitive for lateral semicircular canal dehiscence and facial nerve canal effacement but retained high specificity.

CONCLUSION

The present analytical cross-sectional study highlights a strong correlation between HRCT temporal bone findings and intraoperative observations in squamosal-type chronic otitis media (COM). HRCT proved highly sensitive, particularly for detecting ossicular erosion, tegmen plate involvement, and posterior canal wall erosion—with the latter showing 100% sensitivity and negative predictive value. These findings reinforce HRCT's utility in accurately assessing disease extent and involvement of critical structures, thus aiding in effective surgical planning. Although certain areas, like malleus and incus erosion, showed moderate specificity requiring intraoperative confirmation, HRCT remains an indispensable preoperative tool. It enhances diagnostic confidence, reduces intraoperative surprises, and supports better clinical outcomes.

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