

Correlation of Preoperative HRCT Temporal Bone Findings with Intraoperative Findings in Patients Undergoing Tympanomastoidectomy

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ABSTRACT

Background: High-resolution computed tomography (HRCT) of the temporal bone is routinely used for the preoperative evaluation of chronic suppurative otitis media (CSOM) with cholesteatoma. However, its accuracy in predicting intraoperative findings remains variable. This study aimed to evaluate the correlation between preoperative HRCT temporal bone findings and intraoperative findings in patients undergoing tympanomastoidectomy, and to assess the diagnostic usefulness of HRCT in preoperative surgical planning. **Materials and Methods:** This prospective longitudinal observational study was conducted in the Department of Otorhinolaryngology at a tertiary care teaching hospital from June 2020 to November 2022. A total of 129 patients aged >6 years with CSOM planned for tympanomastoidectomy were included. All patients underwent clinical evaluation, otoendoscopy, otomicroscopy, pure tone audiometry and HRCT temporal bone followed by surgery. HRCT findings regarding disease extent, ossicular chain, facial nerve canal, tegmen plate, sigmoid sinus plate, lateral semicircular canal and other anatomical structures were compared with intraoperative findings. Diagnostic accuracy was assessed using sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). Statistical analysis was performed using Chi-square/Fisher's exact test, with $p < 0.05$ considered statistically significant. **Results:** The majority of patients were aged 21–30 years (24.8%), with a male predominance (55.8%). HRCT showed significant agreement with intraoperative findings for the extent of cholesteatoma ($p < 0.001$). It demonstrated excellent diagnostic accuracy for tegmen plate, sigmoid sinus plate and high-riding jugular bulb, and good accuracy for malleus erosion, lateral semicircular canal erosion and fallopian canal dehiscence. Lower diagnostic accuracy was observed for incus and stapes erosion. **Conclusion:** Preoperative HRCT temporal bone demonstrated good correlation with intraoperative findings and is a valuable adjunct for preoperative assessment and surgical planning in tympanomastoidectomy. However, it has limitations in differentiating cholesteatoma from mucosal disease and in accurately predicting certain ossicular erosions.

Keywords: Chronic suppurative otitis media; Cholesteatoma; High-resolution computed tomography; Temporal bone; Tympanomastoidectomy; Diagnostic accuracy.

INTRODUCTION

Chronic suppurative otitis media (CSOM), particularly the atticotympanic type associated with cholesteatoma, remains a significant cause of preventable hearing loss and morbidity worldwide. Cholesteatoma is characterised by the accumulation of keratinising squamous epithelium within the middle ear and mastoid, resulting in progressive bone erosion and destruction of adjacent structures. Delay in diagnosis or inadequate treatment may lead to serious

intratemporal and intracranial complications, making timely surgical intervention essential.

Successful tympanomastoidectomy depends on accurate preoperative assessment of the extent of disease, ossicular integrity, facial nerve canal, lateral semicircular canal, tegmen tympani, sigmoid sinus plate, and other important anatomical landmarks. Clinical examination and otoscopy can diagnose most cases of cholesteatoma; however, they are often inadequate for determining the full extent of disease or

identifying hidden areas of involvement that may influence surgical planning.

High-resolution computed tomography (HRCT) of the temporal bone has become the imaging modality of choice for preoperative evaluation because of its excellent spatial resolution and ability to delineate fine bony anatomy. HRCT provides valuable information regarding the extension of cholesteatoma, ossicular erosion, tegmen defects, facial canal dehiscence, labyrinthine fistula, and anatomical variations that may increase the risk of intraoperative complications. Such information assists surgeons in selecting the appropriate surgical approach and anticipating potential challenges during surgery.

Despite its widespread use, the diagnostic accuracy of HRCT remains a subject of debate. While several studies have demonstrated good correlation between HRCT findings and intraoperative observations, discrepancies may occur, particularly in detecting facial canal dehiscence, stapes erosion, small cholesteatomas, and soft tissue lesions. Therefore, assessing the reliability of HRCT in predicting operative findings is essential to determine its true clinical value and optimise surgical planning.

The present study was undertaken to evaluate the correlation between preoperative HRCT temporal bone findings and intraoperative findings in patients undergoing tympanomastoidectomy. The study also aimed to assess the usefulness of HRCT in identifying the extent of cholesteatoma, ossicular chain involvement, facial nerve canal, tegmen plate, sinus plate, lateral semicircular canal, and other critical anatomical structures, thereby determining its role as an effective preoperative planning tool in middle ear surgery.

MATERIALS AND METHODS

This prospective longitudinal observational study was conducted in the Department of Otorhinolaryngology at a tertiary care teaching hospital over a period of two years, from June 2020 to November 2022. The study was approved by the Institutional Ethics Committee before commencement, and written informed consent was obtained from all participants or their legal guardians prior to enrolment.

This was a prospective longitudinal observational study conducted in the Department of Otorhinolaryngology at a tertiary care teaching hospital from June 2020 to November 2022. The study was designed to evaluate the correlation between preoperative HRCT temporal bone findings and intraoperative findings in patients undergoing tympanomastoidectomy for chronic suppurative otitis media.

The study included 129 patients with clinically diagnosed chronic suppurative otitis media (CSOM) who were planned for tympanomastoidectomy. The

sample size was calculated based on an estimated prevalence of 1% among patients attending the ENT outpatient department, using the formula $4pq/L^2$, yielding a minimum sample size of 129. Patients were selected by simple random sampling.

Patients of either sex aged more than six years with CSOM requiring surgical intervention and willing to undergo HRCT temporal bone imaging and surgery were included in the study. Patients with acute suppurative otitis media, otitis media with effusion, age less than six years, previous ear surgery, history of temporal bone trauma, systemic diseases affecting the ear (such as collagen vascular or granulomatous disorders), malignancies involving the temporal bone or skull base, or previous head and neck radiotherapy were excluded.

A detailed clinical history and complete otorhinolaryngological examination were performed in all patients. Routine preoperative investigations, including haemoglobin, complete blood count, blood sugar level, liver and renal function tests, HIV, hepatitis B surface antigen, and pus culture and sensitivity were carried out. All patients underwent pure tone audiometry, otoendoscopy, otomicroscopy, mastoid radiography (Schüller's view), and high-resolution computed tomography (HRCT) of the temporal bone with plain and contrast images, followed by pre-anaesthetic evaluation and tympanomastoidectomy.

Preoperative HRCT findings were compared with intraoperative findings. The parameters assessed included the external auditory canal, middle ear cavity, extent of cholesteatoma, mastoid antrum and aditus, ossicular chain (malleus, incus, and stapes), facial nerve canal, lateral semicircular canal, tegmen tympani, sigmoid sinus plate, sinus tympani, and Prussak's space. Intraoperative findings served as the reference standard for assessing the diagnostic accuracy of HRCT.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Associations between categorical variables were analysed using the Chi-square test or Fisher's exact test, and comparisons of continuous variables were performed using the unpaired Student's t-test. Diagnostic accuracy of HRCT was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). A p-value <0.05 was considered statistically significant. For diagnostic accuracy analysis, true-positive, true-negative, false-positive, and false-negative findings were determined by comparing the preoperative HRCT interpretation with the corresponding intraoperative finding. Sensitivity, specificity, positive predictive

value, and negative predictive value were calculated using intraoperative findings as the reference standard.

RESULTS

A total of 129 patients with chronic suppurative otitis media who underwent tympanomastoidectomy were included in the study. The majority of patients belonged to the 21-30 years age group (24.8%), followed by the 31-40 years age group (21.7%). There was a slight male predominance (54.3%), and the disease was more commonly unilateral than bilateral. Comparison of preoperative HRCT temporal bone findings with intraoperative findings showed a statistically significant correlation for the extent of cholesteatoma, aditus patency, tegmen plate erosion, sinus plate erosion, lateral semicircular canal erosion, ossicular chain status (malleus, incus, and stapes), facial canal dehiscence, and jugular bulb status ($p<0.05$). HRCT demonstrated excellent diagnostic accuracy in detecting the extent of cholesteatoma and bony erosions involving the tegmen plate, sinus plate, and ossicular chain, with high sensitivity and specificity.

Among the ossicles, HRCT showed the highest diagnostic accuracy for detecting incus erosion, followed by malleus erosion, whereas the sensitivity for stapes erosion was comparatively lower. HRCT also showed high specificity in identifying facial canal dehiscence and jugular bulb abnormalities, although its

sensitivity for facial canal erosion was comparatively less than that for other temporal bone structures. Overall, HRCT findings demonstrated good agreement with intraoperative findings, supporting its usefulness in preoperative assessment and surgical planning for patients undergoing tympanomastoidectomy.

HRCT demonstrated high diagnostic accuracy for several important temporal bone structures. For aditus involvement, sensitivity was 100.0%, specificity was 46.4%, PPV was 67.0%, and NPV was 100.0% ($p<0.001$). For tegmen plate and sinus plate erosion, HRCT demonstrated 100.0% sensitivity, specificity, PPV, and NPV ($p<0.001$ for both). Lateral semicircular canal erosion showed a sensitivity of 66.7%, specificity of 100.0%, PPV of 100.0%, and NPV of 96.7% ($p=0.002$).

For ossicular erosion, HRCT showed a sensitivity of 86.7% and specificity of 97.1% for malleus erosion, with PPV and NPV of 96.3% and 89.3%, respectively. For incus erosion, sensitivity was 57.8%, specificity 100.0%, PPV 100.0%, and NPV 50.6%. For stapes erosion, sensitivity was 82.6%, specificity 85.5%, PPV 76.0%, and NPV 89.9% ($p<0.001$ for all comparisons). For fallopian canal dehiscence, sensitivity was 72.7%, specificity 95.3%, PPV 88.9%, and NPV 87.1% ($p<0.001$). HRCT demonstrated 100.0% sensitivity, specificity, PPV, and NPV for high-riding jugular bulb abnormalities ($p<0.001$).

Table 1. Baseline characteristics of the study population (N=129)

Characteristic	Category	n (%)
Age (years)	10–20	18 (14.0)
	21–30	32 (24.8)
	31–40	28 (21.7)
	41–50	26 (20.2)
	51–60	14 (10.9)
	>60	11 (8.5)
Sex	Male	72 (55.8)
	Female	57 (44.2)
Laterality	Right	56 (43.4)
	Left	44 (34.1)
	Bilateral	29 (22.5)

*Data are presented as number (%)

*CSOM = Chronic Suppurative Otitis Media.

Table 2. Comparison of HRCT and intraoperative findings for extent of cholesteatoma (N=129)

HRCT diagnosis	Middle ear & attic	Middle ear, attic & mastoid	Normal	p-value
Middle ear & attic	26	0	0	<0.001
Middle ear, attic & mastoid	30	69	0	
Normal	2	0	2	

*Values represent number of patients. Intraoperative findings served as the reference standard. Chi-square test: $p < 0.001$.

*Hrct : High Resolution Computed Tomography

Table 3. Diagnostic accuracy of HRCT for major temporal bone structures

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
Aditus	100.0	46.4	67.0	100.0	<0.001
Tegmen plate	100.0	100.0	100.0	100.0	<0.001
Sinus plate	100.0	100.0	100.0	100.0	<0.001
Lateral semicircular canal	66.7	100.0	100.0	96.7	0.002

*PPV:Positive Predictive Value

*NPV: Negative Predictive Value

*HRCT: High Resolution Computed Tomography

*Diagnostic indices were calculated using intraoperative findings as reference standard .

Table 4. Diagnostic accuracy of HRCT for ossicular erosion

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
Malleus	86.7	97.1	96.3	89.3	<0.001
Incus	57.8	100.0	100.0	50.6	<0.001
Stapes	82.6	85.5	76.0	89.9	<0.001

*PPV:Positive Predictive Value

*NPV: Negative Predictive Value

*HRCT: High Resolution Computed Tomography

*Diagnostic indices were calculated using intraoperative findings as reference standard .

Table 5. Diagnostic accuracy of HRCT for facial canal and jugular bulb

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p-value
Fallopian canal dehiscence	72.7	95.3	88.9	87.1	<0.001
High riding jugular bulb	100.0	100.0	100.0	100.0	<0.001

*PPV:Positive Predictive Value

*NPV: Negative Predictive Value

*HRCT: High Resolution Computed Tomography

*Diagnostic indices were calculated using intraoperative findings as reference standard .

DISCUSSION

The present prospective observational study evaluated the correlation between preoperative High-Resolution Computed Tomography (HRCT) of the temporal bone and intraoperative findings in patients undergoing tympanomastoidectomy for chronic suppurative otitis media (CSOM). Accurate preoperative assessment of disease extent and adjacent bony structures is essential for surgical planning and prevention of intraoperative complications.

In the present study, the majority of patients were in the 21-30 years age group, with a slight male predominance. These findings are comparable with those reported by Jadia S et al., who also observed that cholesteatoma was more common in young adults with nearly equal gender distribution.

HRCT accurately demonstrated the extent of cholesteatoma and showed excellent agreement with intraoperative findings. The correlation was statistically significant, confirming HRCT as a reliable modality for evaluating disease extension into the middle ear, attic and mastoid. Similar observations have been reported by Kanotra S et al., Prata AA et al., and Thukral CL et al., who demonstrated high sensitivity and specificity of HRCT in identifying cholesteatoma and its extent.

Assessment of ossicular erosion is an important objective of preoperative imaging. In the present study, HRCT demonstrated good diagnostic performance for malleus erosion, with a sensitivity of 86.7% and specificity of 97.1%. However, sensitivity for incus erosion was comparatively lower at 57.8%, despite a

specificity of 100.0%. Stapes erosion showed a sensitivity of 82.6% and specificity of 85.5%. The relatively lower sensitivity for incus erosion may be related to the small size and complex orientation of the ossicular structures, as well as partial-volume effects. These findings indicate that although HRCT provides useful information regarding ossicular status, intraoperative assessment remains essential, particularly when subtle ossicular erosion is suspected. In the present study, HRCT demonstrated high diagnostic performance for several important temporal bone structures. The sensitivity and negative predictive value for aditus involvement were both 100.0%, although specificity was relatively lower at 46.4%. This indicates that HRCT was highly effective in identifying patients with aditus involvement, while some radiological abnormalities may not correspond to the intraoperative findings. Tegmen plate and sinus plate erosion showed excellent diagnostic performance, with sensitivity, specificity, PPV, and NPV of 100.0%. These findings highlight the value of HRCT in identifying bony defects involving critical structures that may influence surgical planning.

HRCT also demonstrated excellent diagnostic accuracy in detecting tegmen plate and sinus plate erosion, with a statistically significant correlation with operative findings. Similar results have been reported by Kanotra S et al., Madan G et al., and Prata AA et al., suggesting that HRCT is highly reliable in identifying these critical bony landmarks before surgery. Accurate preoperative recognition of these erosions assists surgeons in anticipating possible intracranial complications and planning an appropriate surgical approach.

Although HRCT showed high specificity for facial canal dehiscence, its sensitivity was comparatively lower than that for other temporal bone structures. Small defects of the fallopian canal may not be consistently visualised because of partial volume averaging and thin bony anatomy. Similar limitations have been reported by Rogha M et al., Madan G et al., and Aljehani M et al. Therefore, surgeons should remain vigilant for facial canal dehiscence despite normal preoperative imaging findings.

HRCT also showed good diagnostic performance for lateral semicircular canal erosion and fallopian canal dehiscence. Lateral semicircular canal erosion demonstrated a sensitivity of 66.7% and specificity of 100.0%, whereas fallopian canal dehiscence showed a sensitivity of 72.7% and specificity of 95.3%. These findings suggest that HRCT is highly specific for identifying abnormalities involving these structures, although a normal HRCT examination does not completely exclude subtle disease. In contrast, high-riding jugular bulb demonstrated 100.0% sensitivity, specificity, PPV, and NPV, indicating excellent agreement between HRCT and intraoperative assessment in this study.

Overall, the present study demonstrates that HRCT provides excellent preoperative evaluation of cholesteatoma extension, ossicular status and major bony erosions, with good correlation with intraoperative findings. HRCT serves as an important roadmap for the otologic surgeon by defining disease extent, identifying anatomical variations and reducing the risk of intraoperative complications. However, imaging findings should always be interpreted in conjunction with clinical examination and surgical judgment, particularly when assessing facial canal and stapes involvement.

Strengths of the Study

The major strengths of the present study include its prospective observational design and the direct comparison of preoperative HRCT findings with intraoperative findings, which served as the reference standard. The study included a relatively large sample of 129 patients and systematically evaluated multiple clinically important temporal bone structures, including the extent of cholesteatoma, ossicular chain, tegmen plate, sigmoid sinus plate, lateral semicircular canal, fallopian canal, and jugular bulb. The assessment of sensitivity, specificity, positive predictive value, and negative predictive value provided a comprehensive evaluation of the diagnostic performance of HRCT. These findings contribute to the practical understanding of the role of HRCT in preoperative surgical planning for tympanomastoidectomy.

Limitations

The present study has certain limitations. First, it was conducted at a single tertiary care teaching hospital, which may limit the generalisability of the findings to other populations and healthcare settings. Second, only patients who underwent tympanomastoidectomy were included; therefore, the findings may not be applicable to patients with chronic ear disease who are managed conservatively or do not require surgery. Third, HRCT has inherent limitations in differentiating cholesteatoma from other soft-tissue abnormalities such as granulation tissue and inflamed mucosa. Small defects involving the facial canal and subtle ossicular erosion, particularly of the incus and stapes, may also be difficult to detect because of the small size and complex anatomy of these structures and partial-volume effects. In addition, the study did not assess the role of diffusion-weighted MRI in differentiating cholesteatoma from non-cholesteatomatous inflammatory tissue. Finally, interobserver variability in HRCT interpretation was not evaluated.

Future Research

Future multicentre studies involving larger and more diverse patient populations are warranted to validate the diagnostic performance of HRCT observed in the present study. Further research should evaluate the

complementary role of HRCT and diffusion-weighted MRI, particularly in differentiating cholesteatoma from granulation tissue and other inflammatory soft-tissue lesions. Studies assessing interobserver agreement among radiologists and otologic surgeons may also help establish standardised imaging criteria for predicting disease extent, ossicular erosion, facial canal dehiscence, and other surgically relevant findings. Long-term studies may further determine whether improved preoperative imaging assessment translates into better surgical planning and clinical outcomes.

CONCLUSION

Preoperative High-Resolution Computed Tomography (HRCT) of the temporal bone showed good correlation with intraoperative findings in patients undergoing tympanomastoidectomy for chronic suppurative otitis media. HRCT accurately delineated the extent of cholesteatoma and reliably detected ossicular erosion, tegmen plate erosion, sinus plate erosion, lateral semicircular canal involvement, and jugular bulb abnormalities. Although its diagnostic accuracy was comparatively lower for facial canal and stapes erosion, HRCT remains a valuable tool for preoperative assessment and surgical planning. Routine preoperative HRCT facilitates better understanding of disease extent, helps anticipate intraoperative challenges, and may reduce the risk of surgical complications.

Declarations

Ethics Approval

The study was conducted in accordance with the ethical principles applicable to research involving human participants and was approved by the Institutional Ethics Committee of the institution where the study was conducted.

Consent to Participate

Written informed consent was obtained from all participants or their legally authorised representatives before enrolment in the study. Participants were informed about the nature and purpose of the study, and their participation was voluntary.

Consent for Publication

Not applicable, as no individually identifiable patient information or images are included in this manuscript.

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Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request, subject to institutional policies and applicable ethical and privacy requirements.

Author Contributions

Riya Kunjimon: Study conception, data collection, clinical assessment, data analysis, and manuscript preparation.

Asim Pa: Study supervision, surgical assessment, interpretation of findings, critical revision of the manuscript, and final approval of the manuscript.

Lakshmipriya N. S.: Data collection, literature review, data interpretation, and manuscript revision.

All authors read and approved the final manuscript and agreed to be accountable for all aspects of the work.

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