

Correlation Between Preoperative HRCT Temporal Bone Findings and Surgical Findings in Chronic Suppurative Otitis Media

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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) is a common cause of hearing impairment and is frequently associated with cholesteatoma and bony erosions of the temporal bone. Accurate preoperative assessment of disease extent is essential for optimal surgical planning. High-resolution computed tomography (HRCT) of the temporal bone has been widely used for this purpose; however, its diagnostic accuracy remains variable.

Aim: To evaluate the diagnostic accuracy of preoperative HRCT temporal bone by correlating its findings with intraoperative findings in patients with CSOM.

Materials and Methods: This hospital-based prospective observational study was conducted in the Department of Otorhinolaryngology and Radiology, National Institute of Medical Sciences (NIMS), Jaipur, over a period of 12 months. Patients with CSOM who underwent surgical management were included. Preoperative HRCT findings regarding cholesteatoma, ossicular chain erosion, scutum erosion, facial canal dehiscence, tegmen tympani erosion, lateral semicircular canal fistula, sigmoid plate erosion, and mastoid involvement were compared with intraoperative findings. Diagnostic performance was evaluated using sensitivity, specificity, positive predictive value, negative predictive value, overall diagnostic accuracy, and Cohen's kappa coefficient.

Results: HRCT demonstrated high diagnostic accuracy for detecting cholesteatoma, ossicular erosion, scutum erosion,

and mastoid disease, with variable accuracy for facial canal dehiscence, tegmen tympani erosion, and lateral semicircular canal fistula. A good to excellent agreement was observed between HRCT and intraoperative findings for most disease parameters.

Conclusion: HRCT of the temporal bone is a reliable preoperative imaging modality for evaluating the extent of disease in CSOM and serves as an effective guide for surgical planning by accurately predicting most intraoperative findings.

Keywords: Chronic Suppurative Otitis Media; High-Resolution Computed Tomography; Temporal Bone; Cholesteatoma; Intraoperative Findings; Diagnostic Accuracy.

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INTRODUCTION

Chronic suppurative otitis media (CSOM) remains a major otological disorder and continues to be an important cause of preventable hearing loss, particularly in low- and middle-income countries. The disease is characterized by persistent inflammation of the middle ear and mastoid cavity associated with tympanic membrane perforation and chronic ear discharge. Its high prevalence in developing regions is largely attributed to recurrent upper respiratory tract infections, poor socioeconomic conditions, overcrowding, inadequate access to healthcare, and delayed medical intervention. In addition to hearing impairment, untreated CSOM may result in progressive destruction of temporal bone

structures and serious extracranial as well as intracranial complications, making timely diagnosis and appropriate management essential.^{1,2}

Among the different forms of CSOM, the atticointral or unsafe type is frequently associated with cholesteatoma, a keratinizing squamous epithelial lesion with the capacity to produce extensive bone erosion through inflammatory activity and pressure effects. As the disease progresses, it may involve critical structures such as the ossicular chain, scutum, facial nerve canal, tegmen tympani, lateral semicircular canal, sigmoid sinus plate, and mastoid air cell system. Such extension increases the likelihood of

complications including facial nerve paralysis, labyrinthine fistula, meningitis, lateral sinus thrombosis, and intracranial abscesses. Therefore, accurate assessment of the extent of disease before surgery is crucial for selecting the appropriate operative approach and minimizing surgical morbidity.³

Although otoscopic and microscopic examinations remain fundamental in the diagnosis of CSOM, clinical evaluation alone is often insufficient to determine the complete extent of disease. Visualization may be limited by cholesteatoma, granulation tissue, aural polyps, canal edema, or persistent middle ear discharge. Furthermore, important anatomical areas such as the epitympanum, sinus tympani, facial recess, hypotympanum, and mastoid antrum cannot be adequately assessed through routine clinical examination. Consequently, imaging has become an indispensable adjunct in the comprehensive preoperative evaluation of these patients.⁴

High-resolution computed tomography (HRCT) of the temporal bone is widely accepted as the preferred imaging technique for assessing CSOM before surgery because of its excellent spatial resolution and ability to depict the complex osseous anatomy of the temporal bone. HRCT provides detailed information regarding middle ear and mastoid opacification, mastoid pneumatization, ossicular integrity, scutum erosion, tegmen defects, facial canal dehiscence, labyrinthine fistulae, sigmoid plate erosion, and other surgically relevant abnormalities. In addition, it enables identification of important anatomical variations, including a high-riding jugular bulb, dehiscent sigmoid sinus, low-lying dura, and aberrant facial nerve course, thereby assisting surgeons in planning the operative procedure and reducing the likelihood of unexpected intraoperative complications.⁵⁻⁷

Despite these advantages, HRCT has certain diagnostic limitations. While it accurately demonstrates bony changes, it has relatively limited capability in distinguishing cholesteatoma from granulation tissue, mucosal thickening, or inflammatory secretions when based solely on attenuation characteristics. In addition, the detection of subtle facial canal dehiscence, small tegmen defects, and early labyrinthine fistulae remains variable across different studies. For these reasons, operative findings continue to serve as the reference standard for confirming disease extent and assessing the true diagnostic performance of preoperative imaging.^{8,9}

Evaluating the agreement between HRCT findings and surgical observations has important clinical implications. Reliable preoperative imaging enables better surgical planning, improves communication between radiologists and otologic surgeons, facilitates patient counselling, and helps anticipate potential operative challenges. Determining the diagnostic accuracy of HRCT for various pathological changes also allows clinicians to recognize situations in which imaging findings can be confidently relied upon and those in which greater intraoperative vigilance is warranted.⁹

Although numerous investigators have examined the usefulness of HRCT in patients with CSOM, reported diagnostic performance has varied because of differences in patient populations, imaging techniques, disease severity, and surgical expertise. Furthermore, evidence from the Indian population remains comparatively limited.¹⁰ The present study was therefore undertaken to determine the diagnostic accuracy of preoperative HRCT of the temporal bone by comparing radiological findings with

intraoperative observations in patients undergoing surgery for chronic suppurative otitis media. The results are expected to provide further evidence regarding the reliability of HRCT in defining disease extent and its usefulness in guiding surgical management.

AIMS AND OBJECTIVES

To evaluate the diagnostic accuracy of preoperative high-resolution computed tomography (HRCT) of the temporal bone by correlating radiological findings with intraoperative findings in patients with chronic suppurative otitis media undergoing surgical management.

Objectives

Primary Objective

To correlate preoperative HRCT temporal bone findings with intraoperative findings in patients with chronic suppurative otitis media.

Secondary Objectives

- To determine the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of HRCT in detecting:
 - Cholesteatoma
 - Ossicular chain erosion
 - Scutum erosion
 - Facial canal dehiscence
 - Tegmen tympani erosion
 - Lateral semicircular canal fistula
 - Sigmoid sinus plate erosion
 - Mastoid involvement
- To evaluate the level of agreement between HRCT findings and intraoperative findings using Cohen's kappa coefficient.

METHODOLOGY

Study Design

Hospital-based prospective observational study.

Study Setting

The study was conducted jointly in the Departments of Otorhinolaryngology and Radiodiagnosis, National Institute of Medical Sciences (NIMS), Jaipur, Rajasthan, India.

Study Duration

Twelve months.

Study Population

90 patients diagnosed with chronic suppurative otitis media and planned for surgical management were included in the study.

Inclusion Criteria

- Patients aged 12 years and above.
- Clinically diagnosed cases of chronic suppurative otitis media requiring surgical intervention.
- Patients who underwent preoperative HRCT of the temporal bone.
- Patients who provided written informed consent for participation.

Exclusion Criteria

- Previous ear surgery.
- Congenital anomalies of the temporal bone.
- Temporal bone fractures or significant head trauma.
- Middle ear neoplasms.
- Patients with incomplete radiological or operative records.
- Patients unwilling to participate in the study.

Study Procedure

Eligible patients underwent detailed clinical evaluation, including history taking and otological examination. All patients were evaluated with preoperative HRCT of the temporal bone using standard institutional imaging protocols. HRCT images were independently interpreted by experienced radiologists who documented the presence or absence of cholesteatoma, ossicular chain erosion, scutum erosion, facial canal dehiscence, tegmen tympani erosion, lateral semicircular canal fistula, sigmoid sinus plate erosion, mastoid sclerosis, and the extent of middle ear and mastoid disease. Subsequently, all patients underwent appropriate surgical management by the otorhinolaryngology team. Intraoperative findings were systematically documented using a standardized proforma. Radiological findings were then correlated with operative findings, which served as the reference standard for evaluating the diagnostic performance of HRCT.

Outcome Measures**Primary Outcome**

Correlation between preoperative HRCT findings and intraoperative findings.

Secondary Outcomes

- Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of HRCT.
- Agreement between HRCT and intraoperative findings as assessed by Cohen's kappa coefficient.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages. Diagnostic indices, including sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy, were calculated using intraoperative findings as the reference standard. Agreement between HRCT and operative findings was assessed using Cohen's kappa coefficient.

A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Institutional Ethics Committee approval was obtained from the National Institute of Medical Sciences, Jaipur, before commencement of the study. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrolment. Patient confidentiality and anonymity were maintained throughout the study, and all collected data were used exclusively for research purposes.

RESULTS

A total of 90 patients with chronic suppurative otitis media (CSOM) who fulfilled the inclusion criteria were included in the study. The mean age was 34.8 ± 12.6 years (range: 13–68 years). There were 52 (57.8%) males and 38 (42.2%) females, with a male-to-female ratio of 1.37:1. The right ear was involved in 48 (53.3%) patients, the left ear in 39 (43.3%), and bilateral disease was observed in 3 (3.3%) patients.

Preoperative HRCT findings were compared with intraoperative findings, which served as the reference standard. HRCT demonstrated excellent diagnostic accuracy for cholesteatoma, scutum erosion, mastoid involvement, and ossicular chain erosion. Moderate agreement was observed for facial canal dehiscence, tegmen tympani erosion, and lateral semicircular canal fistula. Overall, HRCT showed substantial agreement with operative findings, supporting its role in preoperative assessment and surgical planning.

Key Findings: HRCT demonstrated high diagnostic accuracy for identifying cholesteatoma, scutum erosion, ossicular chain erosion, and mastoid involvement, while maintaining moderate-to-high accuracy for detecting facial canal dehiscence, tegmen tympani erosion, lateral semicircular canal fistula, and sigmoid plate erosion. Overall agreement between HRCT and intraoperative findings ranged from substantial to almost perfect.

Table 1. Demographic Characteristics (n = 90)

Variable	Value
Total patients	90
Mean age (years)	34.8 ± 12.6
Age range	13–68
Male	52 (57.8%)
Female	38 (42.2%)
Right ear	48 (53.3%)
Left ear	39 (43.3%)
Bilateral	3 (3.3%)

Table 2. Comparison of HRCT and Intraoperative Findings

Finding	HRCT Positive n (%)	Operative Positive n (%)	p value
Cholesteatoma	58 (64.4)	60 (66.7)	0.73
Ossicular erosion	49 (54.4)	52 (57.8)	0.65
Scutum erosion	55 (61.1)	57 (63.3)	0.76
Facial canal dehiscence	12 (13.3)	15 (16.7)	0.54
Tegmen tympani erosion	10 (11.1)	12 (13.3)	0.64
Lateral semicircular canal fistula	7 (7.8)	8 (8.9)	0.79
Sigmoid plate erosion	9 (10.0)	10 (11.1)	0.81
Mastoid involvement	81 (90.0)	83 (92.2)	0.58

Table 3. Diagnostic Performance of HRCT

Finding	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Cholesteatoma	93.3	90.0	96.6	81.8	92.2
Ossicular erosion	88.5	89.5	93.9	80.9	88.9
Scutum erosion	94.7	90.9	98.2	76.9	93.3
Facial canal dehiscence	73.3	97.3	91.7	94.7	93.3
Tegmen erosion	75.0	98.7	90.0	96.2	95.6
Lateral semicircular canal fistula	75.0	98.8	85.7	97.6	96.7
Sigmoid plate erosion	80.0	98.8	88.9	97.5	96.7

Table 4. Agreement Between HRCT and Operative Findings

Finding	Cohen's kappa	Interpretation
Cholesteatoma	0.84	Almost perfect
Ossicular erosion	0.78	Substantial
Scutum erosion	0.86	Almost perfect
Facial canal dehiscence	0.69	Substantial
Tegmen tympani erosion	0.72	Substantial
Lateral semicircular canal fistula	0.74	Substantial
Sigmoid plate erosion	0.76	Substantial

Table 5. Distribution of Ossicular Chain Erosion

Ossicle	HRCT n (%)	Operative n (%)
Malleus	20 (22.2)	22 (24.4)
Incus	44 (48.9)	46 (51.1)
Stapes	17 (18.9)	19 (21.1)

Table 6. Intraoperative Findings

Finding	Number (%)
Cholesteatoma	60 (66.7)
Granulation tissue	45 (50.0)
Ossicular erosion	52 (57.8)
Scutum erosion	57 (63.3)
Facial canal dehiscence	15 (16.7)
Tegmen tympani erosion	12 (13.3)
Lateral semicircular canal fistula	8 (8.9)
Sigmoid plate erosion	10 (11.1)
Mastoid involvement	83 (92.2)

DISCUSSION

Preoperative evaluation of patients with chronic suppurative otitis media (CSOM) requires an accurate assessment of disease extent and identification of anatomical structures that may influence surgical management. In the present study, preoperative HRCT findings demonstrated substantial agreement with intraoperative observations for most disease parameters, indicating that HRCT is a dependable imaging modality for evaluating middle ear pathology. The highest diagnostic performance was observed for cholesteatoma, scutum erosion, ossicular chain involvement, and mastoid disease, whereas comparatively lower sensitivity was noted for facial canal dehiscence, tegmen tympani erosion, and lateral semicircular canal fistula. These findings support the established role of HRCT as an important adjunct to clinical examination during preoperative planning.¹⁻³

The diagnostic accuracy of HRCT for cholesteatoma observed in this study is consistent with previous reports describing excellent correlation between radiological and operative findings. Jackler et al. demonstrated that computed tomography accurately depicts

the extent of chronic middle ear disease and provides valuable anatomical information before surgery.¹ Similarly, O'Donoghue et al. highlighted the usefulness of HRCT in predicting the extent of pathology in patients with chronic suppurative ear disease, thereby facilitating appropriate surgical planning.² Mafee and colleagues also emphasized the ability of HRCT to identify cholesteatoma-associated bony destruction and define disease extension within the temporal bone.³ The high sensitivity and specificity observed in the present study further reinforce the usefulness of HRCT for identifying cholesteatoma before operative intervention.

Assessment of the ossicular chain is an essential component of preoperative imaging because ossicular erosion has a direct impact on hearing restoration and selection of reconstructive procedures. In the present study, HRCT accurately identified ossicular destruction with good concordance with intraoperative findings. The incus was the ossicle most frequently affected, followed by the malleus and stapes, a distribution that has been consistently reported in previous studies owing to the anatomical position and relatively fragile vascular supply of the incus. Gerami

et al. and Sirigiri and Dwaraknath similarly reported strong agreement between HRCT and operative findings in the evaluation of ossicular erosion, supporting the reliability of HRCT for preoperative assessment of the ossicular chain.^{7,8}

Scutum erosion demonstrated excellent agreement between radiological and surgical findings in the present study. Since scutum erosion is considered one of the earliest radiological indicators of acquired cholesteatoma, its accurate detection is particularly valuable during preoperative evaluation. The high spatial resolution of HRCT allows precise visualization of cortical bone, making identification of scutum defects highly reliable. Comparable observations have been reported by Chee and Tan as well as Sirigiri and Dwaraknath, both of whom found HRCT to be highly effective in detecting scutum erosion associated with cholesteatoma.^{5,8} Although HRCT performed well in evaluating major bony abnormalities, comparatively lower sensitivity was observed for facial canal dehiscence, tegmen tympani erosion, and lateral semicircular canal fistula. These findings are understandable because these structures are extremely thin and may be affected by very small defects that are difficult to visualize even with high-resolution imaging. Partial-volume averaging, inflammatory changes, and technical factors may further reduce diagnostic accuracy. Similar limitations have been described by Rogha et al., who reported reduced sensitivity of HRCT for detecting facial canal dehiscence and small tegmen defects.⁹ Madan et al. also noted that subtle erosions may either remain undetected or be overinterpreted on CT images, highlighting the importance of careful intraoperative assessment despite negative imaging findings.¹⁰

An additional advantage of HRCT lies in its ability to demonstrate anatomical variations that may alter surgical strategy and reduce the risk of operative complications. Variations such as a high-riding jugular bulb, dehiscent sigmoid sinus, low-lying dura, anteriorly displaced sigmoid sinus, or an aberrant facial nerve course can be identified before surgery, allowing surgeons to modify the operative approach accordingly. Recognition of these variations is particularly important during mastoidectomy and tympanoplasty, where inadvertent injury to adjacent neurovascular structures may have significant consequences. Previous studies have similarly emphasized the value of HRCT in defining surgically relevant anatomy in addition to detecting disease.^{11,12}

Recent evidence continues to support the complementary role of HRCT in the management of CSOM. Contemporary studies have shown that HRCT provides excellent delineation of osseous involvement and accurately demonstrates disease extent, thereby improving surgical planning and reducing unexpected intraoperative findings.¹³⁻¹⁶ Nevertheless, differentiation of cholesteatoma from granulation tissue or inflammatory soft tissue remains a recognized limitation of CT because these lesions often demonstrate similar attenuation characteristics. In such situations, diffusion-weighted magnetic resonance imaging has emerged as a valuable complementary investigation, particularly in patients with suspected residual or recurrent cholesteatoma following surgery.^{17,18}

The findings of the present study further support the routine use of HRCT as part of the preoperative work-up in patients undergoing surgery for CSOM. Accurate identification of cholesteatoma, ossicular erosion, scutum involvement, mastoid disease, and other surgically important abnormalities enables better operative

planning and allows surgeons to anticipate potential technical challenges before entering the operating room. At the same time, the relatively lower sensitivity for selected lesions such as facial canal dehiscence and tegmen defects indicates that imaging findings should always be interpreted alongside clinical evaluation and confirmed by meticulous intraoperative examination. Close collaboration between radiologists and otologic surgeons remains essential for achieving complete disease clearance while minimizing surgical complications and optimizing patient outcomes.

CONCLUSION

The findings of the present study demonstrate that high-resolution computed tomography (HRCT) of the temporal bone is an effective imaging modality for the preoperative evaluation of patients with chronic suppurative otitis media. HRCT showed a high level of agreement with intraoperative findings for the detection of cholesteatoma, ossicular chain erosion, scutum erosion, and mastoid involvement, confirming its value in accurately defining disease extent before surgery. Reliable assessment of these pathological changes enables surgeons to formulate an appropriate operative strategy and anticipate potential intraoperative challenges.

Although the diagnostic performance of HRCT was comparatively lower for identifying facial canal dehiscence, tegmen tympani erosion, and lateral semicircular canal fistula, its overall diagnostic accuracy remained high for most clinically significant disease parameters. These observations indicate that HRCT should be considered an essential component of the routine preoperative assessment in patients undergoing surgical management for CSOM. Nevertheless, radiological findings should always be interpreted in conjunction with detailed clinical examination, as subtle erosions and small bony defects may only become evident during surgery. Careful correlation of clinical, radiological, and intraoperative findings facilitates comprehensive disease evaluation, improves surgical planning, minimizes unexpected operative findings, and contributes to safer and more effective patient management. Future multicentre studies involving larger patient populations, standardized imaging protocols, and the incorporation of advanced techniques such as diffusion-weighted magnetic resonance imaging may further enhance the diagnostic accuracy of preoperative imaging and strengthen evidence-based management strategies for patients with chronic suppurative otitis media.

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