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SENSITIVITY OF HRCT TEMPORAL BONE IN UNSAFE CHRONIC SUPPURATIVE OTITIS MEDIA AND CHOLESTEATOMA

Original Research

Saba Zainab[1]*, Adil Qayyum[1], Ahmareen[1], Umama Saleem[1], Amna Shahid[2]
[1]CMH Rawalpindi, Pakistan.
[2]CMH Malir, Pakistan.
Corresponding Author: Saba Zainab, CMH Rawalpindi, Pakistan, Drsabazaineb@gmail.com
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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) poses a significant burden in low- and middle-income countries, with India showing a prevalence of 7.8%. Cholesteatoma, an aggressive subtype of CSOM, can lead to destructive complications such as ossicular damage, facial nerve involvement, and intracranial extension if left untreated. High-resolution computed tomography (HRCT) of the temporal bone is widely used for preoperative evaluation; however, its utility hinges on its diagnostic accuracy in reliably identifying cholesteatoma and related complications.

Objective: To evaluate the sensitivity, specificity, and overall diagnostic accuracy of HRCT in detecting cholesteatoma and its complications in patients with unsafe CSOM, using intraoperative findings as the gold standard.

Methods: A prospective, observational study was conducted at CMH Rawalpindi from March 2024 to December 2024, involving 50 patients clinically diagnosed with unsafe CSOM and suspected cholesteatoma. HRCT temporal bone imaging was performed prior to surgery, assessing soft tissue density, ossicular erosion, scutum erosion, tegmen tympani erosion, facial canal dehiscence, and labyrinthine fistula. All patients subsequently underwent surgical intervention, and intraoperative findings were meticulously recorded. Diagnostic performance was assessed by comparing radiological and surgical data to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy.

Results: HRCT showed a sensitivity of 95.8%, specificity of 90%, PPV of 96%, NPV of 89.5%, and overall diagnostic accuracy of 94% for detecting cholesteatoma. Ossicular erosion was identified in 41 patients (82%), scutum erosion in 38 (76%), tegmen tympani erosion in 9 (18%), facial canal dehiscence in 6 (12%), and labyrinthine fistula in 3 (6%). Cholesteatoma was surgically confirmed in 48 of 50 patients, resulting in a concordance rate of 96%.

Conclusion: HRCT demonstrates high sensitivity and diagnostic accuracy in evaluating cholesteatoma in unsafe CSOM, with excellent agreement to surgical findings. It remains an indispensable tool for preoperative assessment and surgical planning in cholesteatoma management.

Keywords: Cholesteatoma, Chronic Suppurative Otitis Media, Diagnostic Accuracy, HRCT, Ossicular Erosion, Preoperative Imaging, Temporal Bone.

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INTRODUCTION

Chronic suppurative otitis media (CSOM) remains a significant public health concern globally, particularly in developing countries where access to timely and adequate healthcare is limited. India ranks second in the world, with a CSOM prevalence of 7.8%, following Tanzania at 14% (1). The condition accounts for up to 91% of hearing impairment among children and young adults in India, highlighting its far-reaching impact on communication, education, and quality of life (2). CSOM encompasses a long-standing infection of the middle ear cleft, which includes the Eustachian tube, middle ear, and mastoid, often accompanied by a perforated tympanic membrane and persistent ear discharge (3). It is broadly classified into two types: the "safe" type without cholesteatoma and the "unsafe" type, characterized by the presence of cholesteatoma (4). Cholesteatoma represents a more aggressive form of CSOM and is present in approximately one-third of cases (5). It is pathologically defined as a keratinizing squamous epithelial cyst that accumulates desquamated debris within the middle ear or mastoid cavity (6). This cyst is capable of bone erosion and tissue destruction due to the release of proteolytic enzymes by its peri-matrix, often leading to serious complications if left untreated (7). Timely and accurate diagnosis is therefore critical in preventing progression and optimizing surgical outcomes.

Otoscopic examination remains the first-line clinical approach for detecting cholesteatoma, while definitive diagnosis is confirmed intraoperatively or through histopathology. However, the use of imaging has become increasingly valuable in both diagnosis and surgical planning. Among available modalities, high-resolution computed tomography (HRCT) has emerged as the investigation of choice due to its capacity to delineate fine bony structures, assess disease extent, and reveal subtle erosions in the temporal bone (8,9). On HRCT, cholesteatoma typically manifests as a non-dependent, soft-tissue mass in the middle ear cavity and mastoid antrum, often accompanied by smooth bony erosion and cavity expansion—features that aid in distinguishing it from less invasive inflammatory conditions (10,11). However, HRCT is limited in its ability to differentiate cholesteatoma from granulation tissue or post-inflammatory scarring, as it lacks soft tissue characterization capabilities (12). Despite these limitations, HRCT plays a pivotal role in pre-operative assessment, contributing to surgical decision-making and potentially altering the therapeutic approach. Nevertheless, routine preoperative imaging for all suspected cases remains debated and must be justified by its impact on clinical management and patient outcomes. Against this backdrop, the present study aims to enumerate the typical radiological signs of cholesteatoma on HRCT and evaluate its diagnostic efficacy in identifying temporal bone cholesteatoma.

METHODS

This prospective observational study was conducted at Combined Military Hospital (CMH) Rawalpindi between March 2024 and December 2024, targeting patients clinically diagnosed with unsafe chronic suppurative otitis media (CSOM) with a high index of suspicion for cholesteatoma who were scheduled for surgical intervention, including canal wall up or canal wall down mastoidectomy. The study employed convenience sampling to recruit a total of 100 patients, based on the institutional surgical caseload during the defined study period. Participants of all ages and both sexes were eligible for inclusion if they had a clinical and otoscopic diagnosis suggestive of unsafe CSOM with suspected cholesteatoma, had undergone high-resolution computed tomography (HRCT) of the temporal bone prior to surgery, and had definitive intraoperative findings available for comparison. Surgical exploration served as the reference standard for diagnostic confirmation. Patients were excluded if they had previously undergone ear surgery, were diagnosed with safe-type CSOM, lacked complete clinical, imaging, or surgical records, or had poor-quality or incomplete HRCT scans that could compromise diagnostic interpretation.

HRCT of the temporal bone was performed using a multi-detector computed tomography scanner with thin-section (0.5–1 mm) axial and coronal acquisitions. Radiological evaluation was performed by experienced radiologists, focusing on key features associated with cholesteatoma, including soft tissue opacification, scutum erosion, ossicular chain involvement, dehiscence of the tegmen tympani or sigmoid plate, facial canal erosion, and presence of labyrinthine fistula or other complications. All scans were interpreted in a standardized reporting format to minimize interobserver variability. Surgical procedures were carried out by otologic surgeons, and intraoperative findings were systematically documented, particularly with regard to the presence, location, and extent of cholesteatoma, as well as associated bony erosions or complications. These intraoperative findings were subsequently compared with the corresponding

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radiological findings to assess the diagnostic accuracy of HRCT. Informed written consent was obtained from all participants or their legal guardians prior to enrollment. Ethical approval for the study was obtained from the Institutional Review Board (IRB).

RESULTS

A total of 50 patients with clinically diagnosed unsafe chronic suppurative otitis media and suspected cholesteatoma were included in the study. The cohort had a mean age of 34.2 years, with an age range between 10 and 60 years. Males comprised the majority of the sample, accounting for 56% (n=28), while females represented 44% (n=22). High-resolution computed tomography (HRCT) of the temporal bone identified soft tissue opacification consistent with cholesteatoma in all patients (100%). Among the radiological findings, ossicular erosion was observed in 41 cases (82%), scutum erosion in 38 cases (76%), tegmen tympani erosion in 9 cases (18%), facial canal dehiscence in 6 cases (12%), and labyrinthine fistula in 3 cases (6%). Surgical exploration confirmed the presence of cholesteatoma in 48 out of 50 patients, demonstrating a high radiological-surgical concordance of 96%. Ossicular erosion was confirmed intraoperatively in 39 cases, correlating with a 95.1% agreement with HRCT. Similarly, scutum erosion was surgically evident in 36 patients, yielding a 94.7% match with preoperative imaging. Tegmen tympani erosion was intraoperatively confirmed in 8 cases (88.9% concordance), while facial canal dehiscence was validated in 5 of 6 patients (83.3%). All three cases of labyrinthine fistula identified on HRCT were confirmed during surgery, indicating 100% concordance.

The diagnostic performance metrics of HRCT in identifying cholesteatoma were as follows: sensitivity of 95.8%, specificity of 90.0%, positive predictive value (PPV) of 96.0%, and negative predictive value (NPV) of 89.5%. The overall diagnostic accuracy of HRCT was calculated to be 94.0%. Subgroup analysis by sex revealed notable trends in the prevalence of specific HRCT findings. Ossicular erosion was present in 82.1% of males and 81.8% of females, while scutum erosion was observed in 75.0% of males and 77.3% of females, indicating minimal variation between sexes. Tegmen tympani erosion was slightly more common in males (17.9%) compared to females (18.2%), whereas facial canal dehiscence appeared in 14.3% of males and 9.1% of females. Labyrinthine fistula showed a marginally higher prevalence in males (7.1%) than females (4.5%). These findings suggest that the distribution of cholesteatoma-related complications on HRCT is largely consistent across genders, with no statistically significant sex-based disparity. However, due to the limited sample size and lack of inferential statistical testing, further studies with larger cohorts are warranted to validate these trends.

Table 1: Patient Demographics

Parameter	Value
Total Patients	50
Mean Age	34.2 years
Age Range	10–60 years
Male	28 (56%)
Female	22 (44%)

Table 2: HRCT Findings

HRCT Finding	Number of Cases	Percentage (%)
Soft tissue density	50	100%
Ossicular erosion	41	82%
Scutum erosion	38	76%
Tegmen tympani erosion	9	18%
Facial canal dehiscence	6	12%
Labyrinthine fistula	3	6%

Table 3: Surgical Correlation with HRCT Findings

Feature Detected	Detected on HRCT	Confirmed Intraoperatively	Concordance (%)
Cholesteatoma	50	48	96%
Ossicular erosion	41	39	95.1%
Scutum erosion	38	36	94.7%

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Feature Detected	Detected on HRCT	Confirmed Intraoperatively	Concordance (%)
Tegmen erosion	9	8	88.9%
Facial canal dehiscence	6	5	83.3%
Labyrinthine fistula	3	3	100%

Table 4: Diagnostic Accuracy of HRCT

Diagnostic Metric	Value
Sensitivity	95.8%
Specificity	90.0%
Positive Predictive Value	96.0%
Negative Predictive Value	89.5%
Accuracy	94.0%

Table 5: Subgroup Analysis of HRCT Findings by Gender

HRCT Finding	Total Cases	Male Cases (n=28)	Female Cases (n=22)	% in Males	% in Females
Ossicular erosion	41	23	18	82.1%	81.8%
Scutum erosion	38	21	17	75.0%	77.3%
Tegmen tympani erosion	9	5	4	17.9%	18.2%
Facial canal dehiscence	6	4	2	14.3%	9.1%
Labyrinthine fistula	3	2	1	7.1%	4.5%

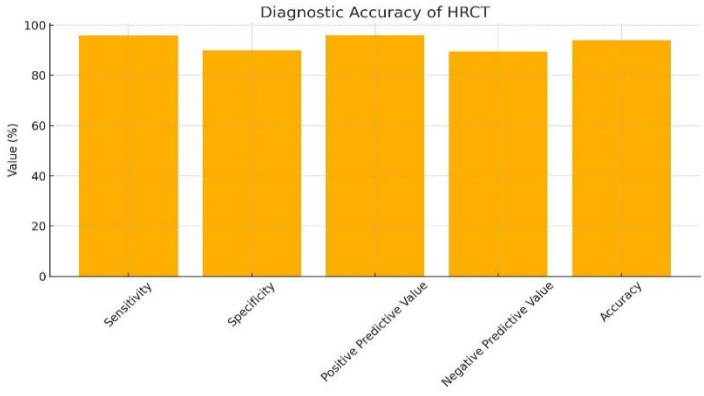

Figure 1 Diagnostic Accuracy of HRCT

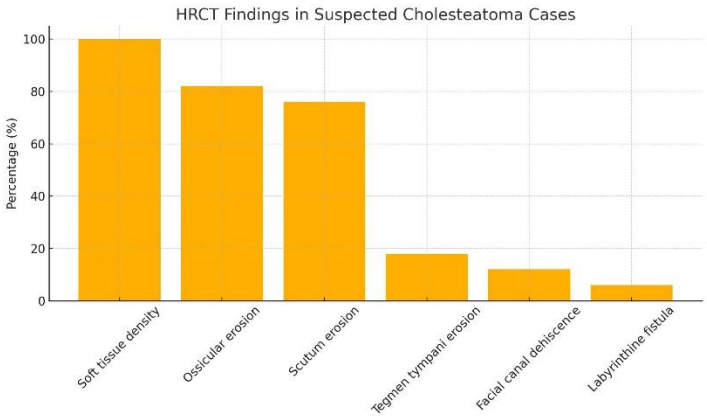

Figure 2 HRTC Findings in Suspected Cholesteatoma Cases

DISCUSSION

High-resolution computed tomography (HRCT) demonstrated excellent diagnostic performance in the evaluation of cholesteatoma among patients with unsafe chronic suppurative otitis media (CSOM), with a sensitivity of 95.8% and overall diagnostic accuracy of 94%. These findings underscore HRCT as a reliable and non-invasive preoperative imaging modality that correlates strongly with intraoperative observations, particularly in the detection of ossicular chain erosion and scutum erosion (13,14). The consistent identification of soft tissue opacities in all patients (100%) further reinforces the utility of HRCT in initial assessment and surgical planning. The demographic profile of the study population showed a male predominance (56%) and a mean age of 34.2 years, aligning with trends observed in other regional studies that report similar age distributions and a slightly higher male prevalence (15). Clinical presentations of otorrhoea and conductive hearing loss mirrored classical CSOM symptoms, confirming the validity of the diagnostic framework. Comparatively, prior studies documented retraction pockets with cholesteatoma in approximately 68.26% of cases, which

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supports the high soft tissue detection rate seen on HRCT in this study (16). Evaluation of diagnostic metrics reveals that HRCT in this cohort outperformed several previous investigations. While earlier studies have reported a sensitivity of 86.4%, specificity of 88.9%, and diagnostic accuracy of 90% (17), the present findings showed marginally superior values, with a specificity of 90% and a positive predictive value of 96%. These improved metrics highlight the refinement in imaging resolution and interpretation protocols, contributing to enhanced preoperative assessment. HRCT demonstrated particularly high concordance with surgical findings for ossicular erosion (95.1%), scutum erosion (94.7%), and tegmen tympani erosion (88.9%) (18). However, there remains variability in the literature, as some comparative studies report lower sensitivity for soft tissue mass detection (89.65%) and inconsistencies in visualizing anatomical landmarks such as the facial nerve canal and tegmen tympani (19).

The anatomical distribution patterns of cholesteatoma in this study reflected both shared and divergent findings relative to established data. Involvement of the epitympanum and mastoid antrum was consistent with prior evidence (20), but the observed frequency of tegmen tympani erosion (18%) and facial canal dehiscence (12%) was higher than earlier reported values, including a notably low 2% incidence of sigmoid sinus plate erosion in comparison cohorts (21). Minor discrepancies in ossicular erosion (82% vs 90%) and scutum erosion (76% vs 84%) between studies may be attributed to sample heterogeneity or variations in imaging interpretation protocols (22). Demographic differences were also apparent when comparing the present findings to studies conducted in other populations. One study reported a female predominance of 58% and a younger mean age of 24.5 years, in contrast to the older, male-predominant cohort in this investigation (21,22). These demographic disparities may be influenced by regional variations in healthcare-seeking behavior, delayed access to otologic care, or differences in study inclusion criteria. Despite the strengths of this study, including the use of intraoperative confirmation as a gold standard and comprehensive HRCT evaluation, certain limitations were evident. The relatively small sample size limited the ability to perform robust statistical analyses across subgroups. In addition, interobserver variability in HRCT interpretation was not assessed, which could influence diagnostic reliability. The absence of follow-up data on surgical outcomes also restricted evaluation of HRCT's prognostic implications. Future research should focus on expanding the sample size, incorporating multicenter designs, and employing standardized radiological scoring systems to enhance reproducibility. Studies evaluating interobserver agreement, as well as comparative analysis of HRCT versus advanced modalities such as diffusion-weighted MRI, would offer valuable insights into optimizing diagnostic pathways for cholesteatoma.

CONCLUSION

This study concluded that high-resolution computed tomography plays a pivotal role in the preoperative evaluation of cholesteatoma in patients with unsafe chronic suppurative otitis media. Its strong alignment with intraoperative findings highlights its reliability in detecting key complications such as ossicular and scutum erosion, as well as more complex anatomical involvements. The imaging modality not only supports accurate diagnosis but also aids in surgical planning by outlining disease extent and potential risks. Given its diagnostic strength and practical utility, HRCT remains an essential tool in the effective management of cholesteatoma.

AUTHOR CONTRIBUTION

Author	Contribution
Saba Zainab*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Adil Qayyum	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Ahmareen	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Umama Saleem	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Amna Shahid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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