International Journal of Otorhinolaryngology and Head and Neck Surgery
Mohammed R et al. Int J Otorhinolaryngol Head Neck Surg. 2026 Jun;12(3):384-389
https://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937
DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20261502

Original Research Article

Preoperative high-resolution computed tomography temporal bone evaluation in patients with chronic otitis media-squamous disease and its correlation with intraoperative findings

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Received: 11 April 2026
Accepted: 17 May 2026

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ABSTRACT

Background: Chronic otitis media (COM) with squamous disease is a significant cause of morbidity and may lead to serious intratemporal and intracranial complications if not adequately evaluated. High-resolution computed tomography (HRCT) of the temporal bone plays a key role in preoperative assessment; however, its diagnostic accuracy requires validation with intraoperative findings. Objectives were to evaluate the diagnostic accuracy of HRCT temporal bone in patients with COM-squamous disease and to correlate radiological findings with intraoperative findings.
Methods: This was a hospital-based observational study conducted on 55 patients diagnosed with COM-squamous disease who underwent HRCT temporal bone followed by surgical management. HRCT findings regarding disease extent and bony erosion were compared with intraoperative findings, which were considered the gold standard. Diagnostic performance parameters including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.
Results: HRCT demonstrated high sensitivity (96.3%) in detecting disease involvement, with a specificity of 50.0%. The PPV and NPV were 86.7% and 80.0%, respectively. Good correlation was observed between HRCT and intraoperative findings for major bony structures and ossicular erosion. However, reduced accuracy was noted in assessing smaller structures such as the stapes, facial canal, and lateral semicircular canal.
Conclusions: HRCT is a valuable preoperative imaging modality in COM-squamous disease, demonstrating high sensitivity and good correlation with intraoperative findings. Despite limitations in soft tissue differentiation and evaluation of small structures, HRCT remains an essential tool for surgical planning; adjunctive imaging such as MRI may be useful in selected cases.

Keywords: Chronic otitis media, Squamous disease, HRCT temporal bone, Cholesteatoma, Intraoperative correlation, Diagnostic accuracy

INTRODUCTION

Chronic otitis media (COM) is a substantial worldwide health burden, affecting around 2-4% of the world's population, with greater prevalence rates in developing nations and neglected populations.[1] It is characterised by ongoing inflammation of the mastoid air cells and middle ear, which can cause irreparable tissue damage, hearing loss, and potentially fatal consequences if treatment is not received. The squamous form, commonly referred to as cholesteatoma, is one of the several subtypes of COM that pose unique diagnostic and treatment challenges due to its erosive character and tendency to recur.[2]

The hallmark of COM-squamous disease is cholesteatoma, which is an aberrant proliferation of

keratinising squamous epithelium in the mastoid cavity and middle ear. The otic capsule, ossicular chain, facial nerve canal, and base of the skull were among the surrounding osseous structures that may be eroded by this epithelial growth, which generates a growing, destructive mass made of desquamated keratin debris. A comprehensive preoperative evaluation is necessary to guide optimal surgical care due to the insidious nature of cholesteatoma growth, which is frequently concealed by limited symptomatology until advanced stages.[3,4] Although middle ear structures could be seen more clearly after the advent of conventional tomography, it still lacked the spatial resolution required for a thorough assessment of COM-squamous illness.[5,6] The invention of high-resolution CT scanning marked a turning point in preoperative evaluation by offering previously unheard-of levels of detail on temporal bone architecture and disease. HRCT is becoming a vital tool in the treatment of COM-squamous illness, as technical advancements have consistently improved picture quality while reducing radiation exposure.[6,7]

Advanced uses of HRCT in surgical planning, such as augmented reality guidance systems, virtual reality modelling, and three-dimensional reconstructions, have been investigated recently.[8] The gap between surgical reality and radiological prognosis will probably close as imaging technology advances, improving the management of this difficult disease entity even more. The goal of these technologies is to improve the surgeon's mental image of the operating field before incision and to increase spatial knowledge of complex temporal bone architecture.[9] Despite their potential, these applications are still mostly exploratory in nature and should be used in addition to traditional multiplanar HRCT examination. This study focus to assess the relationship between preoperative HRCT findings and intraoperative observations in individuals with COM-squamous illness.

METHODS

This cross-sectional study was conducted over a period of 18 months from September 1st 2025, to March 31st 2026, in the Departments of Radiodiagnosis and Otorhinolaryngology at Jubilee Mission Medical College and Research Centre, Thrissur. The study population included patients referred for HRCT of the temporal bone with a clinical diagnosis or suspicion of COM-squamous type. Based on a previously reported sensitivity of 88% from Chatterjee et al and considering a 95% confidence level with 20% relative allowable error, the minimum required sample size was calculated to be 55.[10] Patients meeting the inclusion criteria were enrolled consecutively using convenience sampling until the desired sample size was achieved. Pregnant women, patients unfit for CT or surgery, those who did not undergo surgery following HRCT, individuals with other middle ear pathologies, congenital ear diseases, or previously operated cases were excluded from the study.

After obtaining informed consent, all eligible patients underwent HRCT temporal bone imaging using a 128-slice multidetector CT scanner. No special preparation was required apart from removal of metallic objects from the head and neck region. Patients were positioned supine with the infraorbital-meatal line aligned perpendicular to the scanning table. Thin-section axial images (0.5-0.6 mm) were acquired, followed by coronal and, where necessary, sagittal reconstructions, using a narrow field of view and bone window settings to optimize visualization of fine bony details. The evaluation included assessment of the external auditory canal, middle ear structures including ossicles and tympanic compartments, inner ear structures, mastoid air cells, facial nerve canal, tegmen tympani, and identification of bony erosions or soft tissue lesions suggestive of cholesteatoma.

The radiological findings were systematically compared with intraoperative findings obtained through follow-up in the otorhinolaryngology department. Data were recorded and analyzed using Microsoft excel and SPSS version 20. Descriptive statistics were used to summarize demographic and clinical variables. Diagnostic accuracy parameters including sensitivity, specificity, positive predictive value, and negative predictive value of HRCT were calculated. The chi-square test was applied to assess associations between variables, and a p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 55 participants were included in the study. In the present study, 13 (23.6%) participants were aged below 18 years, 18 (32.7%) were in the age group of 19-40 years, 15 (27.3%) belonged to the 41-60 years category, and 9 (16.4%) were above 60 years of age. There was a male predominance with 31 (56.4%) males and 24 (43.6%) females. The right ear was affected in 28 (50.9%) participants, while the left ear was involved in 27 (49.1%) (Table 1).

The most common presenting symptom was otorrhea, seen in 53 (96.4%) participants, followed by hearing loss in 46 (83.6%) and otalgia in 43 (78.2%). Tinnitus was reported in 18 (32.7%) cases, vertigo in 9 (16.4%), and facial palsy in 7 (12.7%). Less common symptoms included headache and itching, each observed in 2 (3.6%) participants, while only 1 (1.8%) participant was asymptomatic (Figure 1).

On comparison of HRCT findings with intraoperative findings for bony structures, a statistically significant association was observed for most parameters. External auditory canal involvement was correctly identified by HRCT in 12 (80.0%) cases, with a significant association ($p<0.01$). Similarly, significant correlations were noted for scutum erosion (17 [73.9%], $p<0.01$), malleus involvement (17 [73.9%], $p<0.01$), incus involvement (23 [82.1%], $p<0.01$), and stapes involvement (11 [64.7%], $p=0.003$). Tegmen tympani involvement detected in 10

(66.7%) cases with significant association (p<0.01). Sinus plate and facial canal involvement showed perfect positive predictive values, with HRCT identifying 3 (100%) and 5 (100.0%) cases respectively, both showing statistically significant associations (p<0.01). Lateral semicircular canal involvement less frequently detected, with only 1 (50%) case identified, though association remained statistically significant (p=0.05) (Table 2).

With respect to soft tissue and tympanic membrane findings, HRCT demonstrated high concordance with intraoperative findings. Tympanic membrane involvement was detected in 52 (98.1%) cases, though the association was not statistically significant (p=0.845). Soft tissue involvement of the mesotympanum and antrum showed complete agreement, with 53 (100.0%) and 54 (100.0%) cases detected respectively, precluding statistical analysis. Attic involvement was identified in 51 (98.1%) cases, with no statistically significant association (p=0.808). No intracranial complications were detected on HRCT; however, intraoperatively, 1 (1.8%) case each of abscess and other intracranial complication was identified (Table 3).

The diagnostic performance of HRCT showed high sensitivity for tympanic membrane (96.3%), mesotympanum (96.4%), attic (94.4%), antrum (98.2%), and tegmen tympani (90.9%). Specificity was highest for sinus plate and facial canal (100.0%), followed by lateral semicircular canal (98.1%) and external auditory canal (92.3%). Positive predictive value was highest for sinus plate and facial canal (100.0%), while negative predictive value was highest for tegmen tympani (97.5%) and lateral semicircular canal (96.2%). Overall diagnostic accuracy ranged from 72.7% for stapes to 98.2% for soft tissue antrum and intracranial complications (Table 4).

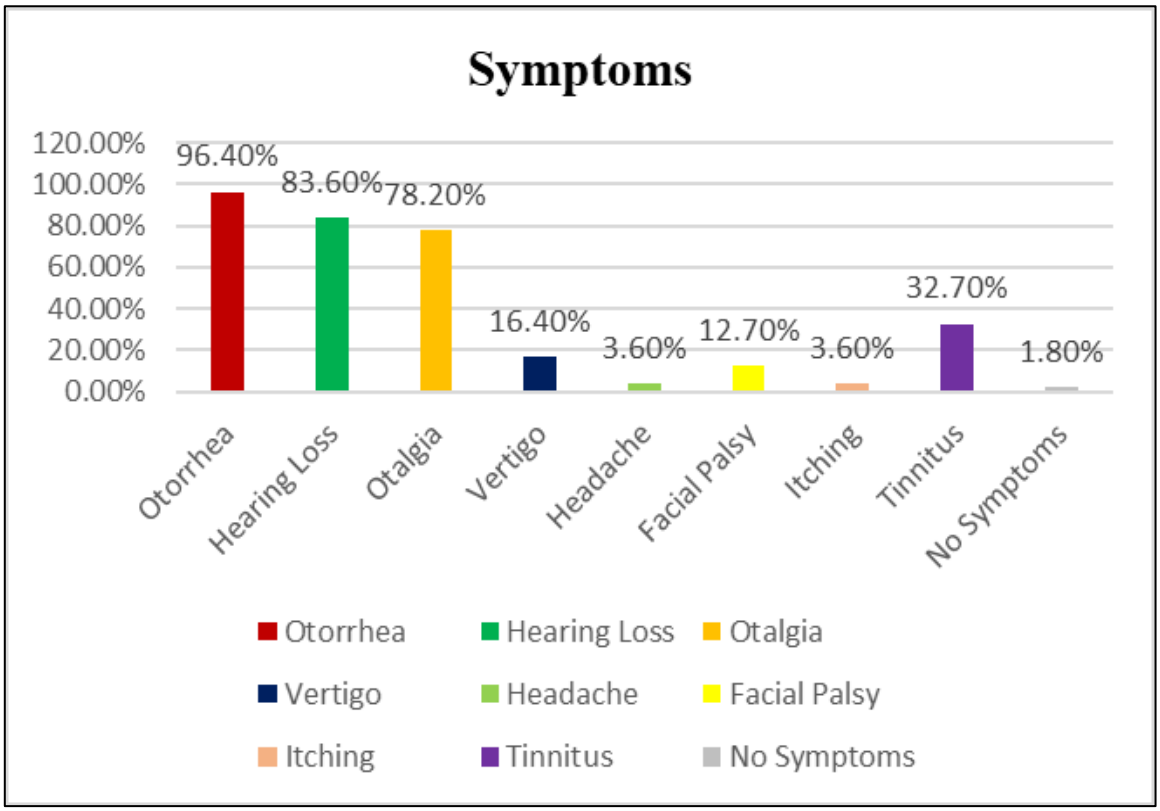

Figure 1: Clinical presentation of study participants.

Table 1: Sociodemographic and clinical characteristics of study participants, (n=55).

Variables	Category	N (%)
Age (in years)	<18	13 (23.6)
	19-40	18 (32.7)
	41-60	15 (27.3)
	>60	9 (16.4)
Gender	Male	31 (56.4)
	Female	24 (43.6)
Side affected	Right	28 (50.9)
	Left	27 (49.1)

Table 2: Association of HRCT findings with intraoperative findings for bony structures among study participants.

HRCTs		Intra-operative findings		Chi-square	P value
		Yes, N (%)	No, N (%)		
External auditory canal	Yes	12 (80.0)	3 (20.0)	25.913	<0.01
	No	4 (10.0)	36 (90.0)		
Scutum	Yes	17 (73.9)	6 (26.1)	27.095	<0.01
	No	2 (6.3)	30 (93.8)		
Malleus	Yes	17 (73.9)	6 (26.1)	18.944	<0.01
	No	5 (15.6)	27 (84.4)		
Incus	Yes	23 (82.1)	5 (17.9)	15.412	<0.01
	No	8 (29.6)	19 (70.4)		
Stapes	Yes	11 (64.7)	6 (35.3)	8.541	0.003
	No	9 (23.7)	29 (76.3)		
Tegmen tympani	Yes	10 (66.7)	5 (33.3)	28.073	<0.01
	No	1 (2.5)	39 (97.5)		
Sinus plate	Yes	3 (100.0)	0 (0.0)	37.731	<0.01
	No	2 (3.8)	50 (96.2)		
Facial canal	Yes	5 (100.0)	0 (0.0)	24.750	<0.01
	No	5 (10.0)	45 (90.0)		
Lateral semicircular canal	Yes	1 (50.0)	1 (50.0)	7.985	0.05
	No	2 (3.8)	51 (96.2)		

Table 3: Association of HRCT findings with intraoperative findings for soft tissue, tympanic membrane, and intracranial complications among study participants.

HRCTs		Intra-operative findings		Chi-square	P value
		Yes, N (%)	No, N (%)		
Tympanic membrane	Yes	52 (98.1)	1 (1.9)	0.038	0.845
	No	2 (100.0)	0 (0.0)		
Mesotympanum	Yes	53 (100.0)	0 (0.0)	NA	NA
	No	2 (100.0)	0 (0.0)		
Attic	Yes	51 (98.1)	1 (1.9)	0.509	0.808
	No	3 (100.0)	0 (0.0)		
Antrum	Yes	54 (100.0)	0 (0.0)	NA	NA
	No	1 (100.0)	0 (0.0)		
Intracranial complications (abscess)	Yes	0 (0.0)	0 (0.0)	NA	NA
	No	1 (1.8)	54 (98.2)		
Other intracranial complications	Yes	0 (0.0)	0 (0.0)	NA	NA
	No	1 (1.8)	54 (98.2)		

Table 4: Diagnostic performance of HRCT compared to intra-operative findings.

Structure involved	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
External auditory canal	75.0	92.3	80.0	90.0	87.3
Tympanic membrane	96.3	0.0	98.1	0.0	94.5
Scutum	89.5	83.3	73.9	93.8	85.5
Malleus	77.3	81.8	73.9	84.4	80.0
Incus	74.2	79.2	82.1	70.4	76.4
Stapes	55.0	82.9	64.7	76.3	72.7
Tegmen tympani	90.9	88.6	66.7	97.5	89.1
Sinus plate	60.0	100.0	100.0	96.2	96.4
Facial canal	50.0	100.0	100.0	90.0	90.9
Lateral semicircular canal	33.3	98.1	50.0	96.2	94.5
Soft tissue mesotympanum	96.4	NA	100.0	0.0	96.4
Soft tissue attic	94.4	0.0	98.1	0.0	92.7
Soft tissue antrum	98.2	NA	100.0	0.0	98.2
Intracranial complications (abscess)	0.0	100.0	NA	98.2	98.2
Other intracranial complications	0.0	100.0	NA	98.2	98.2

*NA: Not applicable, as statistical analysis could not be performed due to the absence of variability or zero cell frequencies.

DISCUSSION

The present study evaluated the diagnostic accuracy of preoperative HRCT in patients with COM-squamous disease by correlating imaging findings with intraoperative observations. HRCT demonstrated high sensitivity for detecting disease extent and major structural involvement, supporting its role as an essential preoperative imaging modality. The demographic profile in the present study showed a predominance of patients in the 19-40 years age group with male preponderance, which is consistent with previous studies by Singh et al and Kumari et al.[11,12] The most common presenting symptom was otorrhea, followed by hearing loss and otalgia, similar to findings reported by Poswal et al indicating a typical clinical presentation of squamous disease.[13]

With respect to diagnostic accuracy, HRCT showed good correlation with intraoperative findings for most bony structures. High sensitivity and statistically significant association were observed for scutum, malleus, incus, and tegmen tympani involvement, which is in agreement with earlier studies.[11,13,14] HRCT also demonstrated excellent specificity and positive predictive value for sinus plate and facial canal involvement, suggesting that positive findings on HRCT are highly reliable for these critical structures, consistent with previous reports.[15,16] However, reduced sensitivity was noted for smaller and complex structures such as the stapes and lateral semicircular canal, which aligns with findings from Vlastarakos et al, Rocher et al and Zhang et al.[17-19] These limitations may be attributed to the small size of these structures and technical constraints of CT imaging, including partial volume effects.

HRCT showed excellent performance in detecting soft tissue involvement in the mesotympanum, attic, and antrum, with near-complete concordance with intraoperative findings, consistent with Mandal et al.[20] However, HRCT was unable to reliably differentiate the nature of soft tissue, which remains a known limitation of CT imaging.[21] In contrast, HRCT demonstrated poor sensitivity for detecting intracranial complications, failing to identify cases detected intraoperatively. This differs from the findings of Singh et al and highlights the limitations of HRCT in identifying subtle or early intracranial involvement.[12] Additional imaging modalities, such as MRI, may be required in such cases. Overall, HRCT demonstrated high diagnostic accuracy for most clinically relevant structures, with particularly high sensitivity for disease extent and excellent specificity for critical bony erosions. These findings are comparable to those of the meta-analysis by Xun et al which reported good diagnostic efficiency of HRCT in cholesteatoma.[22]

This study has certain limitations. The use of convenience sampling and inclusion of only surgically managed cases could have introduced selection bias. HRCT has inherent limitations in differentiating soft tissue pathologies such as cholesteatoma, granulation tissue, and effusion, which may affect diagnostic accuracy. Additionally, small and complex anatomical structures such as the stapes, facial canal, and lateral semicircular canal are difficult to evaluate on HRCT, potentially leading to underestimation of disease involvement. Despite certain limitations, HRCT remains a valuable and reliable tool in the preoperative assessment and surgical planning of COM-squamous disease.

CONCLUSION

The present study concludes that HRCT is a valuable and reliable imaging modality in the preoperative evaluation of COM-squamous disease, demonstrating high sensitivity for detecting disease extent and major structural involvement, particularly tympanic membrane (96.3%), mesotympanum (96.4%), antrum (98.2%), and tegmen tympani (90.9%). HRCT also showed excellent specificity for critical structures such as sinus plate and facial canal (100%), indicating high reliability when positive findings are present. Good correlation with intraoperative findings was observed for scutum, malleus, and incus involvement, while reduced sensitivity was noted for smaller structures such as the stapes (55.0%) and lateral semicircular canal (33.3%). However, HRCT demonstrated limitations in detecting intracranial complications and in differentiating soft tissue pathologies. Based on these findings, HRCT should be routinely employed as a primary preoperative imaging tool for surgical planning, with adjunctive imaging such as MRI recommended in cases with suspected intracranial extension or when detailed soft tissue characterization is required.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Mohammed R, Varghese VB, Ihsan AT. Preoperative high-resolution computed tomography temporal bone evaluation in patients with chronic otitis media-squamous disease and its correlation with intraoperative findings. Int J Otorhinolaryngol Head Neck Surg 2026;12:384-9.