



Study of Middle Ear Cholesteatoma: HRCT Temporal Bone Findings and Histopathological Correlation.

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Abstract

Background: Middle ear cholesteatoma is a locally destructive keratinizing lesion that can cause ossicular erosion, hearing loss, labyrinthine fistula, facial canal involvement, and intracranial complications. High-resolution computed tomography of the temporal bone is widely used for preoperative assessment; however, its ability to differentiate cholesteatoma from granulation tissue and other middle-ear soft-tissue lesions is limited. Histopathological examination remains the confirmatory diagnostic method. **Objectives:** To evaluate HRCT temporal-bone findings in patients with suspected middle ear cholesteatoma and to determine their correlation with histopathological examination. **Materials and Methods:** This prospective observational diagnostic-accuracy study was conducted in the Department of Otorhinolaryngology, Naraina Medical College and Research Centre, from February 2025 to January 2026. The calculated target sample was 88 patients. Consecutive patients with clinically suspected middle ear cholesteatoma who underwent preoperative HRCT temporal bone, tympanomastoid surgery, and histopathological examination were included. HRCT findings related to disease location, ossicular erosion, scutum erosion, mastoid extension, facial canal dehiscence, tegmen erosion, and labyrinthine fistula were recorded. Histopathology was considered the reference standard. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, and Cohen's kappa were calculated. **Results:** Of 88 enrolled patients, 84 had complete radiological and histopathological data. Histopathology confirmed cholesteatoma in 76 patients. HRCT correctly identified 70 histopathologically positive cases, with three false-positive and six false-negative results. The sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of HRCT were 92.1%, 62.5%, 95.9%, 45.5%, and 89.3%, respectively. Agreement between HRCT and histopathology was moderate, with a Cohen's kappa value of 0.48. Epitympanic involvement was observed in 61 patients, mastoid extension in 58, scutum erosion in 54, and ossicular-chain erosion in 60. The incus was the most commonly eroded ossicle. Tegmen erosion, facial canal dehiscence, and lateral semicircular-canal fistula were detected in eight, ten, and six patients, respectively. Histopathological examination commonly demonstrated keratinizing stratified squamous epithelium, lamellated keratin debris, fibroconnective perimatrix, chronic inflammatory infiltrates, and granulation tissue. **Conclusion:** HRCT temporal bone demonstrated high sensitivity, positive predictive value, and diagnostic accuracy for middle ear cholesteatoma. It was particularly useful for determining disease extent, ossicular destruction, and potentially hazardous bony complications. Its lower specificity reflected difficulty in differentiating cholesteatoma from granulation tissue and chronic inflammatory soft-tissue changes. HRCT should therefore be used as a preoperative anatomical road map, while histopathological examination remains essential for definitive diagnosis.

Keywords: middle ear cholesteatoma; HRCT temporal bone; histopathology; ossicular erosion; chronic otitis media; diagnostic accuracy.



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INTRODUCTION

Middle ear cholesteatoma is characterized by the presence of keratinizing stratified squamous epithelium within the middle ear or mastoid cleft. Although histologically benign, it can behave in a locally aggressive manner through accumulation of keratin, chronic inflammation, enzymatic activity, pressure effects, and progressive erosion of adjacent temporal-bone

structures. Untreated disease can lead to ossicular destruction, conductive or mixed hearing loss, labyrinthine fistula, facial nerve involvement, tegmen erosion, intracranial complications, and recurrent infection.

Acquired cholesteatoma commonly develops in association with tympanic-membrane retraction pockets, Eustachian-tube dysfunction, chronic middle-ear inflammation, or migration of squamous epithelium through a tympanic-membrane perforation. Clinically, patients may present with persistent or recurrent foul-smelling otorrhoea, hearing loss, earache, tinnitus, vertigo, postauricular swelling, facial weakness, or complications. Otoscopic examination may identify an attic retraction pocket, marginal perforation, keratin debris, granulation tissue, or a polyp; however, the complete extent of the disease may not be clinically visible.

High-resolution computed tomography is the principal imaging modality for demonstrating temporal-bone anatomy and cholesteatoma-associated bone erosion. Contemporary multidetector CT examinations use thin-section acquisition and high-spatial-resolution bone reconstruction, allowing assessment of the epitympanum, mesotympanum, hypotympanum, aditus, mastoid, ossicles, scutum, tegmen, facial canal, sigmoid plate, labyrinth, and anatomical variants relevant to surgery. Typical HRCT findings include a non-dependent soft-tissue mass, blunting or erosion of the scutum, widening of the aditus, ossicular erosion, mastoid opacification, and erosion of adjacent bony structures. The incus, particularly its long process, is frequently affected. HRCT is valuable as a surgical road map and has demonstrated good correlation with operative findings for disease extent, ossicular status, tegmen erosion, sinus-plate erosion, and lateral semicircular-canal fistula. Its performance is generally less reliable for facial-canal dehiscence and subtle stapes abnormalities.

A major limitation of conventional CT is that soft-tissue attenuation is nonspecific. Cholesteatoma may therefore be difficult to distinguish from granulation tissue, inflamed mucosa, effusion, fibrosis, or postoperative scar in the absence of characteristic bone erosion. Histopathological examination demonstrating keratinizing squamous epithelium, subepithelial connective tissue, and keratinous debris provides definitive confirmation.

The present study was undertaken to document the spectrum of HRCT temporal-bone findings in clinically suspected middle ear cholesteatoma and to correlate the radiological diagnosis with histopathological examination.

2. Objectives

2.1 Primary objective

To determine the diagnostic accuracy of HRCT temporal bone for middle ear cholesteatoma using histopathological examination as the reference standard.

2.2 Secondary objectives

1. To describe the anatomical distribution and extent of cholesteatoma on HRCT.
2. To determine the frequency of ossicular-chain and other bony erosions.
3. To identify HRCT evidence of intratemporal or intracranial complications.
4. To describe the histopathological features of middle ear cholesteatoma.
5. To assess agreement between HRCT diagnosis and histopathological examination.
6. To examine the association between selected HRCT signs and histopathological confirmation.

MATERIALS AND METHODS

3.1 Study design

Prospective hospital-based observational diagnostic-accuracy study.

3.2 Study setting

Department of Otorhinolaryngology, Naraina Medical College and Research Centre.

3.3 Study duration

February 2025 to January 2026.

3.4 Study population

Patients presenting to the ENT outpatient department or admitted under the Department of Otorhinolaryngology with clinical features suggestive of acquired middle ear cholesteatoma.

3.5 Sample-size calculation

The sample size was calculated for estimating the sensitivity of HRCT using the formula:

$$n = \frac{Z_{1-\alpha/2}^2 \times Se(1 - Se)}{d^2 \times P}$$

where:

- $Z_{1-\alpha/2}=1.96$ at a 95% confidence level;
- anticipated sensitivity, ($Se=0.90$);
- desired absolute precision, ($d=0.07$);
- anticipated proportion of histopathologically confirmed cholesteatoma among clinically suspected surgical cases, ($P=0.90$).

$$n = \frac{(1.96)^2 \times 0.90 \times 0.10}{(0.07)^2 \times 0.90} = 78.4$$

The minimum required sample was therefore rounded to 80 patients. After allowing approximately 10% for incomplete radiological records, cancellation of surgery, or inadequate histopathological specimens, the final target sample was fixed at 88 patients. Sample-size determination followed standard principles for estimating diagnostic proportions with specified precision.

3.6 Sampling technique

Consecutive eligible patients were recruited until the target sample was achieved.

3.7 Inclusion criteria

1. Patients of any sex aged 10 years or older.
2. Clinical suspicion of acquired middle ear cholesteatoma.
3. Patients undergoing preoperative HRCT temporal bone.
4. Patients subsequently undergoing tympanomastoid surgery.
5. Availability of an adequate surgical specimen for histopathological examination.
6. Written informed consent from the patient or guardian.

3.8 Exclusion criteria

1. Previously operated or recurrent cholesteatoma where postoperative anatomy prevented uniform interpretation.
2. Congenital cholesteatoma.
3. External auditory-canal cholesteatoma without middle-ear involvement.
4. Temporal-bone malignancy or other destructive neoplasm.
5. Patients managed conservatively without surgical tissue diagnosis.
6. Poor-quality or incomplete HRCT examination.
7. Inadequate or autolysed histopathological specimen.
8. Refusal to participate.

3.9 Clinical assessment

A structured proforma was used to record age, sex, duration of symptoms, ear involved, otorrhoea, hearing loss, otalgia, tinnitus, vertigo, facial weakness, previous treatment, and history of complications.

All participants underwent otoscopy or otoendoscopy. The following findings were documented:

- Attic or pars-flaccida retraction pocket
- Posterior-superior or marginal perforation
- Keratin debris
- Aural polyp
- Granulation tissue
- Tympanosclerosis
- Postauricular swelling or fistula
- Facial-nerve function

Pure-tone audiometry was performed where clinically feasible.

3.10 HRCT temporal-bone protocol

HRCT was performed before surgery using thin-section multidetector CT. Axial acquisition was performed with submillimetric collimation, followed by high-resolution bone-algorithm reconstruction. Coronal and sagittal multiplanar reformations were reviewed. Thin-section multidetector CT with approximately 0.5–0.75-mm collimation is capable of demonstrating the complex bony anatomy and cholesteatoma-related erosions of the temporal bone.

Images were evaluated for:

1. Soft-tissue opacity in:
 - Prussak's space
 - Epitympanum
 - Mesotympanum
 - Hypotympanum
 - Aditus ad antrum
 - Mastoid antrum and air cells
 - Sinus tympani
 - Facial recess
2. Bony abnormalities:
 - Scutum erosion
 - Malleus erosion
 - Incus erosion
 - Stapes erosion
 - Tegmen tympani or tegmen mastoideum erosion
 - Facial-canal dehiscence
 - Lateral semicircular-canal fistula
 - Sigmoid-sinus plate erosion
 - Posterior external auditory-canal wall erosion
 - Cochlear or other labyrinthine erosion
3. Anatomical and surgical risk factors:
 - High-riding jugular bulb
 - Dehiscent jugular bulb
 - Anteriorly placed sigmoid sinus
 - Low-lying tegmen
 - Sclerotic or poorly pneumatized mastoid
 - Aberrant carotid canal
 - Körner's septum

A radiological diagnosis of cholesteatoma was considered when a non-dependent middle-ear or mastoid soft-tissue mass was accompanied by characteristic focal bone erosion, particularly scutum or ossicular erosion. Soft-tissue opacity without erosion was considered indeterminate unless its location and configuration were strongly characteristic.

3.11 Surgical procedure and specimen collection

Patients underwent canal-wall-up mastoidectomy, canal-wall-down mastoidectomy, modified radical mastoidectomy, atticotomy, or tympanoplasty with mastoid exploration according to the extent of disease and the operating surgeon's judgment.

Keratinous material, matrix, and representative granulation tissue were collected separately where possible. Specimens were fixed in 10% neutral-buffered formalin and sent to the Department of Pathology.

3.12 Histopathological examination

Paraffin-embedded sections were stained with haematoxylin and eosin. Histopathological diagnosis of cholesteatoma was based on identification of one or more of the following in an appropriate clinical specimen:

- Keratinizing stratified squamous epithelial matrix
- Lamellated keratin debris
- Subepithelial connective-tissue perimatrix
- Chronic inflammatory-cell infiltrate
- Granulation tissue
- Cholesterol clefts
- Foreign-body giant-cell reaction
- Bone fragments showing erosion or inflammation

Histopathologists were provided with the clinical site but, wherever operationally feasible, were not informed of the detailed HRCT interpretation.

3.13 Outcome measures

The primary outcome was histopathological confirmation of cholesteatoma.

The principal diagnostic measures were:

- Sensitivity

- Specificity
- Positive predictive value
- Negative predictive value
- Overall diagnostic accuracy
- Cohen's kappa agreement

3.14 Statistical analysis

Data were entered into Microsoft Excel and analysed using an appropriate statistical package. Continuous variables were summarized as mean with standard deviation or median with interquartile range. Categorical variables were presented as frequencies and percentages.

A 2×2 table was constructed comparing HRCT diagnosis with histopathology. Sensitivity, specificity, predictive values, accuracy, and 95% confidence intervals were calculated. Cohen's kappa was used to assess agreement beyond chance.

Associations between HRCT findings and histopathological confirmation were assessed using the chi-square test or Fisher's exact test. A two-sided p-value below 0.05 was considered statistically significant.

3.15 Ethical considerations

The study was initiated after approval from the Institutional Ethics Committee of Naraina Medical College and Research Centre. Written informed consent was obtained from all adult participants and from parents or legal guardians of minors, with assent where applicable. Patient identifiers were removed before analysis.

RESULTS

4.1 Study population

A total of 88 patients were recruited. Four patients were excluded from the final analysis: two did not undergo surgery, one had an inadequate histopathological specimen, and one had incomplete HRCT images. Therefore, 84 patients were included in the final radiological–histopathological analysis.

The mean age was 34.8 ± 15.6 years, with a range of 11–72 years. The largest age group was 21–40 years. Fifty patients were male and 34 were female, producing a male-to-female ratio of 1.47:1. The right ear was involved in 43 patients and the left ear in 41.

Table 1. Demographic and clinical characteristics

Characteristic	Number (%)
Total analysed	84
Age ≤ 20 years	15 (17.9)
Age 21–40 years	38 (45.2)
Age 41–60 years	23 (27.4)
Age > 60 years	8 (9.5)
Male	50 (59.5)
Female	34 (40.5)
Right ear	43 (51.2)
Left ear	41 (48.8)
Foul-smelling otorrhoea	75 (89.3)
Hearing loss	71 (84.5)
Otalgia	25 (29.8)
Tinnitus	20 (23.8)
Vertigo	9 (10.7)
Facial weakness	3 (3.6)
Attic retraction/attic disease	49 (58.3)
Marginal or posterosuperior perforation	30 (35.7)
Visible keratin debris	61 (72.6)
Granulation tissue or aural polyp	29 (34.5)

4.2 HRCT findings

Middle-ear or mastoid soft-tissue opacity was present in 81 patients. The mastoid air-cell system was involved in 58 patients, the epitympanum in 61, mesotympanum in 42, Prussak's space in 49, and hypotympanum in 14.

Ossicular-chain erosion was identified in 60 patients. The incus was the most frequently eroded ossicle, followed by the malleus and stapes. Scutum erosion was observed in 54 patients. Potentially serious findings included tegmen erosion in eight patients, lateral semicircular-canal fistula in six, sigmoid-plate erosion in five, and facial-canal dehiscence in ten.

Table 2. HRCT temporal-bone findings

HRCT finding	Number (%)
Middle-ear/mastoid soft-tissue opacity	81 (96.4)
Prussak's-space involvement	49 (58.3)
Epitympanic involvement	61 (72.6)
Mesotympanic involvement	42 (50.0)
Hypotympanic involvement	14 (16.7)
Aditus involvement or widening	55 (65.5)
Mastoid involvement	58 (69.0)
Scutum erosion	54 (64.3)
Any ossicular-chain erosion	60 (71.4)
Malleus erosion	32 (38.1)
Incus erosion	55 (65.5)
Stapes erosion	24 (28.6)
Tegmen erosion	8 (9.5)
Facial-canal dehiscence	10 (11.9)
Lateral semicircular-canal fistula	6 (7.1)
Sigmoid-plate erosion	5 (6.0)
Posterior canal-wall erosion	12 (14.3)
Sclerotic/poorly pneumatized mastoid	63 (75.0)
High-riding jugular bulb	7 (8.3)
Low-lying tegmen	6 (7.1)
Anterior sigmoid sinus	5 (6.0)

4.3 Histopathological findings

Histopathology confirmed cholesteatoma in 76 of the 84 analysed patients. All confirmed cases demonstrated lamellated keratin debris, and keratinizing stratified squamous epithelial matrix was identified in all adequate representative specimens. Chronic inflammatory infiltrate was present in 59 cases and granulation tissue in 51. Bone fragments showing inflammatory or erosive change were identified in 38 specimens.

Eight patients did not demonstrate cholesteatoma on histopathology. Their final diagnoses included granulation tissue with chronic inflammation in five, inflammatory aural polyp in two, and tympanosclerotic tissue with chronic mucositis in one.

Table 3. Histopathological findings among confirmed cases

Histopathological feature	Number (n = 76)	Percentage
Lamellated keratin debris	76	100.0
Keratinizing squamous epithelial matrix	76	100.0
Fibroconnective-tissue perimatrix	70	92.1
Chronic inflammatory-cell infiltrate	59	77.6
Granulation tissue	51	67.1
Bone fragments with erosion/inflammation	38	50.0
Cholesterol clefts	14	18.4
Foreign-body giant-cell reaction	12	15.8
Acute suppurative inflammation	11	14.5

4.4 HRCT and histopathological correlation

HRCT suggested cholesteatoma in 73 patients. Histopathology confirmed the diagnosis in 70 of these, producing three false-positive cases. Six patients with histopathologically confirmed cholesteatoma were not conclusively diagnosed on HRCT and were classified as false negatives. Five patients were negative on both HRCT and histopathological examination.

Table 4. Diagnostic correlation between HRCT and histopathology

HRCT diagnosis	Histopathology positive	Histopathology negative	Total
Positive for cholesteatoma	70	3	73
Negative/indeterminate	6	5	11
Total	76	8	84

Table 5. Diagnostic performance of HRCT

Diagnostic measure	Estimate
Sensitivity	92.1%
Specificity	62.5%
Positive predictive value	95.9%

Negative predictive value	45.5%
Diagnostic accuracy	89.3%
False-positive rate	37.5%
False-negative rate	7.9%
Cohen's kappa	0.48
Agreement category	Moderate

The presence of characteristic focal bone erosion together with non-dependent soft-tissue opacity was significantly associated with histopathological confirmation. Soft-tissue opacity alone was less specific because inflammatory mucosa and granulation tissue produced similar attenuation.

Table 6. Association of selected HRCT findings with histopathological confirmation

HRCT feature	HPE-positive cases with finding, n (%)	Association
Soft tissue with focal bone erosion	67 (88.2)	Strong
Scutum erosion	52 (68.4)	Significant
Ossicular erosion	58 (76.3)	Significant
Prussak's-space mass	47 (61.8)	Significant
Mastoid extension	55 (72.4)	Significant
Soft-tissue opacity without erosion	9 (11.8)	Weak/nonspecific

DISCUSSION

The present study evaluated the diagnostic performance of high-resolution computed tomography of the temporal bone in patients with clinically suspected middle ear cholesteatoma and correlated the radiological findings with histopathological examination. Histopathology confirmed cholesteatoma in 76 of the 84 analysed patients, representing a prevalence of 90.5% in this surgically selected cohort. The high prevalence was expected because only patients with a strong clinical suspicion of cholesteatoma who subsequently underwent surgery were included.

HRCT demonstrated a sensitivity of 92.1%, indicating that it successfully identified most histopathologically confirmed cases. This finding is comparable with previous studies reporting high sensitivity of HRCT for detecting cholesteatoma and its associated bony changes [3,10,11]. Manik et al. similarly observed that HRCT was highly useful for preoperative assessment of cholesteatoma, particularly for identifying disease extent and bone erosion [11]. Other investigators have also demonstrated good correlation between HRCT and operative findings in chronic otitis media with cholesteatoma [2,3,9].

The positive predictive value of HRCT in the present study was 95.9%, suggesting that patients with a characteristic radiological appearance were highly likely to have histopathologically confirmed cholesteatoma. The combination of a non-dependent soft-tissue mass with focal erosion of the scutum, ossicles, or adjacent temporal-bone structures is considered strongly suggestive of cholesteatoma [1,8,13]. Gaurano and Joharjy reported that characteristic CT features included middle-ear soft-tissue opacity, scutum erosion, ossicular destruction, widening of the aditus, and mastoid involvement [1]. Similar findings were described in subsequent radiological reviews and clinical studies [5,8,13].

Despite its high sensitivity and positive predictive value, HRCT showed a comparatively lower specificity of 62.5%. Three patients had radiological findings suggestive of cholesteatoma but histopathological examination demonstrated granulation tissue or chronic inflammatory tissue without a cholesteatoma matrix. This limitation is well recognized because conventional CT has excellent spatial resolution for bone but limited ability to characterize different soft tissues. Granulation tissue, inflamed mucosa, middle-ear effusion, fibrosis, and cholesteatoma may all appear as nonspecific soft-tissue opacities [8,18]. Therefore, soft-tissue opacity without characteristic focal bone erosion should be interpreted cautiously.

The negative predictive value was 45.5%, which was lower than the other diagnostic indices. This was influenced by the high disease prevalence in the study population. Predictive values are dependent on prevalence; in a selected surgical cohort with a high likelihood of disease, the negative predictive value is expected to be relatively low. In addition, small cholesteatomas, early lesions, disease confined to hidden recesses, and cholesteatoma without established bony erosion may be missed or classified as indeterminate on HRCT [4,18].

The overall diagnostic accuracy of HRCT was 89.3%, supporting its role as an important preoperative investigation. However, the moderate Cohen's kappa value of 0.48 indicates that radiological diagnosis and histopathology were not completely interchangeable. HRCT primarily provides anatomical information regarding disease location, extension, bone erosion, complications, and surgical hazards, whereas histopathological examination confirms the tissue diagnosis. Thus, both modalities should be considered complementary rather than competing diagnostic methods.

In the present study, middle-ear or mastoid soft-tissue opacity was seen in 96.4% of patients. Epitympanic involvement was the most common anatomical site, followed by mastoid and mesotympanic involvement. This distribution is consistent with the usual pathogenesis of acquired attic cholesteatoma, which often begins in the pars flaccida or Prussak's space and subsequently extends into the epitympanum, aditus, and mastoid antrum [1,8]. HRCT is particularly valuable in demonstrating this pathway of disease extension and in assessing areas that may not be completely visualized during routine otoscopy.

Scutum erosion was present in 64.3% of patients and was significantly associated with histopathological confirmation. Scutum erosion is one of the classic CT findings of attic cholesteatoma and is often an early indicator of locally destructive disease [1,5,8]. The combination of Prussak's-space soft-tissue opacity and scutum erosion is considered highly suggestive of pars-flaccida cholesteatoma.

Ossicular-chain erosion was detected in 71.4% of patients. The incus was the most frequently eroded ossicle, followed by the malleus and stapes. The long process and lenticular process of the incus are particularly vulnerable because of their delicate structure, limited vascularity, and close proximity to common routes of cholesteatoma extension [5,8]. Previous studies have also reported the incus as the most commonly eroded ossicle in cholesteatoma [3,5,7]. HRCT generally demonstrates gross erosion of the malleus and incus with good accuracy, although subtle stapes erosion may be more difficult to detect because of the very small size of the stapes superstructure [3,10].

Mastoid involvement was observed in 69.0% of patients, while 75.0% had a sclerotic or poorly pneumatized mastoid. Chronic Eustachian-tube dysfunction and recurrent middle-ear inflammation are commonly associated with poor mastoid pneumatization. Preoperative recognition of mastoid sclerosis is important because it may influence surgical access, drilling time, and the choice between canal-wall-up and canal-wall-down procedures [6,9].

Facial-canal dehiscence was identified on HRCT in 11.9% of patients. Although this finding is clinically important, its interpretation requires caution because the bony covering of the tympanic facial-nerve segment is extremely thin and may appear dehiscent because of partial-volume averaging. Several studies have reported lower sensitivity and variable accuracy of HRCT for facial-canal dehiscence compared with its performance for scutum or ossicular erosion [2,3,10]. Therefore, surgeons should remain cautious during dissection even when the facial canal appears intact radiologically.

Lateral semicircular-canal fistula was found in 7.1% of patients. This complication is caused by progressive erosion of the bony labyrinth, most frequently over the lateral semicircular canal. Preoperative identification is crucial because unrecognized fistula may result in sensorineural hearing loss, vertigo, or iatrogenic labyrinthine injury during removal of the cholesteatoma matrix [5,8]. HRCT has been shown to have relatively good specificity for detecting labyrinthine fistula, particularly when thin-section images are carefully reviewed in axial and coronal planes [3,9].

Tegmen erosion was present in 9.5% of patients and sigmoid-plate erosion in 6.0%. These findings indicate advanced disease and may increase the risk of intracranial complications. HRCT is especially useful in identifying defects of the tegmen tympani, tegmen mastoideum, sigmoid plate, and posterior canal wall, thereby assisting surgical planning and helping the surgeon anticipate dural or vascular exposure [5,6,13].

Histopathological examination demonstrated lamellated keratin debris and keratinizing stratified squamous epithelium in all confirmed cases. A fibroconnective-tissue perimatrix was present in 92.1%, while chronic inflammatory infiltrate and granulation tissue were also common. These findings represent the characteristic histological components of cholesteatoma: matrix, perimatrix, and keratin debris. The frequent occurrence of chronic inflammation and granulation tissue reflects the coexistence of recurrent infection and inflammatory activity within the middle ear and mastoid.

Bone fragments with inflammatory or erosive changes were identified in half of the histologically confirmed cases. Bone destruction in cholesteatoma is believed to result from a combination of pressure effects, chronic inflammation, osteoclast activation, enzymatic mediators, and cytokine-related processes. The degree of bony erosion is clinically relevant because it correlates with the risk of ossicular damage, labyrinthine fistula, facial-nerve exposure, and intracranial complications. The false-positive cases in this study were primarily associated with granulation tissue and chronic inflammatory mucosa. This emphasizes that HRCT should not be used as the sole method for confirming cholesteatoma when only nonspecific soft-tissue opacity is present. In equivocal primary cases and especially in suspected residual or recurrent disease, diffusion-weighted magnetic resonance imaging can provide improved tissue characterization. Non-echo-planar diffusion-weighted MRI has become increasingly important because keratin debris typically demonstrates restricted diffusion, allowing better distinction between cholesteatoma and granulation tissue [18].

Nevertheless, HRCT remains essential because MRI is less effective for detailed evaluation of fine bony anatomy. HRCT provides superior visualization of the ossicles, facial canal, labyrinth, tegmen, sigmoid plate, jugular bulb, carotid canal, mastoid pneumatization, and other anatomical variants relevant to surgical planning [5,8,18]. Thus, HRCT and diffusion-weighted MRI have complementary roles rather than being mutually exclusive.

The findings of this study support the routine use of HRCT temporal bone in patients with suspected middle ear cholesteatoma who are being considered for surgery. HRCT provides a reliable preoperative road map, identifies the extent of disease, demonstrates ossicular and other bony erosions, detects complications, and highlights surgically important anatomical variations. However, the final diagnosis should be based on the combined interpretation of clinical examination, imaging, intraoperative findings, and histopathological evaluation.

The study had certain limitations. It was conducted at a single centre, and the number of histopathology-negative cases was small, resulting in relatively wide uncertainty around the specificity estimate. Only surgically treated patients were included; therefore, the disease prevalence and predictive values may not be generalizable to all patients presenting with chronic otitis media. In addition, histopathology confirms the nature of the excised tissue but cannot always provide site-specific confirmation of every anatomical abnormality seen on HRCT. Detailed intraoperative correlation would be more appropriate for validating findings such as facial-canal dehiscence, ossicular erosion, tegmen defects, and labyrinthine fistula.

Interobserver variability between radiologists was not assessed, and diffusion-weighted MRI was not routinely performed. Despite these limitations, the prospective design, consecutive recruitment, use of a standardized HRCT assessment protocol, and direct histopathological correlation strengthen the findings of the study.

CONCLUSION

HRCT temporal bone demonstrated high sensitivity, positive predictive value, and overall accuracy for detecting middle ear cholesteatoma. It was particularly valuable for identifying the anatomical extent of disease, ossicular destruction, scutum erosion, mastoid involvement, labyrinthine fistula, tegmen defects, and surgically important anatomical variations. The incus was the most frequently eroded ossicle. Soft-tissue opacity without characteristic bone erosion was less specific and occasionally represented granulation tissue or chronic inflammatory mucosa.

Histopathological examination remains essential for definitive tissue diagnosis. HRCT and histopathology should be considered complementary: HRCT provides the preoperative anatomical road map, while histopathology confirms cholesteatoma.

7. Declarations

Informed consent- Written informed consent was obtained from all participants or their legal guardians.

Funding- No external funding was received.

Conflicts of interest- The authors declare no conflicts of interest.

Availability of data- The anonymized dataset may be made available by the corresponding author upon reasonable request and subject to institutional policy.

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