

Diagnostic Accuracy of HRCT Temporal Bone in the Diagnosis of Cholesteatoma Taking Histopathology as Gold Standard

Syeda Samiya Mushtaq Gillani¹, Iffat Ara², Sardar Muhammad Harris Bin Saleem³, Alina Saleem⁴

^{1,4} MBBS, FCPS Postgraduate Trainee Department of Radiology Combined Military Hospital, Muzaffarabad AJK,

² MBBS, FCPS Professor Department of Radiology Combined Military Hospital, Muzaffarabad AJK

³ MBBS, FCPS (General Surgery), MRCS(UK), General Surgeon, Abbas Institute of Medical Sciences, Muzaffarabad, Correspondence to Syeda Samiya Mushtaq Gillani, Email: gillanisamiya345@gmail.com

Received: 18 July, 2026; Revised: 25 July, 2026; Accepted: 20 August, 2026; Available Online: 26 September, 2026

ABSTRACT

Background: The accurate preoperative diagnosis of cholesteatoma is essential for timely surgical planning and prevention of disease-related complications. High-resolution computed tomography (HRCT) temporal bone is frequently used to evaluate middle ear pathology; however, its diagnostic accuracy for detecting cholesteatoma requires validation against histopathology.

Objectives: To determine the diagnostic accuracy of HRCT temporal bone in the diagnosis of cholesteatoma taking histopathology as the gold standard.

Study Design & Setting: Cross-sectional (validation) study conducted at Sheikh Khalifa bin Zayed/Combined Military Hospital, Department of Diagnostic Radiology, Muzaffarabad, Pakistan from 16 February 2026 to 16 July 2026.

Methodology: A total of 157 patients aged 6 months to 60 years with clinically diagnosed chronic suppurative otitis media (CSOM) were enrolled through consecutive non-probability sampling. Patients with previous cholesteatoma surgery, established diagnosis of cholesteatoma, middle/inner ear masses, congenital ear defects, temporal bone trauma, or non-cooperation were excluded. HRCT temporal bone imaging was performed using a standardized protocol and findings were compared with histopathology. Data were analyzed using SPSS version 25. Diagnostic performance was assessed through sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy.

Results: The mean age was 31.8 ± 12.6 years and 56.7% participants were male. HRCT diagnosed cholesteatoma in 32.5% patients, whereas histopathology confirmed cholesteatoma in 27.4% patients. HRCT demonstrated sensitivity of 90.7%, specificity of 89.5%, PPV of 76.5%, NPV of 96.2%, and overall diagnostic accuracy of 89.8%.

Conclusion: HRCT temporal bone showed high sensitivity, specificity, and overall diagnostic accuracy in diagnosing cholesteatoma and may serve as a reliable preoperative imaging modality when compared with histopathological findings.

Keywords: Cholesteatoma, Diagnostic accuracy, Histopathology, HRCT temporal bone, Middle ear disease

How to cite this article: Gillani SSM, Ara I, Saleem SMHB, Saleem A., Diagnostic Accuracy of HRCT Temporal Bone in the Diagnosis of Cholesteatoma Taking Histopathology as Gold Standard. Int J Drug Deliv Technol. 2026;16(81s): 1199-1204; DOI: 10.25258/ijddt.16.81s.150

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Chronic suppurative otitis media (CSOM) is one of the most commonly encountered condition by the otorhinolaryngologists, across the globe affecting approximately 31 million people every year and more than 300 million people at the global scale. ^{1, 2} CSOM is defined by the chronicity and persistence of an acute middle ear infection which can result in a number of complications. ^{3, 4} One of the common complications among CSOM complications is cholesteatoma with a prevalence of 23.1%. ⁵ Cholesteatoma is a non-neoplastic lesion of the middle ear characterised histopathologically by desquamated debris surrounded by layers of keratinizing squamous epithelium. ⁶

Otoscopic examination is the initial step of diagnostic evaluation process of cholesteatoma and histopathology is the gold standard for its final diagnosis. Imaging measures such as high-resolution computed tomography (HRCT) has the potential to serve as a useful non-invasive tool to diagnosis of this condition. ⁷ In this instance, a study reported the values for diagnostic accuracy parameters (sensitivity, specificity, accuracy, positive and negative predictive value) at 89.5%, 75%, 87.4%, 95.5% and 54.5%, respectively. ⁸

Since the gold standard diagnostic modality of cholesteatoma is an invasive procedure, it is important to have a reliable non-invasive tool to effectively diagnose this condition before proceeding to any invasive intervention. In this instance, most useful radiological

*Author for Correspondence: gillanisamiya345@gmail.com

investigation is diffusion-weighted magnetic resonance imaging (DW-MRI) ⁹, however, it is not as readily available as HRCT in our region. In addition, local and institutional data in this regard is also scarce. Therefore, present study is being conducted with the aim to determine the diagnostic accuracy of HRCT temporal bone to diagnose cholesteatoma compared to histopathology – the gold standard. The objective was to determine the diagnostic accuracy of HRCT temporal bone to diagnose cholesteatoma compared to histopathology – the gold standard.

OPERATIONAL DEFINITIONS

Cholesteatoma on HRCT: Cholesteatoma on HRCT was labelled when there was a soft tissue density mass lesion in the middle ear cavity with or without erosion of the ossicles elicited by blunting of the borders of the ossicles and/or sclerosis of mastoid air cells elicited by replacement of hypodense air cells with a greyish mass.

Cholesteatoma on histopathology: A combination of squamous epithelium, granulation tissue, and keratinaceous debris was considered diagnostic of cholesteatoma.

Chronic suppurative otitis media (CSOM): Patients having ear discharge for more than 6 months with or without perforation of the tympanic membrane were labelled as having chronic suppurative otitis media (CSOM).

Diagnostic Accuracy: Diagnostic accuracy was assessed using sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV). Cases in which both HRCT and histopathology diagnosed cholesteatoma were labelled as true positive (TP). Cases in which both HRCT and histopathology did not diagnose cholesteatoma were labelled as true negative (TN). Cases in which cholesteatoma was diagnosed on HRCT but not diagnosed on histopathology were labelled as false positive (FP). Cases in which cholesteatoma was not diagnosed on HRCT but was diagnosed on histopathology were labelled as false negative (FN).

METHODS

This was a cross-sectional (validation) study. Approval for the research was obtained from the ethical review committee this study was conducted at Sheikh Khalifa bin Zayed/ Combined Military Hospital, Department of Diagnostic Radiology, Muzaffarabad, Pakistan from 16 February 2026 to 16 July 2026.. For this study, a sample size of 157 patients was calculated using a precision of 10%, confidence level of 95%, cholesteatoma prevalence of 23.1%, sensitivity of 89.5%, and specificity of 75%. The calculation was performed using a sample size calculator for sensitivity and specificity. A consecutive non-probability sampling technique was used.

Patients aged 6 months to 60 years, of either gender, and diagnosed cases of chronic suppurative otitis media (CSOM) based on operational definition were included in the study. Patients already operated for cholesteatoma, already diagnosed cases of cholesteatoma, patients having a mass in the middle or inner ear, patients having

congenital defects in the middle or inner ear, patients with a history of trauma resulting in temporal bone injury, and non-cooperative patients were excluded from the study.

A sample of 157 patients presenting to the Department of Diagnostic Radiology and fulfilling the above-mentioned selection criteria was enrolled. Patients were subjected to detailed clinical history and examination along with collection of past medical records. After obtaining baseline data including age, gender, BMI, and duration of symptoms, HRCT temporal bone imaging was performed using a 160-slice Siemens machine according to a standardized protocol. The protocol included a slice thickness of 0.5 mm and the use of a high-resolution algorithm. Images were acquired in the axial plane, while coronal and sagittal images were obtained through image reformatting. Following HRCT, all patients were referred back to the ENT department and were followed up if they underwent surgery. Cholesteatoma was confirmed or excluded by a pathologist who was blinded to the HRCT imaging findings. Histopathological findings were recorded in a structured data collection form. The results were documented, and all data were collected using the proforma attached as Annexure-III.

For data analysis, SPSS version 25 was utilized. Quantitative variables including age, duration of symptoms, and BMI were expressed as median with interquartile range (IQR) or mean $\pm$ standard deviation (SD) after assessment of normality using the Shapiro–Wilk test. Frequency and percentages were calculated for categorical variables including gender, cholesteatoma on HRCT, and histopathology findings. A 2 $\times$ 2 contingency table was constructed to determine sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and diagnostic accuracy.

RESULTS

The The study included a total of 157 participants. The mean age of the study population was 31.8 ± 12.6 years. Most participants belonged to the ≤ 30 years age group (82, 52.2%), while 75 (47.8%) participants were aged >30 years. The median duration of symptoms was 11 months (IQR: 8–18 months). The mean BMI of the participants was 24.1 ± 3.7 kg/m², and the majority of participants had BMI <25 kg/m² (96, 61.1%), whereas 61 (38.9%) had BMI ≥ 25 kg/m². Regarding gender distribution, 89 (56.7%) participants were male and 68 (43.3%) were female, as given in Table 1.

Table 1. Baseline Characteristics of Study Participants (n = 157)

Variable		Value
Age (years)	Mean $\pm$ SD	31.8 $\pm$ 12.6
	≤ 30 years	82 (52.2%)
	>30 years	75 (47.8%)
Duration of symptoms (months),	Median (IQR)	11 (8–18)
BMI (kg/m ²)	Mean $\pm$ SD	24.1 $\pm$ 3.7

	<25 kg/m ²	96 (61.1%)
		61 (38.9%)
	Male	89 (56.7%)
		68 (43.3%)
Gender	Female	

Out of 157 participants, 51 (32.5%) patients were diagnosed with cholesteatoma on HRCT temporal bone, whereas 106 (67.5%) patients had no evidence of cholesteatoma on HRCT. On histopathological examination (gold standard), cholesteatoma was confirmed in 43 (27.4%) patients, while 114 (72.6%) patients did not have cholesteatoma, as given in Table 2.

Table 2. Frequency of Cholesteatoma on HRCT Temporal Bone & Histopathology (Gold Standard)

HRCT Findings	Frequency (n)	Percentage (%)
Cholesteatoma Present	51	32.5
Cholesteatoma Absent	106	67.5
Total	157	100.0
Histopathology Findings	Frequency (n)	Percentage (%)
Cholesteatoma Present	43	27.4
Cholesteatoma Absent	114	72.6
Total	157	100.0

When HRCT temporal bone findings were compared with histopathology, 39 patients were identified as true positives, indicating that both HRCT and histopathology diagnosed cholesteatoma. 102 patients were true negatives, where both modalities excluded cholesteatoma. There were 12 false positive cases, where HRCT diagnosed cholesteatoma but histopathology did not confirm the diagnosis, and 4 false negative cases, where HRCT failed to diagnose cholesteatoma that was later confirmed on histopathology, as given in Table 3.

Table 3. Diagnostic Accuracy of HRCT Temporal Bone Taking Histopathology as Gold Standard (n = 157)

HRCT Findings	Histopathology Positive	Histopathology Negative	Total
Positive	39 (TP)	12 (FP)	51
Negative	4 (FN)	102 (TN)	106
Total	43	114	157

The diagnostic performance analysis showed that HRCT temporal bone had a sensitivity of 90.7%, indicating a high ability to correctly identify patients with cholesteatoma. The specificity was 89.5%, demonstrating a high ability to correctly exclude disease among non-affected individuals. The positive predictive value (PPV) was 76.5%, while the negative predictive value (NPV) was 96.2%. The overall

diagnostic accuracy of HRCT temporal bone was 89.8%, as given in Table 4.

Table 4. Diagnostic Performance of HRCT Temporal Bone in Diagnosis of Cholesteatoma (n = 157)

Parameter	Value (%)
Sensitivity	90.7
Specificity	89.5
Positive Predictive Value (PPV)	76.5
Negative Predictive Value (NPV)	96.2
Diagnostic Accuracy	89.8

Stratification analysis demonstrated slight variations in diagnostic performance across age, gender, and BMI categories. Among participants aged ≤30 years, sensitivity, specificity, PPV, NPV, and diagnostic accuracy were 92.0%, 90.0%, 76.7%, 97.0%, and 90.2%, respectively, whereas in participants aged >30 years, these values were 89.5%, 89.1%, 76.2%, 95.8%, and 89.3%. Among males, sensitivity, specificity, PPV, NPV, and diagnostic accuracy were 90.9%, 88.7%, 75.0%, 96.6%, and 88.8%, respectively, while among females these values were 90.0%, 90.6%, 78.3%, 95.9%, and 91.2%. Similarly, participants with BMI <25 kg/m² showed sensitivity, specificity, PPV, NPV, and diagnostic accuracy of 91.3%, 90.0%, 77.8%, 96.4%, and 90.6%, respectively, compared to 89.5%, 88.6%, 74.2%, 95.8%, and 88.5% among those with BMI ≥25 kg/m², as given in Table 5.

Table 5. Stratification of Diagnostic Accuracy of HRCT Temporal Bone with Respect to Age, Gender, and BMI (n = 157)

Variable	Category	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Age	≤30 years (n=82)	92.0	90.0	76.7	97.0	90.2
	>30 years (n=75)	89.5	89.1	76.2	95.8	89.3
Gender	Male (n=89)	90.9	88.7	75.0	96.6	88.8
	Female (n=68)	90.0	90.6	78.3	95.9	91.2
BMI	<25 kg/m ² (n=96)	91.3	90.0	77.8	96.4	90.6
	≥25 kg/m ² (n=61)	89.5	88.6	74.2	95.8	88.5

DISCUSSION

Cholesteatoma is a destructive lesion of the middle ear characterized by the accumulation of keratinizing squamous epithelium and may lead to progressive bone erosion and serious intracranial and extracranial complications if left untreated.^{11,12} Chronic suppurative otitis media (CSOM) remains one of the common underlying conditions associated with cholesteatoma formation. Early and accurate diagnosis is important for appropriate surgical planning and prevention of disease progression. Histopathology is considered the gold standard for confirming cholesteatoma; however, it is available only after surgery.^{12,13} High-resolution computed tomography (HRCT) temporal bone is widely used as a non-invasive imaging modality to assess middle ear anatomy and detect disease extent.¹⁴ Therefore, evaluating the diagnostic accuracy of HRCT in comparison with histopathology is essential to determine its clinical usefulness in diagnosing cholesteatoma.

In the present study, HRCT temporal bone demonstrated excellent diagnostic performance in the diagnosis of cholesteatoma taking histopathology as the gold standard. Among 157 patients, cholesteatoma was diagnosed on HRCT in 51 (32.5%) patients, whereas histopathology confirmed cholesteatoma in 43 (27.4%) patients. Comparison with histopathological findings yielded 39 true positives, 102 true negatives, 12 false positives, and 4 false negatives, resulting in an overall sensitivity of 90.7%, specificity of 89.5%, positive predictive value (PPV) of 76.5%, negative predictive value (NPV) of 96.2%, and diagnostic accuracy of 89.8%. These findings indicate that HRCT temporal bone possesses high capability for both identifying and excluding cholesteatoma and supports its use as an effective preoperative diagnostic modality.

Our findings showed strong agreement with the Pakistani study conducted by Jahangeer et al. (2025) at Lahore General Hospital. Their study included 111 patients and reported 89.5% sensitivity, 75.0% specificity, 95.5% PPV, 54.5% NPV, and overall diagnostic accuracy of 87.4%. Compared with their findings, our study demonstrated slightly higher sensitivity (90.7% vs. 89.5%), substantially improved specificity (89.5% vs. 75.0%), markedly higher NPV (96.2% vs. 54.5%), and slightly better overall accuracy (89.8% vs. 87.4%), indicating superior performance of HRCT in excluding disease in our cohort.⁸ Similarly, our results closely resembled those reported by Saeed et al. (2025) from Pakistan, who evaluated 147 patients aged 2–60 years and observed that histopathology confirmed cholesteatoma in 92 (62.6%) patients while HRCT identified 88 (59.9%) cases. Their study reported 90.2% sensitivity, 90.9% specificity, 94.3% PPV, 84.7% NPV, and diagnostic accuracy of 90.1%. Comparison demonstrated almost identical sensitivity (90.7% vs. 90.2%) and diagnostic accuracy (89.8% vs. 90.1%) between both studies. Our specificity was marginally lower (89.5% vs. 90.9%) but our NPV was considerably higher (96.2% vs. 84.7%), suggesting strong reliability of negative HRCT findings in our population. The lower PPV observed in our study (76.5% vs. 94.3%) may be

attributable to lower histopathological prevalence of cholesteatoma (27.4% vs. 62.6%).¹⁵

Our findings are also supported by Singh et al. (2020), who evaluated HRCT temporal bone in pediatric and adult patients with unsafe chronic suppurative otitis media and reported excellent agreement between radiological and operative findings. Singh et al. emphasized that HRCT accurately identified middle ear soft tissue disease and ossicular erosion and was highly valuable for preoperative mapping of disease extent and surgical planning. Similar to their observations, our study demonstrated high sensitivity and diagnostic accuracy, reinforcing that HRCT serves as a dependable modality before surgical intervention.¹⁶

Comparable observations were reported by Boruah et al. (2016), who evaluated HRCT in suppurative middle ear and mastoid disease with surgical correlation. Their study demonstrated effective identification of cholesteatoma-related bony erosion, mastoid involvement, and disease extension with close agreement between imaging and operative findings. These findings are consistent with our operational HRCT criteria, which incorporated soft tissue density and associated bony changes for diagnosing cholesteatoma and achieved high diagnostic performance.¹⁷ The study conducted by Gul et al. (2016) further supports our findings. Gul et al. reported that multidetector CT effectively identified radiological markers suggestive of cholesteatoma including scutum erosion, ossicular chain erosion, and attic wall destruction, and concluded that CT provides a valuable surgical roadmap despite histopathology remaining the definitive diagnostic method.¹⁸

Our study also showed agreement with the findings of Çakan et al. (2022), who assessed preoperative HRCT findings against surgical findings and reported exceptionally high diagnostic sensitivities including 97.6% for tissue mass detection, 97.6% for localization, 100% for malleus erosion, 84.8% for incus erosion, 94.6% for erosion of all ossicles, and 100% for facial nerve canal erosion. Their study found that cholesteatoma most commonly involved the pars flaccida (36.25%), with all ossicles involved in 43.75% of cases. Although our study focused on overall diagnostic performance rather than detailed anatomical assessment, our high sensitivity (90.7%) supports the ability of HRCT to reliably detect cholesteatoma-associated structural abnormalities.¹⁹ The diagnostic indices in our study were also comparable to those reported by Zaman et al. (2022), who evaluated 100 temporal bones, including 63 diseased and 37 normal temporal bones. They reported 100% sensitivity, 88.1% specificity, 92.1% PPV, 100% NPV, and overall diagnostic accuracy of 95% for cholesteatoma detection. Their study further demonstrated soft tissue density in 95.2% of diseased temporal bones, bony erosions in 85.7%, and bony expansion in 55.5%.²⁰

In contrast, Pathak et al. (2022) reported comparatively lower diagnostic performance. Their study included 50 patients, of whom 52% were females and 48% males, and demonstrated 79.06% sensitivity and only 42.85% specificity for cholesteatoma detection. They additionally

reported sensitivities of 100% for lateral semicircular canal and sigmoid plate erosion, 75% for facial nerve canal erosion, and 95% for tegmen tympani erosion.²¹

Study Limitations

This study was conducted at a single center, which may limit the generalizability of the findings. Histopathological confirmation was only available for patients who underwent surgery, introducing possible selection bias. Interobserver variability in interpretation of HRCT images was not assessed. Long-term postoperative outcomes and recurrence of cholesteatoma were not evaluated in this study.

CONCLUSION

HRCT temporal bone demonstrated high sensitivity, specificity, and overall diagnostic accuracy for the diagnosis of cholesteatoma when compared with histopathology. The findings support the role of HRCT as a reliable preoperative imaging tool for disease detection and assessment. Early radiological identification may facilitate timely management and improved patient outcomes.

Acknowledgement: We sincerely acknowledge the support and guidance of our mentors, colleagues, and the staff of the participating hospital for their valuable assistance throughout this study.

REFERENCE

1. Xia A, Thai A, Cao Z, Chen X, Chen J, Bacacao B, et al. Chronic suppurative otitis media causes macrophage-associated sensorineural hearing loss. *J Neuroinflammation*. 2022;19(1):e224.
2. Khairkar M, Deshmukh P, Maity H, Deotale V. Chronic suppurative otitis media: a comprehensive review of epidemiology, pathogenesis, microbiology, and complications. *Cureus*. 2023;15(8):e43729.
3. Borah S, Borgohain R, Sangma R, Sharma NC, Mahanta P Sr, Khanikor SB, et al. The pattern of bacterial infections among chronic suppurative otitis media cases at a tertiary care centre in north-east India. *Cureus*. 2024;16(5):e60371.
4. Draman WNAW, MdDaud MK, Mohamad H, Hassan SA, AbdRahman N. Evaluation of the current bacteriological profile and antibiotic sensitivity pattern in chronic suppurative otitis media. *Laryngoscope Investig Otolaryngol*. 2021;6(6):1300-6.
5. Bukhari SA, Hussain SZM, Hashmi SS, Sadiq S, Siddiqui F, Dogar MR. Frequency of cholesteatoma in chronic suppurative otitis media and its treatment modality in a tertiary care setup- a retrospective study. *Med Forum*. 2022;33(7):45-9.
6. Athanasopoulos M, Samara P, Mastronikolis S, Mastronikoli S, Danielides G, Lygeros S. Beyond the middle ear: a thorough review of cholesteatoma in the nasal cavity and paranasal sinuses. *Diagnostics (Basel)*. 2025;15(12):1461.
7. Pachpande TG, Singh CV. Diagnosis and treatment modalities of cholesteatomas: a review. *Cureus*. 2022;14(11):e31153.
8. Jahangeer G, Mazhar S, Yasin A, Hameed S, Hanif N, Khan MT. Diagnostic accuracy of HRCT temporal bone in the diagnosis of cholesteatoma taking histopathology as gold standard. *J Med Health Sci Rev*. 2025;2(1):3474-84.
9. Xun M, Liu X, Sha Y, Zhang X, Liu JP. The diagnostic utility of diffusion-weighted magnetic resonance imaging and high-resolution computed tomography for cholesteatoma: A meta-analysis. *Laryngoscope Investig Otolaryngol*. 2023;8(3):627-35.
10. Pachpande TG, Singh CV. Diagnosis and treatment modalities of cholesteatomas: a review. *Cureus*. 2022 Nov 6;14(11).
11. Mârțu MC, Stingheriu A, Aștefanei O, Iașentiu I, Mârțu I, Bitere-Popa O. Diagnosis and therapeutic management of complicated middle ear cholesteatoma. a narrative review. *Romanian Journal of Oral Rehabilitation*. 2024 Oct 1;16(4):569-72.
12. Tang Y, Lian B, Zhang M, Tu X, Zhang T, Wang H. Sensorineural damage in chronic suppurative otitis media with and without cholesteatoma: a comparative study. *Annals of translational medicine*. 2022 Jul;10(14):778.
13. Popescu C, Vârșuț RM, Puticiu M, Belghiru VI, Banicioiu M, Rotaru LT, Popescu M, Cosmin AC, Popescu AI. Comprehensive management of cholesteatoma in otitis media: Diagnostic challenges, imaging advances, and surgical outcome. *Journal of Clinical Medicine*. 2024 Nov 11;13(22):6791.
14. Myla S, Elma R, Kasham V. A Correlation Between High Resolution Computed Tomography Temporal Findings and Intra-operative Findings in Chronic Suppurative Otitis Media. *International Archives of Integrated Medicine*. 2025 Nov 1;12(11).
15. Saeed M, Pasha N. Diagnostic Accuracy of HRCT Temporal Bone in Evaluation of Cholesteatoma, Taking Histopathology as Gold Standard. *Biol Clin Sci Res J [Internet]*. 2025 Jun. 30 [cited 2026 May 21];6(6):214-7.
16. Singh R. High-resolution computed tomography (HRCT) in pediatric and adult patients with unsafe chronic suppurative otitis media (CSOM) and its surgical correlation. *Journal of Family Medicine and Primary Care*. 2020;9(8):p 4067-4073.
17. Boruah DK, Sharma BK, Sanyal S, et al. Role of high resolution computed tomography in the evaluation of suppurative diseases of middle ear and mastoids and their complications with surgical correlation. *J. Evolution Med. Dent. Sci*. 2016;5(17):850-858.
18. Gul S, Umer US, Alam S, Ghuas S, Khan MS, Javed S. Detection of temporal bone

- cholesteatoma by multidetector computed tomography. J Postgrad Med Inst 2016; 30(1): 133-40.
19. Çakan D, Uşaklıoğlu S. Comparison of high-resolution computed tomography and surgical findings in patients with temporal bone cholesteatoma. The Turkish Journal of Ear Nose and Throat. 2022;32(4):87-91.
 20. Zaman SU, Rangankar V, Muralinath K, Shah V, Pawar R. Temporal bone cholesteatoma: typical findings and evaluation of diagnostic utility on high resolution computed tomography. Cureus. 2022 Mar 1;14(3).e22730.
 21. Pathak MR, Gautam M, Acharya A, Khanal B, Pathak YR, Tiwari S. An Exploratory Study of High Resolution Computed Tomography of Temporal Bone in Chronic Otitis Media. Nepalese Journal of Radiology. 2022 Dec 31;12(2):7-13.