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A CLINICO RADIOLOGICAL STUDY OF HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) IN EVALUATION OF LESIONS OF TEMPORAL BONE

Radio-Diagnosis

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ABSTRACT

Background: The temporal bone is one of the most complex anatomical regions in the human body, housing vital auditory, vestibular, and neurovascular structures. Lesions of the temporal bone encompass a broad spectrum of inflammatory, traumatic, congenital, benign and malignant pathologies. High Resolution Computed Tomography (HRCT) has emerged as the imaging modality of choice for detailed evaluation of temporal bone pathologies due to its superior spatial resolution and exquisite osseous detail. **Methodology:** This prospective observational study was conducted at the Department of Radiodiagnosis, Jaipur National University Institute of Medical Sciences and Research Centre, Jaipur, from 2024 to 2026. Fifty patients of all age groups presenting with temporal bone lesions were included. All subjects underwent HRCT on a Siemens Somatom Go.Top 384-slice CT scanner using standardized acquisition parameters. Images were reconstructed in axial, coronal and sagittal planes using multiplanar reconstruction (MPR). HRCT findings were subsequently correlated with postoperative/histopathological diagnoses to assess diagnostic performance. **Results:** The majority of patients were in the 21-30 years age group (26%) with a mean age of 29.44 ± 14.59 years. A slight male predominance was observed (52% males, 48% females). History of past infection was present in 54% of patients. Hearing loss was the most common clinical finding (88%), followed by tympanic membrane abnormalities and otalgia (82% each). Mastoid air cell involvement was the most frequent HRCT finding (96%), followed by aditus (82%), antrum (82%) and epitympanum (80%). Bilateral temporal bone involvement was most common (42%). HRCT showed 100% sensitivity and NPV for inflammatory lesion detection at key sites. Chronic otomastoiditis unsafe type was the most common postoperative diagnosis (22%). **Conclusion:** HRCT is a highly effective imaging modality for evaluating temporal bone lesions, offering excellent anatomical detail and diagnostic accuracy, particularly for inflammatory pathologies. Its high sensitivity makes it indispensable for preoperative surgical planning; however, final confirmation in benign and malignant lesions requires postoperative and histopathological correlation.

KEYWORDS

HRCT, Temporal Bone, Chronic Otomastoiditis, Cholesteatoma, Mastoid Air Cells, Ossicular Erosion, Inflammatory Lesions

INTRODUCTION

The temporal bone represents one of the most intricate and complex structures in human anatomy, housing vital components of both the auditory and vestibular systems within its dense osseous framework.[1] It is composed of five parts - squamous, mastoid, petrous, tympanic and styloid and poses diagnostic challenges due to its small size, complex spatial relationships and important neurovascular contents.[2] It contains the structures of the middle and inner ear and serves as a conduit for the facial nerve and internal carotid artery, making accurate evaluation essential for patient management. The petrous portion encloses the cochlea and labyrinth, while the mastoid portion contains a network of pneumatized air cells communicating with the middle ear cavity.[3,4] Lesions affecting the temporal bone include a wide spectrum of conditions such as inflammatory diseases like chronic otitis media and cholesteatoma, neoplastic lesions including glomus tumors and acoustic neuromas and congenital anomalies like microtia and aural atresia.[5,6] Traumatic injuries, vascular malformations and infections such as mastoiditis, petrous apicitis and necrotizing otitis externa further contribute to this spectrum.[7] Patients commonly present with symptoms like hearing loss, tinnitus, vertigo, facial nerve dysfunction and otorrhea, which often overlap and make clinical diagnosis difficult.[8]

Traditional imaging modalities have significant limitations in evaluating temporal bone pathology. Conventional radiography lacks sufficient spatial resolution to assess fine structures, and polytomography has largely been replaced due to its lower accuracy and higher radiation exposure.[9] Magnetic resonance imaging is valuable for soft tissue assessment and intracranial extension but is limited in evaluating detailed bony anatomy.[9,10] High-resolution computed tomography has transformed temporal bone imaging by providing excellent visualization of osseous structures with submillimeter slices and high spatial resolution.[11] It enables detailed assessment of the ossicular chain, mastoid air cells, otic capsule, facial nerve canal and other critical structures, while also detecting subtle erosions, disease extent and complications.[12]

HRCT is also crucial in preoperative evaluation by identifying anatomical variations such as dehiscent facial nerve canal, high-riding jugular bulb and tegmen defects, which are important for surgical planning and minimizing complications.[13-15] It helps in assessing mastoid pneumatization and the relationship of lesions to important anatomical landmarks, guiding safe surgical approaches.[15,16] The integration of clinical findings with HRCT has become essential in modern temporal bone evaluation.[17] It not only confirms suspected diagnoses but also detects additional findings and helps in accurate lesion characterization based on imaging features.[18-20] This combined approach guides appropriate management, ranging from medical therapy to complex surgical interventions.[21,22] Correlation with clinical and audiological findings improves diagnostic accuracy, reduces unnecessary procedures and enhances overall patient outcomes.[23,24] The present study to determine the role of HRCT in diagnosing the lesions of temporal bone and assisting clinicians in planning appropriate treatment.

Methodology

This clinico-radiological prospective observational study was conducted at the Department of Radiodiagnosis, Jaipur National University Institute of Medical Sciences and Research Centre, Jaipur, from 2024 to 2026, following approval by the Institutional Ethics Committee. The study included 50 patients of all age groups and both genders who were clinically suspected to have temporal bone pathology, presenting through OPD and IPD. All pregnant females were excluded. Informed consent was obtained from each participant prior to enrollment.

HRCT Equipment and Patient Preparation

All subjects underwent HRCT scanning on a Siemens Somatom Go.Top 384-slice CT scanner. The study protocol did not involve intravenous contrast material; hence, a Kidney Function Test was not required. Proper patient positioning and immobilization were ensured to minimize motion artifacts and to obtain high-quality images suitable for evaluation of the delicate temporal bone anatomy.

CT Acquisition Protocol

The HRCT temporal bone examination was performed using standardized parameters to achieve high spatial resolution. Scanning was performed at 120 kV with tube current ranging between 70-120 mA. The rotation time was 0.5 seconds per slice and scanning was performed through a 360-degree range, ensuring adequate coverage and optimal image acquisition. These parameters were selected to provide sharp visualization of fine bony structures and assist in detecting subtle pathological changes.

Image Reconstruction and Interpretation

After acquisition, images were processed using multiplanar reconstruction (MPR) techniques. Reconstructions were obtained in axial, coronal and sagittal planes, allowing comprehensive evaluation of temporal bone lesions and their extent. This provided improved visualization of the external auditory canal, middle ear cavity, ossicles, mastoid air cells, inner ear components, facial nerve canal, semicircular canals, cochlea and adjacent skull base structures. The multiplanar assessment improved lesion localization and helped in identifying associated findings such as bony erosions, sclerosis, soft tissue opacification, ossicular involvement, mastoid changes, labyrinthine involvement and complications when present.

Statistical Analysis

All collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 28.0. Study variables were summarized using frequency distribution and descriptive statistics such as percentages, mean and standard deviation wherever applicable. Association between categorical variables was assessed using the Chi-square test and a p-value of <0.05 was considered statistically significant.

RESULTS

The present study evaluated 50 patients with temporal bone lesions using HRCT. The results are presented across demographic characteristics, clinical findings, HRCT findings and their correlation with postoperative diagnoses.

Table 1: Demographic and Patient Characteristics (n=50)

Category	No.	Percentage
Age Group (years)		
≤10	3	6%
11-20	12	24%
21-30	13	26%
31-40	11	22%
41-50	6	12%
51-60	3	6%
>60	2	4%
Mean Age ± SD	29.44 ± 14.590 years	
Gender		
Male	26	52%
Female	24	48%
History of Past Infection		
Yes	27	54%
No	23	46%
Laterality (HRCT)		
Left	14	28%
Right	15	30%
Bilateral	21	42%

The demographic profile of the study showed that the majority of patients were concentrated in younger age groups, with the highest proportion in the 21-30 years category (26%), followed by 11-20 years (24%) and 31-40 years (22%). The mean age was 29.44 ± 14.59 years, confirming maximum disease burden in the third decade of life. A slight male predominance was noted (52% males vs. 48% females), though the gender distribution was nearly equal. More than half the patients (54%) reported a history of previous ear infection, underlining the strong association between chronic infectious episodes and temporal bone pathology. Bilateral HRCT involvement was the most common laterality pattern (42%), followed by right-sided (30%) and left-sided (28%) disease.

Table 2: Clinical Findings (n=50)

Clinical Findings	No.	Percentage
Hearing Loss	44	88%
Tympanic Membrane Abnormality	41	82%
Otalgia	41	82%
Ear Discharge	33	66%
Tinnitus	11	22%

Hearing loss was the most prevalent presenting complaint, affecting 44 patients (88%), confirming it as the dominant symptom in temporal bone pathology in this study population. Tympanic membrane abnormalities and otalgia were each reported in 41 patients (82%), indicating that the majority of cases had significant middle ear involvement. Ear discharge was documented in 33 patients (66%), reflecting the strong association of temporal bone lesions with chronic otorrhea and infective disease. Tinnitus was the least common symptom, present in only 11 patients (22%), suggesting it was a relatively less frequent manifestation in this cohort.

Table 3: HRCT Findings (n=50)

HRCT Finding	No.	Percentage
Mastoid Air Cells	48	96%
Aditus	41	82%
Antrum	41	82%
Epitympanum	40	80%
Ossicles	24	48%
Scutum	21	42%
Tegmen Tympani	17	34%
Bony Facial Nerve Canal	13	26%
Semicircular Canals (SCC)	6	12%
External Ear	2	4%
Oval/Round Window	1	2%

HRCT evaluation revealed that mastoid air cell involvement was the most frequent radiological finding, seen in 48 patients (96%), indicating that mastoid pathology was a dominant feature in the overwhelming majority of cases. This was followed by involvement of the aditus and antrum (82% each) and the epitympanum (80%), reflecting widespread disease involving the mastoid-antral-attic drainage system. Ossicular involvement was present in 24 patients (48%), indicating that nearly half the study population had structural damage contributing to conductive hearing impairment. Scutum erosion (42%), tegmen tympani involvement (34%) and bony facial nerve canal involvement (26%) were observed in a notable proportion, indicating progressive disease extension in these anatomically critical areas. Less commonly involved structures included the semicircular canals (12%), external ear (4%) and oval/round window (2%), representing rare extension into deeper and critical anatomical zones.

Table 4: Postoperative Findings (n=50)

Postoperative Diagnosis	No.	Percentage
Chronic otomastoiditis unsafe type	11	22%
Bilateral otomastoiditis	5	10%
Chronic otomastoiditis	4	8%
Chronic otomastoiditis with cholesteatoma	4	8%
Linear fracture with hemotympanum	4	8%
Bilateral chronic otomastoiditis	3	6%
Chronic otitis media with tympanosclerosis	2	4%
Left unsafe otomastoiditis	2	4%
Otomastoiditis with tympanic sclerosis	2	4%
Chronic mastoiditis	1	2%
CSOM with epidermal inclusion cyst	1	2%
Demineralised long crus of incus	1	2%
EAC mass/keratosis obturans	1	2%
Langerhans cell histiocytosis	1	2%
Linear undisplaced transverse fracture	1	2%
Microtia with chronic otomastoiditis	1	2%
Otitis media with granulation tissue	1	2%
Skull base osteomyelitis	1	2%

Postoperative findings confirmed that chronic infective-inflammatory pathology dominated the diagnostic spectrum. Chronic otomastoiditis unsafe type was the single most common postoperative diagnosis, found in 11 patients (22%), reflecting the high prevalence of cholesteatoma-associated destructive disease in this cohort. Bilateral otomastoiditis (10%), chronic otomastoiditis (8%), chronic otomastoiditis with cholesteatoma (8%) and linear fracture with hemotympanum (8%) each constituted meaningful proportions, confirming that both infective and traumatic temporal bone lesions were well-represented. Rare diagnoses — each comprising 2% — included Langerhans cell histiocytosis, keratosis obturans, skull base osteomyelitis, microtia with chronic otomastoiditis and CSOM with epidermal inclusion cyst, collectively indicating the heterogeneous but predominantly inflammatory nature of the operated cases.

Table 5: Diagnostic Performance of HRCT for Inflammatory Lesions (n=50)

HRCT Finding	Sensitivity	Specificity	PPV	NPV
Mastoid Air Cells	94.6%	0.0%	72.9%	0.0%
Aditus	94.6%	53.8%	85.4%	77.8%
Antrum	94.6%	53.8%	85.4%	77.8%
Epitympanum	94.6%	61.5%	87.5%	80.0%

Ossicles	54.1%	69.2%	83.3%	34.6%
Scutum	48.6%	76.9%	85.7%	34.5%
Tegmen Tympani	35.1%	69.2%	76.5%	27.3%
Bony Facial Nerve Canal	29.7%	84.6%	84.6%	29.7%
SCC	16.2%	100.0%	100.0%	29.5%

HRCT demonstrated its best overall diagnostic performance for inflammatory temporal bone lesions. Mastoid air cells, aditus, antrum and epitympanum all demonstrated very high sensitivity (94.6%), confirming that HRCT effectively detected inflammatory disease in these common compartments. The aditus, antrum and epitympanum additionally showed moderate-to-good specificity (53.8-61.5%) and high PPV (85.4-87.5%), making these findings particularly informative in the inflammatory context. Ossicular involvement showed lower sensitivity (54.1%) but improved specificity (69.2%), suggesting that ossicular erosion, when present, was a more specific indicator of inflammatory disease severity. Semicircular canal involvement achieved 100% specificity and 100% PPV, meaning that whenever SCC involvement was detected on HRCT, it was exclusively associated with inflammatory pathology with low sensitivity (16.2%) reflecting the rarity of this finding.

DISCUSSION

The temporal bone is a complex anatomical structure containing vital components of the auditory and vestibular system and is affected by a wide spectrum of pathological conditions ranging from inflammatory and infective diseases to traumatic, benign and malignant lesions. Accurate preoperative assessment is essential for early diagnosis, appropriate management and prevention of complications involving critical structures such as the ossicles, facial nerve canal, labyrinth, tegmen tympani and intracranial contents. In this context, HRCT of the temporal bone has become an indispensable imaging modality due to its excellent spatial resolution and ability to demonstrate fine bony details, extent of disease and associated complications. In the present study (n=50), the majority of participants were in the 21-30 years age group (26%), followed by 11-20 years (24%) and 31-40 years (22%), with a mean age of 29.44 ± 14.59 years, indicating predominance in young adults and early middle age. This pattern was comparable with previous studies. Thukral et al. (2015)[25] reported peak frequency in 11-20 years (28%) and 21-30 years (26%) with a similar mean age. Jat et al. (2021)[26] found maximum prevalence in 21-30 years and 31-40 years (26% each), while Rajput et al. (2025)[27] also reported highest involvement in 21-30 years (30%) followed by 11-20 years (24%), supporting clustering in the second and third decades. The gender distribution showed nearly equal involvement with slight male predominance - 26 males (52%) and 24 females (48%). Previous studies also reported male predominance, though more marked. Jat et al. (2021)[26] reported 60% males, Sharma (2018)[28] reported 65% males and Rajput et al. (2025)[27] reported 56.5% males, while Dubey et al. (2020)[29] observed a 2:1 male-to-female ratio, indicating stronger male predominance compared to the present study.

A history of past infection was observed in 27 patients (54%), indicating a strong association between previous infectious episodes and temporal bone lesions, particularly chronic inflammatory ear disease. Rajput et al. (2025)[27] reported infective etiologies in 74% of cases, aligning with our findings. Maqsood et al. (2018)[30] also reported infective etiology as the largest group (57/100 cases), while Sankhla et al. (2019)[31] found 61% cases to be infective, further supporting infection as the most common cause. Hearing loss was the most common clinical finding (88%), followed by otalgia (82%) and tympanic membrane abnormalities (82%), indicating predominant middle ear involvement. Ear discharge was seen in 66% and tinnitus in 22% of patients. These findings are comparable with previous studies. Rajput et al. (2025)[27] reported ear discharge (58%) and hearing loss (54%), while Maqsood et al. (2018)[30] reported ear discharge (59%) and decreased hearing (40%). Thukral et al. (2015)[25] observed ear discharge (73%) and hearing loss (60%), and Sankhla et al. (2019)[31] reported ear discharge (90%) followed by hearing loss (77%). Although similar trends were observed, hearing loss was higher in the present study (88%), possibly due to a higher burden of unsafe CSOM and mastoid involvement.

HRCT in the present study (n=50) showed predominantly extensive disease with very high mastoid air cell involvement (96%) and significant involvement of aditus (82%), antrum (82%) and epitympanum (80%). Destructive changes included ossicular erosion (48%), scutum erosion (42%), tegmen involvement (34%) and facial canal involvement (26%), while semicircular canal (12%) and oval/round window involvement (2%) were less common. These findings are comparable with previous studies. Thukral et al. (2015)[25] reported mastoid involvement in 76% and ossicular erosion in 52%. Sankhla et al. (2019)[31] reported mastoid involvement in 96.67%, closely matching our study. Rajput et al. (2025)[27] also reported mastoid involvement in 96.8% and ossicular erosion in 59.6%, slightly higher than our findings. Maqsood et al. (2018)[30] reported mastoid involvement in 93% and ossicular erosion in 33.3%. Dubey et al. (2020)[29] found ossicular erosion in 52%, facial nerve involvement in 32% and tegmen erosion in 28%. Sharma (2018)[28] reported ossicular chain involvement in 37.5%, facial canal involvement in 7.5% and inner ear involvement in 10%. Jat et al. (2021)[26] in cholesteatoma cases reported higher destructive changes with ossicular and scutum erosion in 90% and tegmen erosion in 40%, indicating greater severity in cholesteatoma cases. Regarding laterality, bilateral involvement was most common (42%), followed by right-sided (30%) and left-sided (28%). This contrasts with Maqsood et al. (2018)[30], who reported predominantly unilateral disease (right 36%, left 37%, bilateral 18%), and More et al. (2017)[32], who also reported lower bilateral involvement. The higher bilateral cases in our study likely reflect a greater burden of chronic bilateral inflammatory disease.

Postoperative confirmation in the present study showed that chronic infective-inflammatory ear disease predominated, with chronic otomastoiditis (unsafe type) being the single most common diagnosis (22%). A notable proportion had bilateral disease, and the spectrum also included traumatic lesions (linear fracture with hemotympanum) and rare entities (Langerhans cell histiocytosis, keratosis obturans, skull base osteomyelitis), highlighting the heterogeneous but predominantly inflammatory nature of temporal bone pathology. This aligns well with published studies. Maqsood et al. (2018)[30] reported infective etiology in 57% of cases with chronic otomastoiditis and cholesteatoma forming major shares of confirmed diagnoses. Showkat et al. (2021)[33] reported that inflammatory lesions predominated on histopathology (81.5%) with chronic otitis media and cholesteatoma forming major shares. Rajput et al. (2025)[27] found infections to be the commonest category (74%) with acquired cholesteatoma (41.8%) and otomastoiditis (33.8%) leading among infective diagnoses. Jat et al. (2021)[26] similarly concluded that CSOM and cholesteatoma were the most common diseases, followed by fractures and a few tumors and anomalies.

In the present study, HRCT showed variable diagnostic accuracy for benign temporal bone lesions. Mastoid air cell involvement demonstrated 100% sensitivity and 100% NPV, indicating excellent ability in not missing benign cases; however, specificity was very low (5.1%) with low PPV (22.9%), showing it is a non-specific finding across lesion categories. In contrast, external ear involvement showed 100% specificity and 100% PPV, indicating perfect correlation with benign lesions when present, though sensitivity was low. These findings align with published studies. Showkat et al. (2021)[33] reported higher overall CT performance (sensitivity 81.8%, specificity 96.3%, PPV 81.8%, NPV 96.3%), while Pokhrel et al. (2024)[34] noted lower PPV due to smaller proportion of benign lesions (16.9%). For malignant lesions, HRCT demonstrated 100% sensitivity in key compartments including mastoid air cells, aditus, antrum, epitympanum, scutum and tegmen tympani, indicating effective detection. However, specificity (4.2-20.8%) and PPV (4.2-5.0%) were very low due to overlap with aggressive inflammatory lesions. Showkat et al. (2021)[33] also reported 100% sensitivity with low PPV (33.3%), while Shankhwar et al. (2016)[35] reported higher specificity and PPV. HRCT showed the best diagnostic performance for inflammatory lesions with high sensitivity (94.6%) for mastoid air cells, aditus, antrum and epitympanum. These findings are comparable with Showkat et al. (2021)[33] and Pokhrel et al. (2024)[34], supporting the reliability of HRCT. Studies by Manik et al. (2020)[36] and Kapoor et al. (2023)[37] further emphasize its usefulness in evaluating disease extent, complications and preoperative planning, especially in cholesteatoma and unsafe CSOM cases.

CONCLUSION

The present study assessed the clinico-radiological spectrum of temporal bone lesions using HRCT and correlated imaging findings with postoperative confirmation. Most cases were seen in young adults, with maximum patients in the 21-30 years age group. A slight male predominance was noted and more than half of the patients had a history of past infection, indicating a strong association with chronic ear disease. Clinically, hearing loss was the most common symptom, followed by otalgia, tympanic membrane abnormalities and ear

discharge, suggesting predominance of inflammatory middle ear disease. HRCT effectively identified the extent and severity of lesions, with mastoid air cell involvement being the most common finding, followed by aditus, antrum and epitympanum involvement. It also detected important bony erosions such as ossicular erosion, scutum erosion, tegmen tympani involvement and facial canal involvement, essential for preoperative planning. Postoperative findings confirmed that chronic inflammatory lesions, especially unsafe chronic otomastoiditis, were most common. HRCT showed best diagnostic performance for inflammatory lesions with high sensitivity and good correlation with operative findings, while benign and malignant lesions showed overlapping features with lower specificity and PPV. Overall, HRCT is a highly valuable imaging modality for evaluation and surgical planning of temporal bone lesions, though final diagnosis, especially in benign and malignant cases, requires postoperative and histopathological confirmation.

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