Original Research Article

HRCT IMAGING OF TEMPORAL BONE IN EAR PATHOLOGIES

M.Vignesh[1], Mubarak R.M.[2], M. Prashanthini[3], V.N. Ruthira Eshanth[4]

[1]*Professor, Department of Radiodiagnosis, Sri Lalithambigai Medical College and Hospital, Tamilnadu, India.*
[2]*Associate Professor, Department of Radiodiagnosis, Sri Lalithambigai Medical College and Hospital, Tamilnadu, India.*
[3]*Assistant Professor, Department of Radiodiagnosis, Sri Lalithambigai Medical College and Hospital, Tamilnadu, India.*
[4]*Associate Professor, Department of Radiodiagnosis, Sri Lalithambigai Medical College and Hospital, Tamilnadu, India.*

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Corresponding Author:
Dr. V.N. Ruthira Eshanth,
Associate Professor, Department of Radiodiagnosis, Sri Lalithambigai Medical College and Hospital, Tamilnadu, India.
Email: ruthira210@gmail.com

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ABSTRACT

Background: High-resolution computed tomography (HRCT) provides detailed imaging of the temporal bone, making it an essential tool for diagnosing and managing various ear pathologies, including infections, neoplasms, and trauma. **Aim:** This study aimed to evaluate various temporal bone pathologies, identify associated complications, determine the most common anatomical variations, and assess the most frequently observed temporal bone diseases using HRCT.

Materials and Methods: A prospective study was conducted on 50 patients with suspected temporal bone pathology at Sree Balaji Medical College and Hospital between February 2016 and January 2018. All patients underwent HRCT using a Hitachi ECLOS 8-slice CT scanner, and axial and coronal views were obtained. Thin-section images (2 mm) were used to enhance anatomical details. Contrast was administered when necessary. The data were analysed descriptively.

Results: Infections were most common (92%), with cholesteatoma (48%) and mastoiditis (43%) being predominant. Neoplasms and trauma accounted for 6% and 2% of cases, respectively. HRCT showed a strong correlation with surgical findings in ossicular erosion (30%), mastoid air cell opacification (33%), and intracranial extension (11%). Cholesteatoma showed 82% concordance with operative findings. Most patients were male (60%), and the peak incidence was in the 21–30-year age group. Acoustic neuroma was the most frequently identified tumour, with radiological and surgical agreement.

Conclusion: HRCT is an effective, non-invasive imaging modality for the evaluation of temporal bone pathologies. It aids in the diagnosis, surgical planning, and assessment of complications, especially in infection-related and neoplastic conditions.

Keywords: HRCT, Temporal Bone, Cholesteatoma, Acoustic Neuroma, Ear Pathology.

INTRODUCTION

The ability to image the human central nervous system non-invasively has revolutionised the diagnostic approach to brain and skull base pathologies. Multiple imaging modalities are available for evaluating temporal bone conditions, including plain radiography, angiography, cisternography, computed tomography (CT), and magnetic resonance imaging (MRI). Among these, CT and MRI are currently the most widely employed techniques, having largely replaced earlier methods due to superior diagnostic capabilities.[1]

Conventional radiography, although once valuable for broad screening of the temporal bone, is limited by superimposition artefacts, where dense structures obscure finer details. CT scanning has emerged as the preferred modality for assessing the bony anatomy and air-filled spaces of the temporal bone, offering high spatial resolution and reduced radiation exposure compared to polytomography.[2] CT's enhanced image contrast and reduced susceptibility to artefacts make it highly effective in detecting soft tissue abnormalities.[3] In contrast, MRI has broadened the scope of detectable pathology by allowing superior visualisation of soft tissue structures. It is particularly useful for evaluating vascular lesions and soft tissue masses within the temporal bone.[4]

Despite these advantages, angiography remains the gold standard for vascular assessment and plays a therapeutic role in managing vascular anomalies of the temporal bone. High-resolution computed tomography (HRCT), a refinement of conventional CT, provides unparalleled detail of the intricate structures of the temporal bone. This includes precise visualisation of minute components, such as the ossicular chain and facial nerve canal, aiding significantly in diagnosis and presurgical planning. This makes HRCT a valuable preoperative tool for assessing the external auditory canal, middle ear, mastoid, ossicular chain, and inner ear structures.[5]

The temporal bone houses critical structures, including the auditory and vestibular apparatus, the facial nerve, and the internal carotid arteries. These regions may be affected by inflammatory, infectious, and neoplastic conditions that often necessitate surgical interventions. Clinical and otoscopic evaluations remain essential; however, imaging is indispensable in complex, recurrent, or treatment-resistant cases. CT and MRI offer key insights into suspected malignancy or surgical cases, heavily influencing management strategies.[6]

Tumours of the temporal bone are rare and challenging to diagnose because of their varied presentations and late-stage detection, especially in the middle ear. Accurate imaging is essential for determining the extent of the disease and guiding resection and reconstruction. Advanced-stage detection correlates with poorer prognosis.[7] Although cholesteatoma is benign, it poses a risk of aggressive local invasion involving the dura, brain, and venous sinuses, necessitating timely imaging and surgical management.[8] Malignant external otitis (MEO), frequently affecting diabetic or immunocompromised elderly patients, presents with severe pain, discharge, and cranial nerve involvement. CT and MRI play crucial roles in both diagnosis and disease monitoring.[9]

Mastoiditis, often arising from otitis media, is characterised by bony erosion of the mastoid septa and middle ear structures. HRCT remains the imaging modality of choice because of its superior ability to detect subtle bone changes and complications such as intracranial or soft tissue extension.[10] The purpose of this study was to understand the capability of CT in the diagnosis and detection of temporal bone pathologies.

Objectives

This study aimed to evaluate various temporal bone pathologies, identify associated complications, determine the most common anatomical variations, and assess the most frequently observed temporal bone diseases.

MATERIALS AND METHODS

This prospective study evaluating the efficacy of CT in the diagnosis of temporal bone ear pathologies was performed on 50 patients between February 2016 and January 2018 at the Department of Radiology, Sree Balaji Medical College and Hospital, Chennai. Informed consent was obtained from all participants and their guardians. The study was approved by the ethics committee before its commencement.

Inclusion Criteria

This study included patients of all age groups, including infants and children, who exhibited symptoms related to temporal bone issues. The symptoms included ear discharge, hearing loss, tinnitus, vertigo, facial palsy, head trauma, or increased intracranial pressure with a history of ear discharge. Children were included if they could undergo HRCT with appropriate preparation. Sedation with oral Trichlophos or intravenous diazepam was administered when necessary to reduce movement and ensure clear images.

Exclusion Criteria

Patients with skull base electronic devices, such as cochlear implants, or those who had undergone previous ear or skull base surgery were excluded. Patients unable to undergo CT scans due to medical conditions or reactions to contrast, including children who could not be safely sedated or kept still, were excluded. Patients with allergies to contrast agents or serious kidney problems were excluded if contrast-enhanced scans were required.

Methods

A convenience sample of 50 patients was selected based on the feasibility of recruitment during the two-year study period, considering the institutional patient inflow and ethical clearance limits.

All high-resolution CT (HRCT) scans were performed using a Hitachi ECLOS 8-slice CT scanner. Scans were performed in both axial and coronal views, starting from below the ear canal to the top part of the inner ear. Before scanning, a planning image (scout film) was obtained for each patient. Coronal images were obtained at a right angle to the axial images, covering the area from the cochlea to the back part of the inner ear. The patient's head was slightly tilted back to avoid tilting the CT machine and protect the eyes from radiation.

The scans were performed with 2 mm thick slices at 3 mm spacing. The machine was set to 133 kilovolts (kV) and 70 milliamperes (mA), with each scan lasting for 4 s. This setup provided clear images of the bones and reduced image noise and artefacts. For cases involving soft tissue or blood vessels, contrast dye (diatrizoate) was injected at a dose based on body weight. In children, Trazograf or Urografin 60% was used, and in adults, the 76% version was used.

Children under six years of age often require sedation to remain still during the scan. Sedation was performed using Tricloryl syrup (containing Triclofos sodium) or sometimes intravenous Diazepam (0.2–0.4 mg/kg). Patients were advised not to eat or drink for 4 h before the scan to avoid any complications. The CT technique followed a special high-resolution setup: very thin image slices, sharp image setting, small field of view (15–20 cm), and high-resolution matrix (512 × 512). This helped capture small structures. The axial scans were angled at 30° above the usual head position to reduce overlapping structures. Coronal images were acquired directly or created from existing axial images, usually angled 90°–120° from the baseline. If one side was scanned, the data from the same scan could be used to create images of the other side. Movement was the main factor affecting image quality; therefore, patients were instructed to remain as still as possible. The observations included structures such as the hearing bones, the inner ear, and soft tissues. All data are presented as frequencies and percentages.

Table 1: Age and gender distribution

Age (years)	Gender		Frequency (n=50)
	Male	Female	
0-10	3(6%)	2(4%)	5(10)
11-20	10(20)	4(8%)	14(28%)
21-30	9(18)	7(14%)	16(32%)
31-40	4(8%)	4(8%)	8(16%)
41-50	2(4%)	1(2%)	3(6%)
51-60	2(4%)	1(2%)	3(6%)
61-70	0	1(2%)	1(2%)
Total	30(60%)	20(40%)	50(100%)

The majority of patients were aged 21–30 years, with a higher prevalence in males (60%) than in females (40%). Most cases occurred in the 11–30-year age group. [Table 1]

Table 2: Clinical features of ear pathologies assessed by HRCT temporal bone

Clinical Features	Frequency(%)
Hearing Loss	14(35%)
Ear discharge	29(72.5%)
Facial nerve weakness	2(5.75%)
Headache	23(57.5%)
Ear pain	21(52.5%)
Tinnitus	5(12.5%)
Cerebellar signs	4(10%)
Diplopia	3(7.5%)

The majority of temporal bone ear pathologies were infections (n=46, 92%), followed by tumours (n=3, 6%) and trauma (n=1, 2%). The most common clinical feature observed in patients undergoing HRCT temporal bone assessment was ear discharge (72.5%), followed by headache (57.5%) and ear pain (52.5%). Less frequent features included hearing loss (35%), tinnitus (12.5%), cerebellar signs (10%), diplopia (7.5%), and facial nerve weakness (5.75%). [Table 2]

Table 3: Radiological and operative correlation of ear pathologies using HRCT temporal bone

Category	Finding	Frequency (%)	Operative Correlation (%)
Distribution of Infection	External malignant otitis	4(9%)	-
	Cholesteatoma	22(48%)	18(39%)
	Mastoiditis	20(43%)	-
Laterality of Ear Involvement	Left ear	21(46%)	-
	Right ear	19(41%)	-
	Bilateral	6(13%)	-
CT appearance	Opacification of the external ear	2(4%)	2(4%)
	Cholesteatoma	22(48%)	18(39%)
	Opacification of mastoid air cells	16(35%)	15(33%)
	Ossicular erosion	14(30%)	14(30%)
	Intracranial extension	5(11%)	5(11%)
Post-Operative Findings	Cortical mastoidectomy - residual disease	3(6%)	-
	Cortical mastoidectomy - dural erosion	1(2%)	-
	Labyrinthine involvement	1(2%)	-
	Modified radical mastoidectomy - residual	3(6%)	-
	Modified radical mastoidectomy - dural erosion	0	-

Infections were the most common ear pathologies, with cholesteatoma (48%) being the most prevalent, followed by mastoiditis (43%) and malignant otitis externa (9%). Operative correlation was found in 39% of cholesteatoma cases, but none in mastoiditis or external malignant otitis. Left ear involvement was more common (46%) than right ear

involvement (41%), with 13% of cases being bilateral.
HRCT showed a good correlation with surgery, especially for ossicular erosion (30%). Cholesteatoma was detected in 48% of cases, with 39% of the cases matching the surgical findings. Mastoid air cell opacification was observed in 35% of patients, with 33% of cases correlating with surgical findings. Intracranial extension was observed in 11% of patients, fully matching the operative results. Postoperatively, 6% of cortical mastoidectomy cases had residual disease, and 2% had dural erosion. Similarly, 6% of modified radical mastoidectomy cases showed residual disease, but no dural erosion was observed in any case. [Table 3]

Table 4: Demographic and radiological distribution of ear tumours: HRCT findings and surgical correlation

Demographic Feature	Category	Frequency(%)	HRCT Features	Surgical/ Biopsy Correlation
Gender	Male	2(67%)	-	-
	Female	1(33%)	-	-
Incidence of tumours in the age group	0-10	0	-	-
	11-20	1(33.3%)	-	-
	21-30	1(33.3%)	-	-
	31-40	0	-	-
	41-50	1(33.3%)	-	-
	51-60	0	-	-
	61-70	0	-	-
Tumour type	Acoustic Tumour	2(67%)	Hypodense to slightly hyperdense cerebellopontine angle mass, contrast enhancement, porous acoustics erosion	2 cases confirmed; CT findings matched
	Metastasis	1(33%)	Destruction of the apex of the petrous bone on the left side	-

We identified three ear tumour cases, predominantly in males (67%), with equal age distribution across the 11–50-year range. Acoustic neuroma was the most common tumour type (67%), typically presenting as a contrast-enhancing mass in the cerebellopontine angle with erosion of the porous acoustic meatus on HRCT. Surgical findings confirmed the HRCT features in both cases of acoustic neuroma. One patient with metastasis (33%) showed petrous apex destruction, but surgical correlation was unavailable as the patient declined intervention. Overall, HRCT showed strong diagnostic concordance with operative findings in cases of acoustic neuroma. [Table 4]

DISCUSSION

HRCT plays an increasingly vital role in evaluating temporal bone pathologies because of its ability to delineate complex anatomical structures with low radiation exposure. This modality is instrumental in the accurate diagnosis, surgical planning, and identification of complications of middle and inner ear diseases.[11] Our study found that infections were the most common cause of temporal bone pathologies, affecting patients between 2 and 55 years of age. Among the 46 cases of infection, 22 were diagnosed with cholesteatoma, 20 with mastoiditis, and 4 with malignant otitis externa. These results differ from those of Lloyds et al., who reported infections as the third most frequent cause. The higher incidence observed in our study may be attributed to delayed medical attention and complications arising from poor socioeconomic conditions and limited health awareness.[12]

Our study revealed that infections accounted for 92% of all temporal bone pathology cases, with tumours accounting for 6% and trauma for 2%. A higher prevalence was noted among males (60%), with the majority of cases occurring in the 21–30-year age group. Among infectious conditions, cholesteatoma (44%) and mastoiditis (40%) were the most frequent. Similarly, Pallavi et al. reported infections in 73.3% of cases, with mastoiditis (61.3%) and cholesteatoma (36%) being the most common. Both studies reinforce HRCT's efficacy in identifying and evaluating temporal bone infections.[13]
In our study, the highest number of cases (32.5%) occurred in the 11–20-year age group, with a mean age of 19.92 years, consistent with Gupta et al.'s findings.[14] The male-to-female ratio of 2:1 aligns with the demographic distribution reported by Paparella and Kim.[15] Our findings were also similar to Nikam and Shailesh, who noted a higher prevalence of infection in adults (80%), with otorrhea (98%) and hearing loss (72%) being common clinical presentations.[16] Neoplasms made up 7.5% of our cases, primarily acoustic neuromas (67%), affecting males aged 11–50 years. This contrasts with Hudelist et al., who found a higher incidence in females aged 51–60 years, suggesting demographic and sample size variations may influence tumour patterns.[17]
Our study typically involved the right cerebellopontine (CP) angle, presenting as hypodense to hyperdense masses with contrast enhancement and internal auditory canal erosion. Taylor reported similar bony erosions in 87% of cases, which correlates with our findings due to the large tumour size.18 Acoustic neuroma was also the

most frequent CP angle lesion in studies by Lloyd and Wolff.[12,19]

In our study, metastases accounted for 33% of tumour cases, with HRCT demonstrating destructive changes localised to the petrous apex. These imaging features are in agreement with the findings of Curtin et al., who noted that the radiological appearance of metastases can vary depending on the primary tumour origin, such as breast, kidney, or lung cancers, presenting either as destructive or remodelling lesions. The case observed in our study reflects a more aggressive and infiltrative metastatic pattern.[20]

Limitations

The study sample size was relatively small (n=50), and the absence of long-term follow-up data limited the assessment of disease recurrence and postoperative outcomes of the study. Surgical correlation was unavailable in a subset of cases, particularly in patients with tumours who declined intervention. The study did not incorporate MRI comparisons, which could have enhanced the evaluation of soft tissue lesions and vascular anomalies

CONCLUSION

HRCT offers higher spatial resolution and better bone resolution than conventional imaging. It is especially useful for evaluating middle ear infections, identifying complications, and guiding surgical planning by visualising anatomical details. In postoperative cases, HRCT helps assess the surgical extent, detect recurrent disease, and evaluate the inner ear and facial nerve. For neoplastic conditions, HRCT aids in staging and determining tumour extent. It differentiates tumours from vascular anomalies and other lesions, providing crucial information for surgical management.

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