High - Resolution Computed Tomography in the Diagnosis of Temporal Bone Pathologies: A Cross - Sectional Study

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Abstract: *Introduction: The study addresses the diagnostic challenges in evaluating temporal bone pathologies using conventional imaging methods and explores the enhanced capabilities of HRCT in providing detailed visualizations crucial for accurate diagnosis and effective management. Methodology: A diverse cohort of 126 patients suspected of temporal bone pathologies was examined using a 128 - slice CT scanner at R. D. Gardi Medical College, Ujjain. The HRCT protocol was meticulously designed to minimize radiation while maximizing diagnostic yield. Ethical guidelines were strictly followed, with data analyzed for detailed diagnostic insights. Results: The cohort's mean age was 20.98 years, with a slight male predominance (51.6%). HRCT diagnosed CSOM in 41.3% of cases, CSOM with cholesteatoma in 28.6%, and less frequent pathologies such as otitis externa (4.8%) and acoustic neuroma (1.6%). Key anatomical findings from HRCT included significant ossicular erosion (27% for incus erosion), granulation tissue presence in 63.5% of cases, and mastoiditis in 62.7%. The technique proved particularly effective in identifying complications, with meningitis occurring in 11.1% of cholesteatoma patients and brain abscesses in 8.3%. Conclusion: HRCT is an indispensable tool in the diagnosis and management of temporal bone pathologies, offering superior visualization that significantly enhances surgical planning and patient care. Its detailed imaging capabilities allow for earlier detection of complex pathologies and complications, leading to improved treatment outcomes.*

Keywords: High - Resolution Computed Tomography (HRCT), Temporal Bone Pathologies, Chronic Suppurative Otitis Media (CSOM)

1. Introduction

The temporal bone, situated at the skull's base, is crucial for auditory, balance, and facial nerve functions. Pathologies affecting this region, such as Chronic Suppurative Otitis Media (CSOM), cholesteatoma, and various traumatic injuries, can severely impair these functions, leading to symptoms like hearing loss and vertigo. (1, 2) Traditional imaging techniques, like plain radiography and conventional CT, often fall short in detailing these complex structures adequately due to their intricate anatomy and the overlapping nature of the bone structures. (3)

High - Resolution Computed Tomography (HRCT) has significantly advanced the field of radiological diagnosis by providing high spatial resolution and multi - planar imaging capabilities. (4) This allows for detailed visualization of the temporal bone, essential for accurate diagnosis, surgical planning, and effective management of temporal bone pathologies. (5) HRCT's ability to delineate subtle abnormalities and assess the extent of pathologies makes it indispensable, particularly in cases involving intricate anatomical details and complex clinical presentations. This study aims to assess the utility of HRCT in diagnosing a range of temporal bone conditions, offering insights into its advantages over conventional imaging techniques and its applications in clinical practice. (6)

2. Methodology

This cross - sectional study was conducted at the Department of Radiodiagnosis, R. D. Gardi Medical College, Ujjain, utilizing advanced imaging equipment including a 128 - slice CT scanner. Participants included male and female patients of all age groups referred from both in - patient and out - patient ENT departments, presenting with clinically suspected temporal bone or ear pathologies. A total of 126 patients were randomly selected based on the study's sensitivity and specificity requirements, after obtaining written informed consent.

High - Resolution Computed Tomography (HRCT) scans were performed using a multi - detector CT system, with thin section protocols (0.625mm) at 140kV and 300 mAs, and images reconstructed using a high - frequency bone algorithm. Scans were conducted in axial, coronal, and sagittal planes, adhering closely to the infra - orbitomeatal line to minimize radiation exposure. Intravenous contrast was used as needed, with sedation administered to infants and uncooperative patients to prevent motion artifacts.

Data from HRCT findings were meticulously collected and analyzed, including demographic details, clinical history, and diagnostic outcomes. The study adhered to ethical guidelines approved by the Institutional Ethical Committee of RDGMC, Ujjain, and was conducted over a two - year period as part of a postgraduate thesis requirement. Results were

systematically compared with findings from similar studies to validate the conclusions drawn from the HRCT diagnostic utility in temporal bone pathologies.

3. Results

The mean age of the study participants was 20.98 years with a standard deviation of 10.11 years. There were 65 (51.6%) males and 61 (48.4%) females in the current study.

Table 1: Distribution of cases according to their diagnosis (n=126)

Type	Diagnosis	Number	Percentage
Infective	CSOM	52	41.3%
	CSOM with cholesteatoma	36	28.6%
	Otitis Externa	6	4.8%
Traumatic	Longitudinal fracture	8	6.3%
	Transverse fracture	15	11.9%
	Mixed fracture	5	4.0%
Tumour	Acoustic neuroma	2	1.6%
Congenital	Ossicular abnormality	1	0.8%
	Microtia with EAC atresia	1	0.8%

The diagnosis distribution based on HRCT of temporal bone pathologies in the current study is presented in Table 1. Infective pathologies dominate the findings, with Chronic Suppurative Otitis Media (CSOM) representing the largest proportion at 41.3%, followed by CSOM with cholesteatoma at 28.6%. Otitis Externa is also noted, albeit less frequently, accounting for 4.8% of cases. Traumatic injuries are notable, with longitudinal fractures, transverse fractures, and mixed fractures collectively accounting for 22.2% of diagnoses. Tumors, though relatively rare, are represented by Acoustic

Neuroma, identified in 1.6% of cases. Congenital abnormalities, while less prevalent, are still observed, with Ossicular Abnormality and Microtia with External Auditory Canal (EAC) Atresia each noted in 0.8% of cases.

Table 2: Distribution of cases with significant findings on HRCT

Findings on HRCT	Number of cases	Percentage of total cases studied
Malleus Erosion	24	19%
Incus Erosion	34	27%
Stapes Erosion	26	20.6%
Foot plate of stapes thickening	13	10.3%
Scutum Erosion	49	38.9%
Thinning of Tegmen tympani	27	21.4%
Mastoiditis	79	62.7%
Mastoid erosion	32	25.4%
Granulation tissue	80	63.5%
Sigmoid dehiscence	16	12.7%
Semicircular canal involvement	8	6.3%
Lateral Semi - Circular Canal fistula	3	2.4%
Facial Nerve involvement	26	20.6%

Table 2 shows distribution of cases having some significant ossicular findings on HRCT. Incus erosion (27%) was the most common ossicular finding followed by Stapes erosion (20.6%) in patients with temporal bone pathologies in our study. The HRCT findings of the temporal bone in the cases revealed that most of the patients had the presence of granulation tissue (63.5%) followed by Mastoiditis (62.7%). Involvement of Lateral Semi - circular canal (2.4%) was the least common finding.

Table 3: Distribution of complications reported on HRCT among the cases

Diagnosis	Meningitis	Brain abscess	Dural venous thrombus	Hydrocephalus
CSOM (n=52)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (3.80%)
CSOM with cholesteatoma (n=36)	4 (11.10%)	3 (8.30%)	2 (5.60%)	0 (0.00%)
Otitis Externa (n=6)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Longitudinal fracture (n=8)	0 (0.00%)	1 (12.50%)	1 (12.50%)	0 (0.00%)
Transverse fracture (n=15)	0 (0.00%)	0 (0.00%)	1 (6.70%)	0 (0.00%)
Mixed fracture (n=5)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Acoustic neuroma (n=2)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ossicular abnormality (n=1)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Microtia with EAC atresia (n=1)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

No complications were seen on HRCT among the cases with Otitis externa, Mixed fracture, acoustic neuroma, ossicular abnormality and microtia with EAC atresia. Most of the complications were seen among CSOM with cholesteatoma patients and meningitis being the most common among them (11.10%) followed by brain abscess and dural venous thrombus in 3 and 2 cases respectively. Just 2 cases of CSOM presented with hydrocephalus. Brain abscess and dural venous thrombus was seen in 1 case each of longitudinal fracture.1 case of transverse fracture presented with dural venous thrombus.

4. Discussion

This study demonstrated the utility of High - Resolution Computed Tomography (HRCT) in assessing temporal bone pathologies, providing detailed insights into case distribution, HRCT findings, and associated complications. With a focus

on a cohort predominantly within the 10–20 - year age group and a slight male predominance, HRCT proved particularly valuable in diagnosing infective middle ear pathologies such as Chronic Suppurative Otitis Media (CSOM) and cholesteatoma. Common HRCT findings included ossicular erosion, granulation tissue, and mastoiditis, while complications like meningitis, brain abscess, and dural venous thrombus were frequently noted in cases with cholesteatoma.

Our findings align with those of Hassmann - Poznanska et al., who highlighted the importance of preoperative CT scans in cholesteatoma surgery, showing a favorable correlation between preoperative CT findings and surgical outcomes. (7) Although their study was limited by a small sample size and its retrospective nature, it underscored the significance of HRCT in surgical planning. Similarly, the focused research by Fuse et al. on ossicular defects revealed high preoperative

identification rates for defects in the malleus head and body, and the long process of the incus, emphasizing the specificity of HRCT in detecting detailed ossicular abnormalities. (8)

Further comparisons with studies by Zhang et al., which stressed HRCT's role in surgical planning and risk assessment in CSOM, show a strong agreement between radiological findings and actual surgical outcomes, particularly with structures like the malleus and tegmen. (9) However, discrepancies in detecting other structures like the stapes and facial nerve dehiscence suggest variability in HRCT's diagnostic accuracy, which could stem from differences in imaging techniques, patient demographics, or surgical expertise.

The collaborative study by O'Donoghue et al. and Chee and Tan provided comparative insights, illustrating HRCT's exceptional accuracy in visualizing soft tissue involvement and its predictive capacity for ossicular chain integrity in CSOM cases. Their findings, along with our own, which observed granulation tissue in 63.5% of cases and mastoiditis in 62.7%, highlight the critical role of HRCT in preoperative assessment and its potential to significantly influence surgical strategies and outcomes. (10, 11)

In reviewing the broader implications of HRCT, our study aligns with the broader literature, demonstrating its essential role in the management of temporal bone pathologies. While HRCT offers a profound diagnostic advantage, particularly in the precise visualization of complex anatomical details and the identification of surgical risks, the need for meticulous imaging to optimize patient care remains paramount. Our findings, supported by comparative studies, affirm the indispensable value of HRCT in enhancing diagnostic accuracy, surgical planning, and overall management of temporal bone conditions.

5. Conclusion

In conclusion, HRCT emerged as a valuable tool in diagnosing temporal bone pathologies, providing detailed visualization of anatomical structures and aiding in treatment planning. Its ability to accurately identify pathology site, extent, and associated complications underscores its clinical utility in managing these conditions effectively, thereby reducing morbidity and improving patient outcomes.

The study findings emphasize the transformative impact of HRCT on the management of temporal bone pathologies, facilitating earlier detection of complications, better understanding of disease etiology and pathology, and ultimately reducing morbidity and mortality rates associated with lesions in this region. Further research and advancements in imaging technology are warranted to enhance diagnostic accuracy and optimize treatment strategies for temporal bone pathologies.

Conflict of interest
None

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