

ROLE OF HRCT IN EVALUATION OF PATHOLOGIES OF TEMPORAL BONE AND ITS SURGICAL INTERVENTION

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ABSTRACT

Background: Advanced medical imaging techniques like CT and HRCT help diagnose pathologies in the temporal bone, providing detailed visualization and insights into pathological conditions, particularly soft tissue density eg. cholesteatoma, which is difficult to diagnose through clinical examination alone. **Aims and Objectives:** The study aims to identify temporal bone changes in chronic suppurative otitis media patients using HRCT, correlate surgical intervention with HRCT findings, and confirm diagnosis through intraoperative findings. **Methods:** Total 100 patients with temporal bone pathologies. The patients were aged 10-60 years and provided clinical data. They underwent a Siemens Somatom AS 128 Slice multi-slice CT scan, revealing ear ossicle erosion, dural plate erosion, mastoid sclerosis, and scutum erosion. Surgical procedures were scheduled based on HRCT findings. The study compared HRCT and intraoperative findings to determine their correlation, using IBM SPSS 23rd version software and Chi-square test. **Results:** The study analyzed 100 patients with ossicular abnormalities, with incus erosion being the most common. Other common conditions included scutum, malleus, and stapes erosion. Sinus plate erosion was rare, while mastoid sclerosis was common but not as prevalent. Soft tissue/fluid attenuation was prevalent during intraoperative procedures, with the epitympanum having the highest prevalence at 98%, indicating density-related abnormalities. **Conclusions:** The data offers crucial insights into ossicular and mastoid health conditions, aiding clinicians in comprehensive assessments, accurate diagnoses, and effective treatment strategies, ultimately improving patient care and outcomes in otolaryngology.

KEYWORDS: High resolution computed tomography, Cholesteatoma, Temporal bone lesions, Otomastoiditis, Malignant otitis externa.

INTRODUCTION

The temporal bone is crucial for protecting hearing and balance organs. Its proximity to vital structures like the middle ear cleft and mastoid air cells presents complex challenges in evaluating and diagnosing pathologies within this region (1). Pathologies can range from congenital anomalies to acquired conditions, affecting the temporal bone or adjacent soft tissue structures (2-3). Clinical examination alone is often insufficient to determine prevalence, complications, and risk of recurrence. Advanced medical imaging techniques, such as Computed Tomography (CT) and High-Resolution Computed Tomography (HRCT), play a crucial role in addressing these challenges. CT scans have long been the standard imaging modality for assessing temporal bone pathologies (4).

High-Resolution CT (HRCT) is a powerful imaging

technology that provides detailed visualization of temporal bone and its surrounding structures, providing valuable insights into the location, extent, and nature of pathological conditions (5-6). It is particularly useful in assessing soft tissue density eg. cholesteatoma, a condition that can be challenging to diagnose through clinical examination alone. HRCT complements traditional clinical evaluations and helps clinicians make informed decisions regarding patient care, especially in cases where surgical intervention is warranted. Its high-resolution thin-section CT scanning capabilities reveal subtle details of even smaller pathologies, aiding in the formulation of operative strategies based on exact estimation of underlying pathology. By assessing the entire middle ear and neighboring structures, HRCT enhances the precision of surgical interventions (7-8). High-resolution computed tomography (HRCT) is crucial for evaluating temporal bone pathologies, providing

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detailed visualization of complex anatomy. It aids in diagnosing conditions like soft tissue density eg cholesteatoma, otosclerosis, and temporal bone fractures, aiding in surgical planning. HRCT's surgical implications include improved patient outcomes, minimally invasive procedures, and enhanced efficacy and safety in delicate surgeries like mastoidectomy and stapedectomy. This research study aims to investigate the significant role of HRCT in evaluating temporal bone pathologies and its correlation with surgical intervention outcomes, contributing to the ongoing improvement of patient care and medical decision-making within the challenging domain of temporal bone pathologies.

AIM AND OBJECTIVES

The study aims to describe temporal bone changes in chronic suppurative otitis media patients using HRCT, correlate surgical intervention and HRCT findings, and obtain a confirmatory diagnosis through intraoperative findings in patients presenting with temporal bone pathologies.

MATERIAL AND METHODS

A prospective study was conducted at the ENT Department of the Integral Institute of Medical Sciences and Research in Lucknow, India, involving 100 patients with clinical suspicion of temporal bone pathologies. The patients were aged 10-60 years, both genders, and willing to provide informed consent for HRCT evaluation and potential surgical intervention. Patients outside the specified age range, unwillingness to provide consent, contraindications, and pre-existing conditions were excluded from the study.

All patients provided comprehensive clinical data, including name, age, gender, and medical history, focusing on symptoms related to temporal bone pathologies. Patients underwent HRCT scans of the temporal bone and adjacent structures using a Siemens Somatom AS 128 Slice multi-slice CT scanner. The scans assessed the entire middle ear and neighboring structures, including ossicles, tegmen, sinus plate, and dural structures. Results showed ear ossicle erosion, dural plate erosion, mastoid sclerosis, and scutum erosion, as well as soft tissue/fluid density.

Surgical Procedures:

Patients with alopecia, incus, stapes, dural plate, mastoid sclerosis, scutum, and soft tissue/fluid density collection in the middle ear cavity were scheduled for surgical interventions based on HRCT findings, following standard procedures at the Department of Ear, Nose, and Throat (ENT).

Intraoperative Findings:

Surgical procedures involved meticulous documentation of intraoperative findings, including pathologies encountered, variations from HRCT results, and any unexpected conditions or complications.

The study compared HRCT and intraoperative findings to determine their correlation. Data was analyzed using IBM SPSS 23rd version software, and descriptive statistics were used to summarize patient characteristics and pathology types. Surgical success rates and other outcomes were assessed. The Chi-square test was used to analyze the co-relation between groups.

RESULTS

Total 100 patients, with 36% falling into age groups 10-20 and 21-30 years old, 13% in age groups 31-40 and 41-50 years old, and 5% in age groups 51-60 years old. Out of the 100 patients, 41% were male, while 59% were female. The mean age was 27.45 years, with a median age of 23 years, and the age range was 10 years to 58 years (Table 1).

Intraoperative and HRCT Conditions of Cases

The study reveals that incus erosion is the most common ossicular abnormality, accounting for 89% of cases. Other common ossicular conditions include scutum erosion, malleus erosion, and stapes erosion. Sinus plate erosion is rare, while mastoid sclerosis is common but not as prevalent. These statistics provide insights into the distribution and prevalence of intraoperative conditions related to ossicular and mastoid health, aiding in clinical assessment and management strategies. The data shows that scutum erosion is the most common condition observed in High-Resolution Computed Tomography (HRCT) scans, accounting for 88% of cases. Incus erosion followed closely with 79 cases, accounting for 79% of the total cases. Malleus erosion was reported in 71 cases, followed by stapes erosion in 68%. Sinus plate erosion was relatively rare, with only 2 cases reported. Mastoid sclerosis was observed in 73 cases, accounting for 73% of the cases examined. These findings provide valuable insights into the frequency and distribution of ossicular and mastoid-related abnormalities detected through HRCT imaging (Table 2).

Co-relation between Intraoperative and HRCT conditions between different variables

The comparison between intraoperative and HRCT data reveals interesting insights into the prevalence of various conditions related to ossicular and mastoid health. On HRCT- Scutum erosion shows a slight increase in the HRCT dataset, with 88 cases (88%)

compared to 87 cases (87%) in the intraoperative data. Conversely, malleus erosion is more commonly observed during intraoperative assessments, with 88 cases (88%), whereas the HRCT data report 71 cases (71%). Incus erosion follows a similar trend, being more prevalent in intraoperative findings (89 cases, 89%) compared to HRCT scans (79 cases, 79%). Stapes erosion is slightly more common in HRCT scans, with 68 cases (68%) versus 62 cases (62%) in intraoperative data. Sinus plate erosion appears to be rare in both datasets, with 9 cases (9%) intraoperatively and only 2 cases (2%) in HRCT scans. Mastoid sclerosis, on the other hand, is reported in 67 cases (67%) intraoperatively and 73 cases (73%) in HRCT scans. These variations suggest nuanced differences in diagnostic sensitivity or criteria between intraoperative assessments and HRCT imaging, underscoring the importance of utilizing multiple diagnostic modalities for comprehensive evaluation and management of these conditions (Table 3).

Soft tissue/fluid attenuation Intraoperative and HRCT Variables

The data shows that soft tissue/fluid attenuation is prevalent during intraoperative procedures in the epitympanum, with 96% of cases exhibiting this feature, while in the mesotympanum, it is moderately frequent, with 54% of cases showing this. The study reveals a high prevalence of soft tissue/fluid attenuation in the Epitympanum, with 98 cases reported, accounting for 98% of the analyzed cases. In the Mesotympanum, 45 cases were reported, indicating a moderate prevalence compared to the Epitympanum. In the Hypotympanum, 59 cases were observed, indicating a relatively high prevalence in the lower part of the tympanic cavity. The data suggests that soft tissue/fluid attenuation is prevalent in these areas (Table 4).

Correlations between soft tissue/fluid attenuation Intraoperative and soft tissue/fluid attenuation HRCT

The data shows the prevalence of soft tissue/fluid attenuation in tympanic regions, specifically the epitympanum, mesotympanum, and hypotympanum,

during HRCT scans and intraoperative assessments. The epitympanum has the highest prevalence at 98%, indicating density-related abnormalities. The mesotympanum has a moderate frequency at 45%, while the hypotympanum has a high prevalence of 59%. During intraoperative procedures, the epitympanum shows a high prevalence at 96%, while the mesotympanum maintains a moderate prevalence at 54% (Table 5).

Gender	N (n=100)	%
Male	41	41.0%
Female	59	59.0%
Age Intervals		
10-20 years	36	36.0%
21-30 years	36	36.0%
31-40 years	13	13.0%
41-50 years	10	10.0%
51-60 years	5	5.0%
Mean age (Mean±SD)	27.45±10.81	

Table 1: Distribution of Demographic Profile

Class of Intraoperative conditions	N	%
Scutum Erosion	87	87.0%
Malleus Erosion	88	88.0%
Incus Erosion	89	89.0%
Stapes erosion	62	62.0%
Sinus Plate Erosion	9	9.0%
Mastoid Sclerosis	67	67.0%
Class of HRCT Conditions		
Scutum Erosion	88	88.0%
Malleus Erosion	71	71.0%
Incus Erosion	79	79.0%
Stapes Erosion	68	68.0%
Sinus Plate Erosion	2	2.0%
Mastoid sclerosis	73	73.0%

Table 2: Intraoperative and Class of HRCT Conditions of Cases

Variables	Scutum Erosion	Malleus Erosion	Incus Erosion	Stapes Erosion	Sinus Plate Erosion	Mastoid Sclerosis
Intraoperative	87	88	89	62	9	67
HRCT	88	71	79	68	2	73

Table 3: Co-relation between Intraoperative and HRCT Conditions between different Variables

Class of soft tissue/ fluid attenuation Intraoperative variables	Number	%
Epitympanum	96	96%
Mesotympanum	54	54%
Hypotympanum	35	35%
Class of soft tissue/ fluid attenuation HRCT variables	Number	%
Epitympanum	98	98%
Mesotympanum	45	45%
Hypotympanum	59	59%

Table 4: Soft tissue/fluid attenuation Intraoperative and HRCT variables

Class	Epitympanum	Mesotympanum	Hypotympanum
Soft tissue/fluid attenuation HRCT	98	45	59
Soft tissue/fluid attenuation intraoperative	96	54	35

Table 5: Correlations between Soft Tissue/fluid attenuation Intraoperative and Soft tissue/fluid attenuation HRCT

DISCUSSION

Total 100 patients with a mean age of 27.45 years, with a wide age distribution. The median age is 23 years, indicating a diverse demographic. 36% of patients fall within the 10-20 and 21-30 age groups, with a significant proportion of younger individuals. The 31-40 and 41-50 age groups represent 13% and 10%, respectively. The majority of patients are female, with 59%, compared to 41% male. This gender disparity may impact healthcare considerations and research perspectives. Studies by Thukral et al. (2015), Kapoor et al. (2023), Bharat (2024), and Husain et al. (2020) provide a comprehensive overview of temporal bone pathologies, their demographic characteristics, and clinical presentations (9-12). Thukral et al. found a diverse age range, with ear discharge being the most common presenting symptom (9). Kapoor et al. found a mean age of 32.35 years, with a higher representation of females (10). Bharat's study highlighted infections as the primary cause of temporal bone pathologies (53.75%), followed by trauma, tumors, and congenital anomalies.(11) Husain et al. found a prevalence of younger patients, especially below 35 years, in the 15-24 and 25-34 years age brackets (12). These studies highlight the multifaceted nature of temporal bone disorders.

The study reveals that incus erosion is the most prevalent, accounting for 89% of ossicular abnormalities. Stapes erosion is less frequent at 62%, while sinus plate erosion is rare at 9%. Mastoid sclerosis is the most common at 67%. These statistics provide insights into the distribution and prevalence of intraoperative conditions related to ossicular and mastoid health, aiding in clinical assessment and management strategies. The use of High-Resolution CT (HRCT) scans has been shown to detect various pathologies, including scutum erosion, mastoid sclerosis, and tympanic membrane abnormalities. The sensitivity and specificity of HRCT in detecting these conditions are over 90%, with the overall accuracy being above 90% for most pathologies except for identifying erosion in the malleus, incus, and stapes.(10) Mastoid sclerosis is the most common finding on HRCT, observed in all 40 cases (100%). In a

study by Kataria T et al., scutum erosion was detected in 18 cases on pre-operative HRCT, with intraoperative findings confirming erosion in only one case (13). In a study by Mandal et al., the most common findings included non-dependent soft tissue mass (60%), scutum erosion (45%), and ossicular involvement (53.33%). Less frequent findings included labyrinthine fistula, sigmoid sinus plate abnormalities, mastoid cortex erosion, tegmen erosion, and mastoiditis with sub-periosteal abscess. These findings provide valuable insights into the prevalence of different temporal bone abnormalities detected through HRCT imaging in the study population (14).

The data shows a high prevalence of soft tissue/fluid attenuation in the Epitympanum, Mesotympanum, and Hypotympanum, with 98 cases reported in the Epitympanum, 45 cases in the Mesotympanum, and 59 cases in the Hypotympanum, indicating a significant occurrence in the lower part of the tympanic cavity. This indicates a moderate prevalence of soft tissue/fluid attenuation in these areas. The study by Thukral et al. found soft tissue density in the epitympanum in 23 patients, with 20 having unsafe chronic suppurative otitis media (9). Additionally, 16% of patients had soft tissue density involving other

areas. Abdulmonaem et al. (2015) found 94.3% of cases had radiological features typical for cholesteatoma, including location in the epitympanum and mastoid antrum, along with bony erosion (15). Hiral Happani et al. (2018) found the epitympanum as the most commonly involved site (16).

The data shows the prevalence of soft tissue/fluid attenuation in the epitympanum, mesotympanum, and hypotympanum during HRCT scans and intraoperative assessments. The epitympanum has the highest prevalence at 98%, indicating density-related abnormalities. The mesotympanum has a moderate frequency at 45%, while the hypotympanum has a high prevalence of 59%. Intraoperatively, the epitympanum has a high prevalence at 96%, while the mesotympanum has a moderate prevalence at 54%. The epitympanum/prussak's space is the most commonly involved site in diseased temporal bones, with soft tissue density observed in 95.2% of cases. The aditus ad antrum and mesotympanum are also involved in 80.9% of cases. Soft tissue density is present in the mastoid antrum and air cells in 73% of cases and in the hypotympanum in 31.7% of cases (17). In a Jacob et al HRCT study, soft tissue density was found in the epitympanum in 73.3% of patients with chronic suppurative otitis media (CSOM) with cholesteatoma, followed by the mesotympanum in 56.6% and the aditus ad antrum in 53.3%. Understanding the distribution and prevalence of soft tissue/fluid attenuation in different tympanic regions is crucial for accurate diagnosis and management of ear disorders, especially those involving CSOM and cholesteatoma. HRCT remains a valuable tool in assessing these conditions and guiding clinical decisions and treatment strategies for patients with temporal bone abnormalities (18).

The study's 100-patient sample size may not accurately represent the broader population due to potential biases in patient selection, such as recruitment from a specific healthcare facility or demographic group.

CONCLUSIONS

The data provides valuable insights into the prevalence, distribution, and correlation of conditions affecting ossicular and mastoid health. These insights, supported by statistical analysis, aid clinicians in conducting comprehensive assessments, formulating accurate diagnoses, and developing effective treatment strategies for patients with these conditions. Understanding these abnormalities and their diagnostic methods can improve patient care and outcomes in otolaryngology.

HRCT	:	High Resolution Computed Tomography
CSOM	:	Chronic Suppurative otitis Media
CA	:	Cochlear Aqueduct
CC	:	Carotid Canal
EAC	:	External Auditory Canal
ET	:	Eustachian Tube
I	:	Incus
M	:	Malleus
MA	:	Mastoid Antrum
OW	:	Oval Window
SSC	:	Superior Semicircular canal
TM	:	Tympanic Membrane
V	:	Vestibule

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