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Radio-Diagnosis

A PROSPECTIVE STUDY ON ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY IN EVALUATION OF TEMPORAL BONE PATHOLOGIES

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ABSTRACT **Background:** The temporal bone is a complex anatomic structure that contains the organs of hearing and balance and has direct contact with brainstem, cerebellum and temporal lobe of brain. The application of high-resolution computed tomography (HRCT) in the temporal bone study has allowed the detailed assessment of complex bony anatomy and pathology. The aim of this study was to evaluate various temporal bone pathologies (inflammatory, traumatic, neoplastic and congenital anomalies), their extent and complications on HRCT and to correlate these imaging findings with surgical/histopathological findings wherever possible. **Materials And Methods:** This was a prospective study conducted in the Department of Radiology, Silchar Medical College and Hospital, Silchar from 1st of June 2021 to 31st of May 2022 amongst 50 patients with clinically known or suspected pathologies of inner ear, middle or external ear and the temporal bone. **Results:** In our study, the most common temporal bone pathologies were inflammatory (62%) followed by traumatic (24%), neoplastic (10%) and congenital (4%). Most common inflammatory pathology was otomastoiditis (45.16%) followed by acquired Cholesteatoma (35.48%), chronic mastoiditis (9.68%), Otitis media (6.45%) and Otitis externa (3.23%). Out of 12 traumatic cases, longitudinal fracture(58.3%) was found to be the most common type followed by transverse fracture(25%) and mixed fracture(16.67%). Out of 5 cases of neoplastic pathology, 60% of cases were benign and 40% were malignant aetiology with acoustic neuroma being the most common tumour. EAC atresia was the most common congenital anomaly. The surgical and radiological correlation showed a high sensitivity in the identification of cholesteatoma. **Conclusions:** HRCT of the temporal bone is a highly efficacious modality for accurate delineation of the anatomy and various pathologies of the temporal bone and it has revolutionized the role of radiology in diagnosis and management of temporal bone diseases.

KEYWORDS : High-Resolution Computed Tomography, HRCT, Temporal bone, Cholesteatoma, Mastoiditis.

INTRODUCTION

The temporal bones constitute the lateral skull base, forming portions of the middle and posterior fossae. Each temporal bone is made up of five osseous parts: the squamous, mastoid, petrous, tympanic, and styloid components.[1] The temporal bone houses the middle ear, including the ossicles; the inner ear, which consists of the cochlea, vestibule, and semicircular canals; the bony canals for the facial and vestibulocochlear nerves; and the related vasculature and muscles.[2]

HRCT gives a direct visual window into the temporal bone and allows viewing of fine structural elements related to the anatomy and physiology of the temporal bone. It provides an accurate assessment of pathology prior to surgical intervention with regard to the location, severity, and complications of the condition.[3]

HRCT temporal bone gives useful information for the evaluation of congenital anomalies, inflammatory diseases, otosclerosis, tumours and cerebellopontine angle lesions, post-operative mastoid cavities, anatomical variants, as well as temporal bone trauma. Although HRCT excels in the evaluation of the middle ear disease process and adjacent bone, however, in certain cases, MRI scores over HRCT in the evaluation of middle ear soft tissue; and acts as a next step for confirmation and further characterization.[4]

This prospective study aimed to evaluate various temporal bone pathologies (inflammatory, traumatic, neoplastic and congenital anomalies), their extent, complications on HRCT and to correlate radiological findings with surgical/histopathological findings wherever possible.

MATERIALS & METHODS

The present study was conducted in the Department of Radiology, Silchar Medical College and Hospital, Silchar, Assam following institutional ethical committee approval.

Study Design: Prospective study.

Period Of Study: The present study was conducted from July 2021 to June 2022 for a period of one year after taking approval from the ethical committee.

Inclusion Criteria: -

Inclusion criteria included suspected unsafe chronic serous otitis media, known or suspected deformities of the inner, middle or external ear, suspected temporal bone fracture, suspected tumors of the temporal bone, evaluation of congenitally deaf child and evaluation of tinnitus or vertigo.

Exclusion Criteria:

Patients requiring contrast but were clinically unfit for contrast workup, pregnant women and patients who could not give valid consent were excluded from the study.

METHODS

CT Machine:

All the HRCT scans of 50 patients were performed at our institute using Phillips 128 slice ingenuity elite CT scanner.

Preparation of patients:

Prior to performing the scan particularly in infants and children less than six years, sedation was usually required.

Sedatives used in our institution were Ketamine(1-1.5mg/kg) or Midazolam(1-2mg/kg)

HRCT Technique:

All the HRCT scans of 50 patients done was done with 0.625mm thick sections at slice gap of 0.625 mm. 120 kV and 200 mAs as voltage in the axial plane. The images were reconstructed and visualized in

special bone algorithm. Multiplanar reconstructions were done whenever required in sagittal and coronal planes.

For contrast enhancement, a bolus injection of non-ionic agent iohexol (omnipaque) containing 350 mg of iodine per ml was given in the dose of 1.5 ml/kg of body weight. wherever applicable. Data was analysed using appropriate statistical methods.

Follow-up of patients was done for confirmation with operative and/or histopathological findings whenever possible.

RESULTS

In our study, four common categories of temporal bone pathologies were studied, in which infections were predominant, comprising of 62% of cases, followed by trauma (24%), neoplasm (10%) and congenital abnormalities (4%).

Most pathologies were common in younger age groups. However neoplastic conditions were more common in the older age group. The most common overall age group affected in our study was 11-20 years (n=15; 30%) and the least was 71-80 years(n=1; 2%). The mean age was 29.3 ± 18.9 years.

Majority of patients in our study presented with hearing loss (n=31, 62%) followed by ear discharge (n=29; 58%), earache (n=24, 48%). However, in case of cholesteatoma, most common presenting complaints were ear discharge(81.8%) followed by hearing loss(63.6%). Amongst the infective pathologies, Otomastoiditis (45.16%) was the most common, followed by acquired Cholesteatoma (35.48%), chronic mastoiditis (9.68%), otitis media (6.45%), and otitis externa (3.23%).

Table 1- Showing Distribution Of Categories Of Temporal Bone Pathologies

TYPES OF PATHOLOGY	FREQUENCY(N)	%
Infection	31	62.00%
Trauma	12	24.00%
Neoplasm	5	10.00%
Congenital	2	4.00%
Grand Total	50	100.00%

Most common tumour in our study was acoustic neuroma(40%). Right CP angle predominance was found in our study. All cases were hypodense to iso-dense to the surrounding brain with dense enhancement on contrast administration and widening of porus acousticus. In our study, EAC atresia was the most common congenital anomaly. Among the congenital anomalies, 1 case of isolated EAC atresia(50%) was found and 1 case of EAC atresia with ossicular malformation(50%) was found.

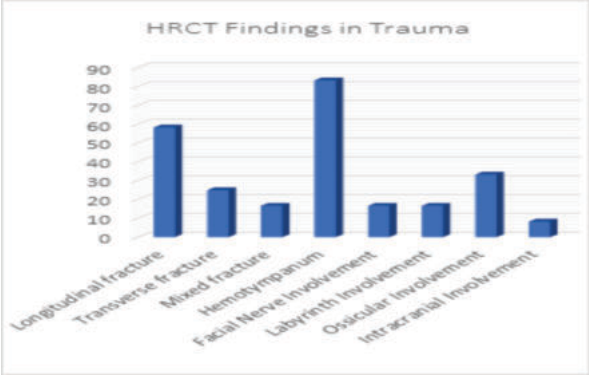
Table – 2 Showing Distribution Of Individual Temporal Bone Pathologies And Mean Age Group Of All Temporal Bone Pathologies

PATHOLOGY	%(CASES)	Age in years (Mean±SD)
CONGENITAL	4	11.55±10.6
EAC atresia with Microtia	2	19.0
EAC atresia with ossicular alformation	2	4.0
INFECTIVE	62	26.7±17.8
Otomastoiditis	28	24.3±15.3
Acquired Cholesteatoma	22	26.6±15.4
Otitis media	4	14.5±2.1
Mastoiditis	6	32.0±29.1
Malignant otitis externa	2	70.0
TRAUMATIC	24	30.0±11.6
Longitudinal fracture	14	28.3±14.6
Mixed fracture	4	38.0±2.8
Transverse fracture	6	28.7±5.0
NEOPLASTIC	10	50.6±29.4
Vestibular Schwannoma	4	52.5±10.6
Basal cell carcinoma of EAC	2	65.0
Metastasis	2	80.0
EAC osteoma	2	3.0
Grand Total	100(n=50)	29.3±18.9

In our study, longitudinal fracture(58.3%) was found to be the most common type followed by transverse fracture(25%) and mixed fracture(16.67%), as per the traditional classification. According to the newer classification system, 83.33% of the trauma cases had otic capsule–sparing fractures, 16.67% had otic capsule–violating fractures.

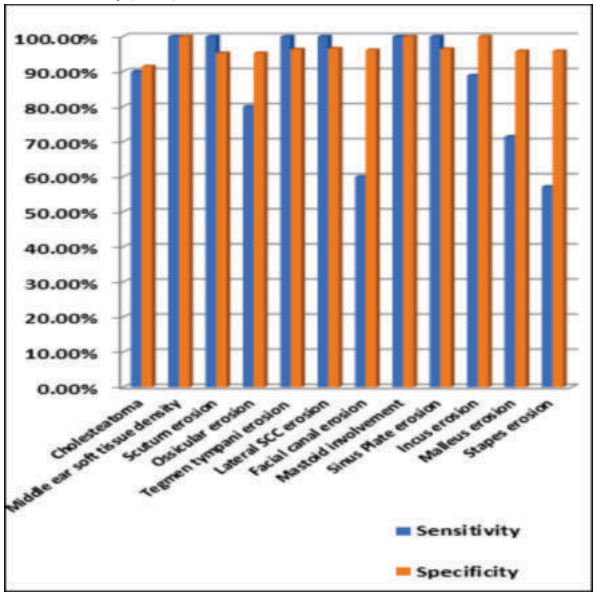
Table 3- Showing HRCT Findings Of Cholesteatoma

HRCT Findings of Cholesteatoma	Number of cases	%
Soft Tissue Mass	11	100%
Ossicular Erosion	9	90.9%
Erosion of Facial Canal	3	27.2%
Tegmen Tympanic Erosion	4	36.4%
Semi-circular Canal Erosion	2	18.2%
Sinus Plate Dehiscence	3	27.2%
Scutum Erosion	10	90.9%
Lateral mastoid cortex erosion	2	18.2%
Opacified Mastoid	11	100%



Bar Chart 1- Showing HRCT findings of temporal bone trauma

HRCT predicted accurately 92% of cholesteatoma cases with a sensitivity of 90%, the specificity of 91%, the PPV of 81.82% and NPV of 95.00%. HRCT predicted facial canal erosion in only 57% of cases. HRCT predicted 100% of LSCC fistula with a sensitivity of 100% and specificity of 100%. Ossicular erosion was picked up by HRCT with sensitivity and specificity of 80% and 95.14% respectively. HRCT predicted incus erosion with excellent sensitivity(89%) and specificity(95%), however, predicted Stapes erosion with moderate to low sensitivity(57%).



Bar Chart 2- Comparative analysis between HRCT temporal bone and surgical observations in infective pathologies of temporal bone

Fig-1 (A)& (B) Axial CT sections of temporal bone showing soft tissue density within a radical cavity involving left middle ear and mastoid cavity with destruction of ossicular chain, lateral mastoid wall defect and dehiscence of LSCC (yellow arrow). (C)& D) CECT axial images showing left post-auricular rim enhancing collection (blue arrow) and filling defect in the left sigmoid sinus (white arrow).

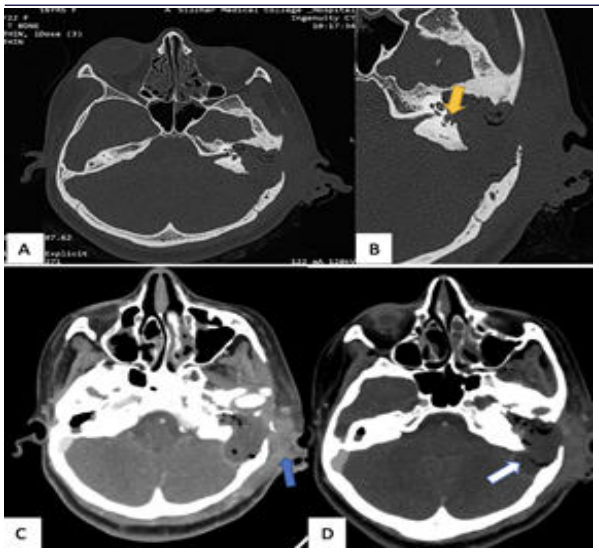


Figure 1- Left extensive Cholesteatoma with Bezold's abscess and Sigmoid sinus thrombosis

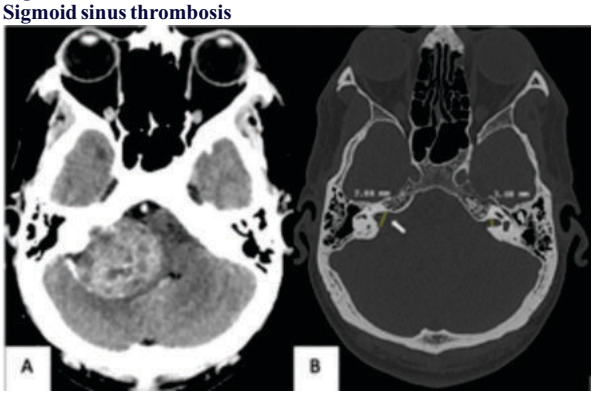


Figure 2-: Right Sided Vestibular Schwannoma

Fig-2(A) Axial CECT image showing heterogeneously enhancing mass lesion with internal hypodense cystic components in the region of right cerebellopontine angle. (B) HRCT axial bone window image showing widening of right porus acusticus(white arrow).

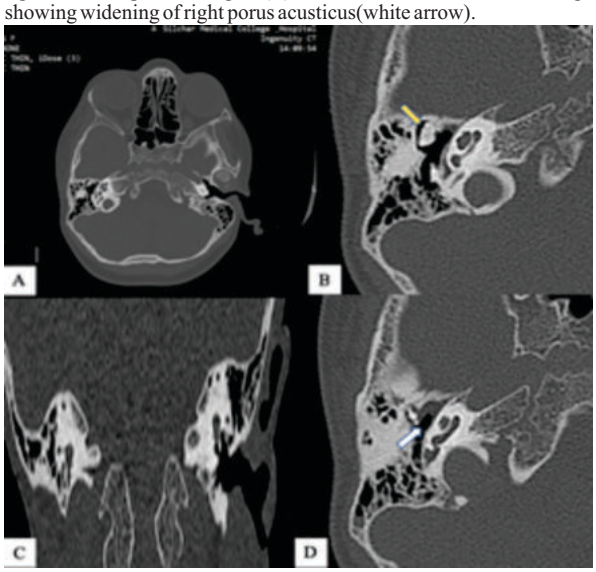


Figure 3- Right EAC atresia with Anotia and ossicular malformation

Fig-3 (A) Axial and (C) Coronal reformatted bone window HRCT images showing absent right pinna (Anotia) with complete bony and cartilaginous obliteration of right EAC. (B) and (D)Axial HRCT magnified images showing fixed malleus head to the epitympanic wall(yellow arrow) and absent long process of incus and stapes(white arrow).

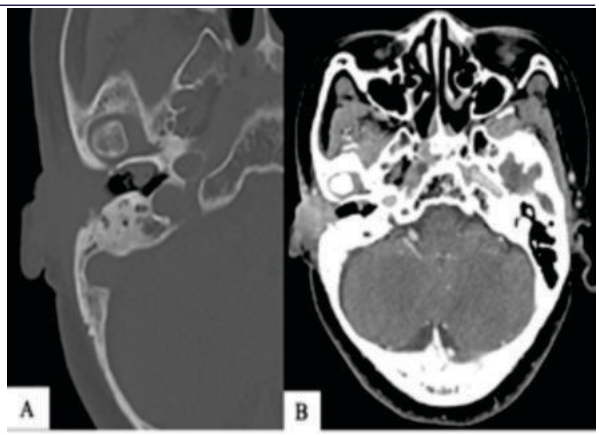


Figure 4- Basal cell carcinoma of right external auditory canal (EAC)

Fig- 4(A) Axial HRCT image and (B) CECT image of right temporal bone show heterogeneously enhancing mass lesion involving the right auricle extending to the right external auditory canal with erosion of the bony part of right EAC and mastoid part of right temporal bone (yellow arrow).

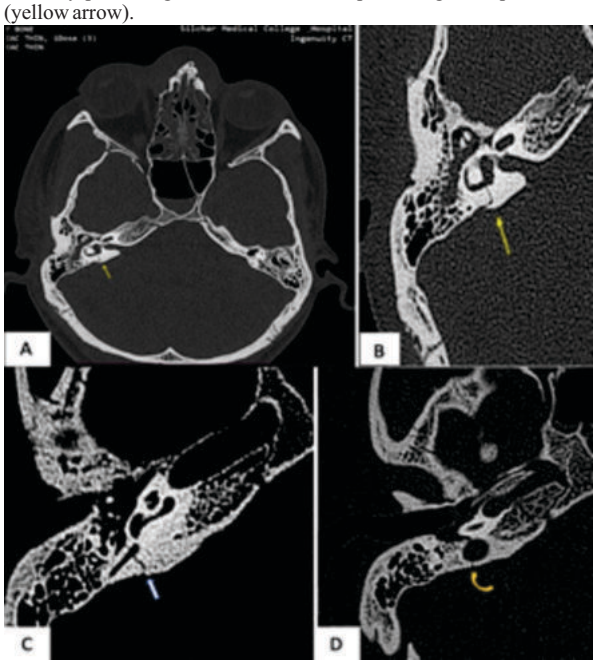


Figure 5- Transverse fracture of right temporal bone (Otic capsule violating)

Fig-5 (A) HRCT axial bone window image showing fracture involving petrous part of right temporal bone. The fracture line extends to involve the (B) lateral SCC (yellow arrow), (C) posterior SCC (white arrow) and (D) jugular foramen (curved yellow arrow).

DISCUSSION

HRCT study of the temporal bone is the imaging modality of choice for most of the pathologic conditions of the temporal bone, especially the middle ear. In this study amongst 50 patients, we found that the infective cause was the most common aetiology, followed by traumatic (24%), neoplastic (10%) and congenital (4%). Similar results were obtained in the study by **More D. et al (2017)**[5] and **Bagul M et al(2016)**[6] which showed infections as the most common temporal bone pathology.

In present study, the most common age group involved was 11-20 years (n=15; 30%), followed by 30-40 years(n=11, 22%). The mean age was 29.3 ± 18.9 years. Similar study conducted by **Thukral C L et al(2015)**[7] showed majority of the patients in the age group 11-20 years and mean age of patients was 27.95±16.85 years. In our study, majority of patients presented with hearing loss (n=31, 62%) followed by ear discharge (n=29; 58%), earache (n=24, 48%) and ear bleeding(n=12, 24%). In another cross-sectional prospective study of 90 patients conducted by **Chidambaram P K et al (2019)**[8] the common

presenting complaints were hearing loss of about 60%(54) followed by discharge about 52.2% (47) and pain 32.2% (29).

Infection

Amongst the infective causes, otomastoiditis (n =14; 45.16%) was the most common cause followed by acquired Cholesteatoma (n = 11; 35.48%), chronic mastoiditis (n=3; 9.68%), otitis media (n = 3; 6.45%), and otitis externa (n =1, 3.23%). Our study well correlated with study of **Boney L et al (2021)**[9], which showed otomastoiditis as the most common infective etiology (50%), followed by acquired cholesteatoma (25%), otitis media (10.7%), chronic mastoiditis(7.1%) and otitis externa (7.1%).

In our study, presence of non-dependent soft tissue mass in the middle ear cavity and mastoid antrum was found in all 11 (100%) cholesteatoma patients. This analysis correlates well with the studies reported by **Abdulmonaem G et al(2015)**[10] and **Khavasi P et al(2018)**[11] who also reported the presence of non-dependent soft tissue mass involving middle ear, attic and mastoid in 100% cholesteatoma patients. In our study, ossicles erosion was the mostly encountered complication seen in 91% cholesteatoma cases. The incus (72.7%) was the most frequently eroded ossicle, followed by the malleus(54.5%) and the stapes(45.4%). This is in accordance with study conducted by **Kim H J et al(1990)**[12] and **Humtsoe E L et al(2019)**[13]. In our study, Post auricular (mastoid) abscess was found to the most common extra-cranial complication of infective pathologies involving middle ear and mastoid, followed by facial nerve palsy(25%), labyrinth fistula(12.5%) and petrous apicitis (12.5%). Among the intracranial complications, Sigmoid sinus thrombosis was the most common, comprising of 50% of all extra-cranial complication, which is in accordance with the study conducted by **Wang Y et al(2003)**.[14]

The sensitivity and specificity of HRCT to diagnose cholesteatoma preoperatively was 89.06% and 91.48% respectively in our study. We could correlate these findings with **Thukral et al.(2015)**[7]**,** who concluded sensitivity and specificity of 89.29% and 77.22% respectively. The sensitivity and specificity of HRCT to diagnose stapes, malleus and incus erosion preoperatively in our study was 88.89%, 71.43% and 57.14% respectively. Similar results reported by **Rohit Vallabhaneni et al.(2016)**[15] in their study. HRCT showed a sensitivity of 60.00% and specificity of 96.15% to diagnose facial canal dehiscence. This low sensitivity and relatively high specificity in our study could be correlated with **Thukral et al(2015)**[7]**.** Moderate to poor radio-surgical correlation was noted in identifying stapes erosion and facial canal erosion. **Rogha M. et al(2014)**[16] reported poor radiologic-surgical correlation in stapes erosion and stated that the small size of the bone may be the cause in poor detection by HRCT.

Trauma

In our study, longitudinal fracture(58.3%) was found to be the most common type, followed by transverse fracture(25%) and mixed fracture(16.67%), as per the traditional classification. The study conducted by **Yalçiner G et al (2012)**[17] also showed longitudinal fracture to be most common type according to the traditional classification system. According to the new classification system, 83.33% of the trauma cases had otic capsule–sparing fractures, 16.67% had otic capsule–violating fractures. Our study well correlated with the study done by **Little S C et al(2006)** [18] in which 24 patients (80%) had otic capsule–sparing fractures, and 6 patients (20%) had otic capsule–violating fractures.

In our study of 12 trauma cases, 10 cases of hemotympanum (83.3%), 4 cases with ossicular involvement (33.3%) and 2 cases each of facial nerve involvement(16.7%) and labyrinth involvement (16.7%) and 1 case of intracranial involvement(8.3%) were found. Similar results obtained in the study by **Bagul M et al(2016)**[6]**,** in which hemotympanum was seen 71.4% of cases, ossicular disruption in 28.57% cases, facial nerve involvement and labyrinth involvement in 14.27% cases.

Neoplasm

In our study**,** out of 5 neoplastic lesions , 2 cases of acoustic neuroma was found(40%) , followed by 1 case of External auditory canal malignancy (40%), 1 case of EAC Osteoma(20%) and 1 case of metastasis in (20%). Our study also fairly correlated with study conducted by **Raini K.P et al(2017)**[19] , in which acoustic neuroma constituted the largest proportion of cases, (n=15) 50 %, followed by external auditory canal malignancy in (n=2), 6.7 %, and metastasis in (n=4), 13.3%).

Congenital

In the present study, EAC atresia was the most common congenital anomaly. Out of the 2 case, 1 was isolated congenital EAC atresia with microtia(Type C) and the other case was congenital EAC atresia(Type C) with Anotia and ossicular malformation, which is also known as combined EAC middle ear malformation. **Kebapci M et al (2003)**[20] in their study also reported EAC atresia to be the most common congenital anomaly. According to **Eavey et al(1985)**[21], the most frequently encountered developmental anomaly of the external ear was microtia, also consistent with our study.

CONCLUSION

HRCT of the temporal bone due to its high spatial resolution helps in accurate assessment of infective, congenital, traumatic and neoplastic aetiologies. Overall, the results of the present study showed a good agreement between HRCT and operative findings. The results of the present study indicate that HRCT is a valuable imaging modality which helps in diagnosis, pre-operative staging and post-operative or post treatment evaluation of temporal bone. Hence it helps the surgeon to decide the course of action in particular clinical problem.

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