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High resolution computed tomography of temporal bone in the evaluation of otologic diseases

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ABSTRACT

Background: Conventional radiological methods like X-ray mastoid have limited ability to delineate the details of the complex temporal bone and cochlea-vestibular anatomy and disease pathology. This can be overcome by the use of High resolution computed tomography (HRCT) evaluation of the temporal bone. HRCT is helpful in evaluating the anatomy and pathology type and extent of disease, thereby helps in preoperative planning.
Methods: The CT scan of forty five patients attending the outpatient department of otorhinolaryngology in a tertiary care centre between August 2014 to August 2017 was evaluated in this study. Each CT scan was interpreted by an otolaryngologist and a radiologist and interpretation was by consensus. The data collected was evaluated and results are reported as rates and proportions (%).
Results: The study evaluated CT scan of 45 patients of which 35 were male patients and 10 were female patients with age ranging from 5 years to 75 years. Most of these patients belonged to the 21-30, 31-40 age groups [9 (20%) in each group]. Infections of middle ear cleft (all with cholesteatoma), fractures of the temporal bone, anomalies and tumors of the external auditory canal and middle ear were the pathologies observed in these CT scans with infection (otomastoiditis) [23 (51.1%)] being the most common pathology observed.
Conclusions: Pre-operative CT scan may not only help in identifying the nature, extent of infectious disease including ossicular, bony erosions; it may also identify anomalies in the temporal bone and surrounding structures. Thus, HRCT temporal bone will help the surgeon in planning effective surgical strategy, reducing morbidity during the surgery.

Keywords: HRCT, Temporal bone, Cholesteatoma, Otologic diseases

INTRODUCTION

Due to the complex anatomy of the temporal bone, conventional radiological methods like X-ray mastoid have limited ability to delineate the details of the temporal bone and cochlea-vestibular anatomy and disease pathology. The availability of modern high-resolution computerized tomography (HRCT) scanners has resulted in ability to demonstrate the detailed temporal bone anatomy and identify significant structures and has revolutionalized the role of radiology in diagnosis and management of temporal bone diseases.[1]

HRCT is particularly helpful in evaluating the anatomy and pathology of external auditory canal, middle ear cavity, vestibular aqueduct, tegmen tympani, sigmoid sinus plate, vertical segment of facial nerve canal, sinodural angle, carotid canal, jugular fossa, infra and supralabrynthine air cells and temporomandibular joint; both soft tissue extension and significantly sensitive

depiction of calcification of the soft tissue. In patients with temporal bone trauma, HRCT accurately evaluates the fracture lines, ossicular disruptions and facial nerve canal injury. Hence it determines the management of trauma patients. HRCT, depicts the ossicular and inner ear abnormality in patients with congenital malformation; helps in characterizing type, extent of neoplastic lesions and resultant temporal bone alterations; helps in detection of otosclerosis and in middle ear infections, cholesteatoma, HRCT appears to be the diagnostic modality of choice. Sagittal projection CT scan follows the plane of surgical approach for mastoid surgery and is particularly advantageous in pre-operative evaluation of otological pathology[1] thereby assisting the surgeons in reducing intraoperative complications and morbidity. HRCT has the additional advantage of excellent topographic visualization, without superimposition of temporal bone, soft tissue details and thus mostly devoid of artifacts. Due to these features and advantages, HRCT is considered the ideal radiological method for the evaluation of temporal bone anatomy and pathology.[2]

In view of this, the current study was undertaken with the objective to evaluate the role of HRCT temporal bone of patients with otological symptoms in delineating the features of temporal bone pathology.

METHODS

The CT scan of forty five patients attending the outpatient department of otorhinolaryngology in a tertiary care centre between August 2014 to August 2017 were evaluated in this study. Patients with otological and vestibulocochlear symptoms indicating requirement of CT scan evaluation were included in the study. Patients who were previously operated, those with electric devices at the skull base, such as cochlear implants, patients with tubotympanic type of chronic otitis media, and reported as normal studies; were excluded.

CT scan was performed with a Philips CT scanner. Direct axial sections were done in all the patients with the patients in supine position; with coronal reconstruction. Axial and coronal views in bone and soft tissue windows of all the CT scan films were reviewed using Philips Dicom viewer software. Scanning commenced from the lower margin of the external auditory meatus and extended upward to the arcuate eminence of the superior semicircular canal as seen on lateral tomogram. All the CT scans evaluated in this study except patients with suspected malignancies, were performed without contrast. Intravenous contrast studies were performed in the case of suspected malignancies. The study parameters evaluated were age, sex, and radiographic findings of disease and any anomalies. Each CT scan was interpreted by an otolaryngologist and a radiologist and interpretation was by consensus. Each scan was reviewed for the presence of temporal bone anatomy, disease and any anomalies identified. The data collected was evaluated and results are reported as rates and proportions (%).

RESULTS

The study evaluated CT scan of 45 patients of which 35 were male patients and 10 were female patients with age ranging from 5 years to 75 years. Most of these patients belonged to the 21-30, 31-40 age groups [9 (20%) in each group] (Table 1).

Table 1: Distribution of cases based on age and sex.

Age group (years)	Male	Female	Total number (%)
01-10	5	1	6 (13.3)
11-20	4	3	7 (15.5)
21-30	8	1	9 (20)
31-40	6	3	9 (20)
41-50	5	0	5 (11.1)
51-60	6	2	8 (17.8)
>60	1	0	1 (2.2)
Total	35	10	45

Table 2: Classification of cases based on the type of pathology observed.

Pathology	Number n (%) N=45
Infections of middle ear cleft	23 (51.1)
Temporal bone fractures	08 (17.7)
Anomalies	06 (13.3)
Tumours of external and middle ear	06 (13.3)
Fibrous dysplasia	02 (4.4)
Total	45

Table 3: HRCT findings seen in cases of infective disease in the middle ear cleft.

Radiological features	Number N=23 (%)
Ossicular erosion	15 (65.2)
Scutum erosion	10 (43.5)
Fallopian canal erosion	09 (39.1)
Tegmen tympani erosion	04 (17.4)
Lateral semicircular canal erosion	01 (4.3)
Mastoid fistula	03 (13.0)

Infections of middle ear cleft (all with cholesteatoma), fractures of the temporal bone, anomalies and tumors of the external auditory canal and middle ear were the pathologies observed in these CT scans (Table 2) with infection (otomastoiditis) [23 (51.1%)] being the most common pathology observed. Infection of the middle ear cleft was associated with ossicular erosion in 15 cases. In

3 cases, mastoid fistula was observed in association with infection.

Figure 1: Cholesteatoma in attic with exposed facial nerve tympanic part right side.

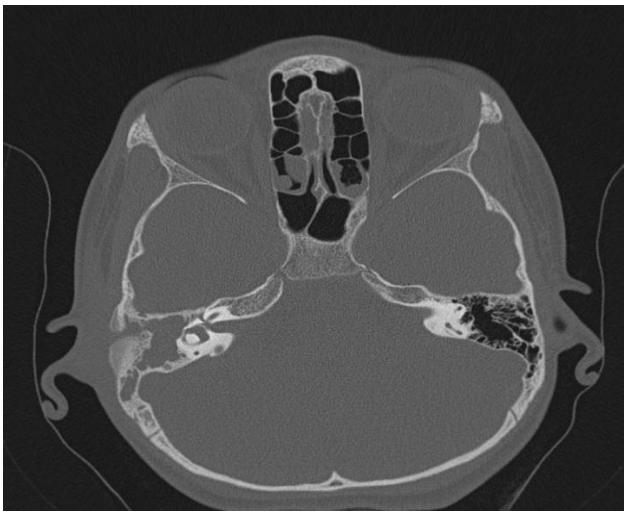

Figure 2: Cholesteatoma with mastoid fistula with osscicular erosion with thinning of lateral semicisrular canal- right side.

Longitudinal fracture of the temporal bone [4 (50%)] was the most common fracture observed, followed by transverse fracture [02 (25%)], complex fracture and fracture of tympanic bone [01 (12.5%)] each. Of the six cases with anomalies, most commonly observed [3(50%)] anomaly was external auditory canal (EAC) atresia with hypoplastic middle ear. The other anomalies observed were two cases of EAC atresia with normal middle ear and one case of absence of development of bilateral lateral and superior semicircular canals. Glomus tumour [3 (50%)] was the commonly observed tumour. 2 cases of middle ear malignancy and one case of external auditory canal malignancy were also observed.

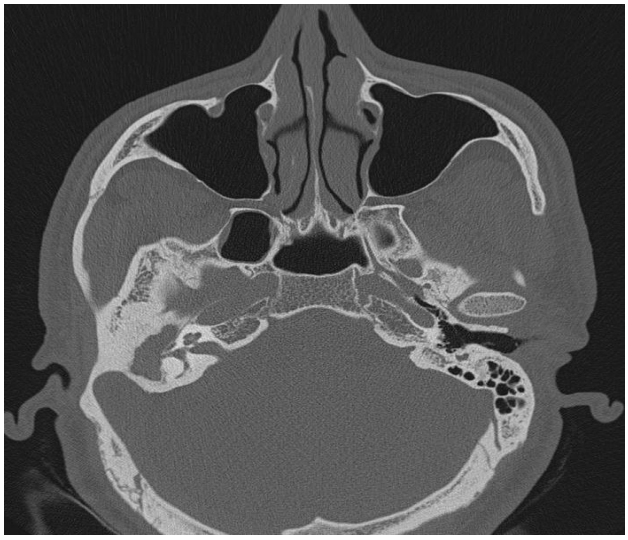

Figure 3: Right lateral semicircular canal erosion.

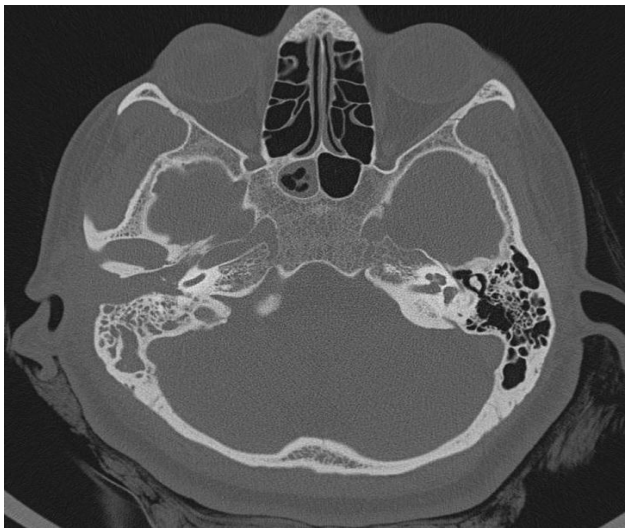

Figure 4: Glomus tympanum in right ear.

Figure 5: Longitudinal fracture right temporal bone.

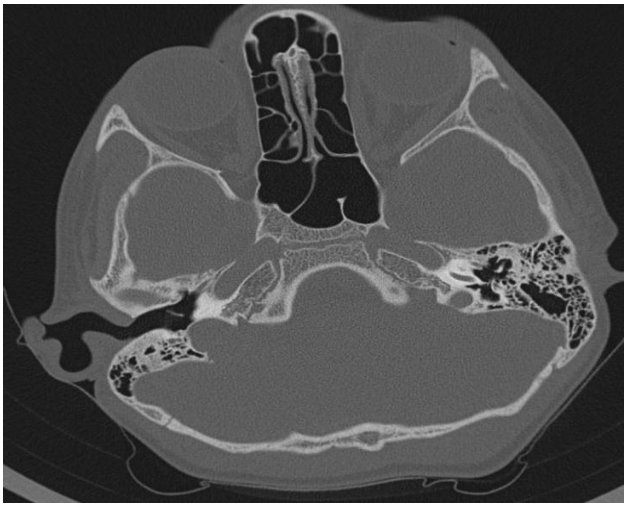

Figure 6: Left external auditory canal atresia.

DISCUSSION

HRCT temporal bone plays a crucial role in addressing the challenge of delineating the details of temporal bone anatomy and pathology, thus aiding in more accurate diagnosis, assessment of extent of disease, earlier detection of complications and thus helps in planning the management strategy in temporal bone disease.[2,3] HRCT has helped in considerably reducing the morbidity and mortality pertaining to lesions of this region[3]. Assessment of temporal bone anatomy and pathology accurately on HRCT requires considerable training and experience for both the radiologist and otologist. The air in the tympanic cavity surrounded by the dense temporal bone and the mastoid air cells provide an inherent natural contrast to the HRCT imaging of temporal bone and provides excellent delineation of bony land marks within the temporal bone.[3]

HRCT is recommended as the preferred method for evaluating most patients with cholesteatomas of the temporal bone.[3] Despite some concerns that CT cannot reliably distinguish cholesteatoma from mucosal disease and regarding its limitation in sensitively recognizing erosive complications, imaging of ear has been a routine test in preoperative evaluation of the disease and many studies support the value of CT-scan in preoperative evaluation of cholesteatoma.[4-6] The hallmarks of cholesteatoma on CT scans are a soft tissue mass in attic and mastoid antrum associated with smooth bony expansion, scalloping of the mastoid, erosion of lateral wall of attic and erosion of ossicles.[3] While a definitive diagnosis of cholesteatoma can only be made at the time of surgery, the CT scan evaluation may at times influence the decision and timing of surgical exploration with evidence of bony erosion, complications like acute mastoiditis, brain abscess prompting earlier surgical intervention.[5] CT scan may also assist in pre-operative detection of varied pneumatisation of the mastoid temporal bone and the presence of anatomical variations like dehiscence of semicircular canal while showing lower specificity in detecting facial canal dehiscence, dural plate erosion, and sigmoid plate erosion.[5] In the current study evaluating HRCT temporal bone, infections of middle ear cleft (with cholesteatoma) was the most common pathology observed and this is in line with studies by Jyothi et al and Seema et al.[2,3] Also, the CT scan accurately delineated ossicular erosion, scutum erosion, fallopian canal, tegmen tympani and lateral semicircular canal erosions in the cases with cholesteatoma. 3 mastoid fistula were also identified effectively on CT scan.

Facial nerve paresis, conductive hearing loss, cochlear and vestibular dysfunction, and leakage of cerebrospinal fluid (CSF) resulting from temporal bone trauma form an important group of delayed sequelae of head injury.[7] HRCT is the preferred and most sensitive mode for radiological assessment in cases of temporal bone trauma.[1,2] HRCT accurately images the site of fractures, with fine bony detail sufficient to detect even small fracture lines in the region of the genu of the facial nerve. In addition, soft-tissue findings, such as blood in the middle ear or mastoid antrum and CSF leakage associated with fracture, can be assessed.[7] HRCT is able to accurately delineate the fracture lines, ossicular disruptions and facial nerve canal injury.[1] While some authors recommend selective use of HRCT to complement decision making in cases of trauma, many studies indicate that HRCT temporal bone helps in planning the management of patients presenting with temporal bone trauma.[1,2,7,8] Appropriate and timely radiological imagining with accurate delineation of the fracture plane and assessment of associated soft-tissue injury, may help in improved management of the patients with temporal bone trauma. In some cases, this may improve or prevent permanent deficits related temporal bone trauma and its complications.[7]

Longitudinal fractures have been reported as the most common of temporal bone fractures.[2,3,7] These fractures begin in the squama, extend medially across the posterior superior external bony canal wall, involve the roof of the middle ear, and run along the surface of the petrous pyramid anterior to the labyrinth capsule, finally terminating near the foramina spinosum and lacerum in the middle cranial fossa.[7] Transverse fractures are the next common type with the fracture line following the internal auditory canal usually with extension across the pyramidal process of the temporal bone, or through the labyrinthine capsule, including both the cochlea and vestibule. These fractures may extend medially or laterally through the temporal bone or external auditory canal respectively.[7] In the current study, 8 cases of temporal bone fractures were observed with longitudinal fractures comprising the most common type which was in line with literature.[2,3,7]

HRCT using the "bone algorithm" without intravenous contrast is used for the evaluation of middle ear soft tissue except in cases of suspected vascular abnormality,

a tumor, or other enhancing lesion such as an intracranial abscess which may required intravenous contrast administration prior to HRCT.[9] Temporal bone tumours usually appear as isodense to slightly hypodense lesions compared to adjacent brain, on HRCT.[2] Guilford and Alford coined the term glomus tympanicum to describe those paragangliomas limited to the middle ear. Glomus tympanicum on CT scan appears as a soft tissue mass abutting the promontory of the middle ear with or without displacement of ossicles or bony erosion of the tympanic cavity. Presence of air or bone between the tumour and the jugular bulb is highly indicative of glomus tympanicum. While magnetic resonance imaging may be better than CT for delineating tumour edges and intracranial extent; CT scans are best for evaluating bony destruction and erosion, which is a hallmark of jugulotympanic glomus tumours.[10] Other vascular abnormalities like high jugular bulb or an aberrant carotid artery can masquerade with a similar presentation as glomus but CT scan features are helpful in ruling out these abnormalities.[11] Primary malignant tumors of EAC are rare with squamous cell carcinoma (SCC) being by far the most common EAC malignancy. SCC tends to involve both the cartilaginous and bony part of EAC while in adenocarcinoma only the cartilaginous part is involved.[12] True neoplasms of the middle ear include paraganglioma i.e. glomus tumor (most common), facial nerve schwannomas and geniculate region hemangiomas extending to middle ear, choristomas, and malignancies such as carcinomas and metastases (rare).[13] In the current CT scan study, three of the six tumors observed were glomus tympanicum tumors, more commonly in female patients than male (2:1), in line with literature.[10] The other tumors observed in this study were middle ear malignancy and EAC malignancy.

In cases of congenital aural atresia, HRCT scan can be very helpful in differentiation of only external auditory atresia from EAC atresia associated with anomalous middle ear structures, thus identifying the patients best suited for reconstructive surgery.[14] In patients with EAC anomaly, anomalous course of the facial nerve canal is often observed.[15] In the current study, six cases (13.3%) were ear anomalies. EAC atresia with normal or hypoplastic middle ear was the most common anomaly in this study, which is in line with literature.[14] The other anomalies observed were absence of development of bilateral lateral and superior semicircular canals.

CONCLUSION

The findings of this study suggest that HRCT has a significant role in identifying the temporal bone pathology, especially infections of the middle ear associated with cholesteatoma and in otological malignancies. Pre-operative CT scan may not only help in identifying the nature, extent of infectious disease including ossicular, bony erosions; it may also identify anomalies in the temporal bone and surrounding structures. Even in cases of EAC atresia, presence or absence of middle ear anomaly is an important diagnostic information. Thus, HRCT temporal bone will help the surgeon in planning effective surgical strategy, reducing morbidity during the surgery. The details observed on HRCT also help to avoid surgical exploration for visualisation of the pathology alone especially in cases of temporal bone trauma.

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