DOI: 10.21276/sjams.2017.5.3.17

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(3B):770-779 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

High-resolution Computed Tomographic Evaluation of Pathologies of Temporal Bone

Dr. Sneha Ankush More[1], Dr. Dilip L. Lakhkar[2], Dr. Sushil Kachewar[3], Dr. Pramod Kumar S[4], Dr. Rekha Panpatil[5]
[1]Radiology Resident, [2]Professor and Head of the Department of Radio-diagnosis, [3]Professor
Dr. Vitthalrao Vikhe Patil Foundation's Medical College & Hospital, Ahmednagar, Maharashtra, India 414111

***Corresponding author**
Dr. Sneha Ankush More
Email: snehaankushmore@gmail.com

Abstract: Before the advent of computed tomography (& HRCT), complex bone and air cells anatomy and pathologies of temporal bone were evaluated with the help of plain radiograph, polytomography etc. High resolution computed tomography (HRCT) - a modification of routine CT produces images with higher contrast and a better spatial resolution. In fact HRCT has revolutionized the method of imaging the temporal bone with its special algorithms and multiplanar reformats. This study was aimed to develop a systematic method for evaluation of temporal bone pathologies. The objective is to evaluate the inflammatory, traumatic, neoplastic and congenital pathologies of the temporal bone with the help of HRCT. This was cross-sectional prospective study conducted on a total of 100 patients of varied age group at DVVPF'S Medical College, presenting with symptoms and signs of temporal bone pathologies, between a time period of June2015 to November 2016. Imaging diagnosis was confirmed either by histopathology or follow-up and response to treatment. In our study, temporal bone pathologies were more common in male (60 %) compared to female population (40%). The most common age group affected by the temporal bone pathologies was 21-30 years age group (24%) and least common age group was more than 60 years (1%). The most common temporal bone pathology in our study was inflammatory lesions (78%) followed by traumatic (12%), neoplasm (6%), congenital (4 %). Most common inflammatory pathology in our study was cholesteatoma (51.2%) followed by oto-mastoiditis (48.8%). Out of 6 cases of neoplastic pathology, (83.33%) of cases were benign and (16.66%) were malignant aetiology. There are a variety of other imaging modalities to image temporal bone. Radiological imaging of the petrous bone must meet high standards of topographic representation and spatial resolution. The visualization of small bony structures, lowest radiation dose to the lens, technical factors, interpretation of the images and economic factors were all considered. HRCT outweighs the conventional modalities of investigations and provides higher spatial resolution and better soft tissue contrast. Computed tomography is clearly superior in the imaging trauma, congenital anomalies, neoplasms and infections of temporal bone.
Keywords: High-resolution computed tomography, Acoustic neuroma, Histo-pathological diagnosis, Temporal bone, Cholesteatoma

INTRODUCTION

Before the advent of computed tomography (& HRCT), complex bone and air cells anatomy and pathologies of temporal bone were evaluated with the help of plain radiograph, polytomography, angiography, and cisternography. Though plain radiograph is an inexpensive imaging modality, it is limited by the overlapping of various bony structures and complex anatomy of temporal bone.

With the emergence of cross sectional imaging, Computed tomography (CT) and magnetic resonance imaging (MRI) are the most widely used modalities for evaluation of the temporal bone pathologies [1]. High resolution computed tomography (HRCT) - a modification of routine CT produces images with higher contrast and a better spatial resolution [2]. In fact HRCT has revolutionized the method of imaging the temporal bone with its special algorithms and multiplanar reformats. It gives minute structural details of complex anatomy of temporal bone which consist of tiny structures like ear ossicles, cochlea and semi-circular canals - organs of hearing and balance. It depicts the detailed anatomy and course of the carotid canal, jugular fossa and other bony canals & major vessels and nerves traversing through them. Middle cranial fossa and posterior cranial fossa with its important brain structures are located anterior and posterior to temporal fossa respectively. These fine details help us to localise the disease, its extent, bony erosion or destruction and intracranial complications precisely. Addition of contrast to our study helps to further characterize the soft tissue lesions. This study was done to evaluate the extent of chronic middle ear infections and their complications, temporal bone trauma, neoplasms involving temporal bone and the congenital anomalies of the ear according to compartment involvement.

MATERIAL AND METHODS

This prospective observational study was conducted on 100 patients of varied age group, with complaints related to temporal bone pathologies referred to Department of Radiology at DVVPF's Medical college & Hospital, Ahmednagar. Informed consent was obtained (after clearance from ethical committee) after explaining details of the study protocol to the subjects. Imaging diagnosis was confirmed either by histopathology or follow-up and response to treatment.

A) Duration of study:
From June 2015 to November 2016

B) Depending Study group:
The cases will be recruited from patients referred to Department of Radiology, with complaints related to temporal bone pathologies

C) The inclusion criteria:
Patients with symptoms related to temporal bone.

D) The exclusion criteria:
History of previous surgery and those with electric devices at the skull base, such as cochlear implants
Abnormal Renal Function Tests
Pregnant Cases

E) Equipment Used
GE light speed 16 slice CT scanner

HRCT TECHNIQUE

HRCT was done using thin section (0.6-1.5mm), high-resolution (512 X 512 matrix and FOV 15-20 cm) and bone algorithm technique. CT images are usually acquired or displayed in axial or coronal planes. Axial imaging was done in supine and neutral position of the neck, in a plane rotated 30° superior to the baseline so that planes are parallel to the lateral semi-circular canal. Coronal imaging was done by neck extension and prone position, in a plane that is rotated approximately 105° to 120° the baseline which is perpendicular to the lateral semi-circular canal. Iodine Based contrast was used mainly in the neoplastic pathologies and intracranial complications. Final imaging diagnosis correlated with histo-pathological confirmation or follow-up and treatment response.

Scout	lateral (90 degrees)
Start	below mastoids
End	clear petrous bones
kVp	130
mA	140
Raw Slice Thickness	1.0 mm
Reconstructed Slice Thickness	0.75 mm
Intravenous Contrast (if indicated)	Omnipaque350 65mls with pressure injector
Multiplanar Reconstructions	Axial 1mm thick coronal 1mm thick

RESULTS

Table 1: Showing Sex Distribution

Sex	No. of Patients	Percentage
Male	60	60
Female	40	40

Table 2: Showing Distribution of Disease

Diseases	No. of Patients	Percentage
Infections	78	78
Trauma	12	12
Tumor	6	6
Congenital anomaly	4	4

Table 3: Showing Age and sex distribution of infection

Age in years	Male	Female
0-10	8	4
11-20	10	8
21-30	12	12
31-40	6	4
41-50	6	2

51-60	5	2
61-70	1	0

Table 4: Showing Clinical Features

Clinical features	No. of Patients	Percentage
Hearing loss	24	30
Ear discharge	60	75
Facial nerve weakness	4	5
Head ache	40	50
Ear pain	20	25
Tinnitus	12	15
Cerebellar signs	8	10

Table 5: Showing Distribution of Infection

Distribution of Infection	No. of Patients	Percentage
Cholesteatoma	40	51.2 %
Oto-mastoiditis	38	48.8

Table 6: Showing Ear affected

Unilateral/Bilateral	No. of Patients
Left	37
Right	32
Bilateral	11

Table 7: CT features of cholesteatoma

CT findings	Number of cases	Percentage
Soft tissue lesion	40	100
Opacified mastoid	27	67
Ossicular and scutum erosion	36	90
Erosion of sigmoid sinus plate	13	32.5
Erosion of tegmen tympanii	7	17.5
Erosion of fascial canal	6	15
Erosion of lateral semi-circular canal	4	10

Table 8: Various complications of cholesteatoma

Complications	Number of cases	Percentage
Brain abscess	9	(42.85)
Meningitis	3	(9.52)
Dural sinus thrombosis	5	(14.28)
Post auricular abscess	3	(19.04)

Table 9: Distribution of CT findings in temporal bone fracture

CT findings	Number of cases	Percentage
Longitudinal fracture	6	(50)
Transverse fracture	3	(25)
Complex fracture	3	(25)
Haemotympanum	9	(75)
Ossicular disruption	4	(33.33)
Labyrinthine injury	1	(8.33)
Facial nerve canal injury	4	(33.33)
Intracranial injury	3	(25)

Table 10: Distribution of external and middle ear anomalies

HRCT findings	Number of cases (%)	Percentage
Bony atresia	2	50
Soft tissue atresia	1	25
Ossicular deformity	3	75
Small tympanic cavity	2	50

Facial canal	1	25
Inner ear anomaly	1	25

Table 11: Distribution of neoplastic lesions

Neoplasm	Number of cases	Percentage
Acoustic neuroma	3	50
Glomus Tumour	2	33.33
Metastasis	1	16.66

DISCUSSION

The aim of radiological study of temporal bone is to give an accurate radiological diagnosis as it can help the clinician to predict the complications and to give prompt topographic representation of petrous bone lesions preoperatively. There are a variety of imaging modalities to image temporal bone however radiological imaging of the petrous bone must meet high standards of topographic representation and spatial resolution. The visualization of small bony structures, lowest radiation dose to the lens, technical factors, interpretation of the images and economic factors were all considered. Though in conventional radiology, a particular structure can be optimally represented with number of special projections but they are often diagnostically insufficient and HRCT outweighs these investigations and provides higher spatial resolution and better soft tissue contrast. Computed tomography is clearly superior in the imaging trauma, congenital anomalies, neoplasms and infections of temporal bone.

In this study, 100 patients were evaluated for their various symptoms pertaining to temporal bone. Temporal bone pathologies were more common in males with male: female ratio of 3:2 (Table 1) which correlates with the study of Paparella and Kim in 1977 [3]. And most pathology was seen in 21- 30 age group with age distribution as shown in Table 3. This correlated well with Gupta *et al.;* study in 1998 [4]. The inflammatory diseases (78%) were the most common pathology, cholesteatoma being the most common followed by otomastoididtis. In otitis media and mastoiditis, there is pathological fluid or soft tissue accumulation within the middle ear and mastoid cavity, possibly with several fluid levels. In coalescent mastoiditis, there is erosion of the mastoid septations with associated development of intramastoid empyema. And hallmark of cholesteatoma on CT was a non-dependent, homogenous, soft tissue mass in the middle ear cavity with bony erosion. HRCT can accurately depict the exact extent of soft tissue mass including hidden areas of middle ear (like posterior recess, facial recess, and prussak space), ossicular disruption, bony erosion, involvement of facial canal, and spatial relationship of mass to lateral semi-circular canal [5-7].

Identifation of cholesteatoma masses adjacent to the lateral semicircular canal threaten the possibility of a closed fistula and influence the operative approach as the fistula may be opened during surgical procedures, which may lead to serious complications [8]. Cholesteatoma in our study was soft tissue mass (100 %) with bony erosion – ossicular and scutum erosion being the most common followed by erosion of sigmoid sinus plate, tegmen tympani, facial canal and lateral semicircular canal in that order. In addition it shows high sensitivity in detection of the intracranial complications of infection. An empty delta sign- a filling defect within the dural sinus on CECT study clinches the diagnosis of dural sinus thrombosis. Whereas cerebral or cerebellar abscess is seen as a thick walled, ring enhancing lesion. However a close clinical correlation is essential to evaluate the nature of middle-ear soft tissue masses as cholesteatoma is mimicked by many other middle-ear pathologies and HRCT cannot characterize the lesion as cholesteatoma unless there is bone erosion associated with soft tissue mass. It also depicts certain normal variants of surgical significance preoperatively.

CT showed high sensitivity and specificity not only in detection of fractures but also in their classification into longitudinal, transverse and combined fractures. In Longitudinal fractures, the fracture line is parallel to the longitudinal axis of the petrous portion of the temporal bone whereas in transverse fractures, fracture line is perpendicular to the petrous pyramid. Longitudinal fractures formed the most common type in our study with equal incidences of Transverse and combined type.

In addition to this, HRCT could give information about Ossicular disarticulation, facial canal and labyrinthine injury which has prognostic and surgical implications. Such information matched with Fritz *et al.;* in 1987 study which states that, in the case of CSF fluid loss, the exact identification of the fracture line determines the operative approach [8]. The demonstration of a fracture through the facial canal facilitates the decision to undertake a decompression operation which might preserve function. Radiological evidence of Ossicular disruption will be the deciding factor in planning an Ossicular chain reconstructive operation in a case of posttraumatic conductive hearing loss. Radiological evidence of labyrinthine damage determines the prognosis of post-traumatic sensorineural hearing loss. Facial canal injury, ossicular chain dislocation and injuries of the inner ear can be visualized way better by CT than conventional radiography. Out of the 12 cases of trauma in our study, 8 cases presented with Conductive hearing loss and 1 case presented with SNHL. Conductive hearing loss could be due to tympanic membrane rupture, Haemotympanum or ossicular disruption. Out of 8 cases of conductive hearing loss, 4 cases were due to ossicular disarticulation out of which 3 cases were due to incudo-stapedial separation which was seen as increased gap between stapedial process of incus and head of stapes. The other case was due to incudo-malleolar separation which was seen as a gap between the head of the malleus("ice cream") and the body and short process of the incus ("ice cream cone"). The one case of SNHL was associated with longitudinal fracture, causing labyrinthine damage [9]. Facial nerve injury was more commonly associated with combined fracture (3 cases) followed by transverse fracture (1 case).

HRCT is not only superior in detection of soft tissue tumour but also helps in determination of exact extent of mass, bone erosion, its characterization with the help of plain and contrast enhancement scans and staging as it precisely defines the intratympanic, mastoid, jugular wall, infra-labyrinthine and petrous apical involvement as well as posterior, middle and infra-temporal fossa extension. HRCT provides essential information for planning the surgical approach. However, HRCT can predict but cannot clinch the histo-pathological diagnosis.

In our study, benign neoplasms (5 cases) were more common than malignant neoplasms (1 case). Acoustic schwannoma was the most common neoplasm which on CT appeared as iso-hypodense lesions, based on internal auditory canal (an ice-cream cone appearance) with widening of IAC. Schwannomas showed homogenous to heterogeneous enhancement on contrast study. Next common neoplasm was glomus tumour (2 cases), one case of glomus jugulare which on CT appeared as jugular foramen mass with irregular rim of jugular fossa and other of glomus jugulo-tympanicum which appeared as an expansile, intensely enhancing mass centered on jugular foramen with extensive destruction of left temporal bone with extension of mass in middle and external ear, internal auditory canal, petrous apex, skull base and intracranially into posterior cranial fossa in left CPA. One case of infiltrating lesion of petrous apex was seen which proved to be a secondary deposit from lung ca.

The main role of imaging in congenital anomalies is to identify the type of anomaly and determine the surgical correct ability [10]. If surgical correction of EAC atresia is to be done to improve hearing, normal inner ear structures and adequate middle ear cleft are necessary. It is important to evaluate the thickness of atresia plate, associated ossicular abnormalities, status of middle ear cleft, and status of inner ear, course of facial nerve canal and position of sigmoid sinus and mastoid pneumatisation which is accurately depicted on HRCT [10]. In our study, congenital anomalies of the external and middle ear (3 cases) were common than inner ear anomalies (1 case). The most common external auditory canal (EAC) anomaly was its atresia which was bony atresia in 2 cases and soft tissue atresia in 1 case [11-13]. Ossicular chain abnormalities were seen in association with EAC atresia in all the three cases [11, 12]. The present study correlated well with findings of Swartz *et al.;* [14].Only one case of congenital anomaly of inner ear was noted in our study which showed mildly dilated vestibule and wide, stunted lateral semicircular canal.

REPRESENTATIVE CASES

CEREBELLAR ABSCESS- COMPLICATED OTOMASTOIDITIS

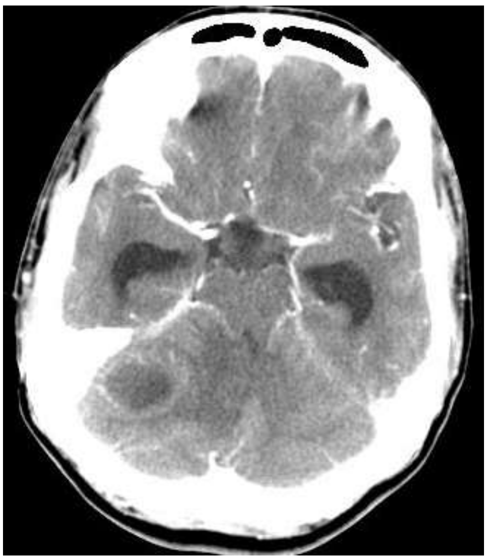


Fig-1A: CE Axial CT scan – Rim enhancing cerebellar abscess.

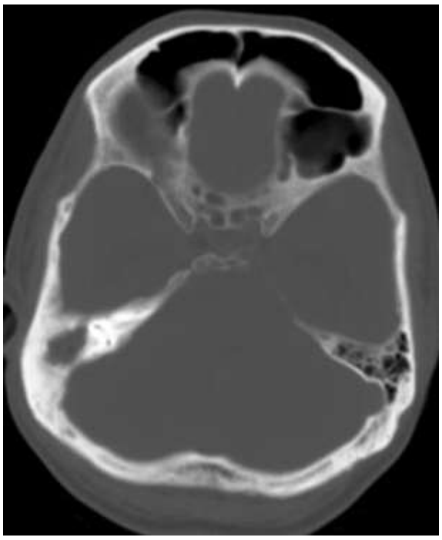


Fig-1B: Axial CT bone window- Soft tissue mass filling mastoid antrum with erosion of bone and ossicles.

COMPLICATED OTOMASTOIDIDS WITH EXTENSION TO MIDDLE AND POSTERIOR CRANIAL FOSSA

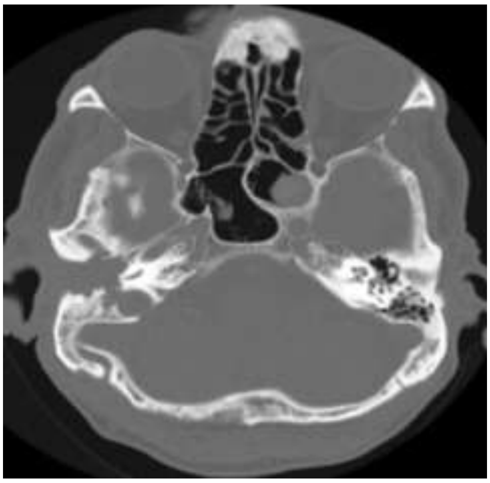


Fig-2: Axial CT scan – Bone window showing erosion of bone with extension to middle and posterior cranial fossa.

ACOUSTIC NEUROMMA

Fig-3A: Axial CT section – heterogeneously enhancing CPA angle mass with ice cream cone appearance

Fig-3B: Axial CT section - Hydrocephalus

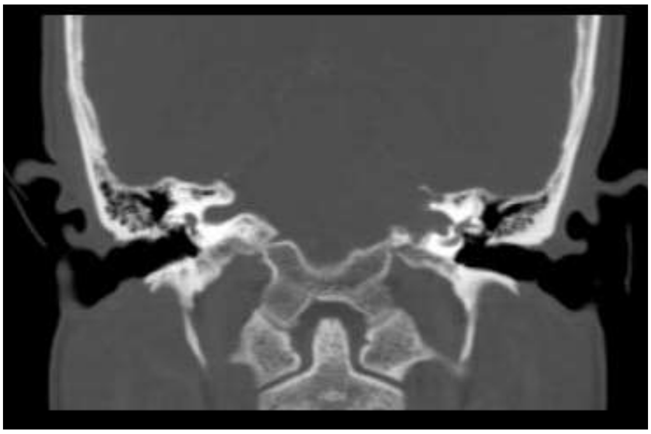
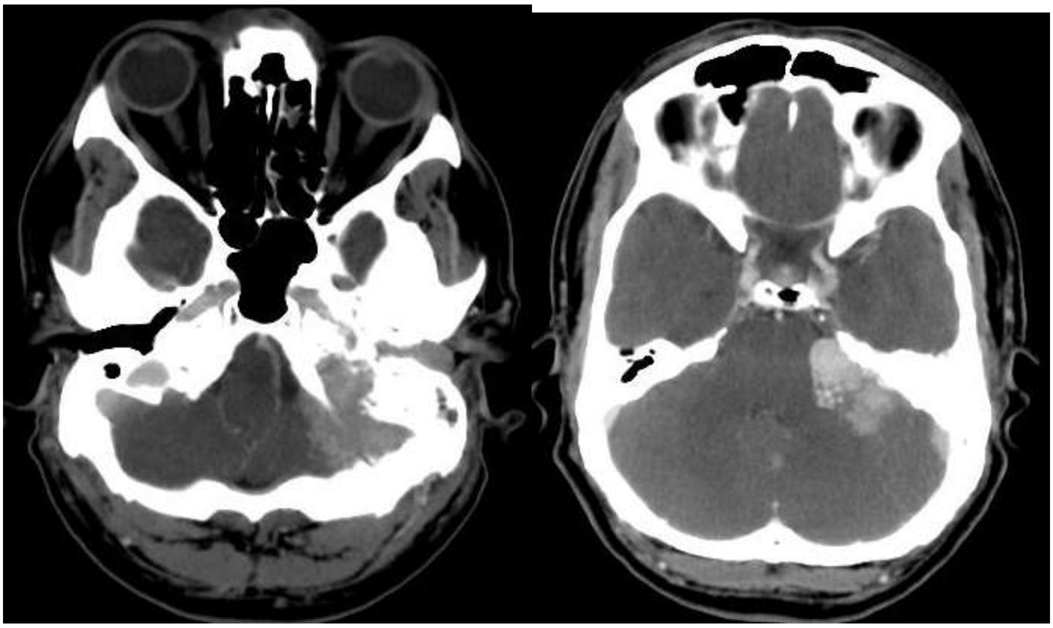


Fig-3C: Coronal section – widened and eroded left IA

GLOMUS JUGULOTYMPANICUM



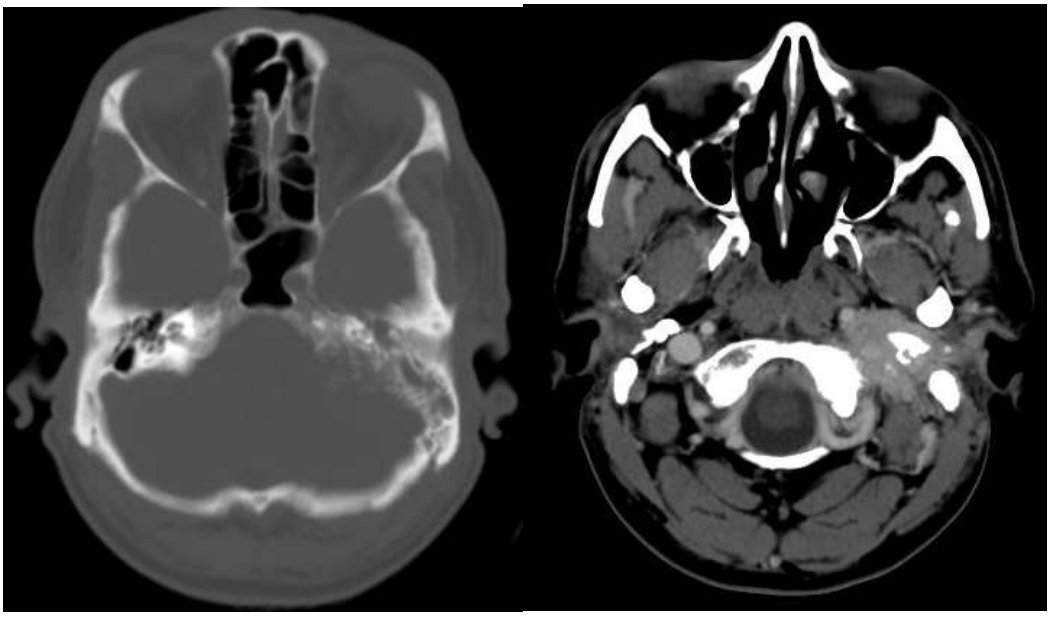


Fig-4: Axial CT scans – Enhancing soft tissue density mass in left jugular fossa with intra-labyrinthine, intracranial (CP angle) extension and erosion of left petrous ridge.

CONGENITAL ANOMALY

Fig-5A: Coronal Reconstructed CT scan - Left sided complete EAC atresia.

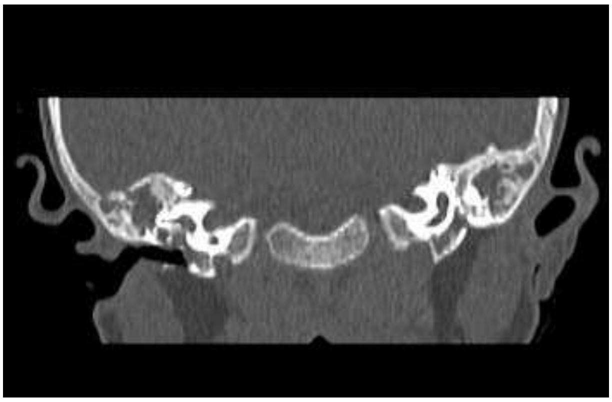


Fig-5B: Axial CT scan – Rudimentary ossicles

TEMPORAL BONE TRAUMA WITH COMPLEX FRACTURE

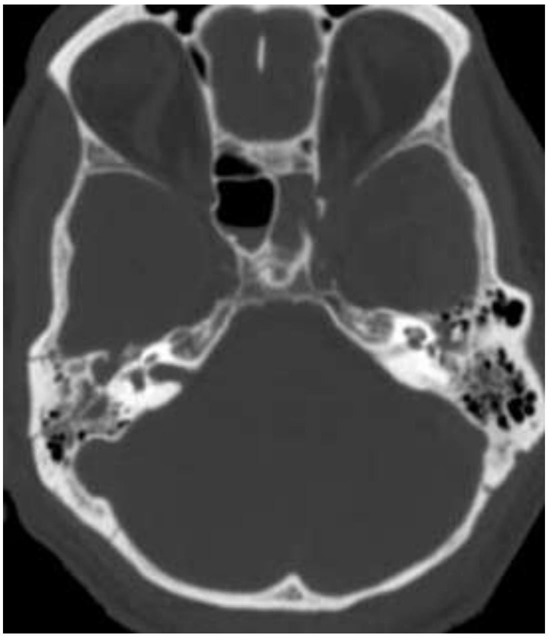


Fig-6A: Axial scan - Longitudinal fracture of right petrous bone.

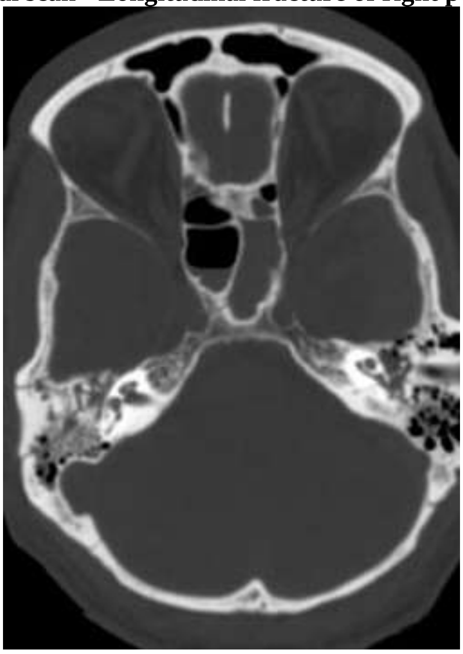


Fig-6B: Axial scan - Ossicular disarticulation due to fracture.

CONCLUSION

There are a variety of other imaging modalities to image temporal bone. The purpose of this study was to develop a systematic method for evaluation of temporal bone. Radiological imaging of the petrous bone must meet high standards of topographic representation and spatial resolution. The visualization of small bony structures, lowest radiation dose to the lens, technical factors, interpretation of the images and economic factors were all considered. HRCT outweighs the conventional modalities of investigations and provides higher spatial resolution and better soft tissue contrast. Computed tomography is clearly superior in the imaging trauma, congenital anomalies, neoplasms and infections of temporal bone.

REFERENCES

1. Virapongse C, Rothman SL, Kier EL, Sarwar M. Computed tomographic anatomy of the temporal bone. American Journal of Neuroradiology. 1982 Jul 1; 3(4):379-89.
2. Shaffer KA, Haughton VM, Wilson CR. High resolution computed tomography of the temporal bone. Radiology. 1980 Feb; 134(2):409-14.
3. Paparella MM, Kim CS. Mastoidectomy, Larangoscope, 1977: 87:1977-88.
4. Gupta V, Gupta A, Sivarajan K. Chronic

suppurative otitis media: an aerobic microbiological study. Indian journal of otology. 1998; 4(2):79-82.
5. Baráth K, Huber AM, Stämpfli P, Varga Z, Kollias S. Neuroradiology of cholesteatomas. American Journal of Neuroradiology. 2011 Feb 1; 32(2):221-9.
6. Anbarasu A, Chandrasekaran K, Balakrishnan S. Soft tissue attenuation in middle ear on HRCT: Pictorial review. The Indian journal of radiology & imaging. 2012 Oct; 22(4):298.
7. Valvassori GE. Benign tumors of the temporal bone. RadiolClin North Am 1974; 12:533-42.
8. Fritz P, Rieden K, Lenarz T, Haels J, Winkel KZ. Radiological evaluation of temporal bone disease: high-resolution computed tomography versus conventional X-ray diagnosis. The British journal of radiology. 1989 Feb; 62(734):107-13.
9. Swartz JD, Zwillenberg S, Berger AS. Acquired disruptions of the incudostapedial articulation: diagnosis with CT. Radiology. 1989 Jun; 171(3):779-81.
10. Eelkema EA, Curtin HD. Congenital anomalies of the temporal bone. InSeminars in ultrasound, CT, and MR 1989 Jun (Vol. 10, No. 3, pp. 195-212).
11. Phelps PD, Lloyd GA, Sheldon PW. Congenital deformities of the middle and external ear. The British journal of radiology. 1977 Oct; 50(598):714-27.
12. Swartz JD, Faerber EN. Congenital malformations of the external and middle ear: high-resolution CT findings of surgical import. American journal of roentgenology. 1985 Mar 1; 144(3):501-6.
13. Chakeres DW, Kapila AS, LaMasters D. Soft-tissue abnormalities of the external auditory canal: subject review of CT findings. Radiology. 1985 Jul; 156(1):105-9.
14. Swartz JD, Glazer AU, Faerber EN, Capitanio MA, Popky GL. Congenital middle-ear deafness: CT study. Radiology. 1986 Apr; 159(1):187-90.
15. Teunissen EB, Cremers WR. Classification of congenital middle ear anomalies report on 144 ears. Annals of Otology, Rhinology & Laryngology. 1993 Aug; 102(8):606-12.