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Original Article

High-resolution Computed Tomography Study of Temporal Bone Pathologies

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Abstract

Introduction: The application of high-resolution computed tomography (HRCT) in the temporal bone study has allowed the detailed assessment of complex bony anatomy and pathology. HRCT temporal bone accurately depicts bony erosion or destruction and associated soft tissue pathology. The purpose of this study is to determine the role and efficacy of HRCT temporal bone in evaluation of congenital, inflammatory, traumatic, and neoplastic conditions. This was the cross-sectional prospective study of 1½ year's duration.

Aims and Objectives: To evaluate the congenital, inflammatory, traumatic, and neoplastic conditions of the temporal bone with the help of HRCT.

Materials and Methods: This was cross-sectional prospective study conducted at RKDF Medical College between December 2014 to March 2016. A total of 120 patients of varied age group presenting with symptoms and signs of temporal bone pathologies were included in the study. Imaging diagnosis was confirmed either by histopathology or follow-up and response to treatment.

Results: In our study, temporal bone pathologies were more common in male (66.66%) compare to female population (33.33%). The most common age group affected by the temporal bone pathologies was 11-20 years age group (38.33%) and least common age group was more than 60 years (<4%). The most common temporal bone pathologies in our study were inflammatory (50%) followed by traumatic (11.66), benign neoplasm (10%), congenital (6.66), and malignant neoplasm (5%). Approximately, 16.66% cases of HRCT temporal bone study revealed no abnormality. Most common inflammatory pathology in our study was cholesteatoma (73.3%) followed by otomastoiditis/otitis externa constitute (26.66%). Out of 14 traumatic cases of temporal bone, 57.14% cases were associated with intracranial injuries in our study. Out of 18 cases of neoplastic pathology, 66.66% of cases were benign and 33.33% were malignant etiology.

Conclusion: HRCT scan of temporal bone depicts complex bony details and associated soft tissue pathologies accurately. Due to various limitations of clinical examination and radiography, HRCT temporal bone is single most important imaging tool for pre-operative evaluation and management of various pathologies of the temporal bone.

Key words: High-resolution computed tomography, Histopathological diagnosis, Temporal bone

INTRODUCTION

The temporal bone is a complex anatomic structure that contains the organs of hearing and balance. In addition, major vessels and nerves course through it and it also has a close proximity to the brain. Temporal bone has direct contact with brainstem, cerebellum and temporal lobe of brain. Before computed tomography (CT) imaging modalities available for the evaluation of temporal bone were plain radiograph, polytomography, angiography, and cisternography. Plain radiograph remains inexpensive tool of the study of temporal bone but has major limitations due to complex anatomy and overlapping of various bony structures.

High-resolution computed tomography (HRCT) offers excellent spatial and density resolution using special algorithms. It provides information not only about bony outline but also soft tissue changes making it possible to demonstrate the location and extent of disease as well as its complications. Furthermore, coronal and axial CT scanning together has dramatically improved the imaging of temporal bone. HRCT accurately depicts the boundaries between the external, middle and inner

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ear cavities thereby localized the disease precisely and also greatly demarcate thin boundary between temporal bone and intracranial compartment with exact details of intracranial spread of primary temporal bone disease. Contrast media help to evaluate the vascularity and contrast enhancing characteristics particularly in soft tissue lesions of temporal bone giving clues to the histopathology.

Aims and objective of this study is to evaluate the congenital, inflammatory, traumatic, and neoplastic conditions affecting the temporal bone with the help of HRCT.

MATERIALS AND METHODS

The present prospective study was conducted at RKDF Medical College, Bhopal, Madhya Pradesh from December 2014 to March 2016.

Study Area

The study area includes Bhopal city and district with peripheral small towns/villages.

Study Population

A total of 120 patients of varied age group presenting with symptoms and signs of temporal bone diseases were included in the study.

Inclusion Criteria

- Patients referred for HRCT, who were suspected to have of temporal bone pathology.

Exclusion Criteria

Post-operative cases of temporal bone pathology.

Equipment Used

Spiral CT, Siemens Somatom, Siemens Medical Systems, Forchiem, Germany.

HRCT was done using thin section, high-resolution and bone algorithm technique. Sections in both axial and coronal planes were obtained. Coronal imaging was done by neck extension and prone position and axial imaging done in supine and neutral position of the neck. Iodine Based contrast used mainly in the neoplastic pathologies. Final imaging diagnosis correlated with histopathological confirmation or follow-up and treatment response.

OBSERVATIONS AND RESULTS

HRCT scan was performed in 120 patients who presented with history, symptoms, and signs of the temporal bone pathologies. The results are enumerated in Tables 1-8.

Table 1: Gender distribution

Gender	Number of cases (%)
Female	40 (33.33)
Male	80 (66.66)
Grand total	120 (100)

Table 2: Clinical presentation

Sign and symptoms	Number of cases (%)
Deafness	78 (65.00)
Otorrhoea	70 (58.33)
Headache	32 (26.66)
Otalgia	48 (40.00)
Fever	16 (13.33)
Vertigo	20 (16.66)
Fascial nerve palsy	12 (10.00)
Ataxia	4 (3.33)
Tinnitus	12 (10.00)
Ear bleed	8 (6.66)

Table 3: Age distribution

Age distribution	Number of cases (%)
1-10	14 (11.66)
11-20	46 (38.33)
21-30	18 (15.00)
31-40	16 (13.33)
41-50	12 (10.00)
51-60	10 (8.33)
61 and above	4 (3.33)
Total	120

Table 4: Etiopathological distribution of cases

Etiology	Number of cases (%)
Inflammatory	60 (50)
Traumatic	14 (11.66)
Congenital	8 (6.66)
Benign	12 (10)
Malignant	6 (5.0)
Normal	20 (16.66)
Grand total	120 (100)

Table 5: Distribution of various lesions

Pathology	Number of cases
Congenital malformation	
External and middle ear anomalies	6
Inner ear abnormalities	2
Temporal bone fractures	14
Inflammatory process	
Otitis externa	3
Malignant otitis externa	1
Otomastoiditis	12
Cholesteatoma	
Congenital	2
Acquired	42
Neoplasm	
Benign	12
Malignant	6

Table 6: Distribution of external and middle ear anomalies

HRCT findings	Number of cases (%)
Bony atresia	4 (66.66)
Soft tissue atresia	2 (33.33)
Ossicular deformity	4 (66.66)
Thick atresia plate	4 (66.66)
Small tympanic cavity	4 (66.66)
Fascial canal	2 (33.33)
Inner ear anomaly	2 (33.33)

HRCT: High-resolution computed tomography

Table 7: Distribution of CT findings in temporal bone fracture

CT findings	Number of cases (%)
Longitudinal fracture	10 (71.42)
Transverse fracture	2 (14.28)
Complex fracture	2 (14.28)
Haemotympanum	10 (71.42)
Ossicular disruption	4 (28.57)
Labyrinthine injury	2 (14.28)
Fascial nerve canal injury	2 (14.28)
Intracranial injury	8 (57.14)

CT: Computed tomography

Table 8: CT features of cholesteatoma

CT findings	Number of cases (%)
Soft tissue lesion	42 (100)
Ossicular and scutum erosion	40 (95.23)
Erosion of tympanic wall	38 (90.47)
Erosion of sigmoid sinus plate	18 (42.85)
Opacified mastoid	24 (57.14)
Erosion of lateral semicircular canal	8 (19.04)
Erosion of tegmen tympanii	8 (19.04)
Erosion of vestibule and fascial canal	4 (9.52)

CT: Computed tomography

Table 9: Various complications of cholesteatoma

Complications	Number of cases (%)
Brain abscess	18 (42.85)
Post auricular abscess	8 (19.04)
Dural sinus thrombosis	6 (14.28)
Meningitis	4 (9.52)

Table 10: Distribution of neoplastic lesions

Neoplasm	Number of cases
Acoustic neuroma	6
Glomus tumor	3
Epidermoid	2
Osteoma	1
Primary carcinoma	4
Secondary metastasis	2

DISCUSSION

The varied temporal bone pathologies including congenital, inflammatory, traumatic, and neoplastic conditions were evaluated by HRCT. The lack of specificity in clinical examination and the imprecise result of conventional radiography renders CT as the modality of choice in the evaluation of temporal bone pathology.

In this study, 120 patients were evaluated for their various symptoms pertaining to PNS. The gender ratio in this study was 2:1 (male:female) (Table 1). A maximum number of patients presented with the chief complaints of hearing problem or deafness (65%) followed by otorrhea (58%) (Table 2). Other chief complaints were otalgia, vertigo, tinnitus, ataxia, and fascial nerve palsy. Patients with intracranial complications had headache, fever, vomiting in addition to above complaints. The most common age group involved was 11-20 years (38%) and least common age group was 61 and above comprising (3%) of total cases (Table 3).

The etiologic distribution of the lesions was inflammatory (50%) followed by traumatic (11.6%), benign (10%), congenital (6.6%), and malignant (5%) (Table 4). Thus, the inflammatory disease was found to be the most frequently occurring pathology affecting the temporal bone. Inflammatory pathologies were common in younger age group (<30 years) and neoplastic pathologies were common in older age group (>50 years). Traumatic conditions equally distributed in all age group. Congenital disease frequently diagnosed in <10 years of age group.

Congenital malformation of the external and middle ear is more common than inner ear anomalies. Atresia or hypoplasia of the external auditory canal (EAC) is most common anomaly detected in our study.[1,2] The degree of distortion range from web to small band of soft tissue covering EAC to complete absence.[3] Ossicular chain abnormalities are commonly found in association with external meatal atresia.[1,2] Isolated ossicular chain anomalies are less common.[4] The main role of HRCT in atresia of HRCT to identify the type of anomaly and determine the surgical correctability.[5] 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, status of inner ear, course of fascial nerve canal and position of sigmoid sinus and mastoid pneumatisation.[6] In our study, we came across 6 cases of external and middle ear anomaly, out of 6, four cases had unilateral EAC atresia and two cases had bilateral atresia. In two cases, there was soft tissue atresia and in four cases bony atresia

was found. Ossicular deformities and thick atresia plate were present in 4 cases and in 2 cases anteriorly placed descending fascial canal was found. The present study correlated well with findings of Swartz *et al*.[4] Congenital anomalies of inner ear are relatively uncommon compare to middle and external ear anomalies. In this study, 2 cases (33.33%) of inner ear anomalies were detected on HRCT temporal bone. One case was unilateral enlarged vestibular aqueduct (EVA) or large vestibular aqueduct syndrome (LVAS) and the second case was bilateral EVA or LVAS with associated unilateral mondini dysplasia or also known as incomplete partition type II characterized by cystic cochlear apex with the normal basal turn. EVA has been reported to be the most common inner ear abnormality associated with sensorineural hearing loss and is also commonly associated with other inner ear abnormalities.[7]

Temporal bone fractures may be longitudinal, transverse or complex. Longitudinal fractures are common and comprise 70-90% of all temporal bone fractures.[8] In our study, 71.42% of cases had the longitudinal type of temporal bone fractures. These type of fractures extend across roof or posterior wall of EAC into tympanic cavity and lead to rupture of the tympanic membrane with hemotympanum.[8,9] Ossicular chain disruption is a common cause leading to hearing loss and incus is most vulnerable for dislocation due to lack of muscular anchor.[10] Fascial nerve palsy occurs in 10-20% of cases and usually delayed and incomplete. A common site for fascial nerve injury is horizontal segment.[10] Transverse fractures are less common and usually associated with temporomandibular joint or mandibular injury and fascial paralysis is more common in the transverse fractures.[10] In our study of two cases of fascial nerve palsy one case (10%) was seen associated with longitudinal fracture and the second case (50%) was seen in a transverse fracture of temporal bone. We studied 10 cases (71.42%) of longitudinal, 2 cases (14.28%) of transverse and 2 cases (14.2%) of complex type of temporal bone fractures. Labyrinth injury involving destruction of the vestibule-cochlear complex is more common in transverse fracture and resulting into sensorineural hearing loss, vertigo, nystagmus and pneumolabryinth.[10,11] In our study, out of two cases of labyrinth injury, one case was associated with transverse and the second case was associated with complex temporal bone fractures.

Otoscopic evaluation alone is usually sufficient to study external ear but HRCT temporal bone needed to rule out osteomyelitis, otomastoiditis or malignant otitis externa. In present study, one patient was found to have malignant otitis externa with soft tissue in EAC causing bony destruction and associated edematous pinna and subcutaneous tissue of the scalp.[12] Three cases of isolated otitis externa with opacified EAC and no bony erosion or destruction included in our study. Acute otitis media seen as middle ear opacification and concomitant mastoiditis seen as opacification or air fluid level in mastoid cavity on HRCT temporal bone.[13,14] Coalescent otitis media seen as resorption and destruction of mastoid bony septii with the irregular mastoid cavity and it can penetrate through bony cortex to form subperiosteal abscess or break at the tip of mastoid bone to form abscess in the neck.[15] In this study, we included 12 cases of otomastoiditis without cholesteatoma. Out of 12 cases of otomastoiditis 8 cases were without significant bony destruction or resorption and 4 cases were with resorption of bony septii and irregular mastoid cavity. 2 out of 4 cases of coalescent otomastoiditis were associated with subperiosteal abscess formation.

Cholesteatoma is the misnomer, it's not true neoplasm but sac of stratified squamous epithelium filled with exfoliated keratin and subepithelial fibrous stroma producing proteolytic enzyme which in turn causes bone resorption.[16-18] Congenital cholesteatoma accounts for 2% of cases.[16] In our study, out of 44 cases of cholesteatoma, 2 cases were of congenital cholesteatoma. Cholesteatoma found behind the tympanic membrane in the patient with no history of otitis media is considered congenital. These lesions can erode internal auditory meatus and semicircular canal leading to hearing loss.[19] In our study, one case of congenital cholesteatoma was present as a cystic lesion in the petrous apex with the destruction of internal auditory canal and the second case of congenital cholesteatoma present as small soft tissue lesion without bony destruction. Acquired cholesteatoma divided into two types primary arising from the pars flaccid and secondary arising from pars tensa. Pars flaccid cholesteatoma arising from the prussak space of epitympanum and extend into mastoid antrum with erosion of bony scutum.[16,17] Pars tensa cholesteatoma arises from posterosuperior retraction of tympanic membrane and spread into surrounding recesses. Cholesteatoma is most frequent soft tissue mass in the middle ear.[20] Expansion and scalloping of mastoid, erosion of lateral attic wall, erosion of the ossicles, tegmen tympani, sigmoid sinus plate, posterosuperior wall of EAC, labyrinth, and fascial nerve canal are signs indicating the presence of cholesteatoma.[17-20] Pre-operative CT scan is helpful in relation to diagnosis and decision making for surgery in cases of cholesteatoma and ossicular erosion.[21] In this study, the most common CT findings in the cholesteatoma was ossicular and scutum erosion (95%) followed by erosion of tympanic wall (90%), opacified mastoid (57%), erosion of sigmoid plate (42%), erosion of lateral semicircular canal wall and tegmen tympanii (19%) and erosion of vestibule and fascial canal (9.5%).

Cholesteatoma may be associated with extratemporal and intracranial complications, and almost all the complications are usually secondary to bone destruction and infected cholesteatoma.[22] Most common complications in our study (Table 9) in descending order are brain abscess (42%), post auricular abscess (19%), dural sinus thrombosis (14.2%), and meningitis (9%). Similar findings were observed in the Mafee *et al.,*[14] Bradley *et al*.,[23] and Sennaroglu *et al.*[24] study.

In this study, 18 cases of neoplastic pathology are included out of which 12 cases are benign tumors and 6 cases are malignant tumors (Table 10). Most common benign tumor in our study was acoustic neuroma[19] found in 6 (50%) out of 12 cases of benign tumors and presented as solid cystic mass at the CP angle extending into the internal auditory canal with its widening, invariably detected in all cases on HRCT study. Two known cases of NF2 with bilateral acoustic neuroma are included in our study. Glomus tumor is second most common tumor in our study.[25] They are commonly divided into glomus jugulare develop at jugular fossa, glomus tympanicum develop at middle ear, carotid body tumor and glomus vagale. In our study, one case of glomus tympanicum presented as small enhancing soft tissue mass in middle ear at cochlear promontory without bony destruction and three cases of glomus jugulare causing bony destruction of jugular fossa and invasion of hypotympanum with significant contrast enhancement are included.[25] Two cases of epidermoid tumor in our study appeared as CSF density lesions at CP angles on HRCT with variable degree extension into internal auditory meatus and no bony destruction or widening.[26] One case of osteoma detected in our study presented as postauricular hard mass and on HRCT broad based bone density lesion arising from the outer cortex of mastoid. Primary malignant neoplasm of ear are relatively uncommon and seen in older age group. Most common malignant neoplasm is squamous cell carcinoma (Ca) and in our study all the 4 cases of primary malignant neoplasm were squamous Ca.[27] HRCT detected soft tissue mass in EAC causing bony erosion and destruction with variable degree extension into middle and inner ear and surrounding extra temporal soft tissue.[27] Two cases of secondary bony deposits into mastoid and petrous part of temporal bones are included, in our study, seen in Ca breast and lung patients.

CONCLUSION

HRCT scan of temporal bone depicts complex bony details and associated soft tissue pathologies accurately. Due to various limitations of clinical examination and radiography, it is not possible to differentiate various pathologies affecting the temporal bone and study their extent. HRCT temporal bone overcome with all these limitations and its single most important imaging tool to evaluate various congenital, inflammatory, traumatic, and neoplastic pathologies of the temporal bone. Now HRCT temporal bone is standard imaging modality for pre-operative evaluation and management of various pathologies of the temporal bone.

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