ORIGINAL RESEARCH ARTICLE

Role of HRCT as a Prime Diagnostic Modality in Evaluation of Temporal Bone Pathologies

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ABSTRACT

Introduction: High resolution computed tomography (HRCT) in temporal bone precisely delineates the bony structures as well as the soft tissue component.It provides excellent window for delineating pathologies of temporal bone. The main aim of this study was to assess the findings of temporal bone involvement in different inflammatory,traumatic, and neoplastic conditions of the surrounding structures and, wherever possible, to correlate various HRCT findings with surgery and/or histopathology.
Material and methods: HRCT of 100 patients after local examination, clinical evaluation and proper consent were evaluated in the study and relevant statistical analyses were drawn out. All the patients who underwent HRCT temporal bone presented with clinical signs and symptoms of external,middle and inner ear pathologies, congenital anomalies and trauma were included in the study. While exclusion criteria included, Patients of age <1 or >80 years and those with cochlear implants.
Results: In our study of 100 patients 60 cases were inflammatory, 20 cases were traumatic, 8 cases were neoplastic and 4 were congenital malformations. Out of 60 cases of infective etiology, 30 were of otomastoiditis/CSOM, 25 were of cholesteatoma and 5 were of otitis externa. Sensitivity, specificity,Positive predictive value (PPV) and negative predictive values (NPV) were calculated for all the etiologies and structures involved in different disease processes as shown in tabulated form in table 3.
Conclusion: HRCT is the modality of choice in evaluation of the temporal bone which is a relatively inaccessible area of the human anatomy. It dictates proper medical treatment or timely surgery that can prevent further serious complications.

Keywords: High Resolution Computed Tomography, Temporal Bone, Cholesteatoma, Mastoiditis

INTRODUCTION

In 1980, the development of HRCT revolutionized the imaging of temporal bone. It gives the highest structural definition of minute structures amongst currently available imaging modalities. Earlier,the diagnosis of temporal bone pathologies was primarily made according to clinical features. However, due to increase in the incidence of infective diseases of the ear, it was considered that the existing approach to prevent and treat the situation was not up to the mark. So, primarily in complicated and recurrent situations, imaging carries a crucial role, as imaging results may fundamentally affect the treatment.[1]

High resolution computed tomography is an alteration of routine CT. It provides a direct and precise visual window of the temporal bone and enables to visualize minute structural information related to anatomy and physiology of temporal bone. It has the advantage of giving excellent topographic observations, devoid of superimposition from structures. It enables an excellent evaluation of pathology before surgical intervention with respect to the location, degree and complications of the Disorder.[2]

The available imaging modalities for temporal bone analysis are plain radiographs,multidirectional tomography, angiography, CT and MRI. Plain Xray is a relatively cheaper method to evaluate temporal bone, but often results in an inaccurate or incorrect diagnosis.[3] Multidirectional tomography provides good bony details but lacks in precise soft tissues delineation. Also, chances of radiation exposure to the eye lens increases. Angiography is considered as the gold standard to study the vascular lesions but is invasive with increased risk of complications.[3] HRCT is better in evaluating air spaces and cortical bones while MRI is preferred for evaluation of soft tissue anatomy and vascular lesions. So, HRCT and MRI may be complimentary to each other in some cases.[4]

The aim of the present study was to evaluate Role of High Resolution Computed Tomography in Temporal Bone Diseases and correlate HRCT image based findings with the operative and pathological findings

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to determine the accuracy of HRCT findings wherever possible.

MATERIALS AND METHODS

A prospective study of 100 cases was done in the Radio diagnosis department of Kalinga institute of medical sciences, Bhubaneswar. The ethical committee clearance and patients' consent were taken for research purpose. All the patients who underwent HRCT temporal bone presented with clinical signs and symptoms of external,middle and inner ear pathologies, congenital anomalies and trauma were included in the study. While exclusion criteria included Patients of age <1 or >80 years and those with cochlear implants. A relevant clinical history and proper clinical examination of the patients were done prior to HRCT of temporal bone and whenever necessary CECT of brain was done.

T scan was performed as follows; Evaluation was done with Multi detector High Resolution Computed Tomography (G E health care, optima CT 660, 64 slices). Thin sections (0.625mm) in axial planes were obtained. 140 kV voltage and 300 mAs current were used. Images were reconstructed in high frequency bone algorithm. The plane of scan was kept parallel to infraorbitomeatal line in order to minimise radiation to lens. In order to study the Hypervascular lesions like glomus tumours, Cerebellopontine angle masses and Intracranial or extra cranial extension of middle ear disease, intravenous contrast was administered. For contrast enhancement, a bolus injection of Iopamidol was given in the dose of 300mg lodine/ml (1.5-2ml/kg of body weight). This was given just before the contrast enhanced CT was to be performed. Children (less than 6 years of age) usually required sedation 30 minutes prior to performing the scan in order to avoid motion artifact and to ensure a good quality of scan. Documentation was done on 14 x 17" films. Patients were followed up and their operative and/ or histopathological findings were correlated wherever possible and required. All the data obtained during the research was documentated in a tabulated form and analysed.

RESULTS

100 patients comprising of both males and females who underwent HRCT temporal bone were included in the study and relevant statistics were drawn from these cases. Our study showed male predominance having male to female ratio as 2:1. Most of the patients were from 3rd decade followed by 4th decade. Left side was predominantly affected in our study. Main clinical signs and symptoms were Hearing loss(30%), Ear discharge (75%), Ear pain (40%), Head ache (50%) and Facial nerve weakness(8%).The distribution of cases according to the etiology is shown in Table - 1. 60 cases out of the total 100 cases were of infective etiology making it the most common etiology involving the temporal bones. Out of 60 infective cases 25 cases were of cholesteatoma, 30 were of otomastoiditis/CSOM, and 5 were of otitis externa. A total of 20 patients of traumatic etiology were seen who had fractures of temporal bone. Out of these 20 patients 5 had longitudinal fracture, 9 had transverse fracture and 6 had mixed fractures. Total 7 patients who were diagnosed having neoplastic etiology are shown in table 1. In the current study 4 patients had symptomatic congenital anomalies which included 2 cases of microtia with EAC atresia (Fig-1a), 1 with anomalous facial nerve and 1 with fused ossicles.

Table 2 shows structures involved in cholesteatoma and trauma.Out of 30 cases of cholesteatoma 13 patients were found with ossicular erosion, 8 with facial nerve involvement, 7 with tegmen tympani erosion and 5 with lateral SCC erosion (Fig-2a). Similarly, structures involved in traumatic cases were also included in table 2. Various findings associated with temporal bone trauma on HRCT showed 16 cases of Hemotympanum, 3 cases of hemosinus, 7 cases with facial nerve involvement, 2 cases of Intracranial involvement, 1case with ossicular involvement and 3 cases with tegmen tympani

Etiology		No. of cases (100)	
Infective	Oto-mastoiditis/CSOM	30	60
	Cholesteatoma	25	
	Otitis externa	5	
Traumatic	Longitudinal	5	20
	Transverse	9	
	Mixed	6	
Neoplastic	Glomus tumor	2	8
	Acoustic neuroma	1	
	Squamous cell Ca.	1	
	Metastasis	1	
	EAC osteoma	2	
	Meningioma	1	
Congenital	Ossicular abnormality	1	4
	Microtia with EAC atresia	2	
	Anomalous facial nerve	1	
Anatomicalvariations	High riding jugular bulb	6	6
Normal (excluding anatomical variations)		2	2
Total		100	

Table-1- Distribution of cases according to etiology.

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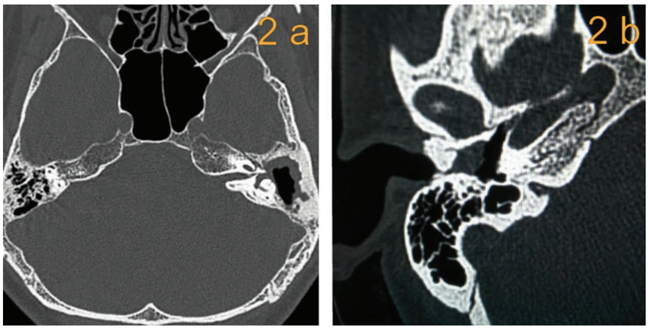

Figure-2: A - Left sided Cholesteatoma with meato-antral fistula and horizontal SCC fistula. B - Right sided Osteoma of EAC leading to almost complete oc

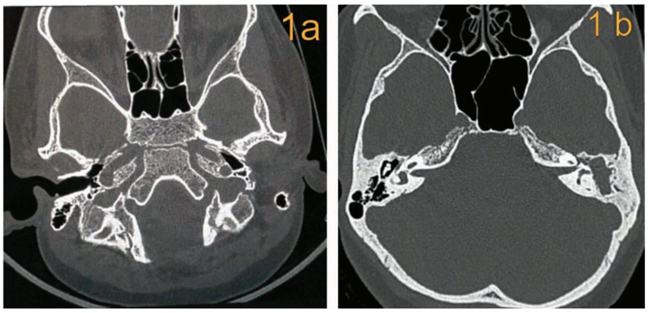

Figure-1: A - Left sided Microtia with EAC atresia. B - Left sided Cholesteatoma with Mastoiditis with bony erosion, horizontal facial nerve canal dehiscence and thinning of tegmen tympani on the left.

fracture. Involvement of facial nerve was predominantly seen in transverse fracture of temporal bone.

In our study 50 patients underwent surgery. Remaining 50 patients who didn't required surgery were followed up and their improvement status was checked and we found that most of the patients of infective etiologies were easily and successfully treated on the basis of HRCT findings. Management of traumatic cases were also followed up and we found excellent correlation with HRCT findings.

In patients who underwent surgical or histopathological diagnosis, the effectiveness of HRCT in evaluating temporal bone pathologies was determined by calculating sensitivity, specificity, PPV and NPV of cholesteatoma, mastoiditis/ CSOM, otitis externa and various structures (facial nerve, LSSC, tegmen tympani, Scutum,ossicles, EAC etc) involved during the disease process (Table 3). The 8 cases of neoplasms were correlated with surgical and/or histopathological findings with a excellent sensitivity, specificity, PPV and NPV of 87%, 98%, 87% and 98% respectively.HRCT accurately diagnosed 4 cases of EAC erosion which was confirmed intraoperatively as well with a sensitivity and specificity of 100%. HRCT predicted accurately 92% of cholesteatoma cases with a sensitivity of 92%, the specificity of 100%, the PPV of 100%, the NPV of 87%. Accurate prediction of tegmen tympani erosion was found in 100% of cases with sensitivity of 100%. A significant association was found between Surgery and HRCT for Facial canal and

Complications and structures involved		Cholesteatoma (n=25)	Trauma (n=20)
Intracranial complications	Meningitis	1	-
	Brain abscess	3	-
	Hydrocephalus	1	-
	Venous sinus thrombosis	1	-
	Intracranial haemorrhage	-	2
Ossicles erosion		13	1
Facial nerve involvement		8	7
Semicircular canal involvement		5	-
Tegmen tympani involvement		7	3
Hemotympanum		-	16
Hemosinus		-	3

Table-2- Distribution of complications and structures involved in cholesteatoma and trauma.

Etiology	HRCT findings	Surgical/ HP correlation	Sensitivity	Specificity	PPV	NPV
Cholesteatoma	17	18	93%	89%	76%	97%
Mastoiditis/CSOM	15	16	94%	97%	94%	97%
Otitis externa	4	5	80%	100%	100%	98%
Otosclerosis	1	1	100%	100%	100%	100%
Tumours	7	8	87%	98%	87%	98%
Ossicular erosion	8	10	80%	97%	89%	95%
Scutum erosion	6	6	100%	98%	85%	100%
Tegmen tympani erosion	3	3	100%	98%	75%	100%
Facial canal dehiscence	4	7	57%	97%	80%	93%
LSCC fistula	2	2	100%	100%	100%	100%
Meato-antral fistula	1	2	50%	100%	100%	98%
EAC erosion	4	4	100%	100%	100%	100%

Table-3: Statistical analysis of HRCT diagnosis in relation to surgical findings.

lateral semicircular canal (LSC) erosion. HRCT predicted facial canal erosion in only 57% of cases. HRCT predicted 100% of LSCC fistula with a sensitivity of 100% specificity of 100%. Significant association was seen between Surgery and HRCT for scutum erosion. Ossicular erosion was picked up by HRCT with sensitivity and specificity of 80% and 97% Respectively.

DISCUSSION

The role of X-rays in evaluation of a cholesteatoma is very little. Minute changes like ossicular erosions, tegmen tympani erosion, facial canal involvement and the LSSC fistulas are extremely difficult to diagnose in a X-ray fim.[5] Due to its high resolution, HRCT effectively delineate minute alterations and small structures of temporal bone and emerged as a major advancement in defining pathology before surgical exploration in patients with cholesteatoma.[6] Cholesteatoma in hidden areas could be revealed by radiological evaluation even if it is not visualized clinically. HRCT emerged as the imaging modalities of choice to evaluate the extension of cholesteatoma before surgery.[7] In patients with cholesteatoma, clinical otologic examination and HRCT were used to assess presence, extension and complications. As YuZ et al[8] described the detection of early bone and scutum erosions. In our study HRCT accurately diagnosed cholesteatoma in 94% of cases with good sensitivity and specificity of 94% and 96% respectively. Chintan Shah et al[9] and Mafee et al identified aditus ad antrum widening with loss of its figure of 8 appearances with mastoid antrum expansion also added value. According to Swartz et al[10] out of 54 patients with cholesteatoma ossicular erosion was found only in 50% of cases in both by imaging and intraoperatively. This observation was also seen in this study where we had found 47% cases of ossicular erosions in patients of cholesteatoma.In our study Incus was the most eroded ossicle similar to reports by Amit Shankhwar et al[11] and Rohit Vallabhaneni et al.[12] Stapes was the least eroded. According to Mehrdad Rocha et al[13] there was poor radio-surgical correlation in stapes erosion which was probably due to the small size of the bone.

In our study males were more commonly affected by tumors than females with a ratio of 2:1 which was correlating with the study by GAS Lloyd et al according to which neoplasms of temporal bone were more common in males.[14] The current study included 8 patients with neoplasms of ear and temporal bone. These included 1 case of squamous cell carcinoma of external auditory meatus, 2 cases of glomus tumor, 1 case of acoustic neuroma, 1 case of metastasis, 2 cases of EAC osteoma and 1 case of meningioma of CP angle. All of these cases were operated and HRCT findings were confirmed except in one case of meningioma which was given as schwannoma on HRCT. HRCT was found to be thoroughly accurate in demonstrating the presence, extent and spread of tumor with a sensitivity, specificity, PPV and NPV of 87% , 98%, 87% and 98% respectively. This was correlated with study by Bird et al who studied 10 cases of primary malignant tumors of temporal bone.[15]

We found that HRCT findings correlated with clinical signs and symptoms (hearing loss, facial nerve dysfunction, etc) of the patients as seen in 2 patients who came with clinical diagnosis of facial nerve palsy; HRCT findings of hematoma in association to facial nerve was confirmed on surgery. This is in accordance with findings of Johnson, et al.[16] They studied 12 cases of trauma and found that HRCT findings correlated well with clinical and operative findings.

The present study included 4 cases of congenital malformations. Out of which 2 cases are of microtia with EAC atresia. Ossicular fusion was found in 1 patient and anterior displacement of facial nerve was found in 1 patient. These findings are in accordance with that of Meyer, et al.[17] Incidental finding of high riding jugular bulb was noted in 6 patients. This is in agreement with study by Overton et al who found the incidence of high riding jugular bulb to be 6%. Preoperative identification of a high riding jugular bulb helps the surgeons to plan the surgery accordingly and to avoid life-threatening complications.

Scutum erosion was correctly predicted with sensitivity and specificity of 100% and 98% respectively which correlated with findings of Gaurano et al[18] and Rocher et al.[19] Our study showed that HRCT accurately predicted LSCC fistula with excellent sensitivity of 100%. Mardassi Ali[20] stated that LSCC is the most common SCC to be eroded in cholesteatoma because of its close proximity to the medial wall of attic anatomically. Similar incidence also noted by Chuni Lal Thukral et al[1] who reported sensitivity and specificity of 100% and 97.73% while, Alzoubi et al[21], Chee and Tan et al[22] and Mafee et al[23] reported HRCT to be 100% sensitive.In this study HRCT accurately predicted tegmen tympani erosion in 100% of cases. Sonika Kanotra et al[24] reported a sensitivity of 100% in detecting tegmen tympani erosion by HRCT which was similar to our findings.

Another important cause of conductive deafness is otosclerosis. In our study we had single patient with clinically suspected otosclerosis which was diagnosed by HRCT and confirmed by surgery with a sensitivity of 100%.

There is an excellent radio-surgical correlation in diagnosing and differentiating cholesteatoma from granulation tissue, in identifying malleus erosion, incus erosion, tegmen tympani erosion, scutum erosion, EAC erosion, high riding jugular bulb, LSSC fistula, neoplasms and otitis externa. Moderate to poor radio-surgical correlation was noted in identifying stapes erosion and facial canal erosion. These disparities in case of identifying stapes erosion could be probably due to the small size of the bone with associated soft tissue density around it making it difficult to identify. Difficulty in identifying facial canal erosion is mainly due to oblique orientation, small size and presence of developmental dehiscence.

Even though the current study sufficiently elaborated the value of HRCT in diagnosing pathologies of the temporal bone, it is limited due to small sample size and the limited spectrum of clinical diagnosis. Hence, larger sample size with more variety of cases will definately add value.

CONCLUSION

HRCT is the modality of choice in evaluation of the temporal bone pathologies especially of infective and traumatic itiologies. It dictates proper medical treatment or timely surgery that can prevent further serious complications in cases of cholesteatoma, matoiditis and congenital malformations. Amongst patients with trauma to temporal bone, HRCT precisely predicts the fracture lines, disruptions of the ossicles and injury to facial nerve. However HRCT has its own limitations like in evaluation of labranthine soft tissue structures, evaluation of enhancement pattern and associated radiation hazards to the eye lens. Despite its limitations, 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 revolutionalized the role of radiology in diagnosis and management of temporal bone diseases.

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