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Research Article

ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY IN THE EVALUATION OF TEMPORAL BONE LESIONS

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ABSTRACT

Objectives: The study's primary goal is to assess inflammatory, traumatic, and neoplastic disorders that impact the temporal bone using high resolution computed tomography (HRCT). The other aim is to comprehend how HRCT can diagnose and detect pathologies of the temporal bone.

Methods: The study was conducted at Dr. Patnam Mahender Reddy Institute of Medical Sciences from Jan 2018 to Jan 2020 with a sample size of 60. Written consent for participation in the study was taken before the scan. The study was evaluated with multidetector HRCT-HITACHI 128 SLICE machine. CT images are usually acquired or displayed in axial and coronal planes.

Results: Among 60 patients, 44 patients were diagnosed with infections, 11 were diagnosed with tumors, and five patients with anatomical variants. Among 60 patients, 32 (53.3%) were male patients, and 28 (46.6%) were female patients; hence, study shows a male preponderance. Out of 60 patients, the highest number was recorded in those aged 21–30 years 16 (36%). Among 60 patients, 44 suspected of having a middle ear infection were studied. Among these 44 patients, 27 (61.3%) were diagnosed with otomastoiditis, 16 (36%) patients were diagnosed with cholesteatoma, and 1 (2.2%) patient was diagnosed with malignant otitis externa. In our study population of 60 patients, 11 were diagnosed with neoplasms. Among the 11 patients, 7 (67%) were diagnosed with acoustic neuroma in the cerebellopontine angle.

Conclusion: The existence of cholesteatoma, changes to the ossicular chain, and erosion of the lateral semicircular canal were all intraoperatively detected in the present study with excellent sensitivity to the clinical and radiographic findings. For correcting any congenital ear anomalies, the HRCT results were helpful for planning and management tools for the surgeon.

Keywords: High resolution computed tomography, Cholesteatoma, Temporal bone lesions, Otomastoiditis, Malignant otitis externa.

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INTRODUCTION

The hearing and balancing organs are located within the complicated anatomical structure known as the temporal bone. It also has close contact with the brain, with essential veins and nerves running through it. The brainstem, cerebellum, and temporal lobe of the brain are all in direct touch with the temporal bone [1]. Both radiologists and otolaryngologists face a complex problem when diagnosing and treating temporal bone disorders. Due to the complex anatomy of the middle and inner ear, it is challenging to examine the temporal bone using radiography [1,2]. Plain radiography, angiography, cerebrospinal fluid analysis, air, and non-ionic contrast cisternography, computed tomography (CT), and magnetic resonance imaging are just a few of the imaging modalities that can be used to evaluate the temporal bone (MRI) [3,4]. However, CT and MRI currently replaced the other procedures [4]. Conventional radiography has been of value in screening the entire temporal bone [5]. Superimposing larger, denser components over smaller, and less dense ones create a composite single plane image of a tridimensional temporal bone. The examination of bone and air space anatomy and pathologies greatly benefited from CT scanning [6]. CT scans have largely supplanted polysomnography because they are more accurate at detecting numerous soft-tissue anomalies and are considerably less prone to artifacts. CT scans expose the earth's lens to less radiation than polysomnography. The advantage of CT is that it results in images with greater contrast and superior spatial resolution. Excellent bony landmarks within the tympanic cavity and mastoid air cells are provided by high-resolution CT [7]. It has also added a new dimension to the temporal bone by allowing visualization of the tissue components within and adjacent to it [8]. It gives data on both soft tissue alterations and bony contour, allowing for the demonstration of the location, scope, and consequences of the disease, as well as a treatment approach that has significantly decreased morbidity and mortality associated with lesions of this region due to surrounding thick bone's natural contrast with the temporal bone. Because it can image numerous soft-tissue entities that are invisible to conventional techniques, MRI has increased the breadth of pathology that may be reliably examined [4,5]. MRI scans can significantly aid the examination of blood vessel-related diseases of the temporal bone. Interventional angiography can be performed to treat vascular lesions of the temporal bone and angiography is considered the "gold standard" for vascular assessment [9]. More than one examination is frequently required for a thorough evaluation of the temporal bone. Each technique has its benefits and drawbacks. The study's primary goal is to assess inflammatory, traumatic, and neoplastic disorders that impact the temporal bone using high resolution computed tomography (HRCT). The other aim is to comprehend how HRCT can diagnose and detect pathologies of the temporal bone.

METHODS

Study place and period

The study was conducted at Dr. Patnam Mahender Reddy Institute of Medical Sciences from Jan 2018 to Jan 2020.

Sample size

60.

Study design

It is a prospective study.

Institutional ethics committee clearance was obtained before the study. Written informed consent from subjects to include their images in the study, with standard disclosures were collected. This study evaluating the efficacy of HRCT in diagnosing temporal bone pathologies was done on 60 patients who came with complaints related to temporal bone pathology from Jan 2018 to Jan 2020. The cases were included in a descriptive study conducted over this period. The study was conducted on HITACHI (SCENARIO) 128-slice CT Machine.

Inclusion criteria

All the patients in this study group were referred by the ENT department of the same hospital. Sixty patients of all age groups were referred to the department of radio diagnosis who are clinically suspected of having temporal bone pathology.

Exclusion criteria

Patients with electrical devices at the skull base, such as cochlear implants, were excluded from the study. Pregnant women were also excluded from the study.

Method

Preparation of patients: Written consent for participation in the study was taken before the scan. Before performing the scan, the patient was explained details of the procedure and advised not to move during the process to avoid motion artifacts. Anesthetists or pediatricians gave sedation to patients included whenever required, especially in infants and children, to prevent motion artifacts and to ensure a CT scan of good diagnostic quality.

HRCT Technique: CT has revolutionized the imaging of temporal bone and its disorders that primarily affects air spaces or cortical bone. Specific intratemporal structures are evaluated using gantry angulations for axial and coronal scans. High-resolution bone algorithm approaches may be sufficient if the objective of a temporal bone CT investigation is to concentrate only on the otic capsule, cortical plates, ossicles, and air gaps. However, if it's also crucial to assess soft tissues, as in the case of a patient with external auditory canal malignancy, then intravenous contrast and methods akin to those used for brain or soft-tissue neck studies may be required. HRCT comprises the use of thin collimation, a high spatial frequency algorithm, the smallest practical FOV (15–20 cm), and a large reconstruction matrix (512×512) (Table 1). Axial and coronal planes are typically used to acquire or present CT images. Sections are prepared for axial imaging in a plane 30° higher than the anthropologic baseline. An anthropologic baseline is a line drawn between the inferior orbital rim and the external auditory canal on a lateral scout film. Scan results obtained in this plane effectively show the temporal bone features. This plane enables the separation of each temporal bone component to be more clearly seen individually, with less overlap and partial volume imaging distortions. While reconstruction coronal images are often orientated 90° from the arthropologic baseline, direct coronal images are typically taken at an angle of about 120°. Retrospective image targeting and reconstruction of the other side from stored raw data significantly reduces image pixel size and increases spatial resolution.

Protocol

The study was evaluated with a multidetector high-resolution CT – HITACHI 128 SLICE machine. The vital patient factor influencing HRCT is motion. Therefore, patients were instructed to be motionless during the procedure (Table 2).

Table 1: Showing HRCT technique I

Thin collimation	Thick collimation due to volume averaging reduces CT resolution significantly.
High spatial frequency algorithm	Reduces image smoothening and increases spatial resolution, making structures appear sharper, but increases image noise.
High kVp	Reduction in noise ratio level. Better bone penetration and minimal beam hardening with this technique.
High mAs	Better soft-tissue differentiation with this technique.

Iohexol 350 mg (65 mL) was injected in a bolus through an 18 gauge intravenous catheter at a rate of 5 cc/s using a pressure injector for the contrast study specified in the chosen research: (1) Cerebellopontine angle masses were investigated with intravenous contrast, (2) middle ear disorders that extend intracranially or externally, And (3) lesions with high blood flow, such as glomus tumors. The lesion's type, location, and size were determined by analyzing HRCT images for particular features pertinent to the diagnosis of temporal bone diseases: (1) Middle ear wall bone erosion, (2) the structural integrity of the internal ear structures, facial nerve canal, and ossicular chain, (3) the system of mastoid air cells is involved, and (4) the interior and external auditory canals.

RESULTS

Among 60 patients, 44 were diagnosed with infections, 11 were diagnosed with tumors, and 5 had anatomical variants. In our study of 60 patients, 32 (53.3%) were male patients, and 28 (46.6%) were female patients; hence, study shows a male preponderance. In our study population of 60 patients, 3 (7%) patients were in the age group between 0 and 10 years, 12 (27%) patients were in the age group between 11 and 20, 16 (36%) patients were in the age group between 21 and 30, 7 (16%) were in the age group between 31 and 40, 3 (7%) patients were in the age group between 41 and 50, 2 (4.5%) patients were in the age group between 51 and 60, and 1 (2%) were in the age group between 61 and 70. About 63% of temporal bone infections were seen in the 2nd and 3rd decades, which form a significant group. In our study group of 60 patients, patients with disease form the most important proportion of cases studied, 73% followed by tumors constituting 18.3% and others constituting 8.33% of the study population which included congenital anomalies and anatomical variants (Table 3). In our study, 26 male and 18 female patients had infections of the temporal bone. The ratio of males to females in infective diseases of the temporal bone is 1.4:1. In our study, 33 (75%) patients came with complaints of otorrhea and 30 (68%) patients came with complaints of headache, otorrhea, and headache were the chief presenting complaint followed by hearing loss seen in 15 patients (34%), otalgia seen in 12 (27%), tinnitus seen in seven patients (16%), and facial nerve weakness seen in four patients (9%) (Table 4). Forty-four patients suspected of having a middle ear infection were studied.

Table 2: HRCT temporal bone scan technique II

Patient position	Supine
Scout	Dual scan (AP and Lateral)
Scan start point	0 (skull base)
Endpoint	60 (superior margin of petrous temporal bone)
Scan time	5 s (according to position)
kVp	120
mA	240
Rotation time	0.75 s
Section thickness	1 mm
Reconstructed slice thickness	0.67 mm
Interval	0.3 mm
Pitch	Detailed round hp 11.0
Window width/ window level	Fc81 4500/+560

Table 3: Shows the distribution of diseases

Diseases	Number of patients	Percentage
Infection	44	73.33
Tumors	11	18.3
Others	5	8.33

The age group varies from 5 years to 70 years. The number of males was 26 and females were 18. Among 60 patients, 44 patients were found to have a middle ear infection. Among these 44 patients, 27 (61.3%) were diagnosed with otomastoiditis, 16 (36%) patients were diagnosed with cholesteatoma, and 1 (2.2%) patient was diagnosed with malignant otitis externa. Otomastoiditis forms the major group of infections. Among 44 patients with the disease, 32 (72.8%) patients had unilateral ear affected, among which 19 (43%) had right ear affected, 13 (29.5%) had left ear affected, and 12 (27.2%) had bilateral ear affected. Among 44 patients with infections, the highest number, 20 patients (18%), had cholesteatoma, followed by 19 patients (18%) who had opacification of mastoid air cells (Table 5). In our study population of 60 patients, 11 were diagnosed with neoplasms. Among the 11 patients highest, 7 (67%) were diagnosed with acoustic neuroma in a cerebellopontine angle which is the most common tumor, followed by glomus jugulare seen in 2 patients (18%) (Table 6). Among 11 patients with neoplasms, female patients were 7 (64%) and males were 4 (36%). Female (64%) preponderance was seen in neoplasms. Among 11 patients with neoplasms, 4 patients (36.6%) were between 51 and 60 years, 3 patients (27.7%) were between 21 and 30 years, and 4 patients (36.6%) were between 31 and 50 years. About 73% of neoplasms were above 30 years of age group. Among 7 patients with acoustic neuroma, 6 patients (86%) were between 31 and 60 years, 1 patient (14%) was below 30 years, and the peak age incidence of acoustic neuroma was 31–60. Figs. 1-3 showed the axial sections of HRCT temporal bone images.

DISCUSSION

The radiographic evaluation of temporal bone lesions is becoming more and more dependent on CT [7]. Due to the complex anatomy of the middle and inner ear, radiographic examination of the temporal bone is challenging. This work aims to create a systematic strategy for HRCT evaluation of temporal bone abnormalities. In the present study population of 60 patients, 44 were diagnosed with infections, 11 were diagnosed with tumors, and 5 were diagnosed with anatomical variants. Otomastoiditis was the primary group among infection, majority group had unilateral group affected. Out of 11 patients with neoplasms. Acoustic neuroma was the major group among neoplasm. Fritz *et al*. [10] prospectively examined 62 patients with different temporal bone lesions by HRCT and conventional plain radiography, including pluridirectional tomography. Compared to traditional radiology, high-resolution CT provided a precise diagnosis in 80% of the cases. High-resolution CT also recorded 1.6 times more bone information, making it superior for imaging cholesteatomas, metastases, and inflammatory processes and assessing osseous destruction. Conventional radiology exhibits inadequate sensitivity to diseased soft tissue or effusions filling the tympanic chambers (0.61). Our study results are from the study done by Fritz *et al*. [10]. Patients with infection form the most significant proportion of cases studied. The age range was from 5 to 65 years, 44 subjects were studied, out of which otomastoiditis was 28, cholesteatoma was 15, and 1 was malignant otitis externa. A study by Lloyd *et al*. (1980) [11] in 30 patients with CT showed infection as the 3rd most common cause of the temporal bone lesion.

Table 4: Showing clinical features in infections

Clinical features	Number of patients	Percentage
Hearing loss	15	34
Otalgia	12	27
Otorrhea	33	75
Tinnitus	7	16
Facial nerve weakness	4	9
Headache	30	68
Cerebellar signs	3	7

Table 5: Comparison between HRCT and operative findings

Radiological features	No of the patients diagnosed with HRCT	No patients with similar operative findings
Opacification of the external ear	5	5
Opacification of mastoid air cells	19	18
Cholesteatoma	20	18
Ossicular erosion	16	13
Facial canal erosion	3	2
Extracranial extension	5	5
Intracranial extension	7	7

Table 6: The distribution of neoplasms

Distribution of neoplasm	Number of patients	Percentage
Acoustic neuroma	7	67
Meningioma	1	9
Glomus jugulare	2	18
Adenoid cystic carcinoma	1	9

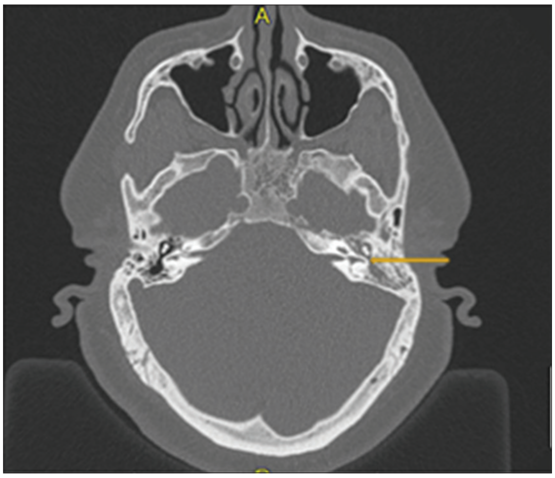

Fig. 1: Axial sections of HRCT temporal bone image showing the left otomastoiditis; opacification of the middle ear cavity (yellow arrow) and mastoid air cells with ear ossicles seen embedded within

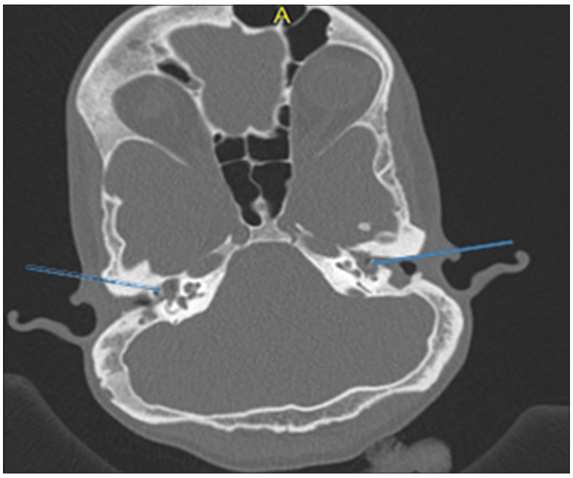

Fig. 2: Axial sections of HRCT temporal bone showing bilateral cholesteatoma: Soft-tissue opacification of bilateral middle ear cavity (blue arrows) and mastoid air cells with near complete erosion of ear ossicles

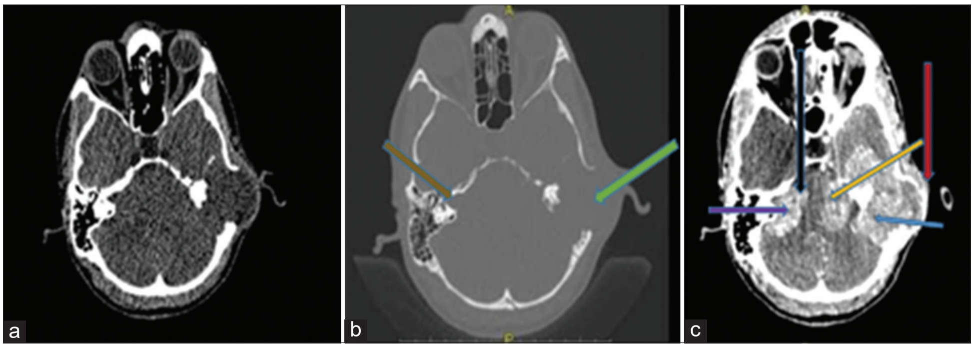

Fig. 3: (a) Axial section of NECT brain, (b) axial sections of HRCT temporal bone, and (c) axial section of CECT brain showing bilateral vestibular schwannoma. Well-defined extra-axial heterogeneously hypodense intensely enhancing lesions noted in left CP angle cistern causing widening of the left IAC (blue arrow) extending medially and causing compression of pons and medulla (yellow arrow), laterally extending into mastoid air cells up to subcutaneous planes and displacing the pinna (red arrow), the lesion is causing widening and erosion of left temporal bone involving IAC, petrous apex, mastoid air cells, left middle ear cavity including malleus, incus, stapes, and the external auditory canal (green arrow). A similar lesion in the right CP angle cistern (purple arrow) causing widening of rt internal auditory meatus (brown arrow), extending medially and compressing pons, medulla, and abutting right cerebellar hemisphere (black arrow)

1st and 2nd were tumors and temporal bone trauma, respectively. In the present study with 60 patients, HRCT showed infection is 1st most common cause of temporal bone lesions 2nd most common in tumors. These results were different from the study conducted by Lloyd *et al*. (1980) [11]. The patients' low socioeconomic status and illiteracy may be responsible for this discrepancy. This is consistent with studies and widely accepted reality. Since most patients were found to be illiterate and unaware of ear illness, poor diet, cleanliness, and illiteracy may have a significant influence. In addition, the most frequent pathology seen in a research by Prakash *et al*. [12] in 64 individuals analyzing HRCT temporal bone was middle ear infections (with cholesteatoma). In addition, in patients with cholesteatoma, the CT scan accurately identified ossicular erosion, scutum erosion, fallopian canal, tegmen tympani, and lateral semicircular canal erosions. About 18.3% of the lesions in our study are tumors which differ from the report of Lloyd *et al*. (1980) [11] that claimed neoplasms were the most common lesions.

CONCLUSION

The most common lesion in our study was infection with male preponderance. Otorrhea, otalgia, hearing loss, and headache were frequent signs of diseases. In the second and third decades, middle ear infectious infections predominated. Acoustic neuromas were the most prevalent tumors. Third–sixth decade was the peak age. It is best to use HRCT to assess temporal bone diseases.

AUTHOR' S CONTRIBUTIONS

The first author of the study, NP, performed the research work and wrote the first draft of the manuscript; the second author, RS, collected the literature, corrected the manuscript, and managed the statistics.

CONFLICT OF INTEREST

The authors declared, "No conflict of interest."

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Nil

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