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Original Article

A Prospective Study of Evaluation of Temporal Bone Pathologies Using High-Resolution Computed Tomography in 50 Cases and its Correlation with Clinical Findings

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Abstract

Background and Objectives: Ear disorders are a frequent clinical issue that people experience every day. Due to the incidence, complications, and recurrence of numerous temporal bone diseases, clinical examination alone is no longer sufficient in the modern world. Imaging is crucial to the management of these conditions and has a significant impact on the course of treatment. High-resolution computed tomography (HRCT) is a modified version of conventional CT and it offers a direct visual window into the temporal bone that reveals fine structural details. The present study aims to evaluate the normal variations, pathological processes such as infections, tumors, vascular lesions, trauma, congenital anomalies, complications from diseases, and their extent involving the temporal bone.

Materials and Methods: A prospective observational study was conducted at Dr B.R Ambedkar medical college on 50 cases presenting with symptoms and signs related to temporal bone pathology from January 1st, 2021 to July 1st, 2022. Patients were scanned in axial and coronal planes with 0.625–1.25 mm thin sections using sharp algorithm obtaining plain/non-contrast and contrast images. Results were tabulated using percentages.

Results: Among the 50 cases which were studied majority of the subjects were found in the age group 21–30 (12 cases). Infection was the most common pathology affecting the temporal bone. The ear pain, headache, tinnitus, Hearing loss, facial weakness and Vertigo are the most commonest symptoms observed. Left part 2 table and right part-2 and mastoid - HRCT findings table shows a significant approach for early screening of the patients. A total (n = 33) cases had complications from cholesteatoma. Amongst, the Facial canal erosion (10%); Malleus erosion (12%) and Stapes erosion (12%) is a common complications found in the above study. The current study will be serve as radiological navigation tool for the ENT specialist for operating the cases surgically.

Conclusion: For evaluating the temporal bone and its surrounding structures for its anatomy and pathologies, HRCT is superior to traditional investigational methods because it offers higher spatial resolution and greater soft tissue contrast. For a precise diagnosis to be made, a thorough clinical history and pertinent clinical examination are crucial.

Key words: Ear Disorders, High Resolution Computed Tomography (HRCT), Hearing Loss, Stapes Erosion, Temporal Bone

INTRODUCTION

The invention of high-resolution computed tomography (HRCT) changed temporal bone imaging in 1980.[1] Clinically, middle ear disease is a common clinical condition.[2] it serves as an extension of the upper respiratory tract and is vulnerable to bacterial and viral invasion through the Eustachian tube. The third most frequent reason for seeing an otorhinolaryngologist is for ear pathology, with inflammatory disorders of the middle ear being a popular justification for giving antibiotic prescriptions and performing surgery on kids and teenagers. In the past, a diagnosis was typically made solely by clinical examination. However, it was recommended that the current strategy for preventing and treating these disorders was insufficient

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given the rise in the occurrence of infectious ear pathologies. Imaging is therefore crucial, especially in complex and recurrent illnesses where the results may have a major impact on the course of treatment.[3]

The complex anatomical structure known as the temporal bone contains the hearing and balance organs. Along with being close to the brain, it also contains vital veins and nerves. The temporal bone is in close contact with the brainstem, cerebellum, and temporal lobe of the brain. Imaging modalities such as plain radiographs, polytomography, angiography, and cisternography are used to evaluate temporal bone.[4] Radiograph has limitations due to complex architecture and overlap. A modification to standard CT is HRCT. A better understanding of the genesis, pathophysiology, and course of the disease is made possible by HRCT, which also allows for the early detection of problems.[5] HRCT accurately localizes primary temporal bone disease and identifies intracranial dissemination. A diagnosis of bone and air space problems is more accurate in HRCT. It provides a topographic image of the temporal bone and surrounding structures that is good.

Aims and Objectives

1. To study infections with in temporal bone and their complications
2. To study the congenital defects in the ear
3. To evaluate variations in the temporal bone anatomy in different pathologies.

MATERIALS AND METHODS

Source of Data

- Patients aged between 4 and 70 years with a complaint of temporal bone pathologies such as hearing loss, ear discharge, and tinnitus are referred from OPD/IPD of the ENT Department.

Study Design

- A Prospective study was done involving 50 patients with complaints regarding temporal bone pathologies such as hearing loss, ear discharge, tinnitus.

Study Period

- The study was done from January 1st, 2021, to July 1st, 2022.

Sample Size

The sample size was 50.

Place of Study

- Department of Radiodiagnosis, Dr B R Ambedkar medical college and Hospital, Bengaluru.

Ethical Clearance

Obtained.

Inclusion Criteria

1. Age: 4–70 years
2. Patient willing to give informed consent
3. The patient referred for HRCT Temporal bone from ENT Department
4. Patient with a history of trauma
5. Malignancies in the temporal bone.

Exclusion Criteria

1. Patient not willing to give informed consent
2. Pregnancy
3. Patients <4 years.

Methodology

This study assessing the efficacy of CT in the diagnosis of pathologies of temporal bone will be done on 50 cases. This study will be conducted between January 1st, 2021, and July 1st, 2022 in the Department of radiodiagnosis, Dr B R Ambedkar medical college, Bengaluru.

Selection of Patients

Patients having clinical features related to temporal bone pathology will be taken and referred for HRCT of the temporal bone.

All the patients will undergo detailed clinical examination in the ENT Department followed by HRCT temporal bone scanning in the Department of Radiodiagnosis. All the patients will be scanned with Toshiba activation 16.

Methods of Data Collection

Informed consent is taken from patients undergoing HRCT. The prospective study includes 50 patients with suspected pathologies in the temporal bone or the ear. Patients with a history of malignancies related to temporal bone were included. Then patients are scanned.

Statistical Analysis

Table 1 shows the disease-wise distribution of patients. As per the results, the common pathology observed was infection constituting 60% of cases (n = 30), followed by trauma (n = 11, 22%), Tumors (n = 5, 10%), congenital malformation (n = 2, 4%), and vascular lesions (n = 2, 4%).

Table 2 shows the gender-wise distribution of the patients. As per the results, the males were 30 (60%) and females were 20 (40%) with a sex ratio is 1:1.

Table 3 shows the age distribution, the mean age of the cases are 39.26 with SD 1.25 years, based on the mean and SD we categorized the age classes, the majority of

Table 1: Distribution of disease in patients

Diseases	No. of patients	Percentage
Infections	30	60
Tumours	5	10
Trauma	11	22
Congenital malformations	2	4
Vascular lesions	2	4

Table 2: Sex distribution

Gender	Number of patients	Percentage
Male	30	60
Female	20	40

Table 3: The age distribution

Age group	No.	%
<11–20	6	12
21–30	12	24
31–40	9	18
41–50	11	22
51–60	7	14
61–70	5	10
Total	50	100

the subjects were expressed the age 21–30 (12 cases) years followed by 31–40 years was 9 cases; 51–60 (7 cases) and least was <11–20 years 6 (12%).

The distribution of clinical diagnosis presented in Table 4, the results shows that majority of the cases were diagnosed B/L CSOM (11.54%) followed by left CSOM (5.77%) (Case 1); right squamous and mastoid temporal bone Fracture (7.69%); the two cases were diagnosed by left squamous temporal bone fracture (Case 2), left cholesteatoma, left EAC atresia were rest of each case were diagnosed by right glomus jugulo-tympanicum (Tumour) (Case 3), right vestibular schwannoma (Case 4), Right high riding jugular bulb, right otomastoiditis, right petrous ICA aneurysm. It was tested by Chi-square, the results were found to be significant $P < 0.01$.

Table 5 depicts that Descriptive statistics of HRCT Right part 1, the right external, middle, and inner ear were hypothetically tested using the logistic multivariate analysis, the results show that different components of the variables of the right ear and middle ear were found to be significant at 1% level of significance. In case of the inner ear, except lateral SCC and internal auditory were found to be significant, the rest of the variables were uncorrelated $P > 0.01$.

Table 6 depicts that descriptive statistics of HRCT findings (Left part-1, the left external, middle, and inner ear were hypothetically tested by using the logistic multivariate analysis, the results show that different components of

Table 4: Distribution of clinical diagnosis

Clinical diagnosis	No	%
B/L CSOM	6	11.54
B/L otomastoiditis	3	5.77
Left CSOM	4	7.69
Right squamous temporal bone fracture	4	7.69
Left otomastoiditis	3	5.77
Left squamous temporal bone fracture	3	5.77
Left cholesteatoma	4	7.69
Left EAC atresia	2	3.85
Left glomus jugulare paraganglioma (tumor)	1	1.92
Left mastoid temporal bone fracture	1	1.92
Left petrous temporal bone fracture	1	1.92
Right vestibular schwannoma (tumor)	3	5.77
Right cholesteatoma	4	7.69
Right glomus jugulo tympanicum (tumor)	1	1.92
Right high-riding jugular bulb	1	1.92
Right mastoid temporal bone fracture	1	1.92
Right otomastoiditis	3	5.77
Right petrous ICA aneurysm	1	1.92
Right squamous and mastoid temporal bone fracture	1	1.92
B/L cholesteatoma	1	1.92
Right CSOM	4	7.69
Total	50	100

Table 5: Descriptive statistics of HRCT findings (Right part-1)

Particulars	Variables	Yes		No		*P*-value
		No	%	No	%	
Right external ear	Tympanic membrane thickening	19	38	31	62	<0.001
	Mass/collection	14	28	36	72	<0.001
	Scutum erosion	12	24	38	76	<0.001
Right middle ear	Prussaks space involvement	17	34	33	66	<0.001
	Opacification	22	44	28	56	<0.001
	Tegmen tympani erosion	4	8	46	92	<0.001
	Malleus Erosion	9	18	41	82	<0.001
	Incus erosion	11	22	39	78	<0.001
	Stapes erosion	10	20	40	80	<0.001
Right inner ear	Superior SCC	0	0	50	100	-
	Lateral SCC	2	4	48	96	<0.001
	Posterior SCC	0	0	50	100	-
	Cochlea andvestibule	0	0	50	100	-
	Internal Auditory canal	4	8	47	94	<0.001

Chi-square=10.85, *P*<0.01

the variables of the right ear and middle ear were found to be significant at 1% level of significance. In case of the inner ear, Lateral SCC was found to be significant, rest of the variables were uncorrelated $P > 0.01$.

Table 7 depicts the Descriptive statistics of HRCT findings (Right part-2), the right part mastoid and HRCT findings are hypothetically tested by using the logistic multivariate analysis, the results show that different all the components of the variables were found to be significant at 1% level of significance.

Case 1: A 50-year-old female patient presented with ear pain, ear discharge for 7 months and headache and hearing loss for 1 year. Axial and coronal image of HRCT temporal bone shows right middle opacification with ossicular erosion and sclerosis of right mastoid air cells. Mucosal thickening was seen in the left middle ear with sclerosis of left mastoid air cells

Table 6: Descriptive statistics of HRCT findings (Left part-1)

Particulars	Variables	Yes		No		*P*-value
		No	%	No	%	
Left external Ear	Tympanic membrane thickening	6	32	34	68	<0.001
	Mass/collection	10	20	40	80	<0.001
	Scutum Erosion	10	20	40	80	<0.001
Left middle ear	Prussaks space involvement	12	24	38	76	<0.001
	Opacification	17	34	33	66	<0.001
	Tegmen tympani erosion	1	2	49	98	>0.001
	Malleus erosion	3	6	47	94	<0.001
	Incus erosion	4	8	46	92	<0.001
	Stapes erosion	6	12	44	88	<0.001
Left inner ear	Superior SCC	0	0	50	100	-
	Lateral SCC	2	4	48	96	<0.001
	Posterior SCC	0	0	50	100	-
	Cochlea andvestibule	0	0	50	100	-
	Internal Auditory canal	0	0	50	100	-

Chi-square=4.61, *P*<0.01

Table 7: Descriptive statistics of HRCT findings (Right part-2)

Particulars	Variables	Yes		No		*P*-value
		No	%	No	%	
Mastoid	Opacified	28	56	22	44	<0.001
	Sclerosed	17	34	33	66	<0.001
	Abscess	1	2	49	98	>0.01
HRCT findings	Facial canal erosion	7	14	43	86	<0.001
	Jugular canal erosion	1	2	49	98	>0.01
	Sigmoid plate erosion	1	2	49	98	>0.01
	Fracture	6	12	44	88	>0.01
	Cholesteatoma	5	10	45	90	>0.01
	CSOM	15	30	35	70	<0.001

Chi-square=13.21, *P*<0.01

Table 8: Descriptive statistics of HRCT findings (Left part-2)

Particulars	Variables	Yes		No		*P*-value
		No	%	No	%	
Mastoid	Opacified	25	50	25	50	<0.001
	Sclerosed	17	34	33	66	<0.001
	Abscess	1	2	49	98	>0.01
HRCT findings	Facial canal Erosion	5	10	45	90	<0.001
	Jugular canal Erosion	0	0	50	100	>0.01
	Sigmoid plate erosion	1	2	49	98	>0.01
	Fracture	5	10	45	90	<0.001
	Cholesteatoma	5	10	45	90	<0.001
	CSOM	14	28	36	72	<0.001

Chi-square=9.68, *P*<0.01

Table 8 depicts that Descriptive statistics of HRCT findings (Left part-2), the left part mastoid, and HRCT findings are hypothetically tested using the logistic multivariate analysis, the results show that different all the components of the variables were found to be significant at 1% level of significance.

The complications of cholesteatoma (Case 5) were tested by the Chi-square test, as per the findings a total of 33 cases had complications from cholesteatoma. Among, the facial canal erosion (10%), malleus erosion (12%), and stapes erosion (12%) were found to be statistically significant $P < 0.01$ Table 9.

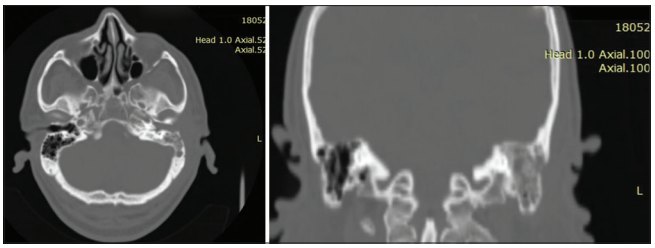
DISCUSSION

The temporal bone houses hearing and balancing organs. Radiography is challenging due to the complexity of the temporal bone. HRCT images have stronger contrast and improved spatial resolution. HRCT images have stronger contrast and improved spatial resolution. HRCT provides topographic viewing without superimposing. Pathology assessment of a disease allows for precise pathology assessment before surgical exploration. According to Jat *et al*.[6] in 2021, 50 patients with clinically suspected temporal bone symptoms underwent HRCT at Geetanjali Medical College and Hospital (Udaipur) between November 2017 and June 2019. By HRCT and Intra-op/Follow-up scans, CSOM and Cholesteatoma were the most frequently discovered diseases, followed by fractures, acoustic neuroma, Glomus tympanicum, and atretic EAC. When validated by intra-op/follow-up results, almost all lesions were appropriately diagnosed

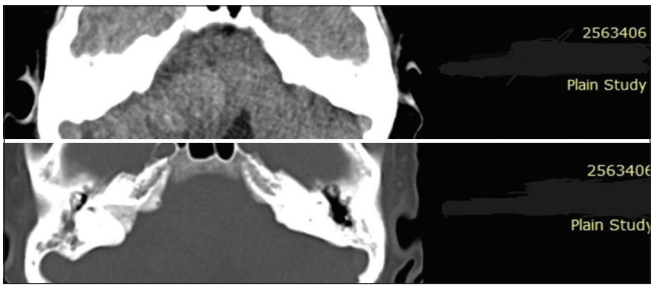
Table 9: Complications of cholesteatoma

Complication	No. of Patients	%
Abscesses	1	2
Facial canal erosion	5	10
Malleus erosion	6	12
Incus erosion	6	12
Stapes erosion	6	12
Tegmen erosion	3	6
Sigmoid plate erosion	2	4
Jugular bulb erosion	1	2
Semicircular canal erosion	3	6
	33	66

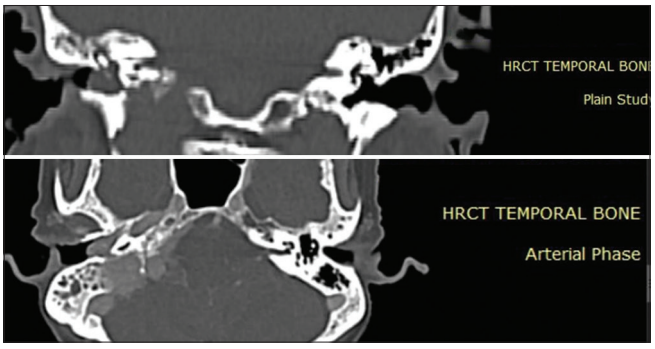
Chi-square=6.40, *P*<0.01



Case 2: A 60-year-old male patient presented with ear pain and ear discharge for 2 months. Axial and coronal image of HRCT temporal bone shows soft-tissue density lesion in the left middle ear with extension into the left external auditory canal. Opacification and sclerosis of left mastoid air cells noted



Case 3: A 45-year-old female patient presented with hearing loss and vertigo for 2 years. CT Axial and coronal section of the brain shows a fairly defined non-homogenous space-occupying mass lesion in the right cerebellopontine angle. The mass is extending into the right internal auditory canal/petrous temporal bone with the expansion of the right internal auditory canal. The mass effect is seen as compression of the right middle cerebellar peduncle /fourth ventricle



Case 4: A 67-year-old female patient presented with Tinnitus, hearing loss, and facial weakness for 5 years. Axial and coronal image of HRCT temporal bone shows a large irregular space occupying mass lesion in the right jugular foramen, right mastoid, and clivus on the right side. Mild destruction of petrous bone was seen. Mass is extending into the right middle ear and encases ossicles in the right middle ear. Mass is also extending into right CP angle.

by HRCT. In our study, the results, the males were 30 (60%) and females comprises 20(40%) with a sex ratio 1:1 the mean age of the cases is 39.26 with SD of 1.25 years, based on mean and SD. The Majority of the subjects expressed the age of 21–30 (12 cases) years followed by 31–40 years (9 cases); 51–60 (7 cases) and the least was <11–20 years 6 cases. A total of 84% of patients had experienced ear pain, 68% of patients had experienced ear discharge, headache presented (22%), tinnitus (12%), hearing loss (68%), and facial weakness and Vertigo (6%). HRCT produces images with higher contrast and spatial resolution. HRCT provides topographic visualization without artifacts. Pathology assessment of disease location, severity, and complications with HRCT is essential for surgical exploration. HRCT reveals the complex anatomy of the temporal bone, including ear ossicles, cochlea, and canals. The carotid canal, jugular fossa, major vessels, and nerves are depicted well on HRCT. This study evaluated the extent of chronic middle ear infections, temporal bone trauma, and neoplasms. Due to the ability to see temporal bone structures with great clarity, HRCT can be recommended not only in cases suspected with potential complications but also in all cases of temporal bone pathologies to know the extent of disease, inter-relationships of the tympano-mastoid compartment with adjacent neurovascular structures, varied pneumatization and the presence of anatomical variations, which should alert the clinician and guide in surgical approach and treatment plan.[7] In the present study, the clinical diagnosis were seen positive correlation, the resultsshow that the majority of the cases were diagnosed with B/L CSOM (11.54%) followed by left CSOM (5.77%); right squamous and mastoid temporal bone Fracture (7.69%); the two cases were diagnosed by left squamous temporal bone fracture, left cholesteatoma, Left EAC atresia were rest of eachcase were diagnosed by right glomus jugulo-tympanicum (Tumour), right high riding Jugular bulb, right otomastoiditis, right petrous ICA aneurysm. It was tested by Chi-square, the results were found to be significant $P < 0.01$. In HRCT - right external, middle and inner ear. The results shows that different components of the variables of the right ear and middle ear were found to be significant at 1% level of significance. In the case of inner ear, except lateral SCC and internal auditory were found to be significant, the rest of the variables were uncorrelated $P > 0.01$. In the case of left part-1, the external, middle and inner

Case 5: A 28-year-old male patient presented with ear pain, ear discharge, hearing loss, facial weakness, and swelling in the right temporal region for 1 day. Axial image of HRCT Temporal bone shows comminuted undisplaced fracture of mastoid part of the right temporal bone with fracture line extending till right middle ear with mild collection within and fracture line is seen extending into tympanic and squamous part of the right temporal bone.

ear results shows that different components of the variables of the right ear and middle ear were found to be significant at 1% level of significance. The inner ear and lateral SCC were found to be significant, rest of the variables were uncorrelated $P > 0.01$; (Right part-2), the right part Mastoid and HRCT findings are shows that all variables were found to be significant at 1% level of significance. A total ($n = 33$) cases had complications from cholesteatoma. Among, the facial canal erosion (10%); malleus erosion (12%) and Stapes erosion (12%) were found to be statistically significant $P < 0.01$. The maximum prevalence of temporal bone pathologies was found in 21–30 years and 31–40 years age groups (26%) each in our study. Temporal bone disease prevalence predominated in males (60%). The maximum prevalence of temporal bone pathologies was found in the right ear (46%), followed by the left ear (40%).

Maximum patients presented with hearing loss, otalgia, otorrhea, and headache.

CONCLUSION

HRCT is better than conventional modalities of investigations and provides high spatial resolution and better soft tissue contrast.

For the assessment of middle ear infections, clinical correlation is needed to evaluate the nature of middle ear soft tissue masses as cholesteatoma is mimicked by many other middle ear pathologies.

In these cases, HRCT,

- Is far advantageous in assessing the complications of infection.
- Lays down an anatomical road map for the surgeon preoperatively.
- Predicts certain normal variants of surgical significance pre-operatively.
- Identifies the hidden areas of the middle ear.
- A previously operated ear has an altered anatomy. The disease of such an ear has a different morphological pattern of involvement.

CT scan plays an important role,

- To comment regarding the extent of surgery and the general overall condition of the post-operative temporal bone including the internal auditory canal.
- The residual/recurrent diseases can be assessed.
- The Status of the inner ear can be established.
- Facial nerve anatomy can be clearly depicted.
- The relationship of the facial nerve to any surgical change or Cholesteatoma tissue can be best studied.
- The status of the ear ossicles or prostheses employed by the surgeon can be seen.

Neoplastic disease of the middle ear is best staged with HRCT. HRCT is not diagnostic of the pathological condition, hence the nature of the neoplastic process needs to be evaluated by a post-contrast scan.

The major functions of HRCT in the valuation of tumors of the temporal bone are summarized as follows –

- When tumors are present in the middle ear, HRCT serves to differentiate tumor from vascular anomalies and to determine the extent of deep involvement often obviating the need for angiography.

Where tumors are present by tinnitus or cranial nerve deficit without mass in the middle ear, HRCT serves to differentiate tumors from other benign and malignant lesions. When a lesion is large or appears atypical, angiography is of complementary value. Otherwise, unless embolization is contemplated, angiography is not always necessary.

By precisely defining intra-tympanic, mastoid, jugular wall, infra-labyrinthine, and petrous apical involvement as well as posterior, middle, and infratemporal fossa extension. HRCT provides essential information for planning the surgical approach.

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