A Hospital based study of High Resolution Computed Tomography and Conventional Radiography for Evaluation of Pathologies of Temporal Bone

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ABSTRACT

Background:

Many imaging modalities have been in use for the evaluation of temporal bone lesions. Plain X-rays are cost-effective however; they provide limited details and hence sometimes may result in an inaccurate diagnosis. With the advent of HRCT, the method of imaging of temporal bone has evolved with special algorithms and multiplanar formats. In the present study, we tried to evaluate the different pathologies of the temporal bone with X-ray and HRCT.

Methods: The study was conducted in the Departments of Otorhinolaryngology and Radiology, Prathima Institute of Medical Sciences, Naganoor, Karimnagar. A total of n=40 patients were identified and selected based on their symptoms and clinical findings suggestive of a lesion involving the temporal bone such as Otalgia, Otorrhoea, And Sensorineuronal deafness, pulsatile tinnitus, vertigo, and giddiness. These patients were subjected to high resolution computed tomography of the temporal bone on the 128 Slice CT Scanner (PHILIPS INGENUITY). The patients also underwent plain Radiography of temporal bone (CARESTREAM DRX-1 System).

Results: Of the total n=40 patients studied the most common temporal bone disease was due to inflammation 85% and tumors were found in 15% of the patients. The common site of involvement of middle ear and mastoid air cells in chronic otitis media was epitympanum in n=30(90%) of cases, Mesotympanum in n=20(60%) of cases. In diseased ears, radiographs of the mastoids revealed pneumatised mastoid in 6(15%), diploic in 6(15%), and sclerosed mastoid in 28(70%) cases. HRCT temporal bone revealed pneumatised mastoid in 9(22.5%), diploic in 5(12.5%) and sclerosed mastoid in 26(65%) cases.

Conclusion: The role of plain radiography is found to be limited to know the type of mastoid pneumatisation. It can also as detect bony erosion in few cases. Because of 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 tympanomastoid compartment with adjacent neurovascular structures, varied pneumatisation and the presence of anatomical variations, which should alert the clinician and guide in surgical approach and treatment plan.

Keywords: High Resolution Computed Tomography, Conventional Radiography, Temporal bone pathologies.

INTRODUCTION

The assessment and treatment of complex lesions of the temporal bone is an important challenge for both Radiologists and Otolaryngologists. Radiographic evaluation of temporal bone is difficult due to the complicated anatomical structure of the middle and the inner ear. Several imaging methods are now available for the assessment of the temporal bone, including plain radiography, angiography, CSF analysis, air, and non-ionic contrast cisternography, Computed Tomography (CT), and Magnetic Resonance Imaging (MRI). CT and MRI are currently the most widely used techniques and have to an extent replaced the other modalities [1]. However, Conventional radiography is still of value in screening the entire temporal bone. It produces a composite single plane image of a tridimensional temporal bone resulting in superimposition, where larger and denser structures obscure smaller and less dense ones. The usage of MDCT, with high-resolution scanning and multiplanar reconstruction capability, has greatly simplified the evaluation of the various anatomical components of the temporal bone. As CT scans are more accurate in identifying many soft tissue abnormalities and are much less prone to artifacts, they have largely replaced polysomnography; there is also less radiation to the lens of the globe with CT scans than with polysomnography. CT has the advantage of producing images with higher contrast and a better spatial resolution [2].

MRI has expanded the range of pathology that can be meticulously evaluated because it can image many soft tissue entities not visible by other techniques. MRI studies can also be extremely useful in the evaluation of blood vessel-related disorders of the temporal bone. All the techniques have their advantages and disadvantages, and often more than one examination is necessary for a complete temporal bone evaluation. HRCT, a modification of routine CT provides a direct visual window into the temporal bone providing hitherto unavailable minute structural details [3]. The purpose of the study is primarily to understand the capability of radiography and HRCT in the diagnosis and detection of pathologies of the temporal bone.

MATERIALS AND METHODS

A prospective study was conducted in the Departments of Otorhinolaryngology and Radiology, Prathima Institute of Medical Sciences, Naganoor, Karimnagar. Institutional Ethical committee permission was obtained for the study. Written consent was obtained from all the participants of the study. The patients were selected based on the inclusion and exclusion criteria.

Inclusion criteria:

1. All-Age groups.

2. All patients who are clinically suspected of having diseases related to the temporal bone.

Exclusion criteria:

1. Pregnant women with suspected temporal bone disease.

2. Patients in whom CT was contraindicated due to any reason.

3. Patients with prior temporal bone surgery.

4. Patients with a history of temporal bone trauma.

A total of n=40 patients were identified and selected based on their symptoms and clinical findings suggestive of a lesion involving the temporal bone such as Otalgia, Otorrhoea, And Sensorineuronal deafness, pulsatile tinnitus, vertigo, and giddiness. After a thorough history and complete clinical examination, these patients were subjected to high resolution computed tomography of the temporal bone on 128 Slice CT Scanner (PHILIPS INGENUITY). The patients also underwent plain Radiography of temporal bone (CARESTREAM DRX-1 System).

In the case of temporal bone inflammation, the parameters studied are:

1. Status of mastoid pneumatisation

2. Soft tissue density

3. Erosion of scutum, tegmen, labyrinth, sinus plate, mastoid cortex

4. Facial canal erosion

5. Ossicular chain status

6. Extension outside temporal bone

In the case of tumors, the parameters studied are:

1. Lesion origin and extent

2. Erosion/remodeling of adjacent bony structures

3. Involvement of adjacent neurovascular structures

4. Intraaxial complications.

Later the lesions were confirmed by biopsy/surgery/ follow-up as and when required. Descriptive statistical analysis has been carried out in the present study. Results are presented in Number (%). Chi-square test has been used to find the significance of the association of Radiographic findings of mastoid pneumatization with HRCT findings of mastoid pneumatization. The P-value less than 0.05 was considered statistically significant at the 95% confidence interval.

Results

This prospective study was done to find the role of HRCT and Radiography in the evaluation of temporal bone lesions. In this study, there was a male preponderance (65%) when compared to females who accounted for (35%) of cases. The age range was from 8 years to 65 years. The commonly involved age group was 21 – 30 years with n=12 (30%) patients.

Table 1: Age-wise distribution of study population

Age	Number	Percentage
0-10 yrs	3	7.5
11-20 yrs	10	25
21-30 yrs	12	30
31-40 yrs	6	15
41-50 yrs	4	10
51-60 yrs	4	10
61-70 yrs	1	2.5
Total	**40**	**100**

Table 2: Gender wise distribution of the study population

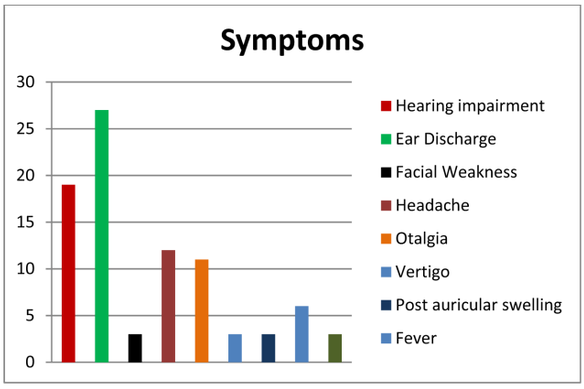
Gender	Number	Percentage
Male	26	65
Female	14	35
Total	40	100

Of the total n=40 patients studied the most common temporal bone disease was due to inflammation 85% and tumors were found in 15% of the patients. In this study, the chief presenting symptoms were ear discharge, hearing loss and headache. 3 patients had ipsilateral facial nerve palsy. 3 patients had postauricular swelling.

Table 3: Distribution of temporal bone disease among the study population

Disease	Number	Percentage
Inflammation	34	85
Tumors	6	15
Total	40	100

Graph 1: Showing the frequency of the Presenting Symptoms



In this study, the maximum percentages of patients with the inflammatory disease were found in the age range of 21 to 30 years (29.4%) followed by the age 11 – 20 years having 26.4% of patients. This shows that inflammatory diseases are more likely to affect the younger age group. In this study, the most commonly affected side was the right side in n=16(44%) out of n=34 inflammatory diseases. The left side was involved in n=11(35%) and bilateral involvement was noted in n=7(21%) of patients.

Table 4: Age and wise distribution of inflammatory disease among the study population

Age	Male	Female	Number	Percentage
0-10 yrs	2	1	3	8.8
11-20 yrs	8	1	9	26.4
21-30 yrs	5	5	10	29.4
31-40 yrs	4	2	6	17.6
41-50 yrs	3	1	4	11.7
51-60 yrs	2	0	2	5.8
61-70 yrs	0	0	0	0
Total	24 (70.6%)	10 (29.4%)	34	100

The common site of involvement of middle ear and mastoid air cells in chronic otitis media was epitympanum in n=30(90%) of cases, Mesotympanum in n=20(60%) of cases, Hypotympanum in n=17(51.5%) of cases, Protympanum and posterior tympanum in n=18(54.5%) each, antrum in n=21(63.6%), Aditus in n=22(66.6%) and Mastoid air cells in n=28(84.8%).

Table 5: HRCT findings in COM

HRCT Findings	No. Cases (n=3)	Percentage
Soft Tissue Density	33	100
Ossicular erosion	28	84.8
Malleus	16	48.4
Incus	27	81.8
Stapes	21	63.6
Scutum erosion	27	81.8
Tegmen erosion	8	24.2
Facial canal erosion	6	18.1
Labyrinthine fistula	4	12.1
Mastoid cortex erosion	5	15.1
Sigmoid Sinus plate erosion	6	18.1

Neoplasms were detected in n=6(15%) of the total n=40 patients in the study. The most common neoplasm was acoustic schwannoma in n=3 (50%) of the patients. The other distribution of neoplasms is given in table 6. The acoustic schwannoma was found in n=3 patients out of which n=2 were from the age group 61-70 years and n=1 was from age group 51- 60 years. Mastoid osteoma n=2 cases were found in the age group of 21 - 30 years. Similarly, the n=1 cases of meningioma were also found in the age group of 21 - 30 years.

Table 6: Distribution of specific neoplasms

Neoplasm	Male	Female	Number	Percentage
Acoustic Schwannoma	0	3	3	50
Osteoma	1	1	2	33.3
Meningioma	1	0	1	16.7
Total	2	4	6	100

In this study, a High riding jugular bulb (20%) is the most common anatomic variant, followed by anterior lying sigmoid sinus (5%), Koerner's septum (5%) and low lying dura. In diseased ears, radiographs of the mastoids revealed pneumatised mastoid in 6(15%), diploic in 6(15%), and sclerosed mastoid in 28(70%) cases. HRCT temporal bone revealed pneumatised mastoid in 9(22.5%), diploic in 5(12.5%) and sclerosed mastoid in 26(65%) cases.

Table 7: Cross Tabulation showing status of mastoid pneumatisation

Imaging modality			HRCT Temporal bone			Total
			Pneumatised	Diploic	Sclerosed	
Radiograph Mastoids	Pneumatised	Cases	6	0	0	6
		percentage	15	0	0	15
	Diploic	Cases	3	3	0	6
		percentage	7.5	7.5	0	15
	Sclerosed	Cases	0	2	26	28
		percentage	0	5	65	70
Total		Cases	9	5	26	40
		percentage	22.5	12.5	60	100

The p-value using the chi-square test is 0.682 greater than 0.05 hence statistically insignificant.

DISCUSSION

The temporal bone is a complex structure consisting of the outer, middle and inner ear and various involved structures such as ossicles which are of small size thus challenges the limits of resolution by imaging techniques. Computed Tomography is acquiring an increasingly important role in the radiographic assessment of temporal bone. Excellent resolution of computed tomography provides unprecedented detail of the temporal bone. In this study, we evaluated n=40 patients with suspected temporal bone lesions. The method of evaluation was with Law's view Radiography (CARESTREAM DRX-1 System) and 128 Slice CT Scanner (PHILIPS INGENUITY) and findings were correlated with follow up/biopsy/surgical findings where ever necessary. Among n=40 patients studied; infections were the most common lesions, seen in n=34(85%) of patients and neoplasms were the second most common lesions, seen in n=6(15%) of patients. In this study, the maximum percentages of cases were seen in the age range of 21-30 years. The study by G Lloyd et al; [4] in 30 patients with CT showed infection as the 3rd most common cause of the temporal bone lesion. 1st and 2nd were tumors and temporal bone trauma respectively. Out of the n=34 cases of inflammatory diseases, 33(97%) were Chronic otitis media and n=1 (3%) was malignant otitis externa. Among the n=34 cases of temporal bone infection, there were n=23 male and n=11 female patients. The male to female ratio is 2.1:1. The distribution of genders of the patients showed a preponderance of temporal bone infection in men (67.6%), compared to women (32.4%). This is similar to the study of Paparella et al; [5] but the contrast to Vlastarakos et al; [6] and M Sunita et al; [7] who found no gender predilection and Gomaa et al;[8] who found female predilection. Male gender occurrence in our study is explained by the fact that in our country, they are exposed to cold, moisture, pollutants, more than women. The common presenting symptoms were ear discharge and impairment of hearing. The discharge was scanty, foul-smelling and purulent it is similar to Gomaa et al; [8]. In this study, non-dependent soft-tissue opacity was present in 100% of patients with COM. This is similar to findings by Sirgiri et al; [7] and Gomaa et al; [8] who reported it in 92%. Early Prussak's space cholesteatoma was detected in n=3 patients as a localized small soft tissue density mass slightly eroding the scutum and displacing the ossicles medially. ossicle erosion was seen in 84.8% of patients with COM in this study. This is per findings by, Banerjee et al; [11] who found it in 82%, Keskin et al; [11] who found it in 76.78% of their patients. Swartz et al; [12] found ossicular erosion in 50% of their patients. It is lesser compared to our study. This difference in rates might be due to inappropriate angles of coronal sections and partial volume artifacts of soft tissue in earlier low-resolution CT scanners. In the current study Incus was the commonest ossicle to be involved in 81% which is similar to 84.2% found by Gomaa et al; [8] and 86.1% seen by Mohammadi et al; [13]. Stapes were the second most commonly seen in 63% and malleus the least commonly seen in 48% of patients HRCT could detect the

erosion of ossicular chains. In this study, 81.8% of patients with chronic otitis media had scutum erosion. The labyrinthine fistula was seen in 12% of patients with cholesteatoma. The values are similar to Gomaa et al; [8] found labyrinthine fistulas in 9%, Banerjee et al; [10] found in 10%, but less than findings of Jackler et al; [14] they found in 19% of cases. In this study, sigmoid sinus plate erosion was found by HRCT in 18% of patients with COM. This value is higher than 14% as reported by both Abdel Karim et al; [15] Gomaa et al; [8] and 2% as reported by M S and A P S (2015)28. In our study, mastoid cortex erosion was seen in 15% of patients with COM. This value is higher to 7% as seen by Keskin et al; [11] and 5% as seen by M Sunita et al; [7]. In our study tegmen erosion was seen in 24%, out of which tegmen tympani was involved in 18% and tegmen mastoideum in 6%. This value is much higher than studies by Keskin et al; [11] found tegmen erosion in only 5% of patients. HRCT was found to be an excellent tool to detect other complications such as extradural abscess and mastoid abscess. Out of 6 neoplastic lesions that we came across during the study n=3(50%) were diagnosed as acoustic schwannoma. The age group of these patients in our series varied from 51 years to 69 years. The mean age is 61.6 years, which does not correlate with Kennedy et al; [16] found that about 80% of vestibular schwannomas presented between the third and fourth decades. There is a female preponderance in our study (100%), similar to Kennedy et al; [16]. Headache and vertigo are the most common presenting complaints. A left CPA predominance was noted in our study. All cases were centered on porus acoustics, at acute angles to petrous bone and hypodense to isodense to the surrounding brain. All cases depicted internal auditory canal widening which does not correlate with Kennedy et al; [16] found IAC widening in only 58% of cases. Calcification and hyperostosis were not evident, All the lesions were large (>26 mm) in size similar to Kennedy et al; [16].

We came across two rare cases of temporal bone osteoma in young patients causing cosmetic deformity. Both are seen in the age range of 20-30 years, and in the mastoid, which correlates with the study by Denia et al; [17] and H Garcia et al; [18]. The male to female ratio is 1:1. On radiological examination, temporal bone radiograph showed a well defined, round to oval dense radiopacity in mastoid with preserved diploe in both cases. On HRCT of the temporal bone, a moderate-sized, lobulated, and densely calcified lesion of bone attenuation was noted in the right mastoid without the involvement of the diploe of the inner table of calvarium in one case. Holmquist et al; [19] stated that the success of the middle ear surgery depends on the degree of mastoid pneumatisation. Most of the mastoids in this study were sclerotic followed by pneumatised and diploic. These values are comparable to studies by Sethi et al; [20] found well-pneumatised mastoid in 48% and poorly pneumatised in 52% patients. The coincidence of x-ray and HRCT findings of the status of mastoid was 87.5%, the difference was seen in 12.5%. P-value using the chi-square test is 0.682. In our study, Radiograph was 87.5% accurate in detecting the status of mastoid pneumatisation. However, HRCT provides a thorough detail regarding the air cells. The types of air cells can be better known with HRCT. HRCT, which correlates with studies by Vlastarakos et al; [6] found a strong agreement for mastoid cell aeration. A well-taken radiograph of temporal bone provides the mastoid pneumatisation status. However, HRCT has the advantage of excellent topographic visualization, devoid of artifacts from the superimposition of structures. It helps inaccurate assessment of pathology before surgical exploration regarding location, extent, and complication of the disease.

CONCLUSION

The role of plain radiography is found to be limited to know the type of mastoid pneumatisation. It can also as detect bony erosion in few cases. Because of 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 tympanomastoid compartment with adjacent neurovascular structures, varied pneumatisation and the presence of anatomical variations, which should alert the clinician and guide in surgical approach and treatment plan.

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