ORIGINAL ARTICLE

Role of High-resolution computed tomography (HRCT) in the detection of temporal bone pathology with Histopathological correlation

M S Showkat[1], A I Ahsan[2], N Gafoor[3], Lkhandokar[4], S N Shakil[5], SN Tushar[6]

ABSTRACT

Background & objective: Pathology of ear is the third most common reason of visiting an Otorhinolaryngologist. Imaging plays an important role, especially in complicated and recurrent conditions and influence the treatment.Because of complicated anatomy radiographic assessment of temporal bone is difficult. An HRCT scan is useful for detail anatomical evaluation, assessment of different pathology, determining the extension and site of cholesteatoma and its sac, assessing the ossicles, evaluating the facial nerve, tegmen and sinus plate, and determining dural, sigmoid sinus, and jugular bulb positions. It is excellent in accurate assessment of pathology prior to surgical exploration regarding location, extent and complication of the disease.

Method: A cross sectional study was carried out in the Department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka in collaboration with the Department of Pathology and Department of ENT of BSMMU and ENT and Head Neck Cancer Hospital, Dhaka, during December 2016 to November 2017, to evaluate the extent of middle ear infections, benign and neoplastic conditions involving temporal bone according to compartment involved.For this purpose, a total of 65 patients having symptoms related to temporal bone pathology was included in this study. HRCT was done for every patient. HRCT findings and diagnoses of the pathologies were then correlated with the histopathological reports. Consecutive type of purposive sampling method was used in this study.

Result: There was mild male preponderance.Majority (96.9%) patients had soft tissue lesion evaluated .by high-resolution computed tomography (HRCT) findings. Predominant findings are inflammatory, 52(80.0%) of the patients , followed by 11(16.9%) benign and 2(3.1%) malignant lesions. In histopathological evaluation 53(81.5%) of the patients had Inflammatory condition, followed by 11 (16.9%) benign and 1(1.5%) malignant lesions. The validity test of CT scan in the evaluation for benign lesion had sensitivity 81.8%, specificity 96.3%, accuracy 93.8% and positive predictive values 81.8% and negative predictive value 96.3%. CT in the evaluation for malignant lesion had sensitivity 100.0%, specificity 96.9%, accuracy 96.9%, positive predictive values 33.3% and negative predictive values 100.0%. CT in the evaluation for inflammatory lesion had sensitivity 94.3%, specificity 83.3%, accuracy 92.3%, positive predictive values 96.2% and negative predictive values 76.9%.

Conclusion: In this study we found significant correlation between the histopathological diagnosis and HTCT of temporal bone pathology, where the validity tests are higher in evaluation of malignant lesion followed by inflammatory and benign. So it can be concluded that the high-resolution computed tomography is a useful diagnostic modality which enables characterization of a wide range of temporal bone pathology and can be used as a reliable tool.

Key words: Temporal bone, High resolution computed tomography (HRCT), Cholesteatoma

*[1]*Dr. Mst Syeeda Showkat, Associate Professor, Department of Radiology & Imaging, BangaBondhu Sheikh Mujib Medical University*

[2]Dr. Ali imam ahsan, Consultant, ENT and Head Neck Cancer Hospital & Institute, Dhaka

[3]Dr. Nusrat Gafoor, Associate Professor & Consultant, Department of Radiology & Imaging, Ibrahim Cardiac Hospital & Research Institute. Dhaka, Bangladesh.

[4]Dr.Lubna khandokar, Associate Professor, Department of Dermatology, Bangabandhu Sheikh Mujib Medical University

[5]Dr. Shahryar Nabi Shakil, Associate Professor, Department of Radiology & Imaging, Dhaka Medical college, Dhaka

[6]Dr. Shaikh NuruzzamanTushar, Consultant, Department of Radiology & Imaging, Green life Medical College, Dhaka

**Corresponding author*

Date of submission: 08.04.2021, Date of acceptance: 16.06.2021

AKMMC J 2021; 12(2) : 91-97

Introduction:

Pathology of ear is the third most common reason of visiting an Otorhinolaryngologist, with inflammatory conditions of the middle ear being a frequent reason to prescribe antibiotics and perform surgery in children and teenagers.[1] Diagnosisof temporal bone pathologies was made by clinical examination aloneearlier, in majority of the cases. However, with an increase in the prevalence of infective pathologies of the ear, it was suggested that the current approach to preventing and treating these conditions was not adequate. Therefore, especially in complicated and recurrent conditions, imaging plays an important role, as imaging findings may fundamentally influence the treatment.[2]

Radiographic assessment of temporal bone is difficult owing to complicated anatomical structure of middle and inner ear. Computed tomography (CT) is the most widely used modalities for evaluation of the temporal bone pathologies.[3] CT scanning excels in the evaluation of bone and air space anatomy and disorders. Also, CT scans are more accurate in identifying many soft tissue abnormalities and are much less prone to artefacts.[4] With the advent of helical scanning techniques, CT is increasingly the imaging study of choice for definitive preoperative temporal bone imaging.[5] Special imaging procedures, such as high-resolution computed tomography (HRCT) may suggest the presence of cholesteatoma within the temporal bone, and may be used to complement the clinical examination. An HRCT scan is useful for planning the surgical approach, determining the extension and site of cholesteatoma and its sac, assessing the ossicles, evaluating the facial nerve, tegmen and sinus plate, and determining dural, sigmoid sinus, and jugular bulb positions.[6]

High-resolution CT (HRCT) of the temporal bone is the modality of choice for the preoperative evaluation of otosclerosis. Demineralised hypodense fenestra lotosclerotic foci are best seen on axial HRCT because of the anteroposterior orientation of the oval window and stapes crura. Fenestra lotosclerotic foci as small as 1 mm in size can be diagnosed on HRCT.[7] HRCT is widely used in diagnosis of inflammatory middle ear diseases, such as chronic otitis media or cholesteatoma and in evaluation of middle ear following mastoidectomy or tympanoplasty.[8] High-resolution CT is the most sensitive method for the imaging and classification of temporal bone fractures, including labyrinthine damage and ossicular chain injuries. Only in cases of atypical fractures with an unfavourable relationship to the CT planes, can carefully directed tomography be more effective. In most cases high-resolution CT replaces conventional radiology and should be the method of choice for comprehensive radiological examination of the temporal bone. The HRCT temporal bone gives valuable information for evaluation of congenital anomalies, inflammatory diseases, otosclerosis, tumors and cerebellopontine angle lesions, post-operative mastoid cavities, anatomical variants as well as temporal bone trauma.[3] High Resolution Computed Tomography (HRCT) has the advantage of excellent topographic visualization, devoid of artifacts from superimposition of structures. It helps in accurate assessment of pathology prior to surgical exploration regarding location, extent and complication of the disease.

Methods and Materials:

A cross sectional study was carried out in the department of Radiology and Imaging,Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhakain collaboration with the Department of Pathology and Department of ENT of BSMMU and ENT and Head Neck Cancer Hospital, Dhaka from January 2016 to December 2017. Patients referred to the Department of Radiology and Imaging, BSMMU, Dhaka having symptoms related to temporal bone pathology referred for High-resolution Computed tomography (HRCT) were included in this study.Then HRCT of the temporal bone was done with proper protocol.HRCT findings and diagnoses of the pathologies were then correlated with the histopathological reports.Consecutive type of purposive sampling method was used in this study. Patients with electric devices at the skull base, such as cochlear implants, with history of trauma,with congenital anomalies andpatients who didn't give consentwere excluded from the study.

Imaging technique and procedure

Patients were placed on the table for the HRCT scan. Variations in head position (rotation at the neck and lateral bending of the neck) were corrected by using the software supplied by the manufacturer. The age and sex of each patient were noted. The scans were obtained on a Whole body CT scanner system SCENARIA HITACHI 64 slice using the following scan parameters: 120 kV, 350 mA (axial) and 200 mA (coronal), 1-mm slice thickness, zero interslice gap, 512 × 512 matrix and bone algorithm. The axial scans were parallel to the orbitomeatal line (outer canthus of the eye to external auditory meatus), and the coronal scans were obtained from the scanned data.The image data were transferred to aworkstation by standard computer network. The 2D multiplanar reconstruction function from the manufacturer was employed to reconstruct each 2D series. The maximum intensity projection, 1-mm sections and zero interslicegap were used. The images were viewed and measurements were made on a standardized window width setting of 4000 HU and a window level of 1000 HU to optimize the contrast and spatial resolution in the temporal bone and maximize the resolution of small and dense structures such as the semicircular canals. Measurements were made directly at the workstation.

Statistical Analysis of Data:

Data were processed and analyzed using SPSS (statistical package for the social science Inc., Chicago, Illinois USA,) version 16.0. The sensitivity, specificity, accuracy, positive predictive values and negative predictive values of HRCT and biopsy findings in diagnosis of temporal bone lesions were calculated out. A "p" value <0.05 was considered as significant.

Results:

This cross sectional study was carried out to evaluate the extent of middle ear infections, benign and neoplastic conditions involving temporal bone according to compartment involved. For this purpose, a total of 65 patients having symptoms related to temporal bone pathology referred to Department of Radiology and Imaging were included in this study.

Table I: Distribution of the study patients by demographic variable (n=65)

Demographic variable	Frequency	Percentage
Age		
21-30	19	29.2
31-40	30	46.2
41-50	16	24.6
Sex		
Male	40	61.5
Female	25	38.5

Table II: Distribution of the study patients by HRCT findings (n=65)

HRCT findings	Frequency	Percentage
Soft tissue lesion	63	96.9
Opacified mastoid	19	29.2
Ossicular and scutum erosion	18	27.7
Erosion of tympanic wall	11	16.9
Erosion of tegmen tympani	7	10.8
Erosion of vestibule and facial canal	3	4.6
Erosion of sigmoid sinus plate	2	3.1
Erosion of lateral semicircular canal	2	3.1

Table III: Comparison CT findings of Benign lesions with histopathology (n=65)

CT finding	Histopathologicalfinding		Total
	Positive	Negative	
Positive for Benign	9 (true positive)	2 (false positive)	11
Negative for Benign	2 (False negative)	52 (true negative)	54
Total	**11**	**54**	**65**

In this current series, it was observed that, true positive 9 cases, false positive 2 cases, false negative 2 and true negative 52 cases are identified by histopathological finding.

Table IV: Comparison CT findings of Malignant lesions with histopathology (n=65)

CT finding	Histopathological finding		Total
	Positive	Negative	
Positive for Malignant	1 (true positive)	1 (false positive)	2
Negative for Malignant	0 (False negative)	63 (true negative)	63
Total	**1**	**64**	**65**

In this current series, it was observed that, true positive 1 case, false positive 1 case, false negative 0 and true negative 63 cases are identified by histopathological finding.

Table V: Comparison CT findings of Inflammatory lesions with histopathology (n=65)

CT finding	Histopathological finding		Total
	Positive	Negative	
Positive for Inflammatory	50 (true positive)	2 (false positive)	52
Negative for Inflammatory	3 (False negative)	10 (true negative)	13
Total	**53**	**12**	**65**

In this current series, it was observed that, true positive 50 cases, false positive 3 cases, false negative 2 and true negative 10 cases are identified by histopathological finding.

Table VI: Sensitivity, specificity, accuracy, positive and negative predictive values of Benign, Malignant and Inflammatory diseases.

Validity test	Benign	Malignant	Inflammatory
Sensitivity	81.8	100.0	94.3
Specificity	96.3	96.9	83.3
Accuracy	93.8	96.9	92.3
Positive predictive value	81.8	33.3	96.2
Negative predictive value	96.3	100.0	76.9

The validity test of benign tumor has sensitivity 81.8%, specificity 96.3%, accuracy 93.8% and positive predictive values 81.8% and negative predictive value 96.3%. The validity test of CT in the evaluation for malignant has sensitivity 100.0%, specificity 96.9%, accuracy 96.9%, positive predictive values 33.3% and negative predictive values 100.0%. The validity test of CT in the evaluation for inflammatory has sensitivity 94.3%, specificity 83.3%, accuracy 92.3%, positive predictive values 96.2% and negative predictive values 76.9%.

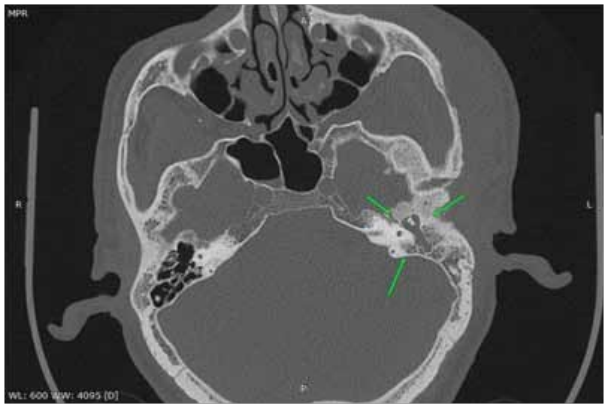

Figure-1: Left sided chronic otomastoiditis with inflammatory granulation tissue/cholesteatoma within the tympanic cavity and mastoid antrum.

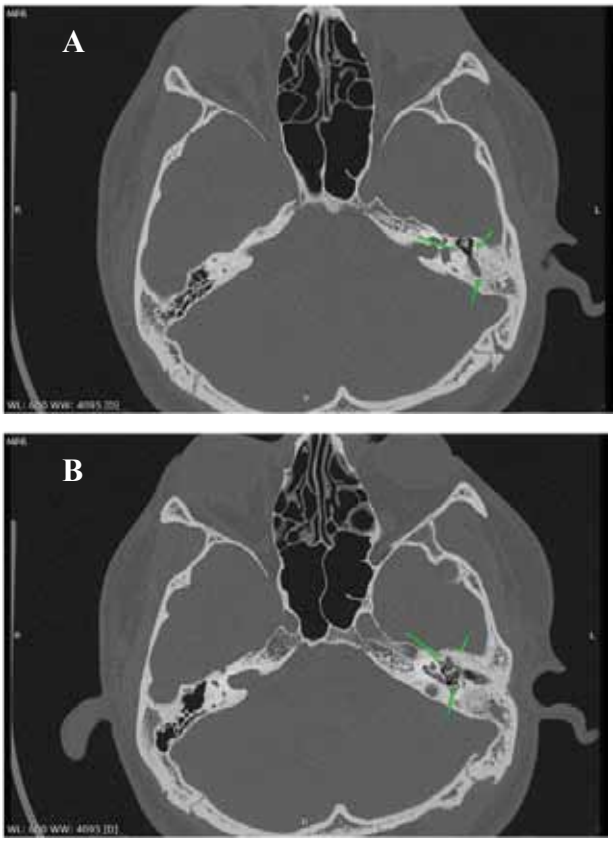

Figure-2 (A,B): Left sided chronic otomastoiditis. Mucosal thickening and collections are seen in tympanic cavity and mastoid antrum.Loss of pneumatization of the mastoid air cells with sclerosis of their walls is seen.

Middle ear ossicles are normal and ossicular chain is maintained.

Discussion

In this current study it was observed that almost half (46.2%) clinically suspected patients having symptoms related to temporal bone belonged to age 31-40 years followed by 29.2% age belonged to 21 -30 years and 24.6% age belonged to 41 -50 years which was in accordance with the study performed by Bagul (2016).[9] Similarly Shankhwar et al. (2016) study showed the youngest patient was 15 months and the oldest was 66 years and maximum (30.0%) patients were in the age group 21 to 30 years which matched with our study.[10] Similar findings was also observed by Gerami et al., 2009.[11] In another study Jyothi and Shrikrishna (2016)[12] observe the age group of the subjects varied from 7 to 60 years, which differed a bit

with the present study.In this present study it was observed that nearly two third (61.5%) patients were male and 38.5% female as well as male to female ratio was 1.6:1. Similar findings was reported byBagul, (2016) 9 who observed that temporal bone pathologies were more common in male where the gender ratio male:female was 2:1 which closely resembles with the present study.Similarl male predominance was also observed by Jyothi&Shrikrishna (2016), Shankhwar et al. (2016) and Viastarakos et al. (2012). [12,10,13]

In HRCT findings it was observed in this present series that majority (96.9%) patients had soft tissue lesion, followed by 29.2.8% opacified mastoid, 27.7% ossicular and scutum erosion, 4.6% Erosion of tympanic wall, 10.8% erosion of tegmen tympani, 4.6% erosion of vestibule and facial canal and 3.1% erosion of sigmoid sinus plate and 3.1% erosion of lateral semicircular canal. Findings were comparable to the study conducted byBagul (2016)9 which showed thecommon HRCT findings in the cholesteatoma was soft tissue lesion in 100% followed by ossicular and scutum erosion 95%, erosion of tympanic wall 90%, opacified mastoid 57%, erosion of sigmoid plate 42%, erosion of lateral semicircular canal wall and tegmentympanii 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, observed by study of Mafee et al. 1988).[14] Similar findings were observed in the studies of Shankhwar et al. 2016; Sirigiri&Dwaraknath, 2011).[10,15]

In this study it was observed that a total 2 cases were diagnosed as malignant lesion evaluated by CT diagnosis among them true positive 1 case, false positive 1 case, false negative not found and true negative 63 cases identified by histopathology. In this study it was observed that a total 52 cases were diagnosed as Inflammatory lesion identified by CT diagnosis among the true positive 50 cases, false positive 2 cases, false negative 3 and true negative 10 cases identified by histopathology. 1 case of cholesteatoma was falsely diagnosed as being malignant by HRCT.Shankhwar et al. (2016)10in their study observed that HRCT diagnosed tumours as 4 cases of Acoustic neuroma, 1 Glomustympanicum and 1 Metastasis. On surgical follow up, it was found that one case of Meningioma was falsely diagnosed as Acoustic neuroma on HRCT and also one case of inflammatory polyp was falsely branded as neoplastic polyp by HRCT. In this present study it was observed that, the validity test of CT scan in the evaluation for benign lesion had sensitivity 81.8%, specificity 96.3%, accuracy 93.8% and positive predictive values 81.8% and negative predictive value 96.3%. On the other hand, the validity test of CT in the evaluation for malignant lesion had sensitivity 100.0%, specificity 96.9%, accuracy 96.9%, positive predictive values 33.3% and negative predictive values 100.0%. Sensitivity and specificity for diagnosing malignancy by HRCT in Shankhwar et al. (2016)[10] study was found to be 85.7% & 97% respectively and PPV & NPV for diagnosing malignancy by HRCT was found to be 85.7% & 97% respectively which were a bit lower compared to our study Similarly, the validity test of CT in the evaluation for inflammatory lesion had sensitivity 94.3%, specificity 83.3%, accuracy 92.3%, positive predictive values 96.2% and negative predictive values 76.9%. Shankhwar et al. (2016)[10] found that HRCT is 100% sensitive and specific to know the type of mastoid pneumatisation. Sensitivity, specificity, PPV & NPV of HRCT in diagnosing CSOM (with cholesteatoma and mastoiditis) was found to be 100% each which was similar to our study. HRCT was found to be excellent to detect the other complications such as mastoiditis and mastoid abscess with 100% sensitivity and specificity. The findings are in concordance with the study of Kanotra et al.(2015).16Shankhwar et al. (2016)[10] also reported that HRCT detected scutum erosion accurately in all cases and found 100% sensitive and specific to detect scutum erosion.[10] Similar findings was also observed by Rai (2014).[17] Thukral et al. (2015)[18] reported that the surgical and radiological findings showed a high level of sensitivity 89.29% in the identification of cholesteatoma.HRCT provides a good sensitivity of 80.65% in the identification of changes to the ossicular chain despite the presence of surrounding soft tissue. HRCT was highly informative in

identification of erosion of lateral semicircular canal. In diagnosis of facial canal dehiscence HRCT had a low sensitivity of 33.33%. Sensitivity of HRCTwas 91.3% in otosclerosisby Minutha et al. (2015) which correlated well with our study.[19]

Conclusion

The histopathological diagnosis of temporal bone pathology in this study correlated significantly well with high-resolution computed tomography, where the validity tests are higher in evaluation of malignant lesion followed by inflammatory and benign. So it can be concluded that the high-resolution computed tomography is a useful diagnostic modality which enables characterization of a wide range of temporal bone pathology and it should be worthy to note here that high-resolution computed tomography can be used as a reliable tool.

Conflict of interest: none.

References:

1. Brogan M and Chakeres DW. Computed tomography and magnetic resonance imaging of the normal anatomy of the temporal bone.In Seminars in Ultrasound, CT and MR 1989; 10(3):178-194.

2. Chakeres DW and Augustyn MA. Temporal bone imaging. Head and Neck Imaging, 4th ed. Mosby, St. Louis, M: 2003; 1093-1108.

3. Lustig LR, Limb CJ, Baden R and LaSalvia MT. Chronic Otitis Media. In: D. S. Basow (Ed.), 2013: Up To Date. Retrieved from www.uptodate.com

4. Phillips GS, LoGerfo SE, Richardson ML and Anzai Y. Interactive Web-based learning module on CT of the temporal bone: anatomy and pathology. Radiographics, 2012; 32(3): 85-105.

5. Tsilis NS, Vlastarakos PV, Chalkiadakis VF, Kotzampasakis DS and Nikolopoulos TP. 2013. Chronic Otitis Media in Children An Evidence-Based Guide for Diagnosis and Management. Clinical Pediatrics 2013; 52(9): 795–802.

6. Rogha M, Hashemi SM, Mokhtarinejad F, Eshaghian A and Dadgostar A. Comparison of preoperative temporal bone CT with intraoperative findings in patients with cholesteatoma. Iranian journal of otorhinolaryngology, 2014; 26(74): p.7.

7. Purohit B and Hermans R. Imaging in otosclerosis: A pictorial review. Insights into imaging 2014; 5(2): 245-252.

8. Chee NWC and Tan TY. The value of pre-operative high resolution CT scans in cholesteatoma surgery. Singapore medical journal2001; 42(4):155-159.

9. Bagul M.High-resolution Computed Tomography Study of Temporal Bone Pathologies. Headache 2016; 32:.26-66.

10. Shankhwar A, Dixit Y, Shukla P and Nagar A. High Resolution Computed Tomography Evaluation of Temporal Bone Lesions. Scholars Journal of Applied Medical Sciences2016. 4(7):2447-2449.

11. Gerami H, Naghavi E, Wahabi-Moghadam M, Forghanparast K and Akbar MH. Comparison of preoperative computerized tomography scan imaging of temporal bone with the intra-operative findings in patients undergoing mastoidectomy. Saudi medical journal2009; 30(1):104-108.

12. Jyothi AC and Shrikrishna BH. 2016. Role of high resolution computed tomography in the evaluation of temporal bone lesions: our experience. International Journal of Otorhinolaryngology and Head and Neck Surgery 2016; 2(3): 135-139.

13. Vlastarakos PV, Kiprouli C, Pappas S, Xenelis J, Maragoudakis P, Troupis G. and Nikolopoulos TP. CT scan versus surgery: how reliable is the preoperative radiological assessment in patients with chronic otitis media?European Archives of Oto-rhino-laryngology2012; 269(1):81-86.

14. MafeeMF, Levin BC, Applebaum EL, Campos M and James CF. Cholesteatoma of the middle ear and mastoid.A comparison of CT scan and operative findings. Otolaryngologic Clinics of North America1988; 21(2):265-293.

15. Sirigiri RR. andDwaraknath K. Correlative study of HRCT in attico-antral disease. Indian Journal of Otolaryngology and Head & Neck Surgery 2011; 63(2): 155-158.

16. Kanotra S, Gupta R, Gupta N, Sharma R, Gupta S. and Kotwal S. Correlation of high-resolution computed tomography temporal bone findings with intra-operative findings in patients with cholesteatoma. Indian Journal of Otology 2015; 21(4):280.

17. Rai T. Radiological study of the temporal bone in chronic otitis media: Prospective study of 50 cases. Indian Journal of Otology 2014; 20(2):48.

18. Thukral CL, Singh A, Singh S, Sood AS and Singh K. Role of high resolution computed tomography in evaluation of pathologies of temporal bone. Journal of clinical and diagnostic research 2015; 9(9):07.

19. Minutha R, Nathan S and Satheesh PV. HRCT in Conductive Hearing Loss: A Study of One Hundred Cases. International Journal of Modern Sciences and Engineering Technology (IJMSET) 2015; 2,(10): 5-11