Role of HRCT Temporal bone imaging in evaluation of patients with CSOM

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Abstract—Chronic suppurative otitis media (CSOM) is an inflammation of the middle ear that is clinically characterized byfever, earache ,ear discharge and hearing loss. Clinical examination using an otoscope or otoendoscope is the primary method of diagnosis. In our study, we examined the role of high resolution computed tomography in cases of chronic suppurative otitis media and determining the extent and severity of various other pathological conditions occurring in the temporal bone . Materials and Methods: Current study was a prospective crosssectional study was conducted in Maharajah's Institute of Medical Sciences, Nellimarla,from January 2021 to May 2022. 50 patients were included who wereclinically diagnosed with a chronic middle ear infection and who were referred to Department of Radio-diagnosis and Imaging for an HRCT scan of temporal bone. Results:In our study, a total number of 50 patients were involved.The Youngest patient was aged 8 years and oldest patient was of58 years age. Majority of patients wereaged between 21-30 years(30%) followed by in 11-20 years(27%) age group. In our study involvement of the mastoid air cell system and middle ear was found as follows: protympanum (22.00%); meso-tympanum (28.40%); posterior tympanum (31.00%); epitympanum (58.00%); hypotympanum (26.50%; aditus (53.93%); antrum (41.80%); mastoid air cells (57.90%). Conclusion:This study demonstrates that HRCT imaging is the gold standard for CSOM and in associated complications such as detecting early cholestatoma

IndexTerms—Chronic suppurative otitis media; High Resolution Computed tomography; Cholesteatoma

I. INTRODUCTION :

Chronic suppurative otitis media (CSOM) refers to the middle ear inflammation which is clinically characterized by the discharging ear, hearing deficit, fever and otalgia. Despite being a clinical diagnosis, imaging is crucial to rule out any related problems that, in addition to causing hearing loss, may prove lethal.Due to the tympanomastoid compartment's strategic location, which is isolated from the middle and posterior cranial fossa by a thin bony partition, otitis media has simple access and the greatest chance of intracranial spread . If detected early and treated effectively, it can be prevented[1]. Knowing the precise size and extent of the disease is therefore crucial before undergoing surgical treatment.Radiological examination of temporal bone plays an important role in providing crucial information to surgeon in this regard.[2,3]. The incidence rate of chronic suppurative otitis media (CSOM) is 4.76% (31 million cases) with 22.6% of under-five cases occurring every year[4].According to the The World Health Organization, CSOM affects 65–300 million individuals worldwide. Among them, 50% of persons experience hearing loss, and 28000 deaths annually are associated to otitis media complications. [5]. Cholesteatoma or a chronic mucosal disease may be the cause of chronic otitis media.Clinical examination is typically used to evaluate. It may not be possible to detect the extent and size of the lesion, despite the fact that otorhinolaryngologists can diagnose the majority of cholesteatomas with a detailed clinical examination.Conventional techniques of temporal bone imaging like X-Ray Mastoid bones have been replaced by High Resolution Computed Tomography (HRCT) at present. HRCT of mastoids is done to evaluateextent of disease and its complications. [6]. With advent of thin section HRCT, it can allow imaging of ossicular chain structures up to a spatial resolution of 0.45 to 0.65mm. [7]. A block of ultra-thin sections of CT imaging (thickness of 0.35mm) can be taken within a minute to cover entire temporal bone. [8]. HRCT scan of an acquiredcholesteatoma of temporal bone imaging could reveal homogeneous soft tissue mass with erosion of local bone, scutum and ossicles, middle ear opacification, and labyrinthine fistula extending to tympanum and widening of aditus and antrum HRCT can detect exposed dura, lateral canal fistulae, and facial canal dehiscences, and demonstrate ossicular chain. [9]. Labyrinthitis risk can rise with canal dehiscence, and brain pathology risk can rise with dural dehiscence. For patients who need surgery for middle ear disorders, having a preoperative knowledge of the anatomy and anomalies of dehiscence in the facial canal is crucial to preventing postoperative morbidity

The use of HRCT imaging of the temporal bone has grown in significance for diagnosis, surgical choice, and subsequent follow-up. To maintain a higher hearing rate and avoid problems, the surgical procedure decision is very crucial. [11]

In order to determine the degree and severity of various pathological changes occurring in the temporal bone in cases of chronic suppurative otitis media, this study was conducted.

MATERIALS AND METHODOLOGY:

This was a prospective cross-sectional study toevaluate the role of CT of the temporal bone in 50patients clinically diagnosed with a chronic middle ear infection and who were referred to the Department of Radiodiagnosis Maharajah's Institute of Medical Sciences, Nellimarla,from January 2021 to May 2022.

Inclusion criteria: All the patients with a chronic middle ear infection who were referred to the Department of Radiology for HRCT Temporal bone were taken into the study.

Exclusion criteria: Patients with electric devices at the skull base,pregnant women, such as cochlear implants, those who have undergone previous temporal bone surgeries, and those with a history of trauma to the temporal bone were excluded from the study. Patients who were not willing to undergo CT were also excluded.

All the scans were done using 16-detector row spiral ct scanner General electricals revolution Actsex 16 slice scanner.After written informed consent, patients were scanned inthe axial plane. Prior to the scan, regular topograms were performed on each subject. The inferior mastoid and lower margin of the external auditory meatus were included in the scanning, which extended upward to the arcuate eminence of the superior semicircular canal as seen on the lateral topogram.The patients were positioned with a slightly extended head to avoid gantry tilt and thereby protect the lens from radiation. Perpendicular to the axial plane, reformatted coronal images were acquired from the cochlea to the posterior semicircular canal. Scanning parameters: Each slice thickness with 0.63 mm applying 130 kV, 240 mAs.The images were reconstructed with a bone algorithm. All images were interpreted using source images, multiplanar reformations, and requiredwindow settings.

RESULTS:

Table 1:Distribution of age among the patients

Age group (Years)	Number(n=50)	Percentage(%)
<10	4	8
11-20	15	30
21-30	13	26
31-40	9	18
41-50	5	10
51-60	4	8
Total	**50**	**100.00**

Table 2: Distribution of gender among the patients

Gender	Number (n=50)	Percentage
Male	**29**	**58**
Female	**21**	**42**
Total	**50**	**100.00**

Table 3: Distribution of the CSOM in relation to the side of the ear affected

Side	Number (n=50)	Percentage(%)
Left	**26**	**52**
Right	**21**	**42**
Bilateral	**3**	**6**

Table 4: Distribution of presenting symptoms among the study group

Chief Complaints	Number of Patients	Percentage (%)
Ear discharge	**43**	**86**
Decreased Hearing	**30**	**60**
Earache	**15**	**30**

Headache	**8**	**16**
Tinnitus	**5**	**10**
Giddiness	**6**	**12**
Facial Paralysis	**0**	**0**

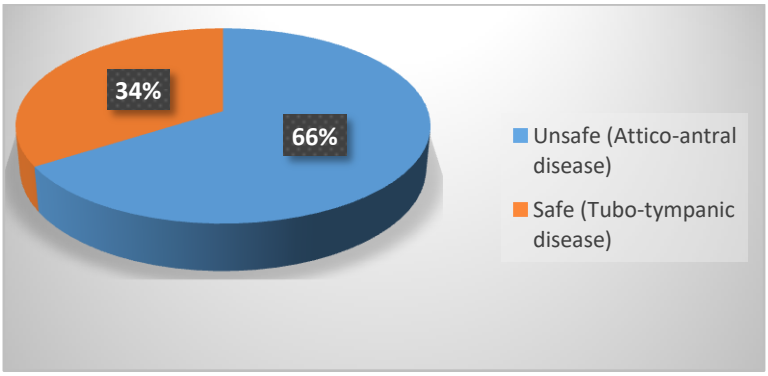
Table 5: Distribution of findings from the HRCT

Findings from the HRCT	Yes(%)	No(%)
Non-dependent soft tissue mass	62.00	38.00
Scutum erosion	44.00	66.00
Ossicular involvement	56.00	44.00
Labyrinthine fistula	4.00	96.00
Mastoid cortex erosion	9.00	91.00
Tegmen erosion	6.00	94.00
Mastoiditis with sub-periosteal abscess	58.00	42.00

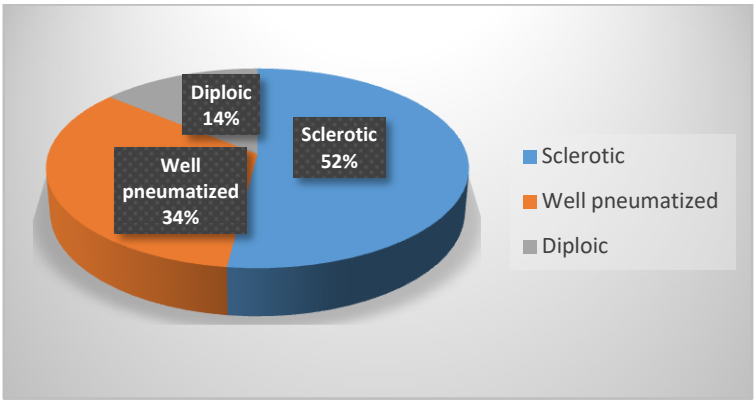
Table 6: Distribution of site and extent of involvement of the middle ear and mastoid air cell system from the HRCT images.

	Number	Percentage
Protympanum	**11**	**22.00**
Mesotympanum	**14**	**28.40**
Posterior tympanum	**15**	**31.00**
Epitympanum	**29**	**58.00**
Hypotympanum	**13**	**26.50**
Aditus	**27**	**53.93**
Antrum	**21**	**41.80**
Mastoid air cells	**29**	**57.90**

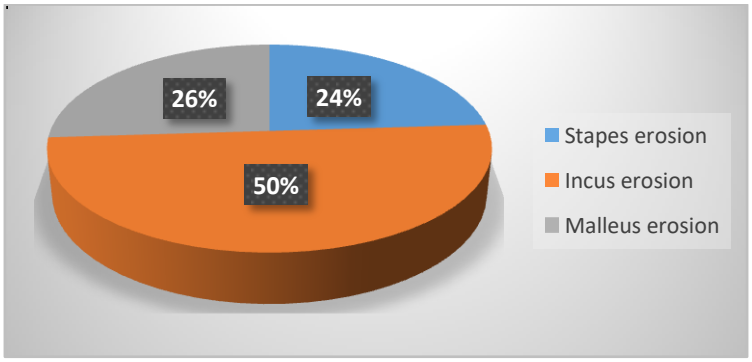
Graph 1: Distribution of the impression of HRCT findings regarding CSOM type



Graph 2: Distribution of the HRCT findings of temporal bone regarding mastoid pneumatization (n=50)



Graph 3: Distribution of the HRCT findings regarding ossicular involvement



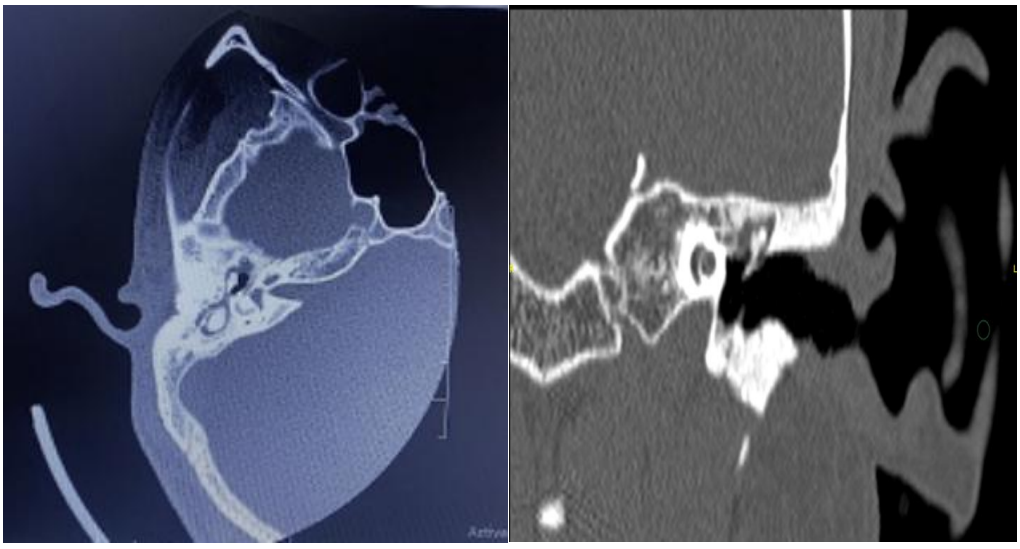
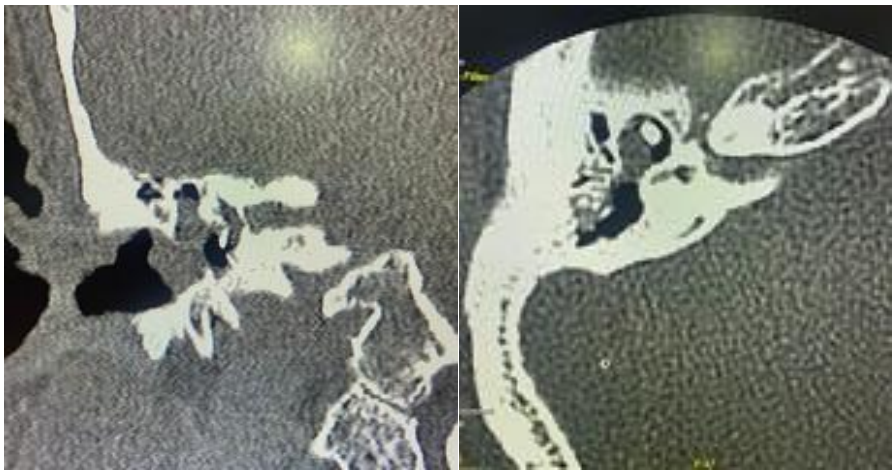


Fig 1: Soft tissue density partially filling right epitympanum,mesotympanum , aditus and mastoid antrum,extending into prussacks space with minimal erosion of roof of tympanic cavity



(a) (

Fig 2 a)Bony erosions are noted involving scutum, roof of middle ear cavity (tegmen tympani), roof of mastoid antrum (tegmen mastoideum).
b)There is destruction incus (- eroded) with loss of articulation between the malleus and incus

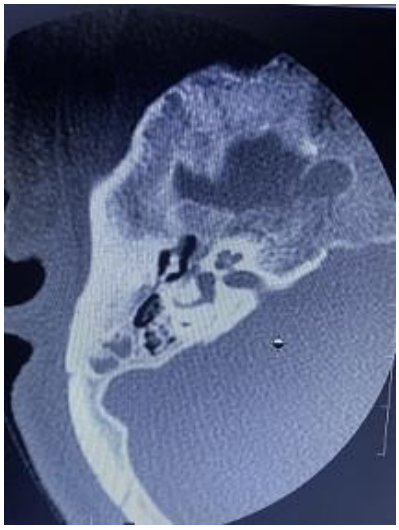


Fig 3: Minimal soft tissue attenuation is noted in mesotympanum and epitympanum

Fig 4: Soft tissue density filling in left epitympanum, mesotympanum, mastoid antrum extending into prussacks space

DISCUSSION:

The use of conventional radiography in determining mastoid pneumatization is limited. The HRCT of the temporal bone can show the soft tissue mass within the air spaces of the mastoid, middle ear, and external auditory canal in addition to providing great features of the temporal bone. Magnetic resonance imaging cannot visualise bony structures like scutum, ossicles, and labyrinthine capsules. Therefore, HRCT is the preferred method to evaluate middle ear pathology.[12]**.**

In our study, a total number of 50 patients were involved.The youngest patient was aged 8 years and oldest patient was of58 years age.Majority of patients wereaged between 21-30 years(30%) followed by in 11-20 years(27%) age group.This finding was similar to a study by Sharma et al where the majority of the patients belonged to the 21-30 years age group (40%) followed by 11-20 years (30%)(36). Dhulipalla et al also observed the majority of the patients (49%) the patients aged between 11 to 30 years. [11].

In this study, the mean age of the patients was 26.7 ±13.1 years. Thukral et al [19]. found that the mean of the patients was 27.95 years which was similar to our study finding [7]. Jadia et al, Chatterjee et al and Kanotra et al observed The mean age of the patients to be 23.2 years, 23.17 years, and 36.38 years respectively. [7,15,16]. Thus most of the studies which targeted to study the temporal bone pathologies had mentioned the mean age of the patients to be between 20 to 30 years.

In our study, the males (58%) were commonly affected than females (42%). Sharma et al identified more male patients (60%) than female patients (40%). [14]. Dhulipalla et al also observed more males (58%) than females (42%) in their study. [11]. Chatterjee et al also observed more male patients (68.86%) than female patients. [15]. Kanotra et al observed male patients (57.44%) be more than female patients (42.55%). [16]. Our study had the chief complaints in the following order: ear discharge (86%); decreased hearing (60%); earache (30%); headache (16%); giddiness (12%) and tinnitus (10%). Jadia et al observed that otorrhoea (100%) was the common presenting finding followed by hearing loss (98.1%), tinnitus (67.3%) and dull headache (21.2%). [7] Tamilarasan et al [13]. reported that the symptoms in their study population were otorrhoea (91.95%), hearing loss (59.77%), otalgia (29.89%), nausea and vomiting (11.49%), headache (10.34%), tinnitus (9.20%), fever with chills and rigors (9.20%) and swelling behind the ear (8.05%)). Dhulipalla et al [11]. observed that the common presenting symptoms of these patients in decreasing order were ear discharge (83%), decreased hearing (70%), otalgia (25%), headache (13%), tinnitus (8%), giddiness (8%).

The present study identified sclerosed mastoid in 52.0%, well pneumatised in 34%, and diploic mastoid in 14%. The finding of sclerosed mastoid pneumatization (100%) in the HRCT of the temporal bone was observed by Jadia et al. [7]. The characteristics of mastoid bone included wellpneumatised bone in 40.23%, sclerotic bone in 43.68%, and diploic bone in 9.20% as reported by Tamilarasan et al.[13]. Regarding the pneumatization of the mastoid, the HRCT revealed sclerotic mastoid in all the patients (100%) and pneumatic in none of the patients as identified by Kanotra et al. [16]. The current study found the presence of non-dependent soft tissue mass in 60.00% of the patients since the current had considered both safe and unsafe ear. Pathologies in the selection criteria. The cholesteatoma is highly suggestive with the presence of non-dependent soft tissue mass in the middle ear cavity. Payal et al observed the presenceof soft tissue mass in 86.67% of the temporal bone study. [18]. Chatterjee et al found the presence of soft tissue mass in all 100% of the patients. [15].

Our study found eroded scutum in 45% of theCSOM patients which was much similar to what Thukral et al [42]. study found. scutum erosion in 42% of the CT findings.Tamilarasan et al identified eroded scutum in 34.48%. [13]. Sharma et al identified 84% and Chatterjee et al found it in 67.07% of the cases. [14, 15]. Ossicular erosion inour study was 53.33% which was similar studies finding ossicular involvement was observed in 90%,62.28%, 73%, and 54.57% by Sharma et al, Chatterjee et al, Bathla et al and Gul et al respectively. [14, 15, 17, 20].

In our study, malleus erosion (26.00%), incus erosion (50.00%), and stapes erosion (24%) were observed in HRCT images which correlate with the findings of Tamilarasan et al and Payal et al. [13, 18]. Destruction of the ossicles is commonly seen in cholesteatoma which enlarges and erodes on touching the contiguous structures in the middle ear cleft. Prior knowledge of the ossicular involvement can help the surgeon in the decisionmaking to preserve the hearing.

The present study observed labyrinthine fistula in 4% of the patients. Tamilarasan et al observed it in 3.8% of the images. [13]. Mandal et al observed this finding in 4% of the images [21]. Sharma et al found this in 6% of cases. [14]. The current study had this finding mastoid erosion in 8.33% of the cases. Tamilarasan et al had observed mastoid cortex erosion in 8% of the cases. [13]. Sharma et al found this in 10% of the cases. [14]. Prakash et al mentioned this erosion as 16.67% in their study. [22]. Our study found tegmen erosion in 6% of the cases in HRCT images. Jadia et al observed the same tegmen erosion in 23.1% of the cases. [7]. Kataria et al found tegmen erosion in 7.14% of the cases. [23]. Keskin et al mentioned it as 19.6% in their study. [24].

Mastoiditis was found in our study in 60% of thecases in HRCT images. This finding corroborated with the study finding of Chatterjee et al and Thukral et al., [15,19]. observed mastoiditis in 50.3% and 76% of the cases respectively.

Our study found the site and extent of involvement of middle ear and mastoid air cell system as follows: protympanum (20.00%); mesotympanum (26.67%); posterior tympanum (30.00%); epitympanum 60.00%); hypotympanum (25.00%); peri-labyrinthine cells (1.67%); aditus (53.33%); antrum (40.00%); mastoid air cells (58.33%). Jadia et al found the extension in epi-tympanum

(100%), mesotympanum (78.85%), hypo-tympanum (55.77%), pro-tympanum (9.62%), sinus tympani (9.62%), aditus (78.85%), antrum (84.62%) and mastoid (19.23%). [7]. Srigiri et al. observed epitympanum, antrum, aditus, mastoid air cells, posterior tympanum, mesotympanum, hypotympanum, protympanum and perilabyrinthine cells as 88%, 88%, 84%, 76%, 52%, 44%, 44%, 36% and 24% respectively. [25]. The decreasing order of the involvement was much similar to our study.

CONCLUSION:

The High Resolution Computed Tomography scan isa standard imaging technique for the temporal bone. The HRCT findings of the temporal bone in patients with chronic suppurative otitis media were the presence of non-dependent soft tissue mass more commonly followed by ossicle erosion, scutum erosion, sigmoid sinus plate erosion, mastoid cortex erosion, tegmen erosion, labyrinthine fistula, and mastoiditis with subperiosteal abscess. HRCT scan is a unique method to detect early cholesteatoma and also to detect cholesteatoma in hidden areas.

What new insights does the study add?

This study demonstrates that HRCT imaging is the gold standard for CSOM and associated complications diagnosis. Additionally, it has a significant impact on the surgical approach, which is essential for preserving hearing and avoiding complications.

REFERENCES:

01. Nadol JB Jr. Revision mastoidectomy. Otolaryngol Clin North Am. 2006 Aug;39(4):723-40, vi-vii.

02. Kangsanarak J, Fooanant S, Ruckphaopunt K, Navacharoen N, Teotrakul S. Extracranial and intracranial complications of suppurative otitis media. Report of 102 cases. J Laryngol Otol. *1993 Nov;107(11):999-1004.*

03. Karki S, Pokharel M , Suwal S , Poudel R. Correlation between Preoperative High Resolution Computed Tomography (CT) Findings with Surgical Findings in Chronic Otitis Media (COM) Squamosal Type. Kathmandu Univ Med J (KUMJ). 2017 Jan. - *Mar;15(57):84-87*

04. Monasta L, Ronfani L, Marchetti F, Montico M, Vecchi Brumatti L, Bavcar A, et al. Burden of disease caused by otitis media: systematic review and global estimates. PLoS One. 2012;7(4):e36226.

05. Browning GG, Weir J, Kelly G, Swan lain R. Chronic otitis media. In: Watkinson JC, Clarke RW, editors. Scott-Brown's Otorhinolaryngology-Head and Neck Surgery. *8th ed. Suite: CRC Press; 2018. p. 977–1021*

06. Majeed J, Sudarshan Reddy L. Role of CT Mastoids in the Diagnosis and Surgical Management of Chronic Inflammatory Ear Diseases. Indian J Otolaryngol Head Neck Surg. 2017 Mar;69(1):113-120.

07. Jadia S, Qureshi S, Sharma S, Mishra K. Correlation of Preoperative 'HRCT Temporal Bone' Findings with 'Surgical Findings' in Unsafe CSOM. Indian J Otolaryngol Head Neck Surg. 2021 Mar;73(1):33-40.

08. Rai T. Radiological study of the temporal bone in chronic otitis media: Prospective study of 50 cases. Indian J. Otol. *2014;20(2):48-55*

09. Rogha M, Hashemi SM, Mokhtarinejad F, Eshaghian A, Dadgostar A. Comparison Of Preoperative Temporal Bone CT with Intraoperative Findings in Patients with Cholesteatoma. Iran J Otorhinolaryngol. 2014 Jan;26(74):7-12.

10. Vallabhaneni, Rohit, C Srinivasa Babu. HRCT temporal bone findings in CSOM: our experience in rural population of South India. IOSR J Dent Med Sci. 2016;15(3):49-53.

11. Dhulipalla S, Swetha C, Madala N. A Study To Evaluate The Role Of High Resolution Ct Temporal Bone In Preoperative Assessment Of Ossicular Chain Status In Chronic Suppurative Otitis Media Patients. IOSR-JDMS. 2018 Jan;17(1):33-37.

12. Valvassori GE. Imaging of the temporal bone. In: Glasscock ME, Gulya AJ, editors. Glasscock-Shambaugh Surgery of the Ear. *5th ed. Hamilton, Ontario: BC Decker Inc; 2003. p. 227–63*

13. V. Tamilarasan, G. Yuvabalakumaran, Md. Ameen, Vinay Jadhav. *Role of CT in documenting the extent of temporal bone and middle ear involvement among patients with chronic otitis media. IJCMSR. 2019 Dec;4(4):D1-D5.*

14. Sharma VK, Prajapati N, Sharma R, Iqbal Z, Dadoo S. Radiological changes in anatomy of temporal bone in cases of unsafe chronic suppurative otitis media: A retrospective study. Indian J. Otol. *2017;23(3):176*

15. Chatterjee P, Khanna S, Talukdar R. Role of High Resolution Computed Tomography of Mastoids in Planning Surgery for Chronic Suppurative Otitis Media. Indian J Otolaryngol Head Neck Surg. 2015 Sep;67(3):275-80.

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

17. Gül A, Akdağ M, Kiniş V, Yilmaz B, Şengül E, Teke M, et al. Radiologic and surgical findings in chronic suppurative otitis media. J Craniofac Surg. 2014 Nov;25(6):2027-9.

18. Payal G, Pranjal K, Gul M, Mittal MK, Rai AK. Computed tomography in chronic suppurative otitis media: value in surgical planning. Indian J Otolaryngol Head Neck Surg. 2012 Sep;64(3):225-9.

19. Thukral CL, Singh A, Singh S, Sood AS, Singh K. Role of High Resolution Computed Tomography in Evaluation of Pathologies of Temporal Bone. J Clin Diagn Res. 2015 Sep;9(9):TC07-10.

20. Bathla M, Doshi H, Kansara A. Is Routine Use of High Resolution Computerized Tomography of Temporal Bone in Patients of Atticoantral Chronic Suppurative Otitis Media without Intracranial Complications Justified? Indian J Otolaryngol Head Neck Surg. 2018 Mar;70(1):79-86.

21. Mandal S, Muneer K, Roy M. High Resolution Computed Tomography of Temporal Bone: The Predictive Value in Atticoantral Disease. Indian J Otolaryngol Head Neck Surg. 2019 Nov;71(Suppl 2):1391-1395.

22. Lyngwa, G Y, Mohanty J, Singh, M, Swain, S. Role of high-resolution computed tomography temporal bone in the evaluation of unsafe chronic suppurative otitis media. EJMS. 2020 Jun;5(2):30-34.

23.EJMS. 2020 Jun;5(2):30-34.

24. Kataria T, Sehra R, Grover M, Sharma S, Verma N, Sharma MP. Correlation of Preoperative High-resolution Computed Tomography Temporal Bone Findings with Intra-operative Findings in Various Ear Pathologies. Indian J Otolaryngol Head Neck Surg. 2020 Jul.

25. Keskin S, Çetin H, Töre HG. The Correlation of Temporal Bone CT With Surgery Findings in Evaluation of Chronic Inflammatory Diseases of The Middle Ear. EUR J GEN MED. 2011 Jan;8(1):24-30.

26. Sirigiri RR, Dwaraknath K. Correlative Study of HRCT in Attico-Antral Disease. Indian J Otolaryngol Head Neck Surg. 2011 Apr;63(2):155-8.