IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 10 Ser. 6 (October. 2024), PP 32-38
www.iosrjournals.org

Evaluation High-Resolution Computed Tomography (HRCT) Of Temporal Bone In Cholesteatoma Of Middle Ear In Comparison With Histopathological Findings: A Prospective Study

Dr. Tukaram Rathod[1], Dr. Rajeshwari D Hoolageri[2*]
[1]*Professor, Department Of Radio-Diagnosis, S. Nijalingappa Medical College And H.S.K Hospital And Research Centre, Bagalkot, Karnataka, India*
[2]*Junior Resident, Department Of Radio-Diagnosis, S. Nijalingappa Medical College And H.S.K Hospital And Research Centre, Bagalkot, Karnataka, India*

Abstract:
Background*: Cholesteatoma is relatively common and potentially dangerous disease of the ear. It is characterised by local destruction and osseous erosion leading to complications. Pre-operative assessment of middle ear cholesteatoma is a must for assessing the disease's location, extent, and complication. High resolution computed tomography (HRCT) is the imaging modality of choice for evaluation of middle ear structures and pathology. Therefore, in the present study we aimed to evaluate HRCT of temporal bone in cholesteatoma of middle ear cleft in comparison with histopathological results.*
Materials and Methods*: This is a prospective study carried out on total of 30 patients who were undergoing HRCT of temporal bone for middle ear cleft pathology and found to have imaging evidence of chronic oto-mastoiditis on HRCT, subsequently undergoing surgery and histopathological validation.*
Results*: The mean age of study subjects was found to be 23.97 ± 11.30 years. Majority of the study subjects were belonged to age group of 11-40 years (40%) with female predominance (53.3%) as compared to male (46.7%). Majority of the patients i.e., 60% showed signs of loss of aeration and sclerosis of mastoid air cells followed by soft tissue density lesions (43.3%), bony erosions (26.7%), and bony expansions (6.7%). Surgical findings and histopathological reports were correlated with pre-operative HRCT scans analyses with 95.88% accuracy.*
Conclusion: *Compared to histopathological findings, HRCT offers a diagnostic capacity that is remarkably sensitive and specific in identifying cholesteatoma and the condition of the bone structures in the temporal bone*
Key Word*: Cholesteatoma; HRCT; Sensitivity; Specificity; Bony erosions; Bony expansions*

Date of Submission: 05-10-2024 Date of Acceptance: 15-10-2024

I. Introduction

Chronic otitis media is a stage of ear disease in which there is a long-term infection of the middle ear cleft, which includes the Eustachian tube, the middle ear, and the mastoid. In this stage, there is the presence of a ruptured tympanic membrane and drainage.[1] Clinically, there are two main types of chronic suppurative otitis media: one with no cholesteatoma, known as the "safe" type, and one with cholesteatoma, known as the "unsafe" type.[2] Cholesteatoma is, in simple terms, "skin in the wrong place." Cholesteatoma consists of an outer lining composed of stratified squamous epithelium, an inner keratin debris content within the cholesteatoma sac which is in turn secreted by the epithelium, and an external peri-matrix that secretes bone destroying proteolytic enzymes Cholesteatoma is known since prehistoric times. In 1683, Joseph Gerhard Duverney described temporal bone lesion probably representing cholesteatoma and the term cholesteatoma was coined by German pathologist Miller.[3]

Middle ear cholesteatoma which is more often acquired than congenital has been recognized clinically and radiologically for many years.[4-6] Acquired cholesteatoma is the main complication of chronic otitis, resulting from ingrowth of the keratinizing squamous epithelium from the external acoustic meatus to the middle ear through the tympanic membrane.[4,6] The hallmarks of cholesteatoma are a soft tissue mass-like opacity in the middle ear cavity and mastoid antrum associated with smooth bony erosion of the ossicles and expansion of adjacent structures. The radiographic appearance of the soft tissue itself does not differ, whether it is cholesteatoma or granulation tissue, but the association of bone erosion is highly suggestive of cholesteatoma. The absence of abnormal soft tissue on CT essentially excludes cholesteatoma.[7] To minimize the interpretative

errors of mild bone erosions, particularly the tegmen, the lateral semicircular canals and horizontal portion of the facial nerve canal, familiarity with the radiographic variations and comparison with the normal side are valuable.[7,8]

The clinical diagnosis of cholesteatoma is made by otoscopic examination, and the gold standard is histopathology or during operative exploration. On the other hand, imaging measures for diagnosis, such as high-resolution computed tomography (HRCT) and magnetic resonance imaging (MRI), are utilized. HRCT is most valuable for detection tool of early erosive changes in the ossicles, particularly in the smaller parts such as the incudostapedial junction, as well as in the detection of non-dependent soft tissue opacification suggestive of cholesteatoma.[3]

With this scenario, present study was designed with the main objective to evaluate HRCT of temporal bone in cholesteatoma of middle ear cleft in comparison with histopathological results.

II. Material And Methods

This study was carried out on total of 30 patients who were undergoing HRCT of temporal bone for middle ear cleft pathology and found to have imaging evidence of chronic oto-mastoiditis on HRCT, subsequently undergoing surgery and histopathological validation. A written informed consent was taken from all the subjects participating in the study. The "Institutional Ethics Committee" approval was obtained before the conduct of study.

Study Design: Prospective study

Study Location: This study was conducted at Department of Radio-diagnosis, S. Nijalingappa Medical College and H.S.K Hospital and Research Centre, Bagalkot, Karnataka, India.

Study Duration: August 2022 to January 2024

Sample size: 30 patients

Sample size calculation: Sample size estimation was done using Medcalc software.

Formula used: Sample size (n) based on sensitivity=$\frac{Z^2_{1-\frac{a}{2}} X S_N X (1-S_N)}{L^2 X\ Prevalence}$ and

Sample size (n) based on specificity= $\frac{Z^2_{1-a/2} X\ S_N X\ (1-S_N)}{L^2 X\ (1\ -Prevalence)}$

Sample size estimated was obtained 22 and 30 for detecting the sensitivity and specificity respectively. Hence the sample size was rounded off to 30.

Inclusion criteria:

1. All patient who are referred to the department of Radiodiagnosis for HRCT of temporal bone for middle ear cleft pathology and subsequently undergo surgery and histopathology evaluation

Exclusion criteria:

1. Suspicious of ear pathology to be malignancy or granulomatous disease, trauma, revision surgery
2. Unfit for surgery
3. Pregnant women
4. Post-operative patients

Methodology

Patient preparation:

Prior to performing the scan particularly in infants and children less than six years, sedation was usually required. The purpose of sedation was to avoid motion artifact and to ensure a CT scan of diagnostic quality. From six years onwards the need for sedation generally decreased. Sedatives used in our institution were Pedichloryl syrup administered orally or Injection Midaz administered intravenously in the dose of 0.1-0.3 mg/kg dose.

HRCT machine

All the HRCT scans were performed at our institute on uCT528 CT machine. Patients were scanned in the axial and coronal (supine or prone) axes. Scout films were taken routinely in all patients before starting the scan. Scanning commenced from the lower margin of the external auditory meatus and extended upward to the

arcuate eminence of the superior semicircular canal as seen on lateral topogram. Slight extension of the head was given to avoid gantry tilt and thereby protect the lens from radiation. Coronal images were obtained perpendicular to the axial plane from the cochlea to the posterior semicircular canal. Contiguous 0.5 mm thick slices were obtained using an ultra-high algorithm with a scan time of 4 seconds at a 120KV tube voltage. The mA selected was 170. At 120KV, the noise level is low, bone penetration is better and there is minimal beam hardening. At 170 mA, the soft tissue differentiation is better. A long scan time of 4 seconds increases the image sharpness but there is a greater probability of motion artifacts.

HRCT technique:

CT excels in the evaluation of disorders that primarily affect air spaces or cortical bone. The optimal technique for HRCT was as described by Shaffer and Turski. Gantry angulations for axial and coronal scans have been suggested for evaluating specific intratemporal structures. If the goal of a temporal bone CT study is to focus on the otic capsule, cortical plates, ossicles and the air spaces alone, and then high-resolution bone algorithm techniques may be adequate. However, it is also important to evaluate the soft tissues.

HRCT comprises the use of a thin collimation, a high spatial frequency algorithm, smallest practical FOV (15 to 20cm) and a large reconstruction matrix (512 x 512). With 1 cm collimation the volume averaging within the plane of scan reduces the ability of CT to resolve small structures significantly. Therefore, scanning with thin collimation is essential. A high spatial frequency algorithm reduces image smoothening and increases spatial resolution, making structures appear sharper. This also increases the noise present in the image, which is reduced by increasing the KVp and MAs setting. CT images are usually acquired or displayed in axial and coronal planes. For axial imaging, sections are made in a plane rotated 300 superior to the anthropologic base line. Scan produced in this plane display the temporal bone structures to good advantage. This plane allows separation of individual component of the temporal bone so that they are better visualized in their entirety, with less of overlap and fewer partial volume imaging artifacts.

Retrospective image targeting and reconstruction of the other side from stored raw data, significantly reduces image pixel size and increases spatial resolution. The important patient factor influencing HRCT is motion. Therefore, patients were instructed to be motionless during the procedure. This was given just before the contrast enhancement CT procedure.

Statistical analysis

Data were entered in Microsoft Excel 2019 and statistical analysis was done using IBM Statistical Software for Social Sciences (SPSS) version 22. Categorical variables were represented in the form of percentages, frequencies and association between variables were assessed with Chi-square test. Continuous variables were presented as descriptive statistics (Mean and Standard deviation). $p \leq 0.05$ was considered statistically significant.

III. Result

Table no 1 shows distribution of study subjects based on demographic characteristics, Results revealed that majority of the study subjects were belonged to age group of 11-40 years (40%) with female predominance (53.3%) as compared to males (46.7%). The mean age of study subjects was found to be 23.97 ± 11.30.

Table no 1: Distribution of study subjects based on demographic characteristics

Variables	Frequency	Percentage
Age (Years)		
0 – 10	3	10.00
11 – 20	12	40.00
21 – 30	6	20.00
31 – 40	7	23.30
41 – 50	2	6.70
Mean ± S.D.	23.97 ± 11.30	
Gender		
Male	14	46.70
Female	16	53.30

Table no 2 shows distribution of study subjects based on clinical observations at patient presentation. Results delineated that in 60% of the patients' ear discharge and loss of aeration and sclerosis of mastoid air was observed at presentation. In 43% of patients hearing loss & Otalgia and soft tissue density lesions were

observed. Bony erosions, bony expansions, and tegmen tympani erosions were observed in 27%, 7%, and 23% of patients respectively.

Table no 2: Distribution of study subjects based on clinical observations at patient presentation

Variables	Frequency	Percentage
Ear Discharge		
Present	18	60.00
Absent	12	40.00
Hearing Loss and Otalgia		
Present	13	43.30
Absent	17	56.70
Loss of Aeration and Sclerosis of Mastoid Air		
Present	18	60.00
Absent	12	40.00
Bony Erosions		
Present	8	26.70
Absent	22	73.30
Bony Expansions		
Present	2	6.70
Absent	28	93.30
Soft Tissue Density Lesions		
Present	13	43.30
Absent	17	56.70
Tegmen Tympani Erosions		
Present	7	23.30
Absent	23	76.70

Table no 3 shows distribution of study subjects based on HRCT signs of chronic suppurative otitis media (CSOM) and cholesteatoma in diseased temporal bone. Results depicted that in majority of the patients i.e., 60% showed signs of loss of aeration and sclerosis of mastoid air cells followed by soft tissue density lesions (43.3%), bony erosions (26.7%), and bony expansions (6.7%). However, signs of petrous apicitis were not observed among the study subjects.

Table no 3: HRCT signs of CSOM and cholesteatoma in diseased temporal bone

Variables	Frequency	Percentage
Loss of aeration and sclerosis of mastoid air	18	60.00
Soft tissue density lesions	13	43.30
Bony erosions	8	26.70
Bony expansion	2	6.70
Petrous Apicitis	0	0.00

Table no 4 shows correlation between radiodiagnosis, surgical and histopathological findings. Results implied that a high degree of accuracy (95.88%) was found in the correlation between the analysis of pre-operative HRCT scans and the surgical findings and histopathologic reports. Of 30 cases, the evaluation of the malleus was in agreement with the postoperative results in 26 cases (94%). In 4 cases, erosions were found in surgery but not in HRCT; this was due to the long interval between the day of actual surgical intervention and the pre-operative HRCT. Thirteen cases (96%) in the incus evaluation matched the surgical findings. Eight patients (92%) had agreement between the stapes in pre-operative imaging and surgical findings. Out of the 13 cases (43.75%), the degree of erosion in HRCT scans was not clearly visible because the surrounding soft tissue density obscured it. The remaining 4 patients (7.81%) had minor erosions as determined by HRCT analysis, but the results of surgery were normal.

Table no 4: Correlation between radiodiagnosis, surgical and histopathological findings

Variables	Radiodiagnosis Findings	Surgical Findings	Histopathology Findings
Cholesteatoma	26	26	24
Cholesteatoma and/or polyp	-	-	2
Tympanosclerosis with inflammatory polyp	1	1	1
Granulation tissues (pure)	1	1	1
Aural polyp	2	2	2
Total	**30**	**30**	**30**

Figure no 1 shows correlation between radiodiagnosis and histopathological findings. Results inferred that surgical findings and histopathological reports were correlated with pre-operative HRCT scans analyses with 95.88% accuracy.

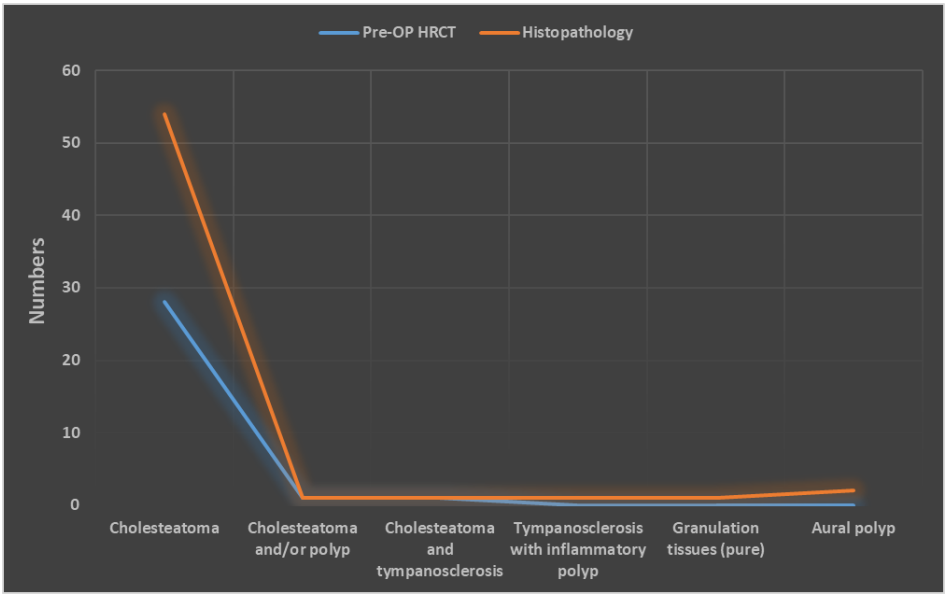

Figure no 1: correlation between radiodiagnosis and histopathological findings

IV. Discussion

It is well known that HRCT can identify CSOM and associated complications, most notably the cholesteatoma before otologic surgery. Especially in the smaller areas such as the sinus tympani and facial canal recess. A cholesteatoma's problems and any congenital anatomic changes that can arise following surgery are also disclosed by an HRCT scan.[9] HRCT is very useful for determining early erosive changes in the ossicles and buried soft tissue. The cholesteatomatous soft tissue cannot be distinguished by HRCT from other disorders such as granulation tissue, scar tissue, wax, granuloma, etc. However, because HRCT is widely accessible, reasonably priced, and provides a thorough picture of the middle ear's bone architecture against the backdrop of CSOM, it is preferable to magnetic resonance imaging (MRI), positron emission tomography (PET), computed tomography (CT), and Technetium-99m examinations. MRI can be helpful in describing soft tissue, but it cannot assess changes in the temporal bone's skeletal structure.

The anatomical extent of the middle ear disease and the connection between these cholesteatoma masses and the surrounding structures can be more precisely defined by HRCT. Osteossicular erosions, smooth erosions of the middle ear boundaries and surrounding structures, and soft tissue density in the middle ear cavity are characteristic features of cholesteatoma. Cholesteatoma is strongly suggested by these alterations when paired with the middle ear cavity's bony growth. These findings, however, are not specific since cholesteatoma cannot be distinguished from other mass lesions such as ectopic meningioma, which can mimic this finding.[9,10]

Our study results showed that non-dependent polypoidal soft tissue densification of the middle ear cavity and antrum (focal, partial, or total), along with related wall expansion and smooth erosion, ossicular displacement, and erosions, are the CT findings that may support a diagnosis of middle ear cholesteatoma. These characteristics resemble those mentioned in the literature.[9,10] Inflammatory disease nearly invariably coexists with neighboring mastoid air cells since they are frequently a consequence of chronic mastoiditis.[10]

Chronic mastoiditis without cholesteatoma is indicated when the air cells seem "cloudy" but retain their irregular trabecular pattern or when there is increased reactive bone production leading to the obliteration of

mastoid antrum and periantral cells.[11] Radiologic separation of cholesteatoma from middle ear effusions and granulation tissue is challenging, if not impossible, due to complete opacification of the middle ear without any damage of the bone.[10,12] An effusion diagnosis would be supported by the existence of an air-fluid level or a soft tissue (fluid) mass in the dependent region of the middle ear.[10] This finding suggested the presence of an infected cholesteatoma in situations where the antrum was expanded with an air-fluid level.[9]

In our study cholesteatoma in the attic is indicated by the following symptoms: erosion or destruction of the scutum or spur (the lateral wall of the attic), erosion of the lateral semicircular canal which may result in fistula formation, dehiscence of tegmen tympani and dehiscence of the sigmoid sinus plate and erosion of the external auditory canal (EAC). While not always able to describe disease, HRCT can consistently identify it. Regretfully, cholesteatoma sac, associated granulation tissue, mucosal edema, and effusion could all be confused with one another during HRCT scanning.[9,13]

Out of the 30 temporal bones of the 26 patients studied, 13 temporal bones showed soft tissue density and were labeled as diseased temporal bones on HRCT. Most of these soft tissue density lesions in our study were non-dependent, i.e., 43.3% of the diseased temporal bones, a vital sign of cholesteatoma. Rai, in their study of 50 patients, reported 45 (90%) patients having non-dependent soft tissue.[14] The loss of aeration and sclerosis of mastoid air cells seen in 18 (60%) diseased temporal bones was the most consistent finding of CSOM in our study. In an HRCT evaluation of 64 patients of unsafe type of CSOM by Gaurano et al., 100% of the patients were found to have affected mastoid air cells.[15]

In our study bone erosion was seen in 8 out of 26 diseased temporal bones. A similar trend was reported by Manik et al. in an HRCT study of 50 symptomatic patients, which showed Incus to be the most commonly eroded in 35 (70%) patients, followed by malleus in 21 (42%) and stapes in 17 (34%) patients.[16] Scutum was eroded in 35 (55.5%) diseased temporal bones in the present study. Rai, in their research, reported scutum erosion in 23 (65%) patients.[14]

The present research saw tegmen tympani erosion in 7 (23%) diseased temporal bones. In an HRCT study done by Jamal et al., in 50 symptomatic patients, tegmen tympani erosion was seen in 13 (30%) patients.[17] There was no case of dural sinus plate erosion encountered in our study as it is a rare complication of CSOM/cholesteatoma.[14-16,18,19] In the present study, bony expansion was seen in 2 (6.7%) diseased temporal bones. We found the facial canal dehiscence in 3 (10%) diseased temporal bones. The study by Jamal et al., reported facial canal dehiscence in 15 (30%) out of 50 patients.[17]

HRCT could not surely differentiate cholesteatoma from granulation tissue (one cases), cholesterol granuloma (two case) and non-cholesteatomatous otitis media (one case). Though cholesteatoma is thought to have less attenuation than granulation tissue, there is a slight difference between the two that can only be identified by magnetic resonance imaging. With 80% specificity, HRCT can detect the degree of cholesteatomas after otoscopy, clinical examination, and cholesteatoma diagnosis by displaying a soft tissue mass and bone erosion.[13]

Imaging modalities should be used on all patients suspected of having a cholesteatoma, even if otoscopic recognition of the condition is frequently trustworthy. This is to ascertain whether there are any noticeable or subtle alterations, as well as whether complications which are primarily caused by bone erosions have occurred. Bone degradation and degree of extension are the specific issues that need to be evaluated on imaging examinations and that will impact the surgical treatment. Early bone erosions can be seen with high sensitivity with CT, and a thorough imaging examination of the soft tissue surrounding middle ear cholesteatomas can provide valuable information that may influence their surgical excision.

The main limitation of our study is sample size. Our study only included 30 patients as a sample. This may be the reason that CSOM problems such as dural sinus thrombosis and intracerebral complications did not manifest.

V. Conclusion

In conclusion, when it comes to identifying early cholesteatoma, microscopic cholesteatoma, and cholesteatoma hidden in places, HRCT temporal bone is an indispensable diagnostic tool. It aids in evaluating the integrity of the bone, accurately identifies a number of related issues, and gives the surgeon a road map for cholesteatoma surgery. Furthermore, HRCT aids in the evaluation of recurrent illness in the temporal bones following surgery. Hence, compared to histopathological findings, HRCT offers a diagnostic capacity that is remarkably sensitive and specific in identifying cholesteatoma and the condition of the bone structures in the temporal bone.

References

[1]. Head K, Chong Ly, Bhutta Mf, Morris Ps, Vijayasekaran S, Burton Mj, Schilder Ag, Brennan-Jones Cg. Topical Antiseptics For Chronic Suppurative Otitis Media. Cochrane Database Syst Rev. 2020, 1:Cd013055.

[2]. Seiden Am, Tami Ta, Penssak Ml, Cotton Rt, Gluckman Jl. Otorhinolaryngology, The Essentials. Seiden Am (Ed): Thieme, New York; 2002.

[3]. Barath K, Huber Am, Stämpfli P, Varga Z, Kollias S. Neuroradiology Of Cholesteatomas. Ajnr Am J Neuroradiol. 2011, 32:221-9.
[4]. Robert Y, Dubrule F, Carcasset S, Et Al. Petrous Bone Extension Of Middle Ear Acquired Cholesteatoma. Acta Radiologica. 1996; 37:166–170.
[5]. Phelps Pd, Lloyd Gas. The Radiology Of Cholesteatoma. Clin Radiol. 1980; 31:501–512.
[6]. Swartz Jd. Cholesteatoma Of The Middle Ear, Diagnosis, Etiology And Complications. Radiol Clin North Am. 1984; 22:15.
[7]. Leighton Sej, Robson Ak, Anslow P, Milford Ca. The Role Of Ct Imaging In The Management Of Chronic Suppurative Otitis Media. Clin Otolaryngol. 1993; 18:23–29.
[8]. Jackler Rk, Dillon Wp, Schindler Ra. Computed Tomography In Suppurative Ear Disease: A Correlation Of Surgical And Radiographic Findings. Laryngoscope. 1984; 94:746–752.
[9]. Mafee Mf, Levin Bc, Applebaum El, Campos Cf. Cholesteatoma Of The Middle Ear And Mastoid. Otolaryngol Clin North Am. 1988, 21:265-8.
[10]. Chee Nc, Tan Ty. The Value Of Preoperative High Resolution Ct Scans In Cholesteatoma Surgery. Singapore Med J. 2001, 2:155-9.
[11]. Huang By, Castillo M, Mukherji Sk. Temporal Bone Disorders In Children. Pediatric Neuroradiology. Berlin, Heidelberg: Springer. 2015:1-13.
[12]. Ishii K, Takahashi S, Matsumoto K, Kabayashi T, Ishibashi T, Sakamoto K, Soda T. Middle Ear Cholesteatoma Extending Into The Petrous Apex: Evaluation By Ct And Mr Imaging. Am J Neuroradiol. 1991; 12:719–724.
[13]. 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, 64:225-9.
[14]. Rai T. Radiological Study Of The Temporal Bone In Chronic Otitis Media: Prospective Study Of 50 Cases. Indian J Otol. 2014, 20:48.
[15]. Gaurano Jl, Joharjy Ia. Middle Ear Cholesteatoma: Characteristic Ct Findings In 64 Patients. Ann Saudi Med. 2004, 24:442-7.
[16]. Manik S, Dabholkar Y, Bhalekar S, Velankar H, Chordia N, Saberwal A. Sensitivity And Specificity Of High-Resolution Computed Tomography (Hrct) Of Temporal Bone In Diagnosing Cholesteatoma And Its Correlation With Intraoperative Findings. Indian J Otolaryngol Head Neck Surg. 2021, 73:25-9.
[17]. Jamal S, Rahman A, Mohan C, Srivastava A. Is Pre-Operative Hrct Temporal Bone Findings Consistent With Tympano-Mastoid Surgical Findings. Int J Health Clin Res. 2020, 3:104-9.
[18]. Gomaa Ma, Abdel Karim Ar, Abdel Ghany Hs, Elhiny Aa, Sadek Aa. Evaluation Of Temporal Bone Cholesteatoma And The Correlation Between High Resolution Computed Tomography And Surgical Finding. Clin Med Insights Ear Nose Throat. 2013, 6:21-8.
[19]. Jacob A, Sreedhar S, Choolakkaparambu A, Anwar S, Bashir, Nalakath K. Utility Of High-Resolution Computed Tomography In Pre-Operative Evaluation Of Cholesteatoma. Int J Otorhinolaryngol Head Neck Surg. 2020, 6:1278.