Original Research Article

Is Pre-operative HRCT Temporal Bone findings consistent with Tympano-mastoid surgical findings?

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Abstract

Introduction:Chronic otitis media (squamosal disease) remains a significant health problem in terms of prevalence and sequelae. The recurrent episodes of otorrhoea and mucosal changes are characterized by bone erosions, and osteitis of temporal bone and ear ossicles. This is followed by ossicular destructions and/or ankylosing which together with the tympanic membrane perforation contributes to the hearing loss. Now-a-days, HRCT of the temporal bone is gaining popularity as a diagnostic modality in COM. Computed tomography scan has allowed good preoperative imaging of anatomy and extent of the disease.**Aims and objectives:-** To correlate pre-operative HRCT temporal bone findings with operative findings of patients undergoing tympano-mastoid surgery in chronic otitis media cases and also to assess the extent of disease. **Materials and methods:-** All patients of COM (squamosal disease) attending the Department of Otorhinolaryngology, Rohilkhand Medical College and Hospital, Bareilly from 1st November 2018 to 31st October 2019. Preoperative HRCT were carried out and compared with intraoperatives findings.**Results:**Evaluation of 50 patients and their HRCT can provide excellent details of temporal bone anatomy, extension of cholesteatoma, status of the ossicles, facial nerve, tegmen and sinus plate. **Conclusion:** HRCT represents the predominant modality for defining the bony anatomy of temporal bone as well as pathologics alterations in that anatomy caused by cholesteatoma. The CT scan can accurately predict the extent of disease and is helpful for detection of dural plate erosion and ossicular erosions.

Keyword: Temporal bone, Computed tomography, Cholesteatoma, Ossicular destruction,

Introduction

"Chronic otitis media (COM) is a stage of ear disease in which there is a chronic infection of the middle ear cleft, i.e. Eustachian tube, middle ear and mastoid, and in which perforation of tympanic membrane and discharge are present." It typically cause mild to moderate hearing impairement and pathologically, it is of two types- mucosal disease and squamosal disease.

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Mucosal type is associated with permanent defect of pars tensa with an inflamed middle ear mucosa which produce mucopus that may discharge whereas squamosal disease is associated with retraction of the pars flaccida or tensa that has retained squamous epithelial debris and is associated with inflammation and the production of pus, often from the adjacent mucosa. The recurrent episodes of otorrhoea and mucosal changes are characterized by bone erosions and osteitis of temporal bone and ear ossicles. This is followed by ossicular destructions and/or ankylosing which together with the tympanic membrane perforation contributes to the hearing loss.The disease is often associated with a bone eroding process due to cholesteatoma, granulation or osteitis. The risk of complications is high in squamous type and is a

significant health problem in terms of prevalence and sequelae.Historically mastoid surgery has been undertaken with otoscopy, audiometry, and possible x-rays as a pre-operative investigation. Cholesteatoma can be recognised by the presence of epithelial debris on otoscopic examination but extension inside the middle ear cleft is not possible and for assessing the extent of disease inside, Computerized Tomography (CT) Scan is recommended and because of better resolution, high resolution computed tomography (HRCT) of the temporal bone is gaining popularity as a diagnostic modality in Chronic Otitis Media. HRCT can provide excellent details of temporal bone anatomy, determining the extension of cholesteatoma, assessing the ossicles, evaluating the facial nerve, tegmen and sinus plate. Anatomical variation of the temporal bone is a significant source of concern in otologic surgeries. In ear surgery, the preoperative assessment of the facial canal, lateral semi-circular canal, dural plate and sinus plate is important to avoid many complications.There is a difference of opinion among surgeons in which one group is of the opinion that preoperative scanning is not essential arguing that nature and extent of pathology finally becomes evident during surgical dissection. The frequency of cholesteatoma is 42% in chronic otitis media and cholesteatoma can be associated with lots of complications, since temporal bone is surrounded by many vital structures and its gross anatomical variation of landmark, makes the surgery difficult at times.[1] HRCT is most valuable for detection of non-dependent soft tissue opacification suggestive of cholesteatoma, as well as its extent and complication. When connected to osseous erosion of some structures like ossicular chain, tympanic tegmen and bony labyrinth it is strongly indicative of cholesteatoma.Comparing the HRCT findings with intraoperative findings helps us to formulate proper surgical intervention and avoid intraoperative complication by understanding the exact anatomic variation of landmark in the temporal bone.

The intent of this study is to evaluate the accuracy of this imaging modality in our patients undergoing surgery for cholesteatoma. HRCT provides excellent details of bony landmarks within temporal bone, due to inherent contrast, its dense bone being surrounded by air of the tympanic cavity and the mastoid air cells, it adds a whole new dimension to the evaluation of the temporal bone by allowing visualization of the soft tissue within and adjacent to the temporal bone. Therefore, one of its major contributions to the otologist dealing with the disease is the pre-operative localization of the cholesteatoma sac, a detail that not only determines the type of surgical approach but also alerts the surgeon to the possible intra and post-operative complications.Earlier studies assessing the role of pre-operative HRCT have used lower generation scanners. Though studies have been conducted which compare pre-operative HRCT findings and surgical findings of middle ear structures the co-relation accuracy still remain variable.This study was undertaken to assess the usefulness of HRCT of temporal bone in cases of COM (Squamosal Disease).

Material and Methods

All patients of chronic otitis media (squamosal disease) attending the Department of Otorhinolaryngology and Head &Neck Surgery, Rohilkhand Medical College and Hospital, Bareilly from 1st November 2018 to 31st October 2019 and fulfilling the following inclusion criteria were enrolled for the study.

Inclusion Criteria: All patient with chronic otitis media (squamosal disease) who gave consent to participate in the study

Exclusion Criteria: Patient with malignancies of the ear and tubo-tympanic type of chronic otitis media.

Plan of Study

HRCT temporal bone were done in axial and coronal planes and was reported in the proforma format.

After due pre anaesthetic check-up patients were posted in the OT for mastoid exploration and extent and severity of the disease was noted and compared with radiological findings.

Scanning was carried out on GE Bright speed + 16 Slices CT scanner and 0.6mm of reconstruction thickness with 295mA & 120Kv.

HRCT were evaluated for the following parameters:

Presence of soft tissue density in middle ear and mastoid bone, its location and extents.

Anterior epitympanum
Posterior epitympanum
Mesotympanum
Hypotympanum
Ossicles
Facial nerve
Tegmen tympani
Sigmoid sinus

Cholesteatoma was said to be present when non-dependent soft tissue density in the middle ear cavity or mastoid bone, medial displacement of ossicular chain and typical pattern of osicular erosion.

Observations

The study included 50 diagnosed cases squamosal type of COM and all of these cases underwent high resolution computed tomography of bilateral temporal

bones followed by Mastoid exploration. The following observations were made.The younger age group was found to be most commonly affected with almost equal representation of disease in both the genders with slightly higher prevalence amongst females. Cholesteatoma was the most common pathology and was found in 31(62%) patients, retraction pocket in 8(16%) patients, granulation in 6(12%), polyps in 2(4%) and cholesteatoma with granulation in 3(6%).Based on surgical findings, patients were divided into two groups: group with cholesteatoma which comprised of 34 cases and group without cholesteatoma consisting of 16 cases.

Table 1: Status of Mastoid Bone

Mastoid Bone	HRCT		Intraoperative findings	
	Number of patients	Percentage	Number of patients	Percentage
Well pneumatised	2	4.0%	2	4.0%
Sclerotic	40	80.0%	40	80.0%
Cavity	8	16.0%	8	16.0%
Total	**50**	**100.0%**	**50**	**100.0%**

CT scan was found to be 100% sensitive and specific in determining the nature of the mastoid bone pneumatization. (Table 1)

Table 2: Comparative evaluation of different Structures (HRCT Vs Intraoperative findings)

Ossicle	Condition	HRCT		Intraoperative Findings	
		Number of patients	Percentage	Number of patients	Percentage
Malleus	Erosion	20	40	26	52%
	Normal	30	60%	24	48%
Incus	Erosion	31	62%	36	72%
	Normal	19	38%	14	28%
Stapes	Erosion	24	48%	29	58%
	Normal	26	52%	21	42%
Tegmen Tympani	Erosion	13	26.0%	7	14.0%
	Normal	37	74.0%	43	86.0%
Sigmoid Sinus	Erosion	7	14.0%	7	14.0%
	Normal	43	86.0%	43	86.0
Facial Nerve	Normal	35	70.0%	41	82.0%
	Dehiscence	15	30.0%	9	18.0%
Total		50	100%	50	100%

Table 3: Values of Diagnostic tests in respect to different structures

Ossicle	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Malleus	76.92%	100%	100%	80%
Incus	86.1%	100%	100%	73.6%
Stapes	82.7%	100%	100%	80.7%
Tegmen Tympani	100%	86.0%	53.80%	100%
Sigmoid Sinus	100%	100%	100%	100%
Facial Nerve	100%	85.36%	60%	100%

Incus was the most commonly eroded, followed by malleus and stapes. HRCT was found to have 100 % specificity and Positive Predictive Value in finding status of ossicles whereas, highest sensitivity was seen in finding the status of incus with 86.1% sensitivity and 73.6% Negative Predictive Value. (Table 2 and 3). The tegmen was reported eroded on CT scan in 13(26%) cases, however intra-operatively only 7(14%) cases had tegmen erosion. The study has 100% sensitivity with 86% specificity with only 53.80% positive predictive value. (Table 2 and 3)The present study can find the status of sigmoid sinus plate with 100 % sensitivity and specificity. (Table 2 and 3)HRCT scan show 100% sensitivity and 85.36% specificity in diagnosing a dehiscent or eroded facial canal. In this study, Facial nerve canal in its tympanic segment was intact in 35cases (70%), in 15 cases (30%) it appeared eroded on CT. The latter findings were confirmed intra-operatively in 11 cases. Vertical part of facial nerve appeared intact in all cases on CT but was eroded in 4 cases intra-operatively. The sensitivity and specificity was 100% and 85.36% respectively with positive predictive value of 60.(Table 2 and 3). CT was able to correctly identify if the vertical and horizontal segment was affected in most of the cases and guided with this information, the surgeon felt more confident while operating. Intra-operatively, none of the cases had any anatomical variation.

Table 4: Soft Tissue Mass

Extent of Soft Tissue Mass	HRCT		Intraoperative Findings	
	Number of patients	Percentage	Number of patients	Percentage
Middle ear and mastoid	42	84	43	86%
Middle ear only	6	12	5	10%
Mastoid only	0	0	0	0
EAC, mastoid and middle ear	2	4	2	4%

Table 5: Values of Diagnostic tests of HRCT for diagnosing soft tissue mass

Extent of Soft Tissue Mass	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Middle ear and mastoid	100	100	100	100
Middle ear only	100	100	100	100
Mastoid only	0	0	0	0
EAC, mastoid, middle ear	100	100	100	100

On comparing CT with per-operative findings, soft tissue masses were found in all 50 cases. HRCT had 100% sensitivity, 100% specificity, 100% positive predictive value, 100% negative predictive value in predicting the extension of soft tissue mass.(Table 4&5)

Discussion

In our study, cholesteatoma was the most common pathology found in 62% of cases. Our study is in accordance with the study done by Payal G et al[2] and Tatlipinar A et al[1] who also found cholesteatoma as the most common pathology. There was 100% agreement in the CT scan findings on degree of **Mastoid bone pneumatisation** and its surgical finding. Similar results were seen in the studies conducted by Kanotra S et al[3] and Dutta G et al[4] which showed 100%, 96%, 100% sensitivity on CT respectively.Ossicular erosion is an important finding on HRCT in cases of Cholesteatoma. Besides a pre- operative knowledge of state of **Ossicles**, it helps in pre-operative planning of methods of ossiculoplasty and its possible outcome, though final decision may differ based on intra-operative findings. Preoperative knowledge of ossicles also helps in counselling of the patients in view of anticipated hearing level in post-operative.On HRCT, sensitivity and specificity of HRCT in diagnosing the status of Malleus in squamosal type of COM is 76.92% and 100% respectively with 100% Positive predictive Value (PPV) and 80% Negative Predictive Value (NPV). A similar specificity rate was also reported by studies done by Rai T et al[5], Rocher P et al[6] and Zhang et al[7], who found 100% specificity. However, they have got a higher sensitivity of 100% in comparison to our present study.Considering Incus, HRCT was found to be 86.1%

sensitive with 100% specificity in predicting the status of Incus with 100% PPV, implying a reliable correlation between HRCT and intraoperative findings. Our study is consistent with the studies done by Datta G et al[4]and Rai T et al[5] who also observed a 100% PPV.HRCT was able to diagnose incus erosion with 76.92% sensitivity, 100% specificity, 100% PPV and 80% NPV. A specificity rate of 100% was also reported by Rai T et al[5], Rocher P et al[6] and Zhang et al[7] for incus erosion. However they all reported HRCT to be 100% sensitive, which was higher as compared to the present study. HRCT was found to have 82.7% sensitivity, 100% specificity in determining the status of stapes with 100% PPV and 80.7% NPV. Rai T et al[5] reported HRCT to be 100% specific but less sensitive(75%) as compared to the present study, and a similar observation was made by O Donoghue et al[8] who reported 100% specificity, 100% PPV and 76.2% NPV but less sensitive (71.2%) as compared to the present study with regards to stapes erosion.Chee et al[9] reported a good radio-surgical correlation for stapes, while Zhang et al[7] reported HRCT to be poor in detecting stapes.The stapes was not consistently visualized by CT, but when seen usually appeared as a structure of soft tissue density in the oval window niche. For this reason it was not possible to distinguish between the destruction of the stapes and its mere envelopment by soft tissue, findings are consistent with the Jackler et al[10] **.** It is relatively easy to visualize the body of the malleus and the incus on HRCT but this has little clinical value unless the ossicular chain continuity can be demonstrated. The long process of incus, malleus and the stapes suprastructutre are the most common components at risk in COM but are also the most difficult to demonstrate on HRCT.In this study, the tympanic segment of the facial nerve was found to be most susceptible to erosion. CT was able to correctly identify if the vertical and horizontal segment was affected in most of the cases. In present study, we reported 100% sensitivity, 85.36% specificity, 60% Positive predictive value, 100% Negative predictive value.Sirigiri et al[11], O Reily et al[12] and Jackler et al[10] were able to diagnose dehiscence in the horizontal part of facial canal with a sensitivity of 60% and specificity 90%. However, Mafee et al[13] found CT to be very accurate in the diagnosis of erosion of facial canal.Rai T et al[5] reported 33.33% sensitivity but 100% specificity for facial canal dehiscence. Similar results were found by Alzoubi et al[14], Garber et al[15] but poor and insignificant correlation was observed by Chee and Tan et al[9], Zhang et al[7].

The **tegmen** was reported eroded on CT scan in 13(26%) cases However, intra-operatively only 7(14%) cases had tegmen erosion. In this study, we found that CT scan over-diagnosed tegmen erosion. A probable reason could be that even rare field and demineralized bone is reported as eroded, however surgically only when dural plate exposure is present, it is considered as eroded. In present study, we found that 100% sensitivity was there for the detection of tegmen erosion, 86% specificity, 53.80% PPV and 100% NPV. Kanotra S et al[3]reported 100% sensitivity, 95.45% specificity. A similar specificity rate of 95% was reported by Gerami et al[16], and a specificity rate of 91.93% and NPV Of 100% were also reported by prata et al[17] and Datta et al[4]respectively. A similar value of 100% sensitivity of HRCT was also reported by Rocher et al[6],, Zhang et al[7], and Dutta G et al[4].As per the results of our study, it was evident that **Sigmoid sinus** was an anatomical structure, the status of which could be accurately reported as normal or eroded by the CT scan with 100% sensitivity and specificity. It was eroded in 7(14%) cases and all were correctly reported by the CT scan. Park et al[18], Rogha et al[19] Dutta G et al[4] reported sensitivity 100% and specificity 100% but Payal et al[2] reported sensitivity 66%, specificity 92.6% & also mention that its utility in spotting out those with normal sinus plate was limited because PPV was 50%.On comparing CT with per-operative findings, soft tissue masses were found in all 50 cases with 100% sensitivity and specificity along with 100% positive predictive value and negative predictive value in predicting the extension of soft tissue mass. This finding is in agreement with that of Walshe et al[20] and Sirigiri et al[11] who reported a sensitivity of 90% and 87.5% respectively. Literature suggests that Intra-operative presence of cholesteatoma could be appreciated in middle ear and mastoid, but differentiation between masses as granulations or cholesteatoma in HRCT was not possible.

Conclusion

A thorough understanding of the surgical anatomy and the knowledge of normal variation are crucial when performing operations for chronically infected ears. Moreover the pre-operative HRCT is useful in this regards. The scan aids even the experienced otologist by alerting him to the presence of a prominent sigmoid sinus that may arise from the destructive nature of the disease as well as erosion of facial canal may also be suggested. Although the ossicles are difficult to assess completely, obvious ossicular abnormalities may predict the need for ossicular reconstruction. Hence, HRCT should be a routine examination before cholesteatoma surgery, but it

is not a replacement to good in depth knowledge of anatomy.

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