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Original Research Article

Study of correlation between preoperative high resolution computed tomography temporal bone and intraoperative surgical findings in 60 cases of unsafe chronic otitis media

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ABSTRACT

Background: Cholesteatoma is a serious health hazard which can give rise to alarming intracranial and extracranial complications as it can progressively enlarge and invade into neighbouring structures. Thus, early diagnosis and prompt management of a suspected cholesteatoma is necessary. High resolution computed tomography (HRCT) temporal bone scan clearly defines the extent and location of soft tissue density in middle ear with adjoining bony erosions. The aim of the study was to determine the role of HRCT temporal bone in early detection of cholesteatoma and finding the correlation between preoperative HRCT temporal bone and intraoperative surgical findings.
Methods: Total 60 cases with unsafe chronic otitis media (COM) attending ENT OPD of Rajindra hospital, Patiala were selected for this prospective study. All patients were scanned for HRCT temporal bone and preoperative radiological data was correlated with intraoperative surgical findings. The results were calculated and analysed statistically.
Results: This study demonstrated good correlation between preoperative temporal bone HRCT scans with intraoperative surgical findings, particularly in ossicular erosion (except stapes), LSC erosion, facial canal erosion, lateral cortical wall erosion and dural and sinus plate erosion.
Conclusions: HRCT temporal bone scan evidently demarcates the soft tissue density in middle ear and mastoid with adjacent bone erosions and it also provide details of anatomical variations. Hence HRCT temporal bone is valuable in diagnosing and guiding surgical management of unsafe COM making it prerequisite before any surgical manipulation.

Keywords: HRCT, Temporal bone, Cholesteatoma, Unsafe COM

INTRODUCTION

Chronic otitis media (COM) remains a major international health problem in terms of prevalence, economics, sequelae and complications. It is divided into two chief clinical types: COM without cholesteatoma or safe type and COM with cholesteatoma or unsafe type.[1] Among the various pathological processes associated with unsafe COM like cholesteatoma, osteitis, ossicular necrosis, granulation tissue and cholesterol granuloma, the most frequently encountered one is cholesteatoma.[2]

This cholesteatoma is likely a serious problem which can give rise to alarming intracranial and extracranial complications as it can progressively enlarge and invade into neighbouring structures. Therefore, early diagnosis and prompt management of a suspected cholesteatoma via surgical mastoid exploration makes it an obligatory procedure.[3]

Previously cholesteatoma was evaluated on the basis of clinical presentation, examination under microscope and conventional radiology i.e., X-ray mastoids.[4] However, one cannot determine the size and extent of soft tissue lesion along with the status of middle ear structures and hidden areas like sinus tympani and facial recess using these methods.[5] Hence the need for HRCT temporal bone came into existence.

The indications of the cholesteatoma on HRCT temporal bone scan being the presence of one of the following: non-dependent soft tissue density mass in middle ear cleft; erosions of the middle ear bony walls (i.e., scutum, attic wall, tegmen plate, sigmoid sinus plate, Korner's septum, posterior and superior metal wall); erosion of the ear ossicles, semicircular canal and facial nerve canal; bony expansion of middle ear cavity, aditus and antrum.[6]

HRCT temporal bone scan is a sensitive tool for detection of early or primary bone erosions. It well delineates the extent and location of the soft tissue density pathology which helps in preoperative counselling to patients regarding the nature of pathology and its related complications and aids in deciding the need for early surgical interventions.[7] It is beneficial in assessing the status of ossicular assembly which helps in deciding the likelihood of hearing restoration post-surgery.[8] Also, it provides detailed view of hidden areas(facial recess and sinus tympani) of middle ear cleft thus assisting in complete clearance of the disease.[5] Moreover, it is useful in determining the anatomical variations in position of dural plate, sigmoid sinus plate and jugular bulb, thus helping in planning the surgical approach without foreseen complications.[7] Therefore, nowadays otologists consider HRCT temporal bone scan as a routine investigation for preoperative evaluation prior to any surgical manipulation.

This study aimed to evaluate the role of HRCT temporal bone in detection and evaluation of middle ear cholesteatoma in 60 cases of unsafe COM. The preoperative HRCT temporal bone and intraoperative surgical findings were compared and analysed statistically for establishment of correlation between them.

METHODS

The study was conducted on 60 patients presenting to ENT department, Rajindra hospital Patiala between November 2012 and September 2014 who were diagnosed with unsafe chronic suppurative otitis media. Considering the prevalence of COM in ENT opd at Rajindra hospital Patiala as 10% and of unsafe COM as 4% and using sample size calculation software with 95% confidence interval level, 5% alpha error, the sample size was estimated to be 60. The exclusion criteria were: whenever there was a suspicion of malignant pathology, patients unfit for surgery and prior history of temporal bone trauma. Written consent was taken from all patients and the study was approved by institutional ethics committee.

Detailed history, clinical examination, Examination under microscope and pure tone audiometery were done in all patients.

In computed tomography, high resolution serial 3 mm thick sections at 0 gantry angle in spiral mode with sharp kernel filter were obtained, in both axial and coronal planes on Siemens 6 slice Somatom emotion machine. The preoperative HRCT findings recorded and evaluated were: extent of soft tissue mass, erosion of malleus/incus/stapes, LSC (lateral semicircular canal) erosion, facial canal erosion, lateral cortical wall erosion, dural plate erosion and sinus plate erosion.

All the cases after routine blood investigations and anaesthetic fitness were subjected to surgical exploration of the middle ear/mastoid and the type of surgery performed was based on the intraoperative findings. The data was collected on the basis of intraoperative findings regarding nature and location of soft tissue masses, status of the ossicles and the presence or absence of any bony erosion. Soft tissue was sent to the department of pathology, Rajindra hospital, Patiala for histopathological diagnosis and to confirm the surgical diagnosis. The HRCT temporal bone scan findings were reviewed retrospectively and a correlation between the intraoperative surgical findings and preoperative HRCT findings was made. The compiled data were expressed in terms of following statistical parameters-percentage, sensitivity, specificity, positive predictive value, negative predictive value and accuracy.

RESULTS

This study comprised of 27 (45%) male and 33 (55%) female cases with female to male ratio being 1.22:1. The most common age groups affected were 21-30 years (30%), 11-20 years (26%) and 0-10 years (20%). Thus, 56% of the cases were in 11-30 years age group.

The left ear was involved in 32 (53.33%) cases and right ear in 28 (46.67%) cases. The most common presenting symptom seen was otorrhoea (100% cases) followed by hearing loss (95% cases), earache (65%), vertigo (16.67%), tinnitus (13.33%), postaural abscess (6.67%) and facial nerve palsy (1.67%). The ear discharge in all the 60 cases was scanty, purulent and foul smelling.

On HRCT temporal bone, the soft tissue density in 42 (70%) cases was present in both middle ear and mastoid, in 12 (20%) cases it was confined to middle ear only and in 6 (10%) cases it was confined to EAC, middle ear and mastoid. Intraoperatively soft tissue was present in middle ear and mastoid in 46 (76.67%) cases and confined to middle ear only in 9 (15%) cases and present in EAC, middle ear and mastoid in 5 (10%) cases.

Attic, aditus and antrum were involved in all the 60 (100%) ears. Attic, aditus, antrum and mesotympanum were involved in 39 (65%) ears. The abnormal soft tissue mass was associated with bony erosion in 41 (68.33%) ears. Widening of attic, aditus and antrum by soft tissue mass was seen in 15 (25%) ears (Table 1).

Table 1: Distribution of abnormal soft tissue mass on HRCT temporal bone in 60 ear cases.

Involvement	No. of ears	Percentage (%)
Attic + aditus+ antrum	60	100
Attic + aditus+ antrum + mesotympanum	39	65
Soft tissue mass + bony erosions	41	68.33
Widening of attic + aditus + antrum	15	25

In 11 cases (18.33%), HRCT indicated abnormal soft tissue density with no osseous erosion. 5 of 11 (45.45%) of these ears showed cholesteatoma intraoperatively while 6 of ears (54.54%) showed granulation tissue intraoperatively. Thus, if non-bone eroding mass is present, the possibility of cholesteatoma is still around 45%.

In 49 (81.67%) ears HRCT indicated the presence of both abnormal soft tissue mass and definite signs of bony destruction involving the ear ossicles, mastoid air cells, antrum, scutum and/or walls of middle ear. Intraoperatively 40 such cases were of cholesteatoma and 9 cases of granulation tissue.

Considering the status of ear ossicles, incus appeared to be intact in 10 (16.66%) cases on HRCT but intraoperatively it was found to be intact in 4 (6.66%) cases and in the remaining 6 cases it was partially eroded. Malleus appeared to be intact in 17 (28.33%) cases on HRCT whereas surgically it was found to be intact in 13 (21.66%) cases, in the remaining 4 cases it was partially eroded. On HRCT stapes appeared to be intact in 25 (41.67%) cases and eroded in 8 (13.33%) cases and was not visualized in 27 (45%) cases, intraoperatively it was eroded in 14 cases (23.33%) and found to be intact in 46 (76.67%) cases. Out of 27 cases not visualized on CT, all 10 were intact intraoperatively (Table 2).

HRCT detected incus erosion in 89.2%, malleus erosion in 91.4% but was poorly sensitive in case of stapes erosion (57.1%).

Regarding lateral semicircular canal, its erosion was seen in 4 (6.67%) cases on HRCT and the same was confirmed intraoperatively. The sensitivity and specificity of HRCT for LSCC erosion was found to be 100 % and 94.74% respectively.

Table 2: Status of ossicular assembly in HRCT vs. surgical findings.

Ossicles		CT findings		Operative findings	
		N	%	N	%
Incus	Intact	10	16.66	4	6.66
	Eroded	50	83.33	56	93.33
Malleus	Intact	17	28.33	13	21.66
	Eroded	43	71.66	47	78.33
Stapes	Intact	25	41.67	46	76.67
	Eroded (superstructure)	8	13.33	14	23.33
	Not visualized	27	45	0	0

The facial nerve canal appeared eroded in 11 (18.33%) cases in tympanic segment on HRCT but was confirmed in 9 (15%) cases intraoperatively. Erosion of the vertical segment in 2 (3%) cases seen intraoperatively was not reported preoperatively on the HRCT shown in the Table 3.

Table 3: Comparison of the status of LSCC, facial canal and lateral cortical wall on HRCT and intraoperative findings.

Variables	CT findings		Operative findings	
	N	%	N	%
LSCC intact	56	93.33	56	93.33
Eroded	4	6.67	4	6.67
Facial canal intact	49	81.67	51	8
Eroded	11	18.33	9	15
Lateral cortical wall intact	44	73.33	44	73.33
Eroded	16	26.67	16	26.67

The lateral cortical wall appeared eroded in 16 (26.67%) cases on HRCT and the same was confirmed intraoperatively.

On HRCT the dural plate erosion was seen in 11 (18.33%) cases, but intraoperatively erosion was found only in 8 (13.33%) cases. Thus, the intact dural plate was seen in 49 (81.67%) cases on HRCT but intact dural plate was present in 52 (86.67%) cases intraoperatively. Sinus plate erosion was seen in 7 (11.67%) cases on HRCT and intact sinus plate was seen in 53 (88.33%) cases, the same findings were confirmed preoperatively.

Thus, our study showed that HRCT is 100% sensitive in detecting the soft tissue extension of mastoid and status of Lateral semicircular canal, lateral cortical wall and sinus plate (Table 4).

Table 4: Correlation of HRCT temporal bone scan with surgical findings.

Variables	HRCT	Intra-operative	False positive	False negative	Sensitivity	Accuracy
Soft tissue mass	60	60	0	0	100	100
Sclerotic mastoid	54	54	0	0	100	100
Incus erosion	50	56	0	6	89.2	90.32
Malleus erosion	43	47	0	4	91.4	92.15
Stapes erosion	8	14	0	6	57.1	70
LSC erosion	4	4	0	0	100	100
Facial canal erosion	11	9	2	0	100	81.81
Lateral cortical wall erosion	16	16	0	0	100	100
Dural plate erosion	11	8	3	0	100	72.72
Sinus plate erosion	7	7	0	0	100	100

DISCUSSION

Nowadays, HRCT temporal bone is increasingly becoming popular for detection of early bone erosions and in providing detailed imaging of soft tissue extent of middle ear cholesteatoma.

The typical features of the cholesteatoma on HRCT temporal bone includes: the presence of non-dependent soft tissue density material in middle ear cleft, ossicular chain erosion, fine erosions of the middle ear borders and adjoining structures. These changes when associated with bony expansion of the middle ear cavity and aditus ad antrum with loss its "figure of 8" appearance is highly suggestive of cholesteatoma.[8] Mafee et al and David et al illusturated the criteria indicating cholesteatoma as "blunting of the scutum's normally sharp tip" as often the earliest indicator of attic cholesteatoma.[9,10]

The present study showed excellent demonstration of above features and established the essential role of HRCT in evaluation of location and extent of cholesteatoma and its sequelae (Figure 1).

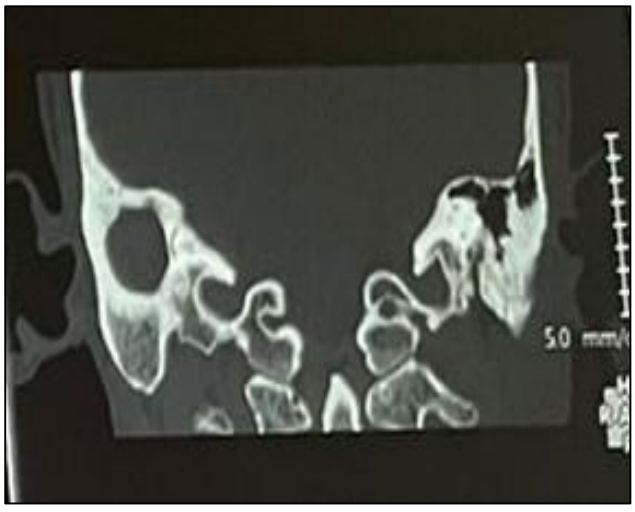

Figure 1: Coronal section HRCT temporal bone showing abnormal soft tissue density in right mastoid cavity with expansile widening of mastoid antrum.

Soft tissue mass

HRCT temporal bone provides brilliant view for evaluation of extension of soft tissue mass in various subdivisions of middle ear cleft, particularly to access the hidden areas which are necessary for complete removal of disease.

In our study, in 49 (81.67%) ears HRCT temporal bone indicated the presence of both abnormal soft tissue mass and definite signs of bony destruction involving the ear ossicles, mastoid air cells, antrum, scutum and/or walls of middle ear suggesting of cholesteatoma. Intraoperatively we found cholesteatoma in 40 of 49 cases (81.63%) and granulation tissue in the remaining 9 cases (18.37%). This is comparable to the reports by O'Donoghue et al who found cholesteatoma to be present in 80% of the cases with bony erosion that were explored surgically.[11] The findings are also consistent with Jackler et al who found that surgical exploration revealed cholesteatoma in 78.6% (11/14) of cases. In the remaining 3 non cholesteatoma cases granulation was found in 2 and cholesterol granuloma in the remaining case.[12]

Thus, on HRCT temporal bone although cholesteatoma shows lower attenuation than granulation tissue but difference is quite subtle and only magnetic resonance imaging (diffusion) can accurately differentiate both of them.[5]

Ossicular erosion

In our study we found out that malleus head and incus body with short process (ice cream cone appearance) were best seen on axial sections while the handle of the malleus and long process of incus were better seen in coronal sections. It is to note that the prior knowledge of status of ossicles helps to decide the likelihood of hearing preservation which can be attained post-surgery. The sensitivity of incus erosion was 89.2% and PPV 100%. Similarly, Datta et al and Rai observed a positive predictive value of 100% with comparable sensitivity (87% and 85%, respectively) in their studies.[13,14]

On HRCT, malleus which appeared to be intact in 17 (28.33%) cases, was found to be intact in 13 (21.66%) cases intraoperatively, with the remaining 4 cases showing partial erosion with sensitivity of 91.4% and PPV of 100%. The sensitivity, specificity, and positive predictive value of the present study were comparable to the study conducted by Jadia et al and Datta et al.[5,13]

Similarly, stapes appeared to be intact in 25 (41.67%) cases on HRCT, was eroded in 8 (13.33%) cases and was not visualized in 27 (45%) cases. Intraoperatively it was eroded in 14 cases (23.33%) and found to be intact in 46 (76.67%) cases. Out of 27 cases not visualized on CT, all 10 were intact preoperatively. The PPV value was 100% with sensitivity of 57.1%. According to Rai et al HRCT is 100% specific but less sensitive (75%), and a similar observation by Tok et al reported a sensitivity of 71.2%, specificity=100%, positive predictive value=100%, and negative predictive value=76.2%.[14,15] The assessment of the stapes erosion was more challenging due to the prevalence of surrounding soft tissue around an already very small structure.[5]

Tegmen and facial canal erosion

Knowledge of the presence of tegmen erosion with dural exposure alerts the surgeon to a prime hazard and establishes the need for early surgical exploration. Such defects are best seen in the coronal plane. In our study, 11 cases of tegmen erosion were demonstrated on HRCT scan (Figure 2) but intraoperatively only 8 cases showed erosion with sensitivity of 100% and both accuracy and positive predictive value of 72.72%. A similar value of 100% sensitivity on HRCT, was also reported by Rocher et al, Zhang et al, Alzoubi et al.[16-18]

Jackler et al detected all their cases of tegmen erosion but also had eight false positive cases.[12] In our study its accuracy and positive predictive value was 72.72% each. The reason for low PPV may be explained due to CT technique artifacts as these are fine osseous lamina and the tomographic cuts vary from 0.5 to 2 mm thus images of this section are aggregated and may lead to a false impression of the tegmen dehiscence. The same occurs with other structures like the lateral semicircular canal and the facial nerve canal.[19]

The presence of facial canal dehiscence, whether congenital or secondary to the cholesteatoma, puts the facial nerve at a higher risk of injury intra operatively making HRCT scans as an essential preoperative diagnostic tool. Facial nerve is best evaluated in its cross section, hence the tympanic segment best seen on coronal while the mastoid segment in axial section.

In our study the facial nerve canal appeared eroded in 11 (18.33%) cases in tympanic segment on HRCT but was confirmed in 9 (15%) cases intraoperatively. Erosion of the vertical segment in 2 (3%) cases seen intraoperatively was not reported preoperatively on HRCT and can be attributed to its oblique course and small diameter of the canal.[8] Similar results were also observed by Alzoubi et al, and Rai et al in their studies.[14,18]

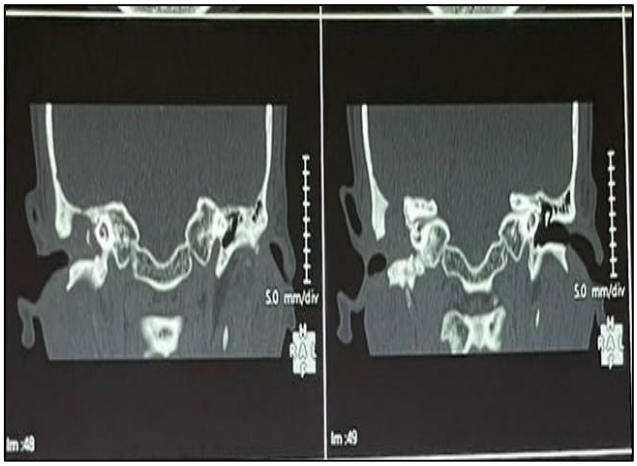

Figure 2: Coronal section HRCT temporal bone depicting extensive abnormal soft tissue density in right middle ear cleft with erosion of ossicles and tegmen plate.

Semi-circular canal erosion

The diagnosis of the semicircular canal fistula is made when the soft tissue density mass is seen in direct opposition to the lumen of labyrinth. HRCT clearly depicts bone erosion which helps surgeon in careful resection of cholesteatoma intraoperatively. All 4 defects in our study occurred on the Lateral semicircular canal with none affecting Superior semicircular canal with sensitivity and accuracy of 100% (Figure 3).

Similarly, Anelise et al stated that the lateral semicircular canal erosion was present in 2 cases and was correctly identified by preoperative HRCT.[19] Chee et al in their series concluded that 5 cases out of 6 lateral semicircular canal fistula were detected by preoperative HRCT temporal bone scan.[12]

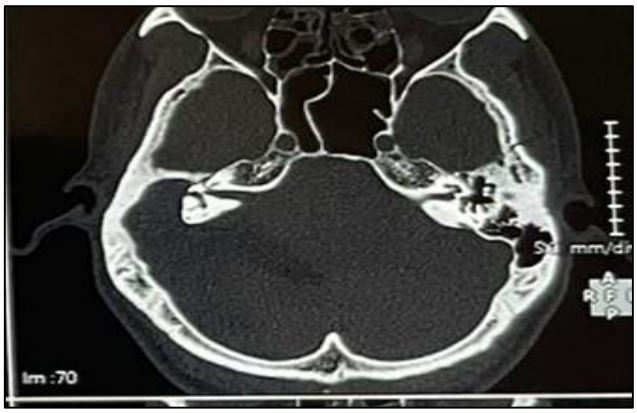

Figure 3: Axial section HRCT temporal bone showing extensive abnormal soft tissue right ear with erosion of lateral semi-circular canal wall.

Sigmoid sinus plate erosion

Sinus plate erosion alerts both the radiologist and surgeon regarding its sequelae and complications (venous sinuses thrombosis and cerebellar abscesses). HRCT temporal bone is highly useful in delineating the erosion (Figure 4) and it also act as a guide during mastoid exploration in cases of anatomical variations of sinus plate. In our study Sinus plate erosion was seen in 7 (11.67%) cases on HRCT and intact sinus plate was seen in 53 (88.33%) cases, the same findings were confirmed preoperatively. Sensitivity and accuracy was 100%. Datta et al. reported results similar to that documented by the present study.[13] Similarly, Jadia et al reported that the sinus plate was found eroded among 2(3.8%) cases in HRCT while it was found eroded in 1 (1.9%) case intra-operatively. There was statistically no significant difference found between HRCT finding and intra-operative findings in respect to sinus plate.[5]

Figure 4: Axial section of HRCT temporal bone showing extensive abnormal soft tissue in right middle ear and mastoid cavity with erosion of sigmoid sinus plate.

CONCLUSION

Thus, we conclude that our findings were consistent with those of previous studies and HRCT temporal bone findings were in good association with intraoperative surgical findings. Hence HRCT temporal bone is valuable in diagnosing and guiding surgical management of unsafe COM. Its role in early course of disease can potentially reduce the risk of late complications associated with underdiagnosed cholesteatoma.

However, the drawback being radiation exposure, high cost, unable to efficiently differentiate between cholesteatoma and soft tissue density of any other variety remains.

Still, we can conclude that the HRCT can be used as a standard radiological imaging modality for the evaluation of temporal bone pathology and as a roadmap for surgical management, making it a pre-requisite before any surgical exploration.

Limitations of the study was-finer cuts of HRCT temporal bone would have been more conclusive in assessing the disease status in unsafe COM patients. Further, additional information from another radiological modality (e.g., MRI) for complicated cases of unsafe COM was not considered in this study, barring from more accurate evaluation of correlation with intraoperative surgical findings.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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