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Evaluation of Temporal Bone in Cholesteatoma Patient by High Resolution Computed Tomography with Surgical Correlation

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ABSTRACT

Background: *Cholesteatoma is dangerous condition diagnosed by otoscopic examination and treated by surgery. This study assesses the usefulness of a pre-operative high-resolution CT scan in depicting the status of the middle ear structures in the presence of cholesteatoma.*

Aim and Objective: *To study the role of HRCT temporal bone in pre-operative evaluation of cholesteatoma.*

Materials and Methods: Total 64 cases with clinically suspected cholesteatoma were selected for the study. The important per-operative surgical findings were correlated with pre-operative HRCT findings.

Results: *This study showed good correlation between the preoperative findings and intra operative findings.*

Conclusion: *HRCT enabled the extent of cholesteatoma and the recognition of its manifestations and complications. HRCT is confirmed to be valuable in the diagnosis and in guiding the surgical management of cholesteatoma and more conservative procedure can be used to eradicate the disease.*

KEYWORDS : High Resolution Computed Tomography (HRCT), temporal bone, cholesteatoma

INTRODUCTION

Infections of the middle ear are common and much of temporal bone surgery is done for infections of the ear. Cholesteatoma traditionally diagnosed by otoscopic examination and treated by explorative surgery. The need for imaging in an uncomplicated case is contentious. This study assesses the usefulness of a pre-operative high-resolution CT scan in depicting the status of middle ear structures in the presence of cholesteatoma.

AIM

To study the effectiveness of pre-operative HRCT temporal bone in evaluation of patients with cholesteatoma.

To correlate pre-operative findings with per-operative findings.

To provide road map for surgeon in these patients.

Preemptive detection of complications in these patients.

MATERIALS AND METHODS

A total of 64 patients of whom 35 were males and 29 were females were studied. Age group varied from 5 to 60 years. Patients were selected from out patients clinic and wards of Otorhinolaryngology Department, Government Medical College & Hospital, Chennai. Period of study from February 2014 to August 2015. Patients were scanned in axial and coronal planes. All the examinations were performed on a Toshiba Asteion spiral CT scanner.

INCLUSION CRITERIA

Patients with unsafe ear

1. Otoscopically evident cholesteatoma
2. Marginal tympanic membrane perforation
3. Refractory otorrhoea.
4. Posterosuperior retraction of tympanic membrane.

EXCLUSION CRITERIA

1. Patients with known complications
2. Patients undergone previous surgery in temporal bone.

The features evaluated were

Erosion and destruction of the lateral attic wall (scutum), Widening of aditus ad antrum as the destruction extends into the antrum, Displacement of the Ossicles, Destruction of the ossicles, Fistula formation with the lateral and posterior semicircular canals and the vestibule, Erosion into the facial canal, Dehiscence of tegmen tympani, Destruction of mastoid(automastoidectomy), Dehiscence of sigmoid plate.

RESULTS AND ANALYSIS

SOFT TISSUE DENSITY

Acquired cholesteatoma are characterized on CT by the presence of a non-dependant, homogenous soft tissue mass with focal area of bone destruction.

In the majority of our cases, this soft tissue density had mass-like features (Figure 4). The tissue masses were homogenous in 62 cases (96.87%), non-dependent in 63 (98.44%), and expansile (smooth bony expansion of the attic and mastoid antrum) in 59 cases (92.2%). The mass sub totally occupied the middle ear cavity and antrum in 52 cases (81.25%).

Only a few (n=7, 11%) of these soft tissue densities had totally filled the whole middle ear cavity, or were focally localized to the attic and mastoid antrum (n=5, 7.81%).

OSSICULAR CHAINS

Erosion of the ossicles is commonly seen with cholesteatomas, as they enlarge and come in contact with contiguous structures in the middle ear. Of the 59 cases (92.19%) with ossicular erosions, the incus was mostly affected (n=48, 75%) (The long process of the incus was the most commonly eroded). The Stapes, the second most affected ossicular bone (n=42, 65.62%), was also totally eroded.

Although the Malleus was the least affected bone by erosion (n=26, 40.64%), its erosion were the most easily observable finding.

In our review, 14 cases (21.87%) showed medial displacement and 2 cases (3%) exhibited lateral shifting.

FACIAL NERVE CANAL

Of the 64 cases we found, 12 cases (18.8%) showed involvement with 9 cases (14%) partially eroded (Figure 2), and 3 cases (4.69%) were totally destroyed.

SEMICIRCULAR CANALS
Due to its anatomical close proximity to the medial wall of the attic, the lateral semicircular canal is the most frequently eroded.

We have encountered a total of 9 cases (14%) involving the lateral semicircular canals, 4 cases (6.25%) positive for labyrinthine fistula and 5 cases (5.81%) partially eroded.

TEGMEN
Two cases (3.13%) were positive for dehiscence (tegmen bone defect) (Figure 1). N the remaining 62 cases (96.8%), the tegmen were intact.

SCUTUM (SPUR)
Involvement of the scutum was present in 50 cases (78%) in our series.

Forty cases (62.5%) were blunted and 10 cases (15.6%) were destroyed.

ADITUS AD ANTRUM
When cholesteatoma is present, it may erode its wall and widen the "waistline" (aditus) resulting in the loss of the "figure of 8".

There were 55 cases (85.9%) of involvement noted, 25 cases (39.06%) with loss of figure of 8 and 18 cases (28.13%) of these had wall erosions (Figure 4).

PETROSQUAMOSAL SEPTUM (KOERNERS SEPTUM)
An antral cholesteatoma usually erodes this thin structure. In our series, there were 57 cases (89%), with 38 cases (59.38%) partially eroded and 19 cases (29.68%) completely destroyed. In only 5 cases (7.81%) was the septum preserved.

MASTOID AIR CELLS
In all 64 cases (100%) the affected mastoids were all sclerotic due to chronic infection. The majority 43 cases (67.18%) are acellular.

MASTOID ANTRUM
In our series, the antra were replaced by soft tissue densities in 55 cases (85.94%), while 48 cases (75%) were expanded and 15 cases (23.43%) showed partial smooth bony erosions.

EXTENSION BEYOND THE MIDDLE EAR
Complications are related to osseous destruction, which may lead to serious and potentially fatal intracranial conditions.

Two cases were found to have destruction of the tegmen and one case sigmoid sinus plate destruction.

AUTOMASTOIDECTOMY
CT appearance is reminiscent of mastoidectomy. Only one case (1.56%) occurred in our series.

Table 1
OCCURANCE OF POSITIVE FINDINGS

CT findings	*no of cases*	*% of cases*
Ossicular erosion	59	92.18
Mastoid sclerosis	64	100.00
Aditus ad antrum widening	55	85.93
Scutum erosion	50	78.12
Facial canal involvement	12	18.75
Semi circular canal fistula	9	14.06
Tegmen erosion	2	3.12

DISCUSSION
The diagnosis of cholesteatoma is usually made on otologic examination. In cases in which the diagnosis is not obvious, computerized tomography may demonstrate a soft tissue mass with characteristic ossicular displacement and erosion of bone. Cholesteatoma in hidden areas, such as posterior tympanic recess, may be revealed by a CT scan even if it is not detected by otologic examination. A CT scan also provides information about congenital anatomic variations that may encountered during surgery, as well as complications of cholesteatoma.

The hallmarks of cholesteatoma are the presence of soft tissue density in the middle ear cavity, ossicular erosions, smooth erosions of the middle ear borders and adjacent structures. These changes, when associated with bony expansion of the middle ear cavity, are highly suggestive of cholesteatoma.

Our investigation demonstrates that the CT findings that may suggest a diagnosis of middle ear cholesteatoma consist of non-dependent polypoidal soft tissue densification of the middle ear cavity and antrum (focal, partial or total), with associated expansion and smooth erosion of the walls, ossicular displacement and erosions. These features are similar to those described in the literature. Because they are commonly a complication of chronic mastoiditis, there is almost always co-existing inflammatory disease with adjacent mastoid air cells. Our study demonstrates this in all patients.

Complete opacification of the middle ear with no bony destruction makes radiologic differentiation of cholesteatoma from middle ear effusion and granulation tissue difficult. The presence of an air-fluid level or a soft tissue (fluid) mass in the dependent portion of the middle ear would support to a diagnosis of effusion.

In cases where the antrum was enlarged with an air-fluid level, this finding was suggestive of infected cholesteatoma.

In our series, non-dependent, homogenous and polypoidal soft tissue densities were present in the mastoid antrum and middle ear cavity. In the majority of cases, soft tissue occupied all spaces at the time of CT study.

Many patients had both granulation tissue and cholesteatoma, which could not be radiographically distinguished.

Another sign of antral cholesteatoma is erosion or absence of bony partition known as Koerners septum.

Signs indicating cholesteatoma in the attic include erosion or destruction of scutum or spur (lateral wall of the attic), widening of the aditus ad antrum (loss of figure of 8 appearance) (Figure 4), antral wall erosions and widening (Figure 4), ossicular erosion and destruction (Figure 1), medial attic wall erosion which may lead to facial nerve canal involvement, which may cause paresis or paralysis (Figure 2), erosion of lateral semicircular canal which may result in fistula formation, dehiscence of tegmen tympani (Figure 1), dehiscence of sigmoid sinus plate, erosion of external auditory canal (EAC), and automastoidectomy.

After clinical examination, otoscopy and a diagnosis of cholesteatoma, CT can determine its extent by revealing a soft tissue mass and bone erosion, with 80% specificity.

Although otoscopic recognition of cholesteatoma is often reliable, imaging modalities should be used on all patients suspected of cholesteatoma to determine the presence of gross or subtle changes and the presence of complications, which are mostly due to bone erosions. The specific issues that must be assessed on imaging studies and that will affect the surgical treatment are bone erosion and the degree of extension. CT is sensitive for the detection of early bone erosions and detailed imaging of the soft tissue extent of middle ear cholesteatoma, provides information that may affect their surgical resection.

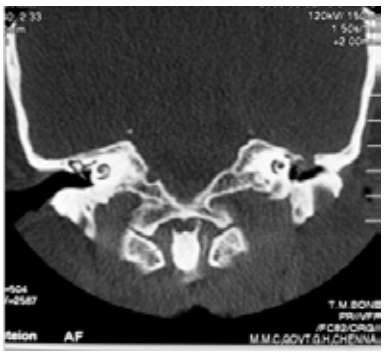

FIG 1 CT CORONAL SECTION SHOWING DESTRUCTION OF OSSICLES TEGMEN TYMPANI DEHISCENCE

FIG 2:CT CORONAL SECTION SHOWING **FACIAL CANAL DEHISCENCE WITH SOFT TISSUE LESION IN TYMPANIC CAVITY**

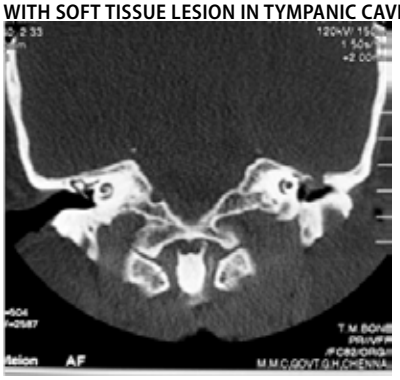

FIG 3:CT CORONAL SECTION SHOWING NON DEPENDENT SOFT TISSUE LESION WITH SCUTUM EROSION

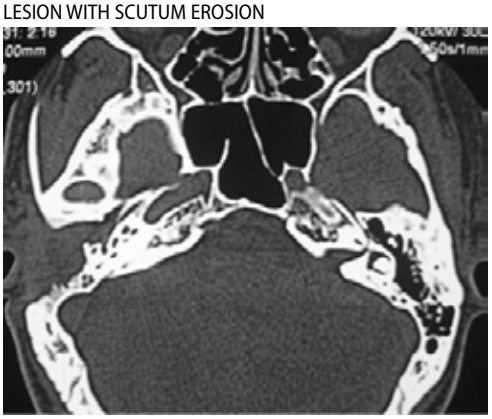

FIG 4:CT AXIAL SECTION SHOWING **WIDENING OF ADITUS AD ANTRUM WITH EROSION OF ANTRAL WALL ON RIGHT SIDE**

COMPARATIVE ANALYSIS

The analysis of pre-operative HRCT scans correlated with the surgical findings with a high degree of accuracy (96.88%) (Table 3). Of 64 cases, evaluation of the malleus was in agreement with post-operative results in 60 cases (94%). In 4 cases, no erosion was seen in HRCT but erosions were found in surgery, but this was due to long interval between the pre-operative HRCT and the day of actual surgery. In the assessment of incus, 61 cases (96%) matched with the operative findings. Subtle erosion in 3 cases seen in CT images was found to be negative in surgery. The stapes showed agreement in 59 cases (92%) in both pre-operative scans and surgical results. Of the 28 cases (43.75%) with an unclear degree of erosion in HRCT scans (due to being masked by surrounding soft tissue density), the surgical reports indicated total destruction of the stapes in 26 cases (40.63%) while 2 cases(3.13%) were severely eroded. The remaining 5 cases (7.81%) showed subtle erosions as analyzed in HRCT, but were found normal in surgery. The HRCT surgical evaluation of lateral semicircular canal revealed 63 cases (94.44%) in agreement. There were 4 cases (6.25%) that had labyrinthine fistula in HRCT but 3 cases (4.69%) were in agreement with the surgical findings. However, the post-operative report stated that the remaining case (1.56%) had marked erosions with dehiscence.

Pre-operative demonstration of facial nerve canal involvement was often difficult not only because of its small size but due to its oblique orientation (tympanic portion) and the presence of developmental dehiscence, particularly when abutted by the soft tissues. The usefulness of coronal planes is very important in doubtful cases. In our series, 55 cases (86%) had CT agreement. In partially eroded canals, 12 (18.7%) positive cases were shown by CT. only 7 cases (10.9%) were noted in surgery, 2 cases (3.13%) of which had dehiscence. The other 5 cases with very subtle marginal irregularities in HRCT were negative in surgery. In 3 cases (4.69%) with facial nerve canal destruction, 2 cases (3.13%) had similar changes in surgery while in 1 case (1.56%) more than 50% dehiscence was reported in surgery.

Complete agreement was noted in one case of automastoidectomy.

The radiosurgical agreement was excellent for malleus, (kappa statistics, k=0.811), stapes (0.817), semicircular canal (0.93), incus(0.867) but good for facial nerve canal (0.633)(Table 2**)**

TABLE 2-AGREEMENT BETWEEN SURGICAL FINDING AND RADIOLOGICAL FINDING

	Surgical findings	Radiological findings		Kappa
		Intact	Abnormal	
Malleus	Intact	32	02	0.811
	Eroded	04	26	
Incus	Intact	13	03	0.867
	Eroded	0	48	
Stapes	Intact	17	05	0.817
	Eroded	0	42	
Facial canal	Intact	43	05	0.633
	Dehiscent	04	12	
Labryinth	Intact	54	01	0.938
	Fistula	0	09	

TABLE 3- PRE-OPERATIVE CT AND SURGICAL CORRELATION

Diagnosis	Pre-op CT	Surgery
Cholesteatoma	62	61
Cholesteatoma with other pathology	2	-
Granulation tissue	-	1
Aural polyp	-	2
Total	64	64

Kappa statistics was used to measure the degree of agreement between surgical and radiological findings. Kappa values exceeding 0.75 represent excellent agreement, values between 0. And 0.75 fair to good agreement, and values less than 0.4 poor agreements.

CONCLUSION

This study concludes that HRCT imaging for cholesteatoma accurately depicts the status of middle ear structures. The scan delineates the location and extent of the disease, and provides information on anatomical variations and complications. It serves as a road map to assist the surgeon during cholesteatoma surgery. The HRCT scan is a valuable, useful and indispensable tool prior to cholesteatoma surgery.

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