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Original Article

Usefulness of Pre-operative High-resolution Computed Tomography in Middle Ear Cholesteatoma

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Abstract

Introduction: Cholesteatoma is traditionally diagnosed by otoscopic examination and treated by exploratory surgery. The need for imaging in an uncomplicated case is contentious. The study assesses the usefulness of a pre-operative high-resolution computed tomography (HRCT) in depicting the status of middle ear structures in the presence of cholesteatoma.

Aim: The aim of this study is to evaluate the efficacy of pre-operative HRCT in the assessment of disease in patients with middle ear cholesteatoma. Pre-operative high-resolution temporal bone CT scans were carried out and compared with intraoperative findings.

Materials and Methods: In this prospective observational study, 30 patients with cholesteatoma were included in the study.

Results: HRCT shows the presence of non-dependent tissue mass in 28 of 30 cases. Evidence of destruction of bony walls of the middle ear, mastoid antrum, or ossicles was sought after, and 25 cases showed all the 3 features.

Conclusion: The patient is benefited as he has presurgical assessment rather wait for results of surgical exploration. Forewarned about complications, the patient has a pictorial depiction of the disease and understands the need for surgical intervention and difficulty in hearing preservation.

Key words: Auditory canal, Cholesteatoma, Ossicles, Tympanic

INTRODUCTION

Cholesteatoma is traditionally diagnosed by otoscopic examination and treated by exploratory surgery. The need for imaging in an uncomplicated case is contentious. The study assesses the usefulness of a pre-operative high-resolution computed tomography (HRCT) in depicting the status of middle ear structures in the presence of cholesteatoma.[1] Cholesteatoma is a sac of keratinizing squamous epithelium in the middle ear cleft. The lesion is classically recognized by the presence of attic squames on otoscopic examination. The presence of cholesteatoma must also be suspected beneath polyps protruding from the pars flaccid or when there is a marginal tympanic membrane perforation or granulation. Cholesteatoma is a potentially serious condition as it can progressively enlarge and erode into neighboring structures giving rise to serious intracranial and extracranial complications.[2,3] Barring any medical contraindications, treatment of suspected cholesteatoma is by surgical exploration and eradication of disease with tympanomastoidectomy operation. Unlike the situation with endoscopic sinus surgery whereby routine pre-operative CT scan is widely accepted as standard practice, the need for pre-operative imaging studies for cholesteatoma is controversial. Even among experienced otologist, there is no single accepted standard for the need of CT scan in uncomplicated cases.[4] The advent of HRCT has brought about significant enhancement in the pre-operative assessment of temporal bone pathology and fine anatomical details. The intent of this study is to evaluate the accuracy of this imaging modality in our patients undergoing surgery for cholesteatoma.[5] HRCT provides

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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 has also added a whole new dimension to the evaluation of the temporal bone by allowing visualization of the soft tissue components within and adjacent to the temporal bone.[6] 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.

Aim

The aim of this study is to evaluate the efficacy of pre-operative HRCT in the assessment of disease in patients with middle ear cholesteatoma and to provide a road map for surgery in these patients.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of ENT at tertiary care hospital.

Inclusion Criteria

Cholesteatoma detected by otoscopy, marginal tympanic membrane perforation, posterosuperior retraction and granulomas, history of scanty purulent blood, and foul-smelling discharge, modified radical mastoidectomy was planned, and surgical finding correlated were included in this study.

Exclusion Criteria

Patients with known intracranial/intratemporal complications and patients undergone previous mastoid surgery were excluded from the study. All the patient examinations were performed with Toshiba asterion spiral CT scan. Patients were scanned in two planes one. axial 30° with the patient placed supine with head flexed and scan plane passing through the external auditory canal and superior orbital rim. Coronal sections were performed with the patient placed prone with the neck maximally extended, and the scan plane was oriented to intersect the external auditory canal to the posterior margin of the maxillary sinus presurgical HRCT scan was retrospectively assessed by the radiologist. In addition, being blinded to the surgical findings, the radiologists were asked to comment on the status of ossicles, integrity of the facial canal, semicircular canals and the tegmen tympani, and any anatomical variations and disease complications.

RESULTS

In our study, 30 patients were included, 14 were male and 16 were female. Ear discharge is the most common symptoms observed.

HRCT shows the presence of non-dependent tissue mass in 28 of 30 cases. The location of the pathology on the scan was typical for cholesteatoma in 28 cases, and in 27 cases, there was radiological evidence of destruction of bony walls of the middle ear, mastoid antrum, or ossicles. All the cases had at least one radiological feature, and 25 cases showed all the 3 features. The correlation was found to be excellent for malleus, stapes, and semiauricular canal, good for the incus and tegmen tympani but poor for the facial nerve canal (Figure 1).

Status of the Ossicles

Incus was the most frequently eroded, followed by malleus and stapes. Out of the 27 incus found eroded in the surgery, 24 were found eroded in the scan. Out of 15 eroded malleus, 13 were picked by the scan. 13 out of 15 of absent stapes suprastructure were correctly predicted by imaging (Table 1).

Semicircular Canal Fistula

3 out of 4 labyrinthine fistulae were picked by scan. One case had thinning of otic capsule. In remaining 26 cases, CT was incorrect in one case (Table 1).

Erosion of the Tegmen Tympani

3 patients had erosion of tegmen exposing dura, and this was shown in the scan. Of the remaining 27 cases, the scan missed one case as having tegmen dehiscence (Table 1).

Facial Canal Dehiscence

Of the 7 surgically confirmed facial canal dehiscences, only 3 could be detected by the radiologist. In 23 cases, the canal was found to be intact during surgery, but the scan suggested possible erosion in 2 of these cases. Various other anatomical variations and surgical hazards were detected as follows (Table 1).

- Erosion of posterior canal wall
- Erosion of sinus plate
- High and dehiscent jugular bulb
- Anteriorly lying sigmoid sinus
- Low lying Dura.

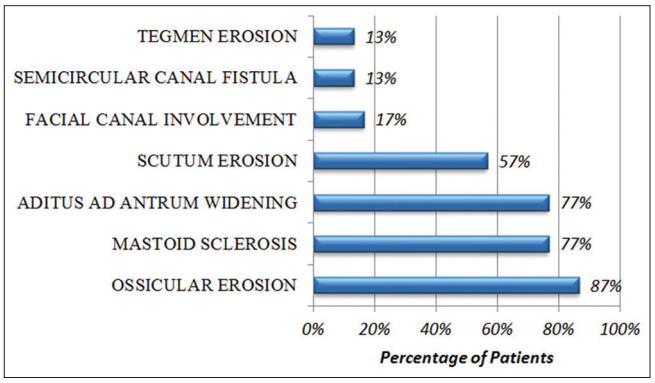

Figure 1: Distribution of computed tomography findings

Table 1: Cross tabulation of radiological findings and surgical findings

Surgical finding	Radiological findings		Kappa
	Intact	Abnormal	
Malleus			
Intact	15	0	0.867
Eroded	2	13	
Incus			
Intact	3	0	0.527
Eroded	3	24	
Stapes			
Intact	12	3	0.667
Absent	2	13	
Facial canal			
Intact	21	2	0.379
Dehiscent	4	3	
Labyrinth			
Intact	25	1	0.712
Fistula	1	3	
Tegmen			
Intact	25	1	0.712
Eroded	1	3	

DISCUSSION

Cholesteatoma can be accurately diagnosed in vast majority of cases. Mafee *et al.*[7] reported correct diagnosis of cholesteatoma in 46 out of 48 patients. All our cases exhibited at least one of three features that are tissue mass, typical location, and bone erosion. 25 cases had all three features. When we base our diagnosis of cholesteatoma on the scan having at least two of the three features, all cases would be correctly diagnosed with cholesteatoma. Scan evidence of cholesteatoma with significant bony destruction or other complications would prompt the surgeon to operate earlier particularly if polyps or a tortuous bony canal obscures visualization of the traditional medicine and hinders clinical diagnosis. On the other hand, threshold to explore the ear may be higher if the scan is non-confirmatory, particularly if the patient has medical risks for surgery.[8] The HRCT scan gives a good-to-excellent radio surgical correlation for the middle ear ossicles in our cases, and this is also the experience that the others have reported. While prior knowledge of the status of the ossicles is probably not critical in so far as the operative risk is concerned, it has bearing on the likelihood of hearing preservation that can be achieved after surgery. For example, the hearing outcomes in patients with an intact stapes tend to be better than those in where the stapes suprastructure is absent. Presurgical knowledge of the status of the ossicular chain would allow the surgeon to better advise the patient on the degree of hearing attainable after surgery.[9]

Labyrinthine fistula can be accurately detected most of the time when both axial and coronal images are taken to look for erosion of the semicircular canal. The most common canal affected is lateral semicircular canal (LSC) and reliance on coronal sections alone may lead to 50% false-positive rate of dehiscence due to the artifact of partial volume averaging. Even with the addition of axial scans, minute fistula may be missed as seen in one of the patients. The scan, in this case, showed thinning of the bone over the LSC but no obvious fistulization. Careful dissection of cholesteatoma matrix over the dome of the LSC revealed a tiny bony canal fistula. The surgeon is well advised to treat every case as a potential fistula until proven otherwise.[10] Tegmen erosion is well seen on coronal imaging, but again misinterpretations may result from volume averaging effects. Such is the case in one patient, where the scan suggested the tegmen to be breached but surgically proven to be intact. The reverse is also possible, whereby the dehiscent area may appear intact radiologically.[11] Facial canal dehiscence is fairly common findings in 55% temporal bones and usually occurring in a focal area in the tympanic portion of the fallopian canal. Problem with partial volume averaging artifact is again evident as fallopian canal can be so thin even in a non-pathological ear as to appear dehiscent on CT scan. This explains poor radiological correlations with the surgical findings. In addition, we also found visualizing the tympanic portion of the facial canal to be, especially, difficult when there is an adjacent pathological soft tissue mass in the mesotympanum. Knowledge of facial nerve anatomy, careful dissection technique in the vicinity of the nerve, and the use of intraoperative facial nerve monitoring all help toward reducing the likelihood of facial nerve injury.[12]

Besides giving information on the status of the middle ear structure, the CT scan can also delineate the extent and location of the disease. Cholesteatoma has a tendency to reside in hidden areas such as sinus tympani and anterior epitympanum. Knowledge of disease extent and information of degree of mastoid pneumatization aid in planning the surgical approach, whether to keep the canal wall up or down. However, CT can overestimate the disease as it cannot distinguish definitively between cholesteatoma and granulation tissue. An enhanced magnetic resonance imaging scan can discern the two better and maybe used if clinically indicated. Complications of cholesteatoma are associated with a high morbidity and can even be life threatening. However, the surgical treatment itself is also fraught with risks to many important structures because of the complex anatomy of the temporal bone. While we cannot quantify how the pre-operative scan decrease the rate of surgical complications, it is undoubtedly helpful in teaching our surgeons in training and enhancing their spatial orientation of the middle ear cavity.[13]

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 regard. The scan aids even the experienced otologist by alerting him to the presence of anatomical variations such as the high-riding jugular bulb or a prominent sigmoid sinus and potential surgical hazards that may arise from the destructive nature of the disease such as the labyrinthine dehiscence.[14]

Pre-operative demonstration of facial nerve involvement was often difficult not only because of its small size but also due to its oblique orientation and the presence of developmental dehiscence particularly when abutted by the soft tissues. Radio surgical agreement is excellent for malleus, good for incus and stapes, labyrinth, and tegmen while poor for facial canal in our study. Hence, HRCT should be a routine examination before cholesteatoma surgery.

CONCLUSION

The patient is benefited as he has presurgical assessment rather wait for results of surgical exploration. Forewarned about complications, the patient has a pictorial depiction of the disease and understands the need for surgical intervention and difficulty in hearing preservation. The surgeon is armed with a visual aid to pre-operative counseling, spatial orientation of disease extent, and identifies problem areas before surgery. Pre-operative HRCT is indispensible in patients with middle ear cholesteatoma.

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