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Role of high resolution computed tomography of temporal bone in preoperative evaluation of chronic suppurative otitis media

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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) is a common condition seen in patients attending ENT department. The diagnosis of cholesteatoma is usually made on otologic examination. The necessity for HRCT imaging in an uncomplicated case is controversial. The objective was to evaluate preoperative HRCT temporal bone and to determine its' usefulness in patients with Chronic suppurative otitis media (CSOM) undergoing surgery.
Methods: This study was a prospective study involving 30 cases of CSOM with cholestaetoma. All the patients underwent pre-operative HRCT screening followed by surgical exploration of middle ear cleft. Pre-operative CT scan and intra-operative findings recorded and compared.
Results: Out of total 30 patients of CSOM, 16 (53%) were males and (90%) presented with chief complaints of otorrhoea. HRCT scan was found to be very sensitive (100%) in detecting cholesteatoma in middle ear cleft but differentiation between granulations or cholesteatoma wasn't possible. HRCT satisfactorily delineated ossicular erosion except stapes suprastructure erosion which had 81.8% sensitivity and specificity 88.88%. For bony boundaries of middle ear, HRCT showed very high sensitivity and specificity for detecting scutum erosion, tegmen erosion, mastoid cortex erosion, jugular bulb dehiscence and bony external auditory canal erosion. It was moderately sensitive for LSCC Erosion (75%), Facial canal erosion (80%) and Sinus plate erosion (85.7%).
Conclusions: These results indicate that preoperative CT temporal bone scan of patients with CSOM serves as an important guide in surgical approach for otolaryngologists, although there are limitations in evaluation of the CT results.

Keywords: HRCT, Temporal bone, Cholesteatoma, Pre-operative evaluation, Sensitivity

INTRODUCTION

Chronic suppurative otitis media (CSOM) is a common condition seen in patients attending ENT department. Cholesteatoma is potentially serious condition as it can progressively enlarge and erode into neighbouring structures.[1] It can be associated with lot of complications, since temporal bone is surrounded by many vital structures [meninges, brain, internal carotid artery, jugular bulb, facial nerve, etc.] and its' gross anatomical variations makes the surgery difficult at times.[2]

The diagnosis of aural cholesteatoma is made with both otoscopic, as well as microscopic examination. Imaging procedures, such as high-resolution computed tomography (HRCT) and magnetic resonance imaging (MRI), may suggest presence of cholesteatoma within temporal bone, and may be used to complement clinical examination.[3]

HRCT Findings suggesting cholesteatoma include attic lateral wall (scutum) erosion, aditus ad antrum widening, erosion of ossicles, labyrinthine fistula, facial nerve canal

(fallopian canal) erosion, middle ear and mastoid (tegmen) dehiscence, mastoid destruction (automastoidectomy), sigmoid plate dehiscence, and bony external auditory canal erosion.[4]

Prior knowledge of the extension and the complications of cholesteatoma will alert the clinician and guide in surgical approach and treatment plan. So this study was undertaken with purpose to evaluate pre-operative HRCT temporal bone and to determine its' usefulness in patients with chronic suppurative otitis media (CSOM) undergoing surgery.

METHODS

This prospective study was conducted at Sri Venkateshwara ENT institute, BMCRI, Bangalore over a period of 3 months (1 Oct 2017 to 31 Dec 2017). Total 30 patients of clinically suspected CSOM with cholestaetoma were enrolled for this study. Written informed consent from all patients was taken before enrollment in the study.

Inclusion criteria

Inclusion criteria were patients with clinically suspected atticoantral type of chronic suppurative otitis media of all age groups and either sex; patients willing to give consent.

Exclusion criteria

Exclusion criteria were patients with previous ear surgeries; patients with history of trauma to temporal bone; patients with neoplastic growth involving middle ear; patients not willing to give consent.

A detailed history with regard to ear discharge, deafness, tinnitus, earache, vertigo, headache and fever was taken, and recorded in a systematic order, with special consideration of associated symptomatology suggestive of any impending or already established complication of chronic otitis media. All patients' ears were examined under microscope before surgery. A thorough clinical evaluation of patients was performed. Hearing status was assessed by pure tone audiometry (PTA). High-resolution CT images for all patients were obtained in axial plane with thin sections (0.6 mm). Scanning commenced from the lower margin of the external auditory meatus and extended upward to the arcuate eminence of the superior semicircular canal. Coronal and sagittal reconstructions were made and images were analysed.

Following areas of interest were looked up in preoperative scans:-

- Status of mastoid air cells,
- External auditory canal(EAC),
- Tegmen plate,
- Sigmoid sinus plate
- Bony boundaries of middle ear,
- Ossicular chain status,
- Fallopian canal,
- Semi-circular canals
- Pathological process (cholesteatoma and it's extension)
- Disease outside middle ear cleft.

All patients underwent surgical exploration of middle ear cleft and the type of surgery was determined by the clinical diagnosis, HRCT findings and per-operative findings. All intra-operative findings were recorded. For each of the above mentioned areas, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) were calculated for HRCT findings comparing with intraoperative findings.

RESULTS

Out of total 30 cases of CSOM, 16 (53%) were males. Majority of the patients (30%) were in the age group of 21-30 years (Table 1). Majority of the patients (90%) presented with chief complaints of otorrhoea (Table 2).

Table 1: Age distribution of patients.

Age group (years)	Frequency	Percentage (%)
<10	5	16.6
11-20	3	10
21-30	9	30
31-40	4	13.3
41-50	6	20
51-60	2	6.6
>60	1	3.3
Total	30	100

Otoscopic and microscopic examinations were key to clinical diagnosis. On otoscopic examination, 43.3% cases had cholesteatoma, 33.3% cases had retraction pocket with granulations, 6.6% had marginal perforation and 16.6% presented with ear polyps. On microscopic examination, cholesteatoma was found in 100% patients with retraction pocket with granulations, marginal perforation and ear polyps.

Table 2: Distribution of patients according to presenting symptom (n=30).

Chief complaints	No. of cases	Percentage (%)
Otorrhoea	27	90
Decreased hearing	20	66.6
Earache	5	16.6
Tinnitus	4	13.3
Vertigo	2	6.6
Facial paralysis	1	3.3

Table 3: Correlation of HRCT findings and surgical findings.

Correlation	HRCT findings	Surgical findings	False +ve	False -ve	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Evidence of Cholesteatoma	30	30	0	0	100	100	100	100
Malleus erosion	18	19	1	2	89.4	90.9	94.4	83.3
Incus erosion	23	24	0	1	95.8	100	100	85.7
Stapes suprastructure erosion	10	11	1	2	81.8	88.88	90	90
Scutum erosion	27	27	0	0	100	100	100	100
Sigmoid plate erosion	6	7	0	1	85.7	100	100	95.8
Tegmen erosion	6	6	0	0	100	100	100	100
Mastoid cortex erosion	5	5	0	0	100	100	100	100
Facial canal dehiscence	4	5	0	1	80	100	100	96.1
Bony EAC erosion	5	5	0	0	100	100	100	100
LSCC Erosion	3	4	0	1	75	100	100	96.2
Jugular bulb dehiscence	1	1	0	0	100	100	100	100

In this study, HRCT of all cases (100%) showed non-dependent homogenous soft tissue (cholestaetoma) in the middle ear cavity with 100% sensitivity (Table 3). There was involvement of epitympanum in (83.3%) cases, mesotympanum (43.3%) and hypotympanum (6.6%). It was extending in aditus ad antrum (83.3%), mastoid antrum (76.6%), external auditory canal (16.6%) and eustachian tube (3.3%). Intraoperatively presence of cholestaetoma could be appreciated in respective areas, but differentiation between these masses as granulations or cholesteatoma in HRCT was not possible.

Ossicular erosion was found in 80% of cases. Incus was the most commonly involved ossicle 80% of cases. HRCT showed 95.8% sensitivity and 100% specificity in detecting incus erosion. Malleus was eroded in 60% of cases (89.4% sensitivity and 90.9% specificity). Delineation of stapes erosion had a moderate sensitivity of 81.8% and specificity of 88.88%.

Total 13.3% cases showed well cellular mastoid while 86.6% showed poorly cellular or sclerotic mastoid. In 16.6% cases, outer wall of mastoid cortex was eroded. Scutum erosion was seen in 90% cases with 100% sensitivity and 100% specificity. Tegmen tympani erosion was seen in 20% cases with 100% sensitivity and 100% specificity, while sinus plate erosion was seen in 20% of cases with 87.5% sensitivity and 100% specificity (Table 3).

Detection of facial canal erosion on HRCT had sensitivity of 80%, specificity of 100%, positive predictive value 100% and negative predictive value 96.1%. This means HRCT has limited role for catching facial canal erosion but it excludes absence of erosion very accurately. Erosion of bony EAC was seen in 16.6% cases (sensitivity and specificity of 100%). Jugular bulb dehiscence was found in 1 case (100% sensitivity and specificity).

Erosion of the lateral semicircular canal was seen in 10% cases (sensitivity 75% and specificity of 100%). None of patients had intracranial complications.

Table 4: Planned surgeries based on HRCT findings.

Surgery	No of cases
Modified radical mastoidectomy	21
Inside out mastoidectomy	6
Cortical mastoidectomy with tympanoplasty	3

In our study, findings of HRCT guided us in planning the surgical procedure in individual patient. 6 patients were planned for inside out mastoidectomy because of limited disease present in epitympanum, 21 patients for modified radical mastoidectomy because of extensive disease in middle ear cleft and 3 patients who were having limited to moderate disease in middle ear cleft were planned for cortical mastoidectomy with tympanoplasty (Table 4).

DISCUSSION

The advent of HRCT has made a significant impact on surgical management of individuals with middle ear pathologies. It confirms and expands upon otoscopic findings, resolves clinical doubts, and plays a significant role in planning surgery.

In this study, male: female ratio was 1.14:1 which is in accordance with the study by Kemppainen et al.[5] The most common presenting symptom was otorrhoea followed by hearing loss which is in accordance with a study by Yorgancilar et al.[6]

In our study, CT was 100% sensitive for diagnosing cholesteatoma by HRCT images which is in correlation with the studies by Sirigiri et al and Bathla et al.[7,8] It was 100% specific for diagnosing cholesteatoma in

epitympanum, mesotympanum and hypotympanum but was less specific for cholesteatoma in antrum and aditus. In our study, HRCT was found to have less sensitivity in differentiating cholesteatoma from granulations which is in consonance with other studies.[8-11] HRCT was found to be helpful in correctly picking out extent of the disease which is in agreement with studies by Donoghue et al and Mafee et al.[12,13]

Early radiological sign of cholesteatoma is bone erosion. In our study, all cases (90%) reported in CT were confirmed at surgery. Hence, HRCT is 100% sensitive and specific to detect scutum erosion as per this study. This is in accordance to study by Juveria et al and Rocher et al.[11,14]

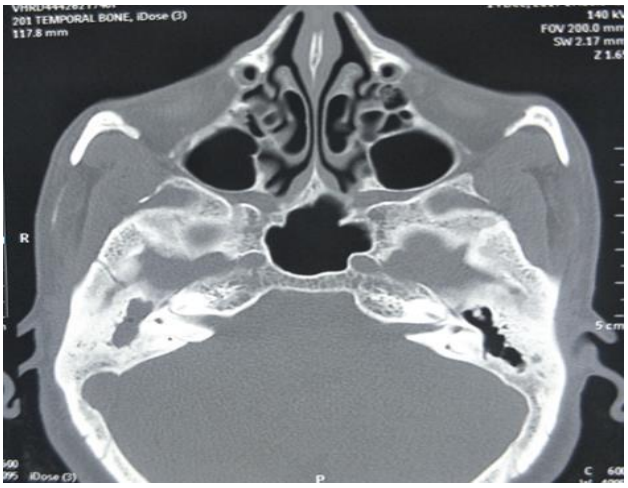

Figure 1: Axial image showing cholesteatoma in right middle ear cavity with widening of aditus and antrum and ossicular erosion.

In this study, ossicles erosion was seen in 80% of patients with CSOM with cholesteatoma (Figure 1). This is comparable to findings by Suat Keskin et al who found it in 76.78% of their patients.[15] Incus was the commonest ossicle to be involved in 80% which is accordance to 86.1% seen by Mohammadi et al.[4] HRCT temporal bone was found to be 95.8% sensitive and 100% specific for incus. This is almost similar to findings by Tak et al who found 91% sensitivity and 100% specificity.[9]

Malleus was second most common seen in 60% with 89.4% sensitivity and 90.9% specificity. Garg et al have reported almost similar findings in their study of 60 patients showing 90.9% sensitivity and a specificity of 89.4%.[10]

Delineation of stapes erosion had moderate sensitivity of 81.8% which is in correlation with study by Shah et al.[1] Pre-operative knowledge of ossicular chain status would allow surgeon to be ready for reconstructive surgery and to better advise patient about degree of hearing attainable after surgery.[16]

Figure 2: Axial image showing cholesteatoma in right middle and mastoid with erosion of mastoid cortex and bony external auditory canal.

In our study, 86.6% cases showed poorly cellular or sclerotic. CT scan was found to have 100% sensitivity and specificity to know the type of mastoid pneumatisation. Mastoid cortex erosion was seen in 16.6% of patients with 100% sensitivity and 100% specificity (Figure 2). Similar results were also noted in study by Niveditha et al and Rai et al.[2,17]

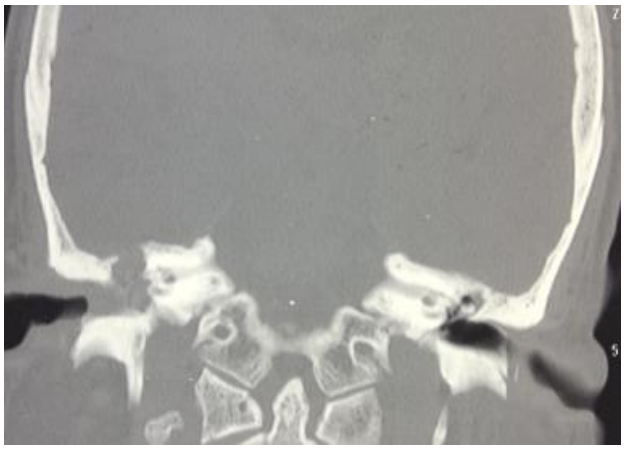

Figure 3: Coronal image showing right tegmen erosion.

The dural plate is best observed in the coronal plane and as a thin bone plaque covering the epitympanum and the mastoid (Figure 3).[11] In our study, HRCT temporal bone was found to be 100% sensitive and specific in identifying tegmen tympani erosion which is in consonance with studies by Tak et al and Chatterjee et al.[9,16]

Sinus plate erosion was seen in 20% of cases with 85.7% sensitivity and 100% specificity (Figure 4). Chatterjee et al have reported almost similar findings in their study of 167 patients showing 88.89% sensitivity and a specificity of 100%.[16]

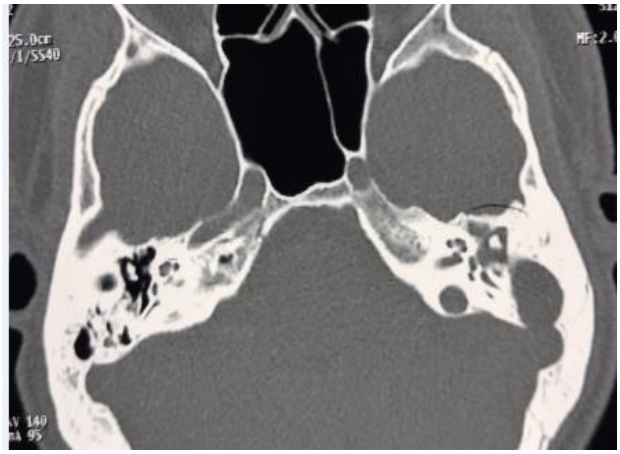

Figure 4: Axial image showing left sigmoid sinus plate erosion.

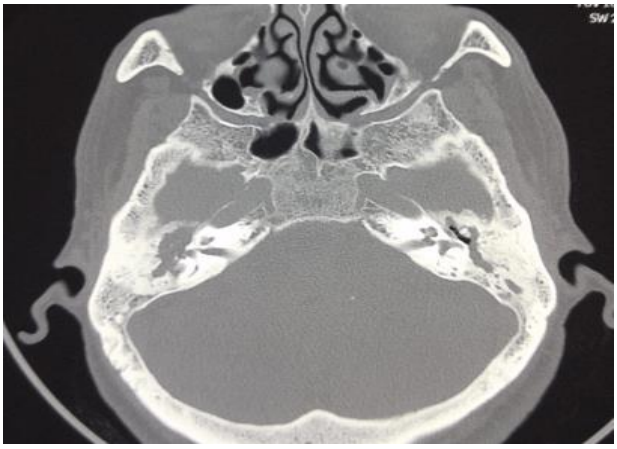

Figure 5: Axial image showing right LSCC and facial canal erosion.

In our study, facial canal erosion was observed on HRCT with moderate sensitivity (80%) but high specificity (100%) (Figure 5). This is in consonance with other studies.[7,8,18-22] The reason of low to moderate sensitivity is that, in the area of tympanic portion of the facial nerve canal, the bony floor is very thin and may not be visualized on coronal and axial CT images.[23]

In our study, Erosion of the lateral semicircular canal was seen in 10% cases with sensitivity 75% (Figure 5) which is similar to study by Rogha et al and specificity 100% which is in correlation with the study by Gul et al.[24,25]

HRCT had 100% sensitivity and 100% specificity for erosion of bony EAC which isn't in correlation with study by Vanita et al who reported 0% sensitivity and 100% specificity.[26]

In Our study, Jugular bulb dehiscence was present in 1 case (Figure 6). It is an important anatomic variation which was observed that can result in catastrophic outcomes during middle ear surgery.[27]

Figure 6: Axial image showing left Jugular bulb dehiscence.

There was significant correspondence between HRCT and clinical findings, which lead to better diagnosis of probable problems before surgery, and improved the success rate of cholesteatoma surgeries.

CONCLUSION

HRCT temporal bone can provide fairly detailed information about anatomy of the middle ear cleft, the extension and the complications of cholesteatoma but misinterpretations are possible.

We believe that it is necessary to routinely evaluate most atticoantral CSOM patients with HRCT temporal bone pre-operative because HRCT is important in surgery decision process and for collecting information on special anatomic structures by which possible complications due to anatomic differences can be prevented during surgery.

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