ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY IN THE EVALUATION OF SUPPURATIVE DISEASES OF MIDDLE EAR AND MASTOIDS AND THEIR COMPLICATIONS WITH SURGICAL CORRELATION

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ABSTRACT

OBJECTIVE

High Resolution Computed Tomography (HRCT), a modification of routine CT, provides a direct visual window in the temporal bone providing minute structural details. Purpose of the present study was to evaluate the suppurative diseases of middle ear and mastoid with their complications on HRCT and to correlate these imaging findings surgically. Our study shows good correlation of various HRCT findings in suppurative diseases of middle ear & mastoids with intra-operative findings.

MATERIALS AND METHODS

This retrospective study included 60 patients who were referred to the Department of Radiodiagnosis, Assam Medical College with clinically suspected temporal bone or ear pathologies. After detailed clinical examination, the patients were subjected to HRCT examination. The imaging findings of all cases were correlated with the surgical findings.

RESULTS

Out of 60 patients, 63.3% had unsafe CSOM with cholesteatoma. The HRCT findings with surgical correlation showed a high 91.89% sensitivity for identifying cholesteatoma. HRCT also provided good sensitivity for detecting erosion of scutum (90.32%), erosion of ossicular chain (86.96%) and erosion of lateral semi-circular canal (80%). HRCT had lower sensitivity (66.67%) for identifying facial canal dehiscence.

CONCLUSION

The HRCT findings showed a good sensitivity with intraoperative findings in identification of cholesteatoma, erosion of scutum, ossicular chain and semi-circular canal.

KEYWORDS

Acute Suppurative Otitis Media (ASOM), Chronic Suppurative Otitis Media (CSOM), High Resolution Computed Tomography (HRCT), Cholesteatoma (CH), Mastoiditis, Tegmen Tympani.

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INTRODUCTION

Chronic Suppurative Otitis Media (CSOM) has been an important cause of middle ear disease since prehistoric times.[1] Chronic suppurative infections of the middle ear and mastoid is the commonest cause of chronic inflammation of the middle ear cleft. Complications of Chronic Suppurative Otitis Media (CSOM) are due to bone erosion by an expanding sac of cholesteatoma. Cholesteatoma is a sac of keratinizing squamous epithelium in the middle ear cleft.

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Acquired middle ear cholesteatoma, which is more common than congenital variety has been recognized clinically and radiologically. Cholesteatoma is potentially serious condition, as it can progressively enlarge and erode into neighboring structures, giving rise to serious intracranial and extracranial complications.[2]

Radiological evaluation of the temporal bone is difficult owing to complicated anatomical structure of the middle ear and inner ear. A major advance in imaging of the ear structures has occurred with advent of helical scanning techniques. CT is increasingly the imaging study of choice for definitive preoperative temporal bone imaging.[3] High Resolution Computed Tomography (HRCT) is widely used in diagnosis of inflammatory middle ear diseases, such as chronic otitis media or cholesteatoma and in evaluation of middle ear following mastoidectomy or tympanoplasty.[4] HRCT helps in evaluating the disorders that primarily affects middle ear cavity, air cells and bony details.

The exact anatomical location of the disease process, erosion of the bony boundaries of the middle ear, the status of the ossicular chain, tegmen tympani, sigmoid sinus plate and lateral semicircular canals can be well visualized. HRCT evaluation of middle ear and mastoid is the investigation, which gives Otologist the accurate location of the pathological processes that cannot be visualized by clinical and other conventional radiological examinations.[5] Early diagnosis of the disease process can prevent the dreaded complications of the diseases of the middle ear and mastoid air cells. As the cholesteatoma, middle ear effusion and granulation tissue all share CT numbers ranging from 40 to 60, only secondary findings found in HRCT can differentiate them.[6] HRCT is ideal in a post operated individual with altered middle ear and mastoid. It will clearly demonstrate the presence of fluid, residual cholesteatoma or granulation tissue within the post operated cavity.

Aims and Objectives of the Retrospective Study

1. To evaluate the anatomy and pathological processes of the middle ear and mastoid by the use of HRCT.
2. To determine the extent of involvement of the disease processes of middle ear and mastoid and associated bone erosions/destruction and correlate with surgical findings.
3. To find out prevalence and types of extra- or intra-cranial complications.

MATERIALS AND METHODS

This was a retrospective study, enrolled 60 patients with clinically suspected temporal bone or ear pathologies, which was conducted in the Department of Radiodiagnosis, Assam Medical College and Hospital for a period of three years from Jun 2012 to July 2015. The congenital, neoplastic and traumatic lesions were excluded from the study.

All the patients underwent a detailed clinical ENT examination, Pure Tone Audiometry (PTA) followed by HRCT temporal bone. All HRCT scans were performed using Siemens Somatom Spirit Dual Slice Computed Tomography System (Made in Germany).

The scanning were performed in both axial and coronal planes. All scans were obtained at an average of mA 130 and 70KV. The scanning parameters are slice thickness and Feed of 1mm in both axial and coronal planes with window settings Width/Center: 2200/300.

In suspected patients of intracranial complications pre- and post-contrast CT scans of brain were also performed. Each HRCT image were analysed for specific features relevant to the evaluation of pathologies of middle ear and mastoid and interpreted in detail to define:

1. The type, location and extent of lesion.
2. Bony erosions of middle ear walls with integrity of the Scutum, Ossicular chain, Tegmen tympani, facial nerve canal and labyrinth.
3. Involvement of mastoid air cell system.
4. Intracranial and extracranial complications.

Then HRCT findings were correlated with surgical findings of those patients who underwent mastoid exploration in the form of either Radical or Modified Radical Mastoidectomy in the Department of ENT, Assam Medical College and Hospital and surgical findings were correlated with Histopathological Examination (HPE) whenever feasible.

RESULTS AND OBSERVATION

60 patients were enrolled in our study. The age of the patients in this study group ranged from 3 years to 76 years. Table 1 shows the age distribution of patients. There was a definite male preponderance in our study with male:female ratio was 1.5:1 and had 36 males and 24 females. Most of the patients presented with ear discharge followed by deafness. Table 2 shows the presenting complaints of patients. Majority of patients (n-56) were presented with chronic symptoms of more than 4 weeks; 4 patients had acute symptoms of less than 4 weeks' duration. In our study, 16 patients had bilateral involvement followed by left side affected in 24 patients and right in 20 patients. HRCT showed ASOM in 4 patients where dependent opacification of middle ear cavity were noted with dependent air-fluid level formations in mastoid air cells in 2 patients. Other 2 patients of ASOM showed erosion of mastoid bony septae with coalescence of mastoid air cells.

In our study HRCT diagnosis of unsafe CSOM with cholesteatoma was made in 38 patients, where 36 patients underwent surgery. Out of 36 patients, intraoperative findings of cholesteatoma was noted in 34 (94.4%) patients with over diagnosis in 2 (5.6%) patients. On HRCT 19 (50%) patient had non-dependent soft tissue component in epitympanum and Prussak's space [Fig. 2 and 4], 13 (34.2%) patient had soft tissue component filling all compartments of middle ear cavity [Fig. 9], while 6 (15.8%) patients had non-dependent soft tissue component confined to Prussak's space. Table 3 shows the HRCT findings in unsafe CSOM with cholesteatoma.

Safe CSOM was diagnosed in 18 patients on HRCT. Table 4 shows correlation between HRCT and intraoperative findings. Out of 18 patients 12 underwent surgery, while 6 patients managed conservatively. Out of 12 patients surgical findings confirmed safe CSOM in 9 patients, while HRCT underdiagnosed 3 (25%) patients, which were confirmed as unsafe CSOM during surgery. Hence, there was a correlation of 75% between HRCT and operative findings in safe CSOM [Fig. 1 and 3]. Similarly, a correlation of 94.4% found between HRCT and operative findings in unsafe CSOM.

HRCT showed erosion of scutum in 30 patients and erosion of ossicular chain in 22 patients. During surgery erosion of scutum noted in 28 (93.3%) patients and erosion of ossicular chain in 20 (90.9%) patients. HRCT was able to identify erosion of semicircular canal in 4 patients and facial nerve canals in 2 patients, which were well correlated with surgical findings [Fig. 7]. However, HRCT failed to identify erosion of semicircular canal and facial nerve canal in 1 patient each, which patients were initially underdiagnosed as safe CSOM. Correlation between HRCT and intraoperative findings in cholesteatoma, erosion of scutum, ossicular chain, semicircular canal and facial nerve canal are shown in Table 5 and 6 with sensitivity, specificity, positive predictive value and negative predictive value.

HRCT along with contrast enhanced CT scan of brain was done to evaluate intracranial complications; 14 patients had intracranial complications associated with unsafe CSOM. Out of 14 patients, 7 (50%) patients had brain abscesses, where 4 patients had abscess in temporal lobe [Fig. 13], while other 3 patients had cerebellar abscess [Fig. 12].

Sigmoid sinus thrombosis was demonstrated in 3 patients [Fig. 10] followed by subdural empyema in 2 patients

and epidural empyema in 1 patient [Fig. 11]. Table 7 shows the intracranial complications in unsafe CSOM patients.

Extracranial complications were demonstrated both in safe and unsafe CSOM. More cases of extracranial complications like mastoid abscess [Fig. 8 and 9], Labyrinthitis [Fig. 7], Bezold's and subperiosteal abscesses were demonstrated in unsafe CSOM than safe CSOM. Mastoid abscess was demonstrated in 55.3% patients of unsafe CSOM, while 38.9% in safe CSOM patients. Labyrinthitis was only encountered in 10.5% patients of unsafe CSOM. Table 8 and 9 showed the various extracranial complications in CSOM.

In 56 cases of CSOM in our study, pneumatization was affected in all cases, where 52 (92.8%) patients showed acellular mastoid with sclerosis and 4 (7.2%) showed diploic mastoid air cells. HRCT in 4 previously post operated patients showed recurrent cholesteatoma in 2 patients and granulation tissue in rest of 2 patients in post operated cavities [Fig. 5 and 6].

Fig. 1
28 yrs. male patient with safe CSOM with aural polyp. Axial (Image A) and coronal (Image B and C) HRCT Images of petrous temporal bones showed a lobulated soft tissue density lesion in right external auditory canal causing medial bulging of right tympanic membrane (Thin arrow in Image A). Dependent CT low dense collections noted in right middle ear cavity and right mastoid air cells with intact ossicular chain and scutum.

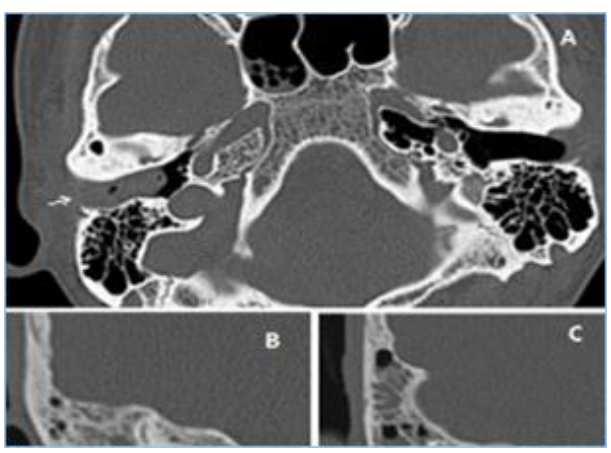

Fig. 1

Fig. 2
40 years female had right ear bloody discharge with early Cholesteatomatous lesion. Axial (Image A) and coronal (Image B and C) HRCT images showed as non-dependent soft tissue density lesion in right Prussak's space extending into right epitympanic space after eroding right scutum. Medial deviation of right ossicular chain was noted without ossicular chain erosion (Thin arrow in Image B). Widening of aditus-ad-antrum was noted with collection in right mastoid antrum (Thicker arrow in Image C). Tegmen tympani was intact. Right sided chronic mastoiditic changes noted with reduction of mastoid air cells pneumatizations with areas of sclerosis.

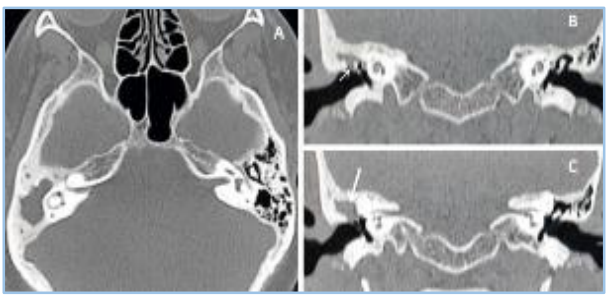

Fig. 2

Fig. 3
11 years female had bilateral ear discharge for long duration with bilateral safe variety of CSOM. Both axial (A and B) and coronal (C and D) HRCT images showed dependent CT low dense collections with mucosal thickenings in bilateral tympanic cavities, more on right side with intact ossicular chain and Prussak's spaces. Mucosal thickenings noted in bilateral mastoid antrum and remained mastoid air cells.

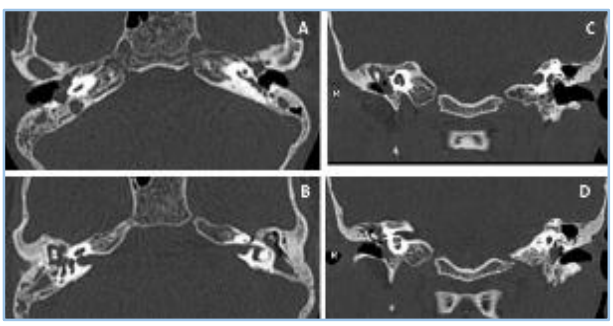

Fig. 3

Fig. 4
25 years female had right ear discharge with early epitympanic Cholesteatoma. Axial (A and B) and coronal (C and D) HRCT images of petrous temporal bone showed as non-dependent soft tissue density lesion in right epitympanic space, which widened the aditus-ad-antrum. Mucosal thickenings with CT low dense collections noted in right mastoid antrum and remained mastoid air cells.

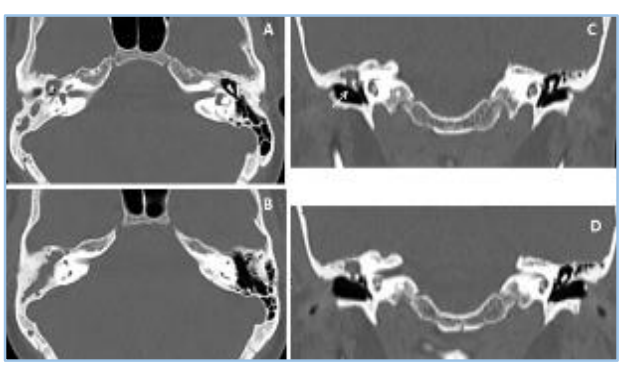

Fig. 4

Fig. 5
27 years male of previous operated status of left temporal bone with residual granulation tissue in post operated cavity. Axial (A and B) and coronal (C and D) HRCT images showed post operated defect in left mastoid portion of left temporal bone. Post operated cavity was filled with CT low dense collection. Minimal dependent CT low dense collection with

mucosal thickenings noted in left tympanic cavity with intact ossicular chain and scutum.

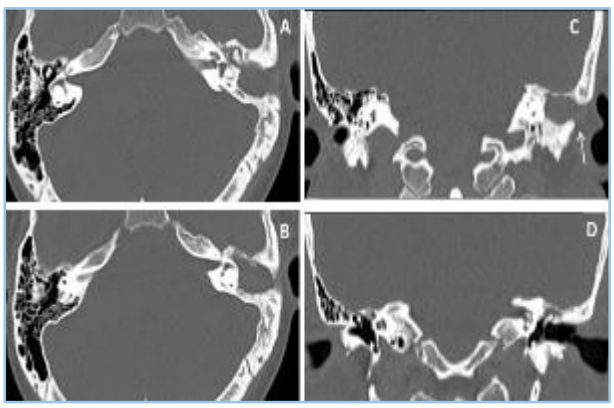

Fig. 5

Fig. 6
24 years male previously underwent left sided modified radical mastoidectomy with granulation tissue ball in post operated cavity. The Axial (A, B) and coronal (D, E, F) HRCT images showed mixed density calcified mass like lesion noted in post operated cavity of left petro mastoid bone, which showed mild heterogeneous post contrast enhancement with central non-enhancing area (Image C). CT low dense cholesteatomatous lesion also noted in right middle ear cavity, more in epitympanic space with erosion of right Tegmen tympani (Arrow in Image D) and intact right-sided scutum and ossicular chain.

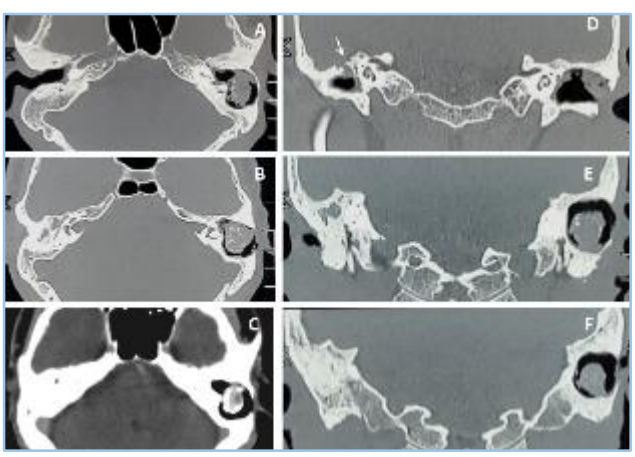

Fig. 6

Fig. 7
65 years male had chronic right ear discharge with Cholesteatoma causing extensive destruction of inner ear structures and carotid canal. Axial (Image A and B) and coronal (Image C, D and E) HRCT images showed as soft tissue replacement of right middle ear cavity causing destruction of bony boundaries of right middle ear cavity, all inner ear structures and right carotid canal. Erosion of Tegmen tympani was also noted (White arrow in Image E).

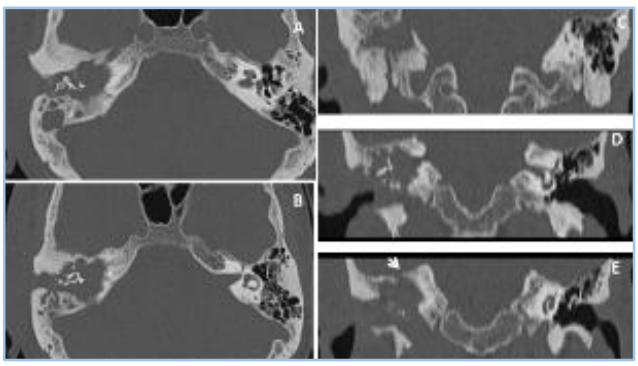

Fig. 7

Fig. 8
13 years female patient with left post auricular swelling with cholesteatoma with sigmoid sinus plate erosion. Axial (Image A and B) and Coronal (Image C) showed left middle ear cholesteatoma causing erosion of left sigmoid sinus plate (Arrow Image C), larger left mastoid abscess formation with irregular destruction of lateral bony mastoid cortex and overlying postauricular abscess. Axial post contrast axial CT scan (Image D and E) images shows mild peripherally mastoid abscess without any cerebellar abscess or left sigmoid sinus thrombosis.

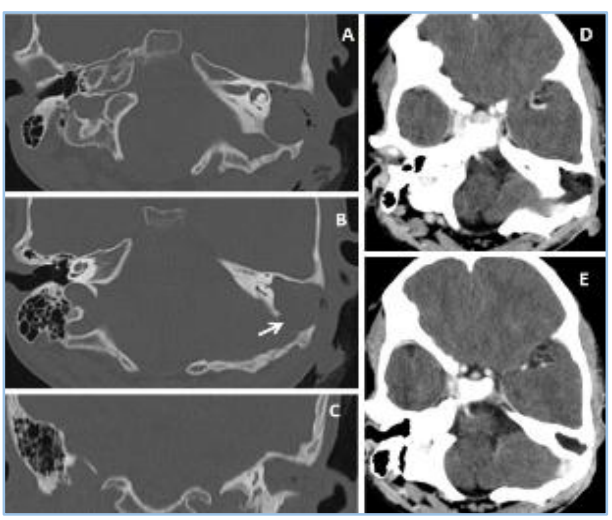

Fig. 8

Fig. 9
37 years female patient with chronic right ear discharge with post auricular swellings had cholesteatoma with erosion of lateral mastoid cortex and Tegmen tympani. Coronal HRCT images (A and B) showed soft tissue thickenings in right middle ear cavity, more in epitympanic space. Larger irregular destruction of right lateral mastoid cortex was noted (Thin arrow in Image A) with mastoid abscess formation. Erosion of Tegmen tympani was also noted. (Thicker arrow in Image B)

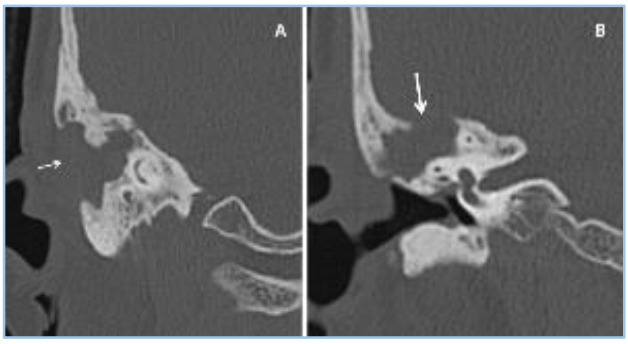

Fig. 9

Fig. 10
18 years male patient with cholesteatoma and sigmoid sinus thrombosis. Axial (A and B) and Coronal (C) HRCT images showed non-dependent soft tissue density lesion filling right middle ear cavity with epicenter in epitympanic space causing erosion of scutum and ossicular chain with a larger mastoid abscess formation and eroded lateral mastoid cortex. Axial post contrast CT scan of brain Images (D and E) showed filling defects in right sigmoid sinus representing sigmoid sinus thrombosis (Arrow in Image E).

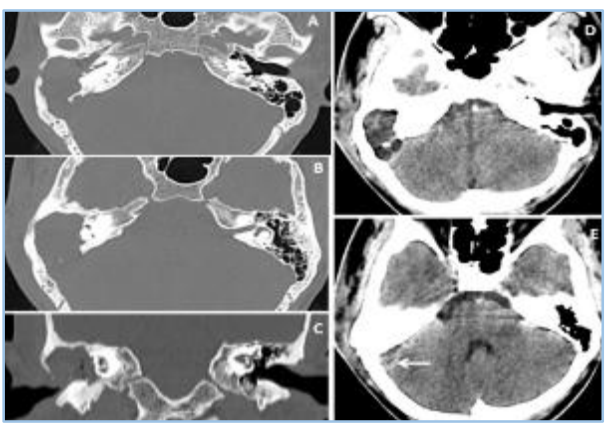

Fig. 10

Fig. 11
25 years female with left side unsafe CSOM and epidural abscess over left cerebellar hemisphere. Axial (A and B) and Coronal (C) HRCT images showed soft tissue density lesion filling left middle ear cavity with erosion of sigmoid sinus plate. Axial post contrast CT scan of brain Images (D and E) showed thicker peripherally enhancing epidural abscess with air focus noted over left cerebellar hemisphere. Abscesses were also noted in left occipital scalp.

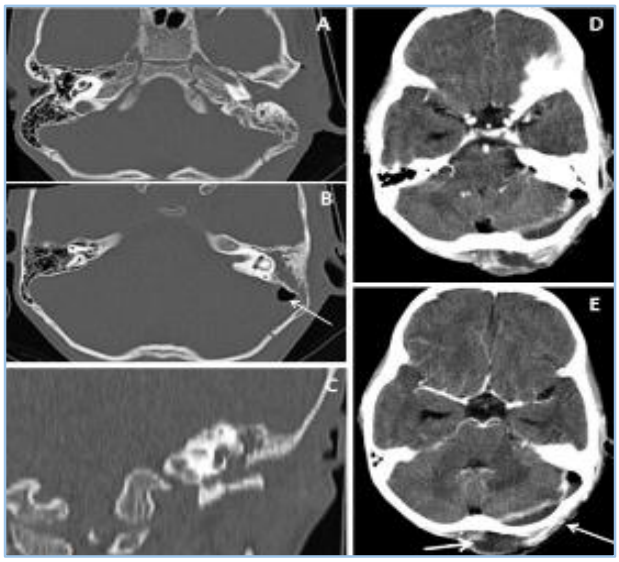

Fig. 11

Fig. 12
45 years male had unsafe CSOM with left cerebellar abscess. Axial (A and B) and Coronal (C) HRCT images showed soft tissue density lesion filling left middle ear cavity, dominantly in epitympanum with erosion of scutum and ossicular chain. Axial post contrast CT scan of brain Images (D and E) showed thicker peripherally enhancing abscess in left cerebellar hemisphere.

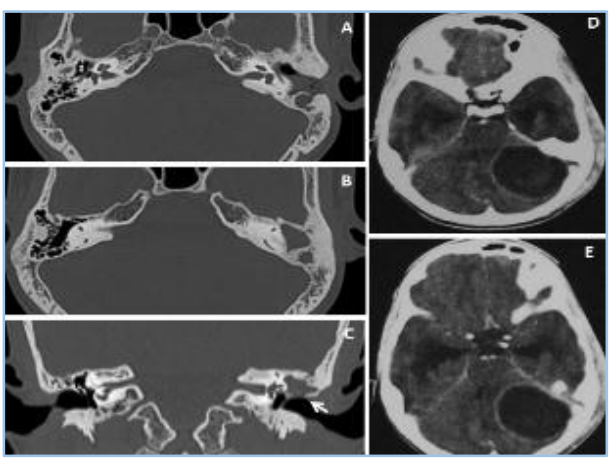

Fig. 12

Fig. 13
30 years male had unsafe CSOM with right temporal lobe abscess. Coronal (A and B) HRCT images showed soft tissue density lesion filling right middle ear cavity eroding right lateral mastoid cortex with thinning of right Tegmen tympani. Axial post contrast CT scan of brain Images (C) showed thicker peripherally enhancing lobulated abscess in right temporal lobe.

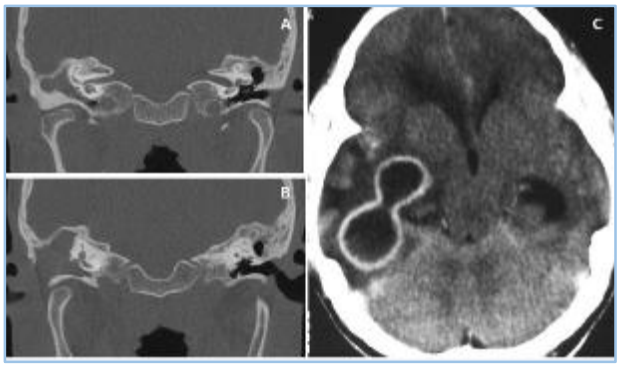

Fig. 13

Age Group (In years)	No. of Cases (n)	Percentage (%)
1 to 10	20	33.4%
11 to 20	14	23.3%
21 to 30	8	13.3%
31 to 40	10	16.7%
41 to 50	4	6.7%
51 to 60	1	1.67%
61 to 70	2	3.3%
71 to 80	1	1.67%

Table 1: Showed Age Distribution of Patients Studied

Clinical Finding	No. of Cases (n)	Percentage
Ear discharge	56	93.3%
Earache	46	76.7%
Deafness	54	90%
Swelling behind ear	12	20%
Headache	8	13.3 %
Fever	8	13.3 %
H/o mastoid operation	4	6.7%

Table 2: Showed Clinical Presentation of Patients Studied

HRCT Findings in Cholesteatoma	Number of Cases (n)	Percentage (%)
Non-dependent soft tissue component in epitympanum and Prussak's space	19	50
Soft tissue component filling epi, meso and hypotympanum	13	34.2
Non-dependent soft tissue component only in Prussak's space	6	15.8
Erosion of Scutum	32	84.2
Erosion of ossicular chain	22	57.9
Erosion of Tegmen Tympani	13	34.2
Erosion of sigmoid sinus plate	8	21
Erosion of lateral semi-circular canal	3	7.9
Erosion of inner ear structures	1	2.6
Erosion of lateral mastoid cortex	14	36.8
Dehiscence of facial nerve canal	2	5.2
Mastoid abscess	17	44.7

Table 3: Showed HRCT Findings in Cholesteatoma (n-38) Patients

HRCT Findings/Diagnosis (Positive in 'n' Number of Patient)	Intraoperative Findings (In 'n' Number of Patient)	
	Positive (n)	Negative (n)
Cholesteatoma (n=36)	34	2
Granulation tissue (n=12)	9	3
Eroded scutum (n=30)	28	2
Eroded ossicular chain (n=22)	20	2
Eroded lateral semi-circular canal (n=4)	4	0
Eroded facial nerve canal (n=2)	2	0

Table 4: Showed Correlation between HRCT and Intra-Operative Findings in N-48 Patients

HRCT Findings/ Diagnosis	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Cholesteatoma	91.89%	81.82%	94.44%	75.00%
Eroded scutum	90.32%	81.82%	93.33%	75.00%
Eroded ossicular chain	86.96%	81.82%	90.91%	75.00%
Eroded lateral semi-circular canal	80.00%	100.00%	100.00%	90.00%
Eroded facial nerve canal	66.67%	100.00%	100.00%	90.00%

Table 5: Showed Sensitivity and Specificity of HRCT

Types of CSOM	HRCT Cases (n=56)	Operated Cases (n=48)	Agreement with Operative Findings	(%)
Safe CSOM	18	12	9	75
Unsafe CSOM	38	36	34	94.4

Table 6: Showed Correlation between HRCT and Intra-Operative Findings

Intracranial Complications (n-14)	Number in 'n' Number of Patient	Percentage (%)
Brain abscess	7	50
Sigmoid sinus thrombosis	3	21.4
Subdural empyema	2	14.3
Epidural empyema	1	7.1
Meningitis and Otitic Hydrocephalus	1	7.1

Table 7: Showed Intracranial Complications in N-14 Patients of Cholesteatomatous Lesions

Extracranial Complication	Number of Cases (n)	Percentage (%)
Mastoid abscess	17	55.3
Labyrinthitis	4	10.5
Bezold's abscess	4	10.5
Subperiosteal abscess	2	5.3
Facial nerve palsy	2	5.3
Post auricular sinus/fistula	2	5.3

Table 8: Showed Extracranial Complications in Unsafe CSOM Patients (n-38)

Extracranial Complication	Number of Cases (n)	Percentage (%)
Mastoid abscess	7	38.9
Bezold's abscess	3	16.7
Subperiosteal abscess	1	5.6

Table 9: Showed Extracranial Complications in Safe CSOM Patients (N-18)

DISCUSSION

HRCT is sensitive for the detection of early bone erosions and detailed imaging of the soft tissue extent of suppurative disease of middle ear, especially the cholesteatoma.[2,7] The hallmarks of the cholesteatoma are the presence of non-dependent soft tissue density in middle ear cavity, ossicular erosion, smooth erosions of the middle ear borders and adjacent structures.[8,9] Early diagnosis of cholesteatoma without presence of bony erosion depended on its position and displacement of the ossicles on HRCT. The majority of acquired cholesteatomas aroused from the pars flaccida involve the Prussak's space. The pars tensa cholesteatomas rapidly spread to sinus tympani and other recesses of the posterior tympanum. Pars flaccida cholesteatomas displace the head of malleus and incus medially, while pars tensa cholesteatomas tend to displace the ossicular chain laterally. It stated that cholesteatomatous erosions of the malleus and incus could be evaluated preoperatively with accuracy rates ranging from 89 to 94%.[10]

Gaurano JL and Joharjy IA (2004) studied characteristic HRCT findings in 64 cases of middle ear cholesteatoma and found non-dependent soft tissue density lesion along with 59 (92%) had expansion of the aditus and mastoid antrum, 59 (92%) had ossicular chain erosion, 55 (86%) had eroded scutum, 55 (86%) had eroded facial canal, 48 (75%) had tegmen erosion and 63 (98%) had erosion of the antral walls.[2] These findings are almost equivalent in our study, but we are observing more cases of scutum erosion and less number of facial nerve canal and ossicular chain erosions.

Knowledge of the mastoid pneumatization aid in the planning of surgical approach, e.g. whether to do canal wall down or up type of surgery.[11] In majority of the adult cholesteatoma patients, mastoid air cells are very few in number and sclerotic.[2,8,9,11]

Pre-operative demonstration of facial nerve canal involvement is often difficult because of its small size, oblique orientation in tympanic part and developmental dehiscence, particularly when abutted by soft tissue.[2,8,9,11] Facial nerve canal dehiscence is a fairly common finding in 55% of temporal bones and usually occurring in a focal area in the tympanic portion of the facial nerve canal.[11,12,13]

The present study conducted in the Department of Radiodiagnosis, Assam Medical College and Hospital, Dibrugarh, Assam, in which 60 patients of suppurative diseases of middle ear were studied clinically and radiologically and subsequently 48 patients of CSOM were subjected to surgery. The intraoperative findings were correlated with that of pre-operative HRCT findings.

Age

In this retrospective study carried out on 60 patients, the age of patients ranged from 3 years to 76 years. Maximum number of patients was in the age group of 1-10 years, i.e. 20 (33.4%). The mean age in this present study was 23.4. CSOM is prevalent in all age groups; it particularly affects the patients in paediatric and younger age groups.[14] Acquired cholesteatomas are commonly seen in patients less than 30 years.[14] In present study, we found that the majority of patients were aged less than 30 years (n=42; 70%), which are similar to findings by Datta et al.[15]

Sex

There was a definite male preponderance in our study with male:female ratio of 1.5:1 and had n- 36 (60%) male and n-24 (40%) female patients. Poursadegh et al., reported a male-to-female ratio of 1.39:1.[16]

Clinical Presentation

In our study, a total of n=56 (93.3%) patients had active discharge. Majority had hearing loss (n=54; 90%) and pain in ear (n=46; 76.7%). In the series of Gomaa et al., chronic ear discharge with hearing loss was the main clinical presentation (60.7%).[14]

Duration of Symptoms

In our study, majority of patients (n=56) were presented with chronic symptoms of more than 4 weeks and only 4 patients had acute symptoms of less than 4 weeks.

Side of Affection

Majority of patients n=44 (73.3%) had unilateral involvement, while bilateral involvement was noted in n=16 (26.7%) patients. In a study by Gomaa et al., bilateral involvement was noted only in 3.57%.[14]

Mastoid Pneumatization

In our study, pneumatization was affected in all 56 patients of CSOM, where 52 (92.8%) patients showed acellular mastoid with sclerosis and 4 (7.2%) showed diploic mastoid air cells.

HRCT Findings in CSOM

According to Mafee et al., the hallmark of cholesteatoma on HRCT is a soft tissue mass in attic and mastoid antrum associated with smooth bony expansion, scalloping of mastoid, erosion of lateral wall of attic (Scutum) and erosion of ossicles.[17] In our study HRCT diagnosis of unsafe CSOM with cholesteatoma was made in 38 patients, where 36 patients underwent surgery. A good correlation of 94.4% was found between HRCT and operative findings in unsafe CSOM patient. Sensitivity of 91.89% and specificity of 81.82% was noted in our study in pre-operative HRCT diagnosis of

cholesteatoma. Mafee et al. reported 96% of the specificity in diagnosing cholesteatoma in pre-operative scans.[18] Cholesteatoma characteristically causes bone erosion and when this feature was present in association with a soft tissue mass on CT, both Jackler et al. and O'Donoghue et al. found cholesteatoma to be present in 80% of cases explored.[19,20] Using the same criteria, we detected 34 (94.4%) out of 36 cases of cholesteatoma on surgical exploration. In our study, diagnosing safe CSOM had a correlation of 75% between HRCT and intraoperative findings.

Scutum Erosion

In our study, HRCT showed erosion of scutum in 30 patients with a sensitivity of 90.32% and specificity of 81.82%.

Ossicular Chain Erosion

In our study, HRCT diagnosed ossicular chain erosion in 22 patients and over diagnosed 2 patients. The sensitivity of HRCT in the present study for ossicular chain erosion was 86.96% and specificity was 81.82%. Study by Keskin et al., showed their sensitivity, specificity of 80%, 46.1% respectively for ossicular chain erosion.[21]

Lateral Semicircular Canal Erosion

HRCT was able to identify erosion of lateral semicircular canal in 4 patients, while intraoperative findings showed lateral semicircular canal erosion in 5 patients with a sensitivity of 80% and specificity of 100%. The findings were comparable to a study conducted by Prata et al., where the sensitivity and specificity was found to be 100% and 96.67% respectively.[22]

Facial Nerve Canal Erosion

HRCT showed facial canal dehiscence in 2 patients, while facial canal dehiscence was found to be present in 3 patients intraoperatively. We calculated a sensitivity of 66.67% and specificity of 100% for HRCT to diagnose facial canal dehiscence. This low sensitivity and relatively high specificity in our study could be correlated with study conducted by Rai et al. with sensitivity and specificity of 33.33% and 100% respectively.[23] Gaurano et al., stated that preoperative demonstration of facial nerve canal involvement was often difficult not only because of the small size of the facial nerve canal, but also due to its oblique orientation and the presence of developmental dehiscence, particularly when abutted by the soft tissue.[2] The most common site for erosion is tympanic portion of the fallopian canal.[24]

Tegmen Tympani and Sigmoid Sinus Plate Erosion

In present study, HRCT showed Tegmen Tympani erosion in 13 patients (34.2%). Intraoperatively, Tegmen tympani was found to be eroded in 11 patients (8.6%). Jackler et al.[4] detected all their cases, but also had eight false positive cases. Mafee et al.[18] missed 3 out of 8 cases. HRCT showed sigmoid sinus plate erosion in 8 patients (21%) and similar findings were confirmed intraoperatively.

Lateral Mastoid Cortex Erosion

In present study, HRCT showed lateral mastoid cortex erosion in 14 (36.8%) patients. Intraoperative findings showed similar findings.

Intracranial Complications

Present study showed intracranial complications in 14 patients of unsafe CSOM, where 7 (50%) patients had brain abscesses, 4 patients in temporal lobe and 3 cerebellar hemisphere. Sigmoid sinus thrombosis was noted in 3 (21.4%) patients, subdural empyema in 2 (14.3%) patients and 1 (7.1%) each of epidural empyema and meningitis. Thappa Naramaya, et al. (2004) in their study of 699 patients showed intracranial complications in 33 (4.72%) patients. Brain abscess was the commonest intracranial complication found in 16 (48.48%) patients, followed by meningitis found in 9 (27.2%) patients.[25]

Extracranial Complications

In present study, extracranial complications were demonstrated in 55.3% patients of unsafe CSOM and 38.9% in safe CSOM patients. Out of 56 patients of CSOM patients, 24 (42.8%) patients had mastoid abscess, 7 (12.5%) had Bezold's abscess, 4 (7.1%) had Labyrinthitis and 3 (5.4%) patients had subperiosteal abscesses. In most of the studies, mastoid abscess was found as the most common extracranial complication.[26] In Rupa and Raman's study.[27] mastoid abscess were seen in more than half of the patients with complications.

CONCLUSION

HRCT is a highly sensitive and specific diagnostic modality to evaluate the hidden structures of middle ear and mastoid and to exactly localize the pathological processes. Widening of aditus-ad-antrum, erosion of scutum and widening of Prussak's space, which were important findings in diagnosis of early cholesteatomatous lesion.

Correlation between HRCT and surgical finding with respect to soft tissue extension, bony boundaries of tympanum, pneumatization, status of ossicular chain, facial nerve canal and fistula of lateral semi-circular canal were excellent in our study. HRCT is the best imaging modality to study suppurative middle ear diseases, hence it plays an important role in pre-operative evaluation, guiding the surgical management and post-operated followup patients. Overall, the results of the present study showed a good agreement between HRCT and operative findings.

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