Temporal Bone Cholesteatoma: Evaluation and Correlation between High Resolution Computed Tomography and Surgical Findings

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ABSTRACT

Introduction: Cholesteatoma is abnormal growth of keratinizing squamous epithelium in middle ear cleft, with expansile and erosive properties and can lead to various extracranial and intracranial complications, if not operated in time. The diagnosis of cholesteatoma is usually made by otoscopic examination, but high resolution computed tomography (HRCT) is gold-standard investigation to detect the exact location and extent of disease and ant possible complications. The aim of this study was to determine the role and accuracy of HRCT temporal bone in detecting cholesteatoma of middle ear cleft and its efficacy by correlating the intra-operative findings with HRCT findings.

Material and methods: This is a prospective study that included 120 cases of active squamous chronic otitis media. Each patient underwent full clinical evaluation with HRCT temporal bone. Preoperative radiological findings were correlated with surgical findings.

Results: HRCT was found invaluable tool in identification of squamous chronic otitis media with early bony changes, had good sensitivity and specificity and helped in planning the appropriate management, but its sensitivity was found to be low for detecting erosion of facial canal, lateral semicircular canal and stapes suprastructure.

Conclusion: An excellent correlation was established between preoperative HRCT and the intraoperative findings in detecting the location and extent of cholesteatoma and bony erosion of the important structures.

Keywords: Squamous chronic otitis media; Cholesteatoma; High Resolution Computed Tomography; Bony erosion

INTRODUCTION

Chronic otitis media (COM) is a common presentation in the otorhinolaryngology clinics. It is an inflammatory condition of the middle ear space. It can lead to long term or permanent changes in middle ear cleft and may lead to various complications, including intratemporal and intracranial complications. COM is classified into healed COM, mucosal type COM and squamous type COM, which may be further classified as active or inactive disease.[1] Cholesteatoma is an erosive process, constituting squamous epithelium that produces and accumulates desquamated keratin debris at its centre. The perimatrix surrounding the matrix consist of collagen fibers, fibrocytes and inflammatory cells.[2] Cholesteatoma can be congenital or acquired. Congenital cholesteatoma is quite rare while acquired type constitutes approximately 98% cases. Cholesteatoma has expansile, erosive and resorptive properties, which leads to destruction of surrounding structures.[3]

Earlier, cholesteatoma was diagnosed on the basis of clinical presentation, otoscopic findings and conventional radiology which included X-ray mastoids. However, X-ray mastoid was not much informative regarding anatomical variations of the middle ear and mastoid, status of ossicles, presence of cholesteatoma in the hidden areas, like sinus tympani and facial recess and for detecting complications.

The introduction of computed tomography (CT) in 1972 improved the diagnostic capabilities of ear diseases and it was very helpful in delineation of the microscopic structures of the ear. Diagnosis and planning for surgical management of cholesteatoma became easier with HRCT temporal bone and hence, it replaced the conventional imaging techniques. HRCT offers excellent spatial and density resolution using special algorithms. It accurately depicts all the anatomical structures of the temporal region, possible anatomical variations, delineates the pathology and its extent and also identifies the associated complications. Thus, it is considered to be the standard imaging modality for evaluation and management of various ear pathologies and allows for better management planning and decision making for surgical exploration, and for suitable surgical approach. Complications of COM may be devastating but can be prevented, if recognized early and timely intervention is done.[4,5]

The aim of this study is to determine the role and accuracy of HRCT temporal bone in detecting cholesteatoma of middle ear cleft and its efficacy by correlating the intra-operative findings with HRCT findings.

MATERIAL AND METHODS

This was a prospective, randomized study carried out over a period of two years from August 2016 to July 2018

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in Department of Otorhinolaryngology at a tertiary care institute. 120 patients with active squamous type of chronic otitis media in whom surgery was planned and who gave consent for the study were included in the study, whereas, patients with history of previous ear surgery, trauma or ear pathology suspected to be of other etiology and those who were unfit for surgery were excluded.

All the patients underwent a detailed history, clinical and radiological examination. General and systemic examination, thorough head and neck examination including otomicroscopic examination, hearing assessment by pure tone audiometry (PTA) and HRCT temporal bone were also done. Routine investigations and pre-anaesthetic clearance were done in every case before taking the patient for surgery. A pre-operative HRCT temporal bone was done, using 128 slice GE CT scanner (VCT GE) in all patients. Axial, coronal and sagittal sections were taken which was interpreted by an expert head and neck radiologist. Contrast study was also done, whenever indicated. Imaging characteristics were recorded and the following parameters were studied:

1. Location and extent of soft tissue density in the middle ear
2. Widening of aditus and antrum
3. Erosion of the scutum
4. Status of ossicular chain, looking for any erosion or discontinuity
5. Erosion of tegmen tympani
6. Erosion of the sinus plate
7. Erosion of semicircular canals
8. Dehiscence of Fallopian canal
9. Any intra/extracranial extension of disease process

The selected patients then underwent tympanomastoidectomy via post-aural route, both under local and general anaesthesia. Intra-operative findings were noted and pre-operative HRCT findings were confirmed and compared with the intra-operative surgical findings. Pathological confirmation of the clinical diagnosis was obtained in each case. The results were compiled, studied and compared with similar studies in the past.

STATISTICAL ANALYSIS

The compiled data were expressed in terms of Percentage, Sensitivity, Specificity, Positive predictive value, Negative predictive value and Accuracy using the SSPS software.

RESULTS

In this study, the age group of the patients ranged from 4 to 55 years. The maximum number of cases belonged to age group of 11-20 years (35%). Male: female ratio was 1.4:1. Majority of patients belonged to lower socioeconomic class. (Table 1).

All the patients presented with ear discharge as chief complaint. Second most common symptom was hearing difficulty, which was present in 110 cases (91.7%). Other symptoms were less common, including earache in 40 cases (33.3%), tinnitus in 24 cases (20%), vertigo in 16 cases (13.3%), post-aural abscess in 12 cases (10%), headache in 6 cases (5%) and facial asymmetry in 6 cases (5%) (Figure 1). The majority of patients, i.e., 88 (73.3%) had purulent, scanty discharge. These patients had foul smelling discharge, irrespective of its type. Maximum number of patients, i.e., 56 (46.7%) had ear discharge for a duration of 1-5 years, followed by 6-10 years in 36 (30%), >10 years in 16 cases (13.3%) and <1 year in 12 cases (10%). The opposite ear findings of 70 patients (58.3%) were normal, 30 patients (25%) had mucosal type of COM while 20 patients (16.7%) had squamous type COM. In pars flaccida, the most common otoscopic finding was cholesteatoma flakes, seen in 44 patients followed by retraction pocket in 24 patients and granulations in 12 patients. In pars tensa, cholesteatoma was seen in 16 patients, retraction pocket in 10 patients, granulations in 8 while aural polyp was seen in 6 cases. Few cases had combination of these pathologies. Attic perforation was found in 80 cases; while 28 cases had perforation in pars tensa, out of which 24 cases had marginal perforation involving posterosuperior quadrant and 4 cases had total perforation; while 12 cases had both pars tensa and pars flaccida perforation. Out of 120 cases, 81 cases (67.5%) had pure conductive hearing loss, 12 cases (10%) had sensorineural hearing loss, 20 cases (16.7%) had mixed type of hearing loss, while in 7 patients (5.8%), audiometric findings were within normal limits. Most of the cases had moderate degree of hearing loss in 60 cases (50 %), followed by mild hearing loss in 35 cases (29.2%), severe in 16 cases (13.3%) and profound hearing loss in 2 cases (1.7%), while 7 cases (5.8%) had normal hearing. (Table 2)

In HRCT, soft tissue density in attic was reported in 24 cases, in atticoantral region in 48 cases, in mesotympanum in 16 cases and it was extensive in 32 cases. Soft tissue extension medial to the ossicles was reported in 86 cases and lateral to ossicles in 116 cases. Poor mastoid pneumatization was reported in 118 cases, aditus was widened in 90 cases, erosion of scutum was seen in 76 cases. Incus was the most common ossicle to be eroded, reported in 90 cases. Malleus was eroded in 70 cases and stapes superstructure was reported to be eroded in 56 cases. The tegmen plate was found to be

S. No.	Demography	No. of cases	Percentage
1	Age (years)		
	0-10	08	6.6
	11-20	42	35.0
	21-30	32	26.7
	31-40	26	21.7
	41-50	10	8.3
	51-60	02	1.7
2	Sex		
	Male	70	58.3
	Female	50	41.7
3	Socioeconomic status		
	High	12	10.0
	Middle	32	26.7
	Low	76	63.3

Table 1: Distribution of cases according to demography

S. No.	Aural findings	No. of cases	Percentage
1	Type of discharge		
	Profuse, mucopurulent	12	10
	Scanty, purulent	88	73.3
	Blood-stained	20	16.7
2	Duration of disease		
	< 1 year	12	10
	1-5 years	56	46.7
	6-10 years	36	30
	>10 years	16	13.3
3	Status of contralateral ear		
	Normal	70	58.3
	Mucosal COM	30	25
	Squamous COM	20	16.7
4	Otoscopic findings		
	Pars flaccida		
	Cholesteatoma	44	36.7
	Retraction pocket	24	20.0
	Granulations	12	10.0
	Pars tensa		
	Cholesteatoma	16	13.3
	Retraction pocket	10	8.3
	Granulations	08	6.7
	Aural polyp	06	5.0
5	Type of perforation		
	Pars flaccida	80	66.7
	Pars tensa		
	Posterosuperior quadrant/ marginal	24	20.0
	Total	4	3.3
	Combined (pars tensa + pars flaccida)	12	10.0
6	Type of hearing loss		
	Conductive	81	67.5
	Sensorineural	12	10.0
	Mixed	20	16.7
	Normal	07	5.8
7	Degree of hearing loss		
	Mild	35	29.2
	Moderate	60	50.0
	Severe	16	13.3
	Profound	02	1.7
	Normal	07	5.8

Table-2: Distribution of cases according to aural findings

eroded in 20 cases, erosion of lateral semicircular canal in 8 cases, sigmoid plate was eroded in 20 cases, posterior canal wall was dehiscent in 16 cases, dehiscent facial nerve was seen in 6 cases, lateral wall of mastoid cortex was eroded in 16 cases, whereas sinus tympani and facial recess were involved in 60 cases, each (Table 3).

Intraoperatively, cholesteatoma in attic was confirmed in 20 cases while 4 cases had retraction pocket only. Cholesteatoma was found involving atticoantral region in 48 cases**,** mesotympanum in 16 cases while extensive disease was noticed in 32 cases. Cholesteatoma medial and lateral to ossicles was noticed in 86 and 112 cases, respectively.

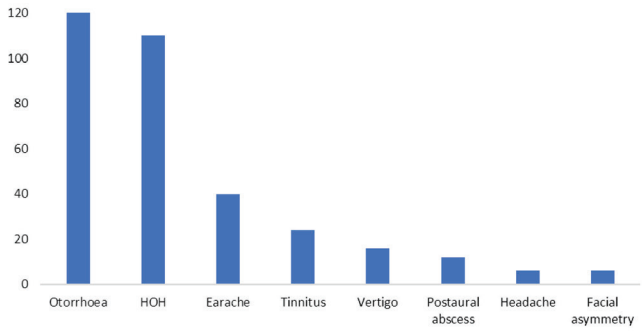

Figure-1: Distribution of cases according to symptoms

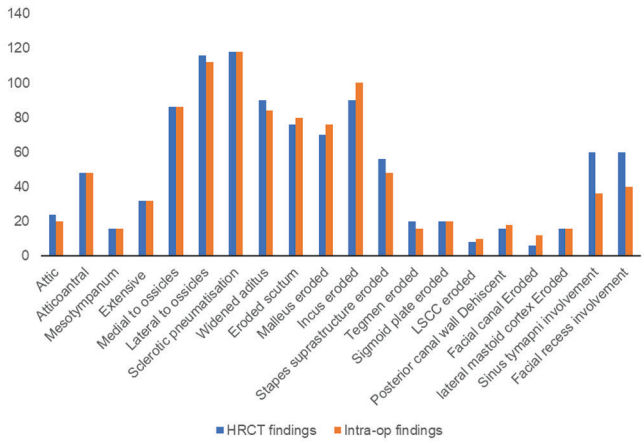

Figure-2: Bar diagram showing correlation between HRCT and Intra-op findings

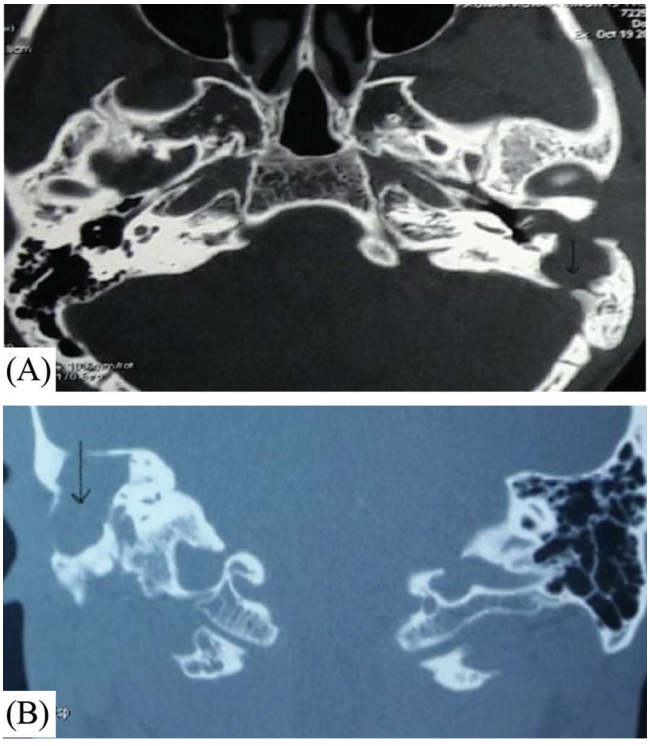

Figure-3: High Resolution CT temporal bone. (A) Axial section showing abnormal soft tissue density involving left mastoid antrum and middle ear cavity with erosion of sigmoid plate and lateral mastoid cortex. (B) Coronal section showing abnormal soft tissue density in right mastoid air cells with erosion of tegmen plate and lateral mastoid cortex with widening of mastoid antrum.

S. No.	Pathology	HRCT findings	Intra-op findings	Sensitivity	Specificity	PPV	NPV	Accuracy
1	Attic involvement	24	20	100	96.15	83.33	100	96.77
2	Atticoantral involvement	48	48	100	100	100	100	100
3	Mesotympanum involvement	16	16	100	100	100	100	100
4	Extensive disease	32	32	100	100	100	100	100
5	Medial to ossicles	86	86	100	100	100	100	100
6	Lateral to ossicles	116	112	100	66.67	96.55	100	96.71
7	Sclerotic pneumatisation	118	118	100	100	100	100	100
8	Widened aditus	90	84	100	85.71	93.33	100	95.24
9	Malleus erosion	70	76	92.68	100	100	80	94.34
10	Incus erosion	90	100	90.91	100	100	66.67	92.31
11	Stapes suprastructure erosion	56	48	87.5	100	100	88.89	93.75
12	Scutum erosion	76	80	95.24	100	100	90.91	96.77
13	Tegmen plate erosion	20	16	100	96.30	80	100	96.77
14	Lateral SCC erosion	08	10	83.33	100	100	98.21	98.36
15	Sigmoid plate erosion	20	20	100	100	100	100	100
16	Posterior canal wall erosion	16	18	100	90	98.08	100	98.36
17	Facial canal erosion	06	12	66.67	100	100	94.74	95.24
18	Lateral mastoid cortex erosion	16	16	100	100	100	100	100
19	Sinus tympani involvement	60	36	100	77.78	60	100	83.33
20	Facial recess involvement	60	40	100	80	66.60	100	85.71

Table-3: Correlation of HRCT with intra-operative findings

Poorly pneumatised mastoid was found in 118 cases, aditus was widened in 84 cases, scutum was eroded in 80 cases, Incus was eroded in 100 cases, malleus was eroded in 76 cases, whereas stapes superstructure was eroded in 48 cases. The long process of the incus was the most common part to be eroded followed by the body of the incus and head of the malleus. Tegmen plate was found to be eroded in 16 cases, lateral semicircular canal in 10 cases, sigmoid plate in 20 cases, whereas posterior canal wall was eroded in 18 cases. Facial nerve canal was dehiscent in 12 patients, lateral wall of cortex was eroded in 16 cases and involvement of sinus tympani and facial recess was found in 36 and 40 cases, respectively (Table 3). Table 3 and Figure 2 shows the correlation between HRCT and surgical findings for active squamous COM, in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy.

DISCUSSION

Cholesteatoma is an abnormal growth of keratinized squamous epithelium in middle ear cleft and has expansile, locally invasive, erosive and resorptive properties. Although the diagnosis of cholesteatoma is based on otoscopic findings, HRCT is increasingly used for diagnosis, for planning management of cholesteatoma, and for proper counselling of the patient regarding possible intra-operative and post-operative complications. HRCT temporal bone is the gold standard imaging for active squamous disease. It precisely determines the exact location and extent of disease and helps in detecting the surrounding bony erosions and possible intra-temporal, extracranial and intracranial complications. It can accurately diagnose even the early microscopic bony erosions and thus, helps in better surgical planning for minimally invasive procedure with hearing preservation.[6,7]

Few signs in HRCT suggesting early bony erosion have been described in literature. Mafee et al described "blunting of scutum" as the earliest sign for attic erosion.[8] Joselitol et al described "loss of figure of 8 appearance" as suggestive of scutum erosion with widening of aditus and antrum.[9]

A comparative study on "Temporal Bone Cholesteatoma: Evaluation and Correlation between High Resolution Computed Tomography (HRCT) and Surgical Findings" was carried out in the department of Otorhinolaryngology (ENT) at a tertiary care institute for the period extending from August 2016 to July 2018. This prospective study included 120 cases suffering from active squamous chronic otitis media. They were full examined, investigated and posted for surgery. Pre-operative HRCT was performed in all the cases. The surgical findings were noted by the operating surgeon and then compared and correlated with the HRCT findings. Figure 3 (A, B) shows high resolution CT temporal bone with abnormal soft tissue density involving various parts of middle ear cleft with different bony erosions.

The highest incidence of cholesteatoma was found in second decade (35%) and among males (58.3%). Incidence was highest in low socio-economic group (63.3%) probably due to overcrowding, poor hygiene and ignorance about the disease. The most common clinical presentation was ear discharge (100%) followed by hearing loss (91.7%). Long standing malodorous, scanty, purulent discharge was the commonest type of ear discharge. In a study conducted by Gomaa et al and Radhika et al, second decade and male population were found to have maximum incidence and most common presentation was ear discharge with hearing loss, similar to our study.[7,10]

Majority of patients had ear discharge for the duration of 1 to 5 years (46.7%). Most common finding on pure tone

audiometry was conductive hearing loss (67.5%), while 16.7% of the patients had mixed hearing loss and 10% had sensorineural hearing loss. Most of the patients (50%) were found to have moderate degree hearing loss. The opposite ear findings were normal in 58.3% cases, 25% cases had mucosal type of COM while 16.7% cases had squamous COM in the other ear. On otoscopy, maximum number of patients had cholesteatoma in pars flaccida (36.7%), followed by cholesteatoma in pars tensa (13.3%). Tympanic membrane perforation most commonly involved pars flaccida (66.7%), followed by posterosuperior marginal perforation in the pars tensa (20%). Similar results were found in a study conducted by Gomaa et al, Radhika et al and Sharma et al.[7,10,11]

HRCT was found to have a sensitivity and specificity of 100% in detecting soft tissue extension in most of the structures of the middle ear, except the attic, where specificity was found to be 96.15%. Both sensitivity and specificity of HRCT in detecting soft tissue extension medial to the ossicles were found to be 100% and the sensitivity and specificity of HRCT in detecting soft tissue extension lateral to the ossicles were 100 and 66.67%, respectively. Soft tissue found during surgery was cholesteatoma in maximum cases, followed by cholesteatoma with granulation tissue. Gomaa et al reported 100% sensitivity and accuracy in detecting soft tissue mass in middle ear cleft and Khavasi et al reported 100% sensitivity and 95% accuracy.[7,12]

The sensitivity and specificity of HRCT in detecting mastoid sclerosis was 100% in our study. Kanotra et al observed sclerotic mastoid in 100% cases on HRCT, which was confirmed intraoperatively.[13]

The most common ossicle to be eroded by cholesteatoma was the incus, followed by the malleus and stapes suprastructure in our study. HRCT had 92.68% sensitivity and 100% specificity in detecting malleus erosion. For incus, HRCT had a sensitivity and specificity of 90.91% and 100%, respectively. For stapes suprastructure erosion, HRCT was found to have a sensitivity and specificity of 87.50% and 100%, respectively in our study. Karki et al reported 100% sensitivity and 95.23% specificity of HRCT in detecting malleus erosion, 100% sensitivity and 80.48% specificity in detecting incus erosion, 96.55% sensitivity and 71.42% specificity in detecting stapes erosion, which is almost similar to our study.[14]

The sensitivity and specificity of HRCT in identifying widening of aditus was 100% and 85.71%. For scutum erosion, HRCT was found to be 95.24% sensitive and 100% specific in our study. The result of this study was in agreement with Rogha et al, who reported 100% sensitivity and 88.8% specificity of HRCT in diagnosing widening of the aditus and antrum and sensitivity of 96.4% and specificity of 87.5% in diagnosing scutum erosion. Khavasi et al also found a sensitivity and specificity of 100% for scutum erosion.[12,15]

The sensitivity and specificity of HRCT in detecting tegmen plate erosion was 100% and 96.30%. The sensitivity and specificity of HRCT to detect sigmoid plate erosion were found to be 100% in our study. Kanotra et al reported a sensitivity of 100% and specificity of 95.45% in detecting tegmen erosion. Several authors have reported excellent correlation of HRCT and surgical findings for sinus plate erosion. Karki et al, Kanotra et al and Rogha et al reported 100% sensitivity and specificity of HRCT in detecting sinus plate erosion.[13–15]

The sensitivity and specificity of HRCT in detecting lateral semicircular canal erosion is 83.33% and 100% in our study. Gomaa et al reported a sensitivity and specificity of 100% for lateral semicircular canal erosion. In a study conducted by Kanotra et al, sensitivity was found to be 66.66% and specificity of 95.74%. Similarly, Rogha et al, reported a sensitivity of 75% and specificity of 87%.[7,13,15]

The sensitivity and specificity of HRCT in detecting facial canal erosion were found to be 66.67% and 100% in our study. Mafee et al reported that HRCT was 100% accurate in the diagnosis of erosion of the facial canal.[8]

HRCT was 100% sensitive and 100% specific in detecting erosion of the lateral mastoid cortex in our study. Khavasi et al, reported 100% sensitivity and specificity in detecting erosion of lateral mastoid cortex wall.[12]

The sensitivity of HRCT in identifying involvement of the sinus tympani and facial recess was 100% each while the specificity was 77.78% and 80%, respectively in our study. Karki et al found 6 cases with extension into sinus tympani and facial recess which was correctly depicted in CT scan in 5 cases, reporting a sensitivity and specificity of 83.33% and 100%.[14]

CONCLUSION

On the basis of this study, an excellent correlation can be established between preoperative HRCT and the intraoperative findings in detecting the location and extent of cholesteatoma and bony erosion for most of the structures. Sensitivity was found to be low for facial canal, lateral semicircular canal and stapes suprastructure erosion. HRCT helps in identification of squamous chronic otitis media with early bony changes/erosions and have a role in planning the appropriate management, for decision making in surgery, for proper surgical approach, and alerts the surgeon regarding possible impending complications and can be useful in pre-op counselling of the patients. The only limitation of HRCT is inability to differentiate cholesteatoma from other ear pathologies. HRCT temporal bone can, thus, be an invaluable tool for pre-operative diagnosis of active squamous chronic otitis media, its extent and for proper planning of the surgical management.

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Declarations

No funding or material support was done by any source.

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Ethical approval was done from the institute ethical committee.

Written informed consent was taken from all patients

participating in the study.

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