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Original Research Article

An evaluation of preoperative high resolution computed tomography of temporal bone in cholesteatoma

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ABSTRACT

Background: Cholesteatoma is relatively common and potentially dangerous disease of the ear. It is characterised by local destruction and osseous erosion leading to complications. High resolution computed tomography (HRCT) is the imaging modality of choice for evaluation of middle ear structures and pathology. The aim of this study is to evaluate role of preoperative HRCT in the diagnosis of the disease, its extension and complications and plan for surgery.
Methods: This prospective study was conducted at a tertiary referral teaching hospital and 40 cases of cholesteatoma were selected and their pre-operative HRCT temporal bone findings and intraoperative findings were correlated.
Results: This study showed good correlation between preoperative HRCT findings of cholesteatoma, and intraoperative findings.
Conclusions: We conclude therefore the preoperative HRCT temporal bone is useful guide for the surgeon for the diagnosis and management of cholesteatoma.

Keywords: Cholesteatoma, HRCT temporal bone, Intraoperative, Findings

INTRODUCTION

Cholesteatoma is an important and common cause of middle ear diseases and its complications challenge both Otologist and Radiologist. It is known since prehistoric times. In 1683, Joseph Gerhard Duverney described temporal bone lesion probably representing cholesteatoma and the term cholesteatoma was coined by German pathologist Miller.[1]

Cholesteatoma is more often acquired than congenital. It is a potentially dangerous disease due to its characteristics of growth, erosion and local destruction.[2,3] By clinical examination diagnosis of cholesteatoma is made quite effectively, but imaging plays an important role in the assessment of the extention of the disease.[4] Schuller was the first to describe pathological lesion in temporal bone radiographically. Many views were developed to improve the recognise pathological changes but none gave sufficient information. Due to its high sensitivity, high resolution computed tomography (HRCT) is the imaging modality of choice for evaluation of cholesteatoma.[4]

Advantages of HRCT are its ability to detect the extent of cholesteatoma in temporal bone and hidden areas especially posterior tympanic spaces. It assists the surgeon to take decision regarding the type of surgical procedure, canal wall up or canal wall down.[5] Since ossicles are commonly eroded, prognosis of hearing can be predicted.[6] In HRCT temporal bone hallmarks of cholesteatoma are soft tissue mass like opacity in middle ear cleft associated with erosion of ossicles, smooth bony erosions and surrounding structures.[7,8] HRCT cannot differentiate cholesteatoma from granulation tissue and

other soft tissue masses if not associated with bony erosions.[6,9] Hence there are lots of controversies in the literatures over use of preoperative HRCT temporal bone in assessment of cholesteatoma.

The aim of this study is to evaluate the role of HRCT in diagnosing the disease, its extension into middle ear cleft and beyond, and complications and planning for surgery.

METHODS

This prospective study was conducted in department of ENT & HNS, SNMC & SHKH, and RC Bagalkot during June 2016 to September 2017. Total 40 cases were selected who were diagnosed as chronic suppurative otitis media attico-antral disease. All the cases were clinically examined, Pure Tone Audiometer done. HRCT is done for all cases. All the cases underwent surgery and intraoperative findings were noted. Comparison was done between HRCT and intraoperative findings. Percentage and proportions were used for descriptive statistics and for validity of test sensitivity and specificity were calculated by using EPI info softwere.

Inclusion criteria

Inclusion criteria was patient having attico-antral disease.

Exclusion criteria

Exclusion criteria were suspicious of ear pathology to be malignancy or granulomatous disease; trauma; revision surgery; unfit for surgery.

CT scanner used was- Siemens Somutron 16 Slice MDCT.

Protocol of CT

A preliminary lateral tomography of the cranium was performed. 1MM axial and coronal sections were performed through the temporal bone in high spatial bony algorithm. Contrast was used whenever required.

Operative procedures

All selected patients underwent the required surgeries, atticotomy, modified radical mastoidectomy, and radical mastoidectomy.

RESULTS

Age and sex distribution

The patients were in the age group varying from first decade to fifth decade and maximum numbers were in the age group 11-20, 18 patients (45%). Female to male ratio in study group was 1:1 out of 40 total patients. Highest incidence of cholesteatoma was found in second decade and lowest in sixth decade.

Table 1: Age and sex distribution of study group.

Age group	Male	Female	Total
0-10	2	1	3
11-20	11	7	18
21-30	4	7	11
31-40	2	3	5
41-50	1	1	2
51-60	0	1	1
Total	20	20	40

Soft tissue masses

HRCT showed non-dependent soft tissue density ranging from 30-40 HU to 60-70 HU involving middle ear, attic and mastoid in all cases 40 (100%). In total 40 cases retraction pocket in 2 cases (5%), granulation tissue in 4 cases (10%). Cholesteatoma 18 (45%) and both granulations and cholesteatoma 16 cases (40%).

In our study, preoperative HRCT showed soft tissue mass in attic 2 cases, attic and mastoid 15 cases and in 23 cases attic, mastoid and middle ear.

Intraoperative soft tissue was found only in 38(95%) cases and two cases (5%) had only retraction pocket with no soft tissue in middle ear and mastoid. HRCT couldn't distinguish soft tissue mass as granulations and cholesteatoma.

Mastoid involvement

HRCT showed sclerosis in all 40 (100%) cases and same was found during surgery.

Erosion of SCUTUM

Preoperative HRCT showed erosion of SCUTUM in all cases (100%) and same was found intraoperatively in all 20 cases.

Tegmen plate (dural plate)

Table 2: Comparison of dural plate erosion.

Dural plate	HRCT (%)	Intraoperative findings (%)
Erosion	6 (15)	4 (10)
Intact	34 (85)	36 (90)
Total	40 (100)	40 (100)

Preoperative HRCT showed erosions of dural plate in 6 (15%) cases, but intraoperatively showed erosions in 4 (10%) cases.

Sinus plate erosion

Preoperative HRCT showed erosions of sinus plate in 16 cases (40%). But intraoperatively only 8 (20%) cases had erosion.

Table 3: Comparison of sinus plate erosion.

Sinus plate	HRCT (%)	Intraoperative findings (%)
Erosion	16 (40)	8 (20)
Intact	24 (60)	32 (80)
Total	40 (100)	40 (100)

Facial nerve canal

Preoperatively HRCT showed erosions in only 6(15%) cases, but intraoperatively involvement of canal was found in 8 (20%) cases. Involving tympanic part in 2 (5%) cases and 6 (15%) cases showed both tympanic and vertical part erosion intraoperatively. HRCT showed cases involving both tympanic and vertical part.

Table 4: Comparison of facial nerve erosion.

Facial nerve canal	HRCT (%)	Intraoperative findings (%)
Erosion	6 (15)	8 (20)
Intact	34 (85)	32 (80)
Total	40 (100)	40 (100)

Lateral semicircular canal (LSCC)

Preoperatively HRCT showed erosion in 2 (5%) cases but intraoperatively 4 (10%) cases had (LSCC) erosions.

Table 5: Comparison of lateral semicircular canal erosion.

LSCC	HRCT	Intraoperative findings
Erosion	2 (5)	4 (10)
Intact	38 (95)	36 (90)
Total	40 (100)	40 (100)

Mastoid cortex

Preoperative HRCT shoved erosions of lateral mastoid cortex in 6 (15%) cases. Intraoperatively same 6 cases had erosion.

Table 6: Comparison of mastoid cortex erosion.

Mastoid cortex	HRCT (%)	Intraoperative findings (%)
Erosion	6 (15)	6 (15)
Intact	34 (85)	34 (85)
Total	40 (100)	40 (100)

Ossicles

In HRCT 34 cases (85%) showed total or partial erosion of ossicles but intraoperatively 38 (95%) cases showed either partial or total erosion of ossicles.

Malleus: HRCT showed erosion of malleus in 34(85%) cases. But during surgery only 22 (55%) cases had partial erosion.

Incus: HRCT showed erosion of incus 36 (90%) cases, but intra-op 36 (90%) cases had partial or total erosion of incus

Stapes: On HRCT stapes erosion was found in 34 (85%) cases and intraoperatively only 18(45%) cases had erosion and only super structure was eroded in all cases.

Table 7: Comparison of ossicular erosion.

Ossicles	HRCT	Intraoperative findings
Malleus erosion	34 (85)	22(55)
Incus erosion	36 (90)	36 (90)
Stapes erosion	34 (85)	18 (45)

Incus was most commonly eroded in our study (90%) and stapes (45%) least.

Out of 40 cases– MRM was done in 32 cases (60%) atticotomy in 2 cases (10%) and radical mastoidectomy was done in 6 cases (30%).

DISCUSSION

The diagnosis of cholesteatoma is usually made by otological examination.[4] Though otscopic recognition of cholesteatoma is often reliable, imaging modalities should be used in all patients suspected of harbouring a cholesteatoma to determine the gross or subtle changes and the presence of complications which are mostly due to bone erosion.[4,10]

Soft tissue mass

Cholesteatoma can be accurately diagnosed by HRCT. The hallmarks are presence of non-dependent soft tissue mass density in middle ear cleft, ossicular erosions, smooth erosions of middle ear borders and adjacent structures. These changes when associated with bony expansions of the middle ear cavity and auditus- ad-antrum are highly suggestive of cholesteatoma.[10]

In our study HRCT was found to be 100% sensitive and 95% accuracy in detecting soft tissue mass in middle ear cleft associated with above features in majority of cases. Similar finding noted in study by Gomma et al. HRCT showed 100% sensitivity and 100% accuracy in detecting soft tissue mass in middle ear cleft.[11]

In study by Payal et al, HRCT showed 89% sensitivity.[12] In study by Anelise et al HRCT showed 72.70% sensitivity and 82.5% specificity in identification of cholesteatoma with PPV 69.5% and NPV 84.62%.[3] In study by Reddy et al. Sensitivity 92% and in study by Shaha sensitivity 92.5%.[8,10]

One of the important advantages HRCT is detection of early cholesteatoma characterised by subtle bony erosions or ossicle displacement. This early detection by HRCT scan with the use of simple non-invasive surgical technique, atticotomy, will solve the problem and preserve hearing.[12] In present study to 2 cases presented with only retraction pocket and only atticotomy was done.

In study by Macfee et al and David et al described the criteria indicating cholesteatoma as blunting of scutum normal sharp tip is often the earliest sign of attic cholesteatoma.[12]

However in our study HRCT could not distinguish cholesteatoma from other soft tissue. Similar thing was observed by various authors.[5,8,10]

Ossicles

Erosion of ossicles is commonly seen in cholesteatoma, as it enlarges and comes in contact with contigious structures in middle ear.[4,10]

In our study HRCT scan malleus was eroded in 34 (85%) cases out of 40 cases but intraoperatively only 22 (55%) cases showed erosion and Incus was eroded in 36 (90%) cases both CT scan and intraoperatevily. Stapes was eroded in HRCT in 34 (85%) cases, but intra-op only 18 (45%) cases had erosion. Incus (sensitivity 100%) was most commonly eroded followed by malleus (100% sensitivity) and stapes (100% sensitivity).

This was similar to study by Dutta et al which showed ossicles destruction with 89% sensitivity and 85% accuracy.[5] Incus was most commonly eroded (90% sensitivity) followed by malleus and stapes. In some studies similar results noted.[2-4,8-13]

In some studies stapes was not consistently visualised in HRCT but appeared as a soft tissue density around oval window niche, for this reason it was not possible distinguished between destruction of stapes and its envelopment by soft tissue.[2-5,8,13]

Previous knowledge of status of ossicles decides likely hood of hearing preservations achieved after the surgery.[2,10]

Lateral semi circular canal erosion

Due to its anatomical close proximity to medial wall of the attic Lateral SCC in the most frequently eroded. However a false impression of the canal fistula may be encountered. Thus axial CT scan sections must be reinforced by coronal images for evidence of cortical thinning.[4]

In our study HRCT showed erosion of LSCC in 2 case but intraop we had 4 case with erosion of LSCC thus showing sensitivity only 33% and specificity 48%. Reddy et al showed sensivity 60% and specificity 90%.[8]

In study by Dutta et al and Gomma et al observed erosion of LSCC on HRCT showed 100% sensitivity and specificity.[5,11] In study Muzeyyan et al, sensivity 98%, specificity75%.[9] Study by Abhijeet et al showed sensitivity 100%, specificity 90%.[7] Study by Shah et al showed sensitivity 85%, specificity 96%.[10] Study Rogha et al showed sensitivity 75% and specificity 87%.[13] Study Prata et al showed sensitivity 100% and specificity 96%.[3]

In study by Payal et al, sensivity was 66% and specificity was 83% and concluding that HRCT sensitivity in defining LSSC fistula moderate.[12] HRCT clearly depicts bone erosion even in the abscens of fistula, which helps the surgeon intra operatively in careful resection of cholesteatoma to prevent labyrinthine fistula formation.[10]

Sinus plate

Erosion of tegmen tympani or sinus plate warrants the radiologist to find intracranial complications if any. [10] In our study, erosion of sinus plates was present in HRCT in 16(40%) cases but intraoperatively only 8 (20%) cases had sinus plate erosion with sensivity 66% and specificity 57%. Similarly Payal et al reported sensitivity 66%.[12] In study by Dutta et al HRCT sensitivity was 100%, specificity was 100% and Reddy et al HRCT showed sensitivity 100%, specificity 100%.[5,8] Also Park et al, Abhijit et al, Gumma et al, Rogha et al, reported sensitivity 100% specificity 100%.[2,7,9,13] Muzeyyen et al, reported sensitivity 98% specificity 85%.[4] Shaha et al, reported sensitivity 97% and specificity 95%.[10] But Payal et al, reported sensitivity 66%, specificity 92.6%,also mention that it's utility in spotting out those with normal sinus plate was limited because PPV 50%.[12] Rogha et al, used co-efeicient score to correlate HRCT findings with intraoperative findings, and greatest radio surgical adaptability was seen sinus plate erosion.[13]

Facial nerve

Preoperative demonstration of facial nerve canal involvement in HRCT is often difficult because of the small size and oblique orientation and presence of developmental dehiscence particularly abutted by soft tissues.[4,10,11]

In this study HRCT showed facial nerve canal erosion in 6 cases but intra-op 8 cases had erosions. Involvement of tympanic part in 2 case and both tympanic and vertical in 6 cases. In our study tympanic part showed more

susceptible for erosion. Thus HRCT sensitivity 42% and specificity 48%, and also Dutta et al, Reddy et al, had similar results with horizontal part showed more susceptibility.[7,8] Literatures showed variation in sensitivity ranging from 40% to 96% and specificity 66% to 100%.[12,13]

Mastoid cavity

Mastoids are almost universally involved in CSOM.[5] In our study all the mastoids showed sclerosis on pre op HRCT and same was confirmed intraoperatively. HRCT very well delineated views of mastoid antrum, auditus ad antrum in either coronal or axial plane. Payal et al, also reported 100% sensitivity in sclerotic mastoid and cellular mastoid specificity 66%.[12]

Lateral mastoid cortex

In our study preop HRCT showed erosion of lateral mastoid cortex in 6 cases and same was confirmed during surgery. We found HRCT to be most accurate in identifying the destruction of lateral cortical wall of mastoid with 100% sensitive and 100% specific. Studies by some authors showed 100% sensitive & specific.[2,5,7] Ranga Reddy et al showed 75% sensitivity and 90% specific.[8]

In summary we found a good correlation between preoperative HRCT and intraoperative findings. HRCT is confirmed to be valuable in diagnosis and guiding the surgical management.

CONCLUSION

HRCT temporal bone significantly enhances the preoperative evaluation of cholesteatoma, it almost identifies soft tissue mass, its extension, erosions, complications both intra cranial and extra cranial. It provides information on anatomical variations of temporal bone. Results of this study showed excellent correlation between preoperative HRCT scan and intraoperative findings in cholesteatoma. Therefore HRCT temporal bone is useful guide for the surgeon for early detection of cholesteatoma, planning surgery, despite its pit falls such as more radiation exposure and high cost.

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