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RADIOLOGICAL IMAGING OF CHOLESTEATOMA IN TERTIARY CARE HOSPITAL

Otorhinolaryngology

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ABSTRACT

Background: Cholesteatoma is a common inflammatory disorder of the middle ear, often described as "skin at wrong place'. The diagnosis of this condition is by combination of clinical examination with cross sectional imaging. HRCT has excellent spatial resolution and helps to delineate key anatomical structures, predominantly the bony landmarks of temporal bone. However, HRCT cannot differentiate between fluid, cholesteatoma and other soft tissue (fibrosis or granulation tissue). Also recurrent and residual cholesteatoma remains a challenge. Hence we have undertaken this study to evaluate the role and utility of HRCT and DW- MRI in the diagnosis of cholesteatoma. **Methods:** Present study was prospective in nature conducted among 65 cholesteatoma patients. All patients fulfilling inclusion criteria and exclusion criteria were taken up for the study. Study was carried out over a period of 1.5 years. **Results:** Majority of the patients was in the age group of 21-40 years and most of them were male. In this study, post-operative histopathology confirmed that there were 60 cases of cholesteatoma (92.31%) & 05 (7.69%) were negative for cholesteatoma; of which 57 (95%) were correctly identified i.e. true positive by HRCT, 3 (5%) came falsely negative, 3 (60%) false positive & 2 (40%) true negative. Sensitivity, specificity, positive predictive value & negative predictive value of HRCT was 95%, 40%, 95%, 40% respectively. So, HRCT has a good sensitivity for cholesteatoma but low specificity. **Conclusion:** HRCT has a good sensitivity for detection of cholesteatoma but low specificity than MRI

KEYWORDS

cholesteatoma, HRCT, MRI-DWI,

INTRODUCTION:

Cholesteatoma is a common inflammatory disorder of the middle ear, often described as "skin at wrong place'. The term cholesteatoma is a misnomer as the lesion is not a tumour and contains no fat[1]. Instead, it is a collection of keratinous debris within a sack of stratified squamous epithelium surrounded by perimatrix which secretes bone destroying proteolytic enzymes trapped in the middle ear. They incite an inflammatory response which promotes osteoclastic activity that can erode the ossicles and bony walls of middle ear cavity[1-3]. Cholesteatoma can be congenital or acquired. They are commonly seen in third to fourth decade and females are more commonly affected than males[4]. Because it is associated with serious local and intracranial complications, surgery is the treatment of choice[5].

The diagnosis of this condition is by combination of clinical examination with cross sectional imaging. Radiological pre-operative assessment can be done with HRCT & MRI. HRCT has excellent spatial resolution and helps to delineate key anatomical structures, predominantly the bony landmarks of temporal bone.[6-9] However, HRCT cannot differentiate between fluid, cholesteatoma and other soft tissue (fibrosis or granulation tissue).[10,11] Also recurrent and residual cholesteatoma remains a challenge.[12]

At conventional MRI sequences, cholesteatomas display non- specific signal intensities and appear T1 hypointense/isointense and T2 hyperintense to brain. These signal characteristics does not differentiate cholesteatoma from fluid and granulation tissue. Post-gadolinium studies may be helpful in such cases, where granulation tissue enhances and cholesteatoma does not.[1] However , more recently, diffusion weighted techniques have shown promising results in differentiating cholesteatoma from granulation tissue.[13-18]

Cholesteatomas show restricted diffusion due to their high keratin content similar to the diffusion restriction seen in epidermoid cysts.[5,11] Hence, this limited-sequence MRI examination along with HRCT of temporal bone may help in the accurate diagnosis of this potentially dangerous and treatable condition. Hence we have undertaken this study to evaluate the role and utility of HRCT and DW- MRI in the diagnosis of cholesteatoma.

OBJECTIVES

- To study the pre-operative findings of HRCT & DWI MRI in cholesteatoma patients.
- To study the findings of HRCT & DWI MRI in residual and recurrent cholesteatoma in post-operative follow up in canal wall down and canal wall up mastoidectomy.

MATERIALS AND METHODS

We have undertaken this facility based prospective observational study, after approval of protocol by the Institutional Ethical committee of the medical college. Written informed consent was taken from all study subjects.

After obtaining consent and satisfying inclusion and exclusion criteria, 65 patients with clinical suspicion of chronic suppurative otitis media (CSOM) with cholesteatoma and referred to department of radio-diagnosis for imaging, were included in the study. Patient with previous history of surgery for cholesteatoma and suspected recurrence were also included in the study. Patient with metallic implants, claustrophobia, pacemakers, MR-incompatible prosthetic heart valve, contrast allergy and morbid obesity (MRI tables have specific weight limitations) were excluded from the study.

All patients were subjected to history, clinical presentation, HRCT of temporal bone and limited-sequence (DWI) MRI examination of temporal region. Cases with suspicion of intracranial complications underwent detailed MR evaluation with or without contrast. Imaging findings were compared and confirmed with intraoperative findings for the presence of cholesteatoma. HRCT and DWI MRI images were evaluated prior to surgery. Cholesteatomatous CSOM was diagnosed on HRCT by the presence of non-dependent soft tissue with bony destruction such as blurring of scutum, erosion of bony wall of middle ear, ossicular erosions, labyrinthine involvement and facial canal/ intracranial extensions. Cases of middle ear and mastoid opacification without bony erosions were labelled as Non-cholesteatomatous CSOM (NC-CSOM). On EP- DWI, primary or recurrent cholesteatomas were recorded as cholesteatoma present or absent based on diffusion restriction on DWI and ADC. False negative cases could be attributed to presence of only soft tissue without bony

destruction and inability to characterise the soft tissue at CT. False positive cases at CT can be attributed to mere bony deossification which can occur in non-cholesteatomatous CSOM being interpreted as destruction that occur in cholesteatoma.

Clinical and laboratory finding were obtained from each case. Data was collected in pre-structured proforma (Annexure I- case record sheet) which was pilot tested and after ensuring it's validity. The data collected was then analyzed by appropriate test of significance.

Sample size was calculated with $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$ using OPENEPI software version 3. Sample Size calculated by using the proportion of occurrence of positive for Cholesteatoma on HRCT. The expected proportion of complications is 44%. The Sample Size calculated by using following formula.

- $^{N=[Z2}(1-\alpha)^{*P*Q]/[D2]Z2}(1\alpha)^{=1.96}$
- P = Percentage change = 44%
- Q = 100 – P = 56%
- D= Experimental error = 12%

Substituting the values in the formula gives minimum sample size is 65 patients.

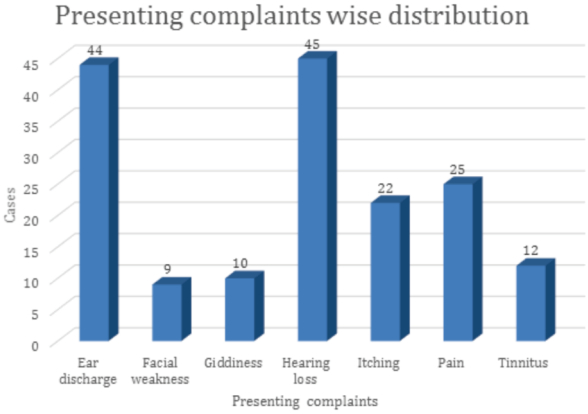
RESULTS:

In the present prospective study, there was no lost to follow up and we could analyze all 65 cholesteatoma patients. Majority, 36 (55.38%) of the study participants were from the age group of 21-40 years followed by 21 (32.31%) from the age group of 41-60 years, 05 (7.69%) from 61-80 years and 03 (4.62%) from <20 years. Mean age of the patients was 32.08 ± 13.91 years. There was male (61.54%) preponderance in our study. In majority (50.77%) of the cases affected ear was left followed by right ear (38.46%) and bilateral (10.77%). On Otoscopic examination most common finding was attic destruction among 36 (55.38%) patients followed by otorrhea in 26 (40%) cases, retraction pocket in attic/ postero-superior quadrant in 24 (36.92%) and aural polyp in 7.69%. (Table 1)

Table 1. Distribution of patients according to baseline characteristics.

Baseline characteristic		Frequency(no.)	Percentage(%)
Age groups	<20	03	4.62
	21-40	36	55.38
	41-60	21	32.31
	61-80	05	7.69
Gender	Male	40	61.54
	Female	25	38.46
Laterality	Left	33	50.77
	Right	25	38.46
	Bilateral	07	10.77
Otoscopy finding	Aural polyp	05	7.69
	Attic destruction	36	55.38
	Otorrhea	26	40
	Retraction pocket in attic/ postero-superior quadrant	24	36.92

In our study, most common presenting complaint was hearing loss in 45 (69.23%), followed by ear discharge among 44 (67.69%), pain in 25 (38.46%), itching reported by 22 (33.85%) patients, giddiness in 10 (15.38%) and facial weakness in 9 (13.85%) patients. (Graph 1)



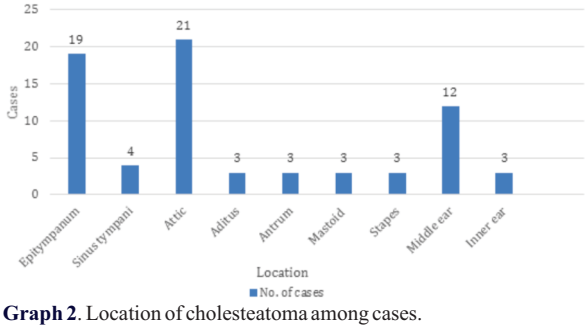
Graph 1. Presenting complaints among study participants.

In the present study, most common HRCT scan pre-operative finding was bony erosion with soft tissue attenuation among 47 (72.31%) cases followed by mass in epitympanum/Sinus tympani in 23 (35.38%), mass in attic in 21 (32.31%), Bony expansion in 11 (16.92%), Granulation tissue/ soft tissue attenuation without bony erosion with cholesteatoma and Highlighted mass in 5 (7.69%) each, Labyrinthine fistula; Mass in mastoid air cells, aditus & antrum and Mass on stapes in 4.62% each and Complete middle ear cholesteatoma in 1 (1.54%) case while there was no cholesteatoma among 5 (7.69%) cases. (Table 2)

Table 2. HRCT scan pre-operative findings among cases.

HRCT findings	Cases (n=65)	
	No.	(%)
Bony erosion with soft tissue attenuation	47	72.31
Bony expansion	11	16.92
Granulation tissue/ soft tissue attenuation without bony erosion with cholesteatoma	05	7.69
Highlighted mass	05	7.69
Labyrinthine fistula	03	4.62
Mass in epitympanum/Sinus tympani	23	35.38
Mass in attic	21	32.31
Mass in mastoid air cells, aditus & antrum	03	4.62
Mass on stapes	03	4.62
Complete middle ear cholesteatoma	01	1.54
No cholesteatoma	05	7.69

In the present study, most common location of cholesteatoma was Attic in 21 (35%) of the cases followed by Epitympanum in 19 (31.67%) cases, middle ear in 12 (18.46%), Sinus tympany (6.67%), aditus; antrum; mastoid; stapes and inner ear among 5% each. (Graph 2)



Graph 2. Location of cholesteatoma among cases.

In the present study, post-operative histopathology confirmed that there were 60 cases of cholesteatoma (92.31%) & 05 (7.69%) were negative for cholesteatoma; of which 57 (95%) were correctly identified i.e. true positive by HRCT, 3 (5%) came falsely negative, 3 (60%) false positive & 2 (40%) true negative. Sensitivity, specificity, positive predictive value & negative predictive value of HRCT was 95%, 40%, 95%, 40% respectively. So, HRCT has a good sensitivity for cholesteatoma but low specificity. (Table 3)

Table 3. Distribution of patients according to surgical and imaging findings.

Surgical finding	Cases (n=60) No. (%)		McNemar's chi square (p)*
	HRCT finding of cholesteatoma		
	Positive No.(%)	Negative No.(%)	
Cholesteatoma (60)	57 (95) (TP)	03 (5) (FN)	0 (1)
No cholesteatoma (05)	03 (60) (FP)	02 (40) (TN)	
Total	60	05	

*As per McNemar's test surgical findings & HRCT findings did not differ significantly (p=1).

In the present study, there were total 19 (29.23%) cases had shown residual disease in post-operative follow up of canal wall up & canal wall down mastoidectomy of which; 14 (73.68%) were cases of residual cholesteatoma, 3 (15.78%) of bony erosion and 2 (10.53%) was having bony expansion. (Table 4)

Table 4. MRI DWI findings among recurrent/residual cases in post-operative follow up of canal wall up & canal wall down mastoidectomy.

Finding	Cases (n=19)	
	No.	(%)
Residual cholesteatoma	14	73.68
Bony expansion	02	10.53
Bony erosion	03	15.78

DISCUSSION:

Present study was prospective observational study, initially planned to include 65 patients considering attrition problem, but during study we have not experienced withdrawal and lost to follow up problem. Finally, we could analyze all 65 patients, important findings of which are discussed below.

In this study, almost 55.38% cases were early adults i.e. in the age of 21-40 years. Mean age of the patients was 40.72 ± 14.61 years. Most (61.54%) of the study participants were male. This is in line with following Misako Hashimoto-Ikehara et al[19] who among 87 cases of attic cholesteatoma noted that 66% were male & mean age at operative treatment was 50 years and Sayed M.S. Kadah et al[20] in the study of efficacy of DW MRI in middle ear cholesteatoma found that 65% were male & study participants were quite young in this study with the mean age of 27.87±14.1 years.

In majority (50.77%) of the cases affected ear was left followed by right ear (38.46%) and bilateral (10.77%). This is in similar to Sayed M.S. Kadah et al[20] who noted laterality of left in 45%, right in 25% & bilateral among 30% & Mitra, et al[21] who has noted laterality of left in 38%, right in 37% & bilateral among 25%. On Otoscopic examination most common finding was attic destruction (55.38%) followed by otorrhea (40%), retraction pocket in attic/ postero-superior quadrant (36.92%) and aural polyp 7.69%.

In our study, most common presenting complaint was hearing loss in 45 (69.23%), followed by ear discharge among 44 (67.69%), pain in 25 (38.46%), itching reported by 22 (33.85%) patients, giddiness in 10 (15.38%) and facial weakness in 9 (13.85%) patients. Mitra et al[21] also in their study found that ear discharge (98%) was the commonest presenting complaint followed by hearing loss (91%), tinnitus (31%), pain (15%), giddiness (12%) & facial weakness (2%)

In the present study, most common HRCT scan pre-operative finding was bony erosion with soft tissue attenuation among 47 (72.31%) cases followed by mass in epitympanum/Sinus tympani in 23 (35.38%), mass in attic in 21 (32.31%), Bony expansion in 11 (16.92%), Granulation tissue/ soft tissue attenuation without bony erosion with cholesteatoma and Highlighted mass in 5 (7.69%) each, Labyrinthine fistula; Mass in mastoid air cells, aditus & antrum and Mass on stapes in 4.62% each and Complete middle ear cholesteatoma in 1 (1.54%) case while there was no cholesteatoma among 5 (7.69%) cases. In the present study, most common location of cholesteatoma was Attic in 21 (35%) of the cases followed by Epitympanum in 19 (31.67%) cases, middle ear in 12 (18.46%), Sinus tympany (6.67%), aditus; antrum; mastoid; stapes and inner ear among 5% each. Consistent findings are reported by Monali Mitra et al[21] who reported that for soft tissue attenuation, HRCT was 100% sensitive and specific for the presence of soft tissue mass. HRCT found to be 100% accurate in predicting cholesteatoma presence and was found to be sensitive in the range of 83.3%–100% and specific in range 87.04%–100%. For bony erosion, HRCT was found to be fairly accurate; also noted like our study that predominant cholesteatoma types were tubotympanic (60%) & atticoantral (40%). Sreedhar, et al[22] also reported similar findings on HRCT& concluded that HRCT scan was found to have a high sensitivity for identification of the disease at most of the sites within the temporal bone except for the sinus tympani and the stapes region. Uz Zaman et al.[23] noted similar findings on HRCT and reported that most common site of bony erosion was incus followed by malleus, scutum etc.

In the present study, post-operative histopathology confirmed that there were 60 cases of cholesteatoma (92.31%) & 05 (7.69%) were negative for cholesteatoma; of which 57 (95%) were correctly identified i.e. true positive by HRCT, 3 (5%) came falsely negative, 3 (60%) false positive & 2 (40%) true negative. According to McNemar's chi square test surgical findings & HRCT findings did not differ significantly (p=1). Sensitivity, specificity, positive predictive value & negative predictive value of HRCT was 95%, 40%, 95%, 40% respectively. So, HRCT has a good sensitivity for cholesteatoma but low specificity. Similar findings are noted by following authors. N.H. Khater et al.[24] in their study observed that the overall CT sensitivity and specificity for detecting cholesteatoma were 100% and 53.8%.

Mafee et al.[25] reported in his series of 48 patients with cholesteatoma that 46 of them (96%) were diagnosed correctly using HRCT scan.[115]

Sayed M.S. Kadah et al[20] found that the DW-MRI had the sensitivity of 93.3%, specificity of 100%, positive predictive value of 100% and negative predictive value of 83.3%

MRI was found to be useful in the detection of residual disease. Total 19 (29.23%) cases had shown residual disease in post-operative follow up of canal wall up & canal wall down mastoidectomy of which; 14 (73.68%) were cases of residual cholesteatoma, 3 (15.78%) of bony erosion and 2 (10.53%) was having bony expansion.

CONCLUSION:

Sensitivity, specificity, positive predictive value & negative predictive value of HRCT for the detection of cholesteatoma was 95%, 40%, 95%, 40% respectively. So, HRCT has a good sensitivity for detection of cholesteatoma but low specificity than MRI while MRI was found to be useful for post-operative follow up of residual or recurrent cases of cholesteatoma.

Declaration: There was no source of funding in our study and there was no any conflict of interest.

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