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Research Article

A RETROSPECTIVE STUDY TO COMPARE HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) FINDINGS WITH INTRA-OPERATIVE FINDINGS IN CASE OF CHOLESTEATOMA

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Abstract: ***Introduction:*** High-resolution computed tomography (HRCT), a modification of the routine computed tomography (CT) is used to detect the cholesteatoma. The objective of this study was to explore the relationship between preoperative high-resolution computed tomography (HRCT) findings of the temporal bone in cases of cholesteatoma and the findings observed during surgery.**Materials and Methods:** This retrospective study was carried out in the ENT department of Basaveshwar Teaching and General Hospital, Kalaburagi. Data from the period of July 1, 2022, to June 30, 2024 (24 months), were analyzed. The study included all patients who underwent surgery for cholesteatoma. HRCT images were examined and compared with the intraoperative findings. Sensitivity and specificity were determined using Statistical Package for Social Sciences version 29.0. The Kappa statistic was employed to assess the level of agreement between preoperative HRCT results and surgical observations.**Results:** In our study, the largest age group represented was <20 years & 21-40 years, accounting for 44% each. Among the patients, 52% (13 individuals) were found to have cholesteatoma with associated granulations. When evaluating the concordance between HRCT and intraoperative assessments, the highest sensitivity recorded was 92.9%, and the specificity was 95.6%. The majority of cases exhibited erosion in the malleus, while the incus showed the least erosion. The greatest level of agreement between HRCT findings and intraoperative observations was noted for the presence of disease in the labyrinth.**Conclusion:** HRCT of the temporal bone provides detailed visualization of cholesteatoma, including its location, extent, and associated bony alterations. Consequently, it offers excellent sensitivity, high specificity, and accuracy in the diagnosis of cholesteatoma.

Keywords: Retrospective study; Cholesteatoma; High Resolution Computed Tomography (HRCT); Chronic Suppurative otitis media (CSOM); Temporal Bone Imaging; Preoperative imaging; intraoperative findings.

INTRODUCTION

Cholesteatoma was defined in 1959 by Freidman as a well-defined cyst covered by stratified squamous epithelium, with variable thickness [1].

Recently, it is being defined as abnormal, noncancerous growth that forms behind the eardrum. It can be detected clinically by otoscopic examination but cannot be seen when present in the hidden areas like epitympanic recess and sinus tympani that can also be missed easily during surgeries. Although it is benign, but it also has locally invasive properties and a potential to relapse. Cholesteatoma tends to erode the surrounding bone. Several factors like inflammation, local pressure, granulation tissue etc contribute to this. Hydrolases and collagenolytic enzymes like tumour necrosis factor, interleukins, prostaglandins etc. lead to bone resorption rather than necrosis. Hence it is essential to evacuate the disease efficiently [2].

This cholesteatoma is likely a serious problem which can give rise to alarming intracranial and extracranial complications as it can progressively enlarge and invade into neighbouring structures. Therefore, early diagnosis and prompt management of a suspected cholesteatoma via surgical mastoid exploration makes it an obligatory procedure [3].

High-resolution computed tomography (HRCT), a modification of the routine computed tomography (CT), provides a direct visual window into the temporal bone providing vision of unavailable minute structural details. Computed tomography scan findings of an acquired cholesteatoma of the temporal bone consist of homogeneous soft tissue mass with local bone erosion, scutum erosion, erosion of the ossicles, middle ear pacification, and labyrinthine fistula extending to tympanum and widening of audits and antrum [4].

Although the previous studies showed good correlation between HRCT and intra-operative findings but also have shown minimal differences between the two. Hence this study is taken up;

1) To evaluate the role of HRCT in detection of Cholesteatoma.

2) To correlate the intraoperative findings of cholesteatoma with its pre-operative radiological findings seen on HRCT scan.

MATERIALS AND METHODS

Source of Data: The data was collected from the Medical Record Department (MRD) of those patients who have been operated for cholesteatoma by the department of ENT, Basaveshwara Teaching and General Hospital attached to Mahadevappa Rampure Medical College, Kalaburagi.

Method of collection of data

- **Study Design:** Retrospective study
- **Study setting:** Department of ENT Basaveshwar teaching and general hospital.
- **Study Sample:** 25

Study Duration: Retrospective data pertaining to the period from 1st July 2022 to 30th June 2024 (24 months) was analyzed.

Inclusion Criteria:

- Patients diagnosed with cholesteatoma who underwent surgery for cholesteatoma
- All age groups

Exclusion Criteria:

- Congenital malformations in any part of the ear.
- Previous ear surgeries.
- Trauma to the temporal bone**.**

RESULTS

In our study, involving 25 participants, the youngest subject was 6 year old, and the eldest subject was 63 years old. The overall subjects were highest in the age groups of ≤20 years & 21-40 years, followed by the age group 41-60 years. The mean (μ) age was 28±13.92 (as the standard deviation (σ) was 13.92); as shown in table-1.

The maximum subjects were males i.e. 17 (68%), and females were 8 (32%). Therefore, the ratio of Male: Female was 2.125.

Age group (years)	Female	Male	Total	Statistics
≤20	3	8	11	SD (σ) = 13.92
21-40	3	8	11	
41-60	2	0	2	
> 60	0	1	1	Mean (μ) age;
Total	8	17	25	28 ± 13.92

Table 1: Comparison between age groups and gender

In our study, HRCT could detect the Epitympanum's involvement of cholesteatoma in all the 25 (100%) cases, this was followed by the extension of cholesteatoma into the Prussak's space in 21 (84%), Aditus and Antrum 20 (80%), Mesotympanum 9 (36%) and so on as shown in table-2.

Involvement of individual parts	Number	Percentage (%)
Epitympanum	25	100%
Prussak's space	21	84%
Mesotympanum	9	36%
Hypotympanum	7	28%
Anterior epitympanic recess	03	12%
Aditus	20	80%
Antrum	20	80%
Sinus Tympani	8	32%
Facial recess	7	28%
Facial canal	0	0
Dural plate	1	4%
Sinus plate	1	4%

Table-2: Involvement of individual locations as detected through HRCT (N=25)

Soft tissue attenuation	Parameters	Findings	SE % (Confidence Interval)	SP % (Confidence Interval)	PPV	NPV
Epitympanum	TP (a)	13	87	70	81	78
	FN(b)	3				
	FP (c)	2				
	TN(d)	7				
Prussak's space	TP (a)	21	87.5	100	100	25
	FN(b)	0				
	FP (c)	3				
	TN(d)	1				
Mesotympanum	TP (a)	8	100	94	89	100
	FN(b)	1				
	FP (c)	0				
	TN(d)	16				
Anterior epitympanic recess	TP (a)	8	67	77	73	71
	FN(b)	3				
	FP (c)	4				
	TN(d)	10				
Aditus	TP (a)	22	96	100	100	67
	FN(b)	0				
	FP (c)	1				
	TN(d)	2				
Antrum	TP (a)	22	96	100	100	67
	FN(b)	0				
	FP (c)	1				
	TN(d)	2				
Sinus tympani	TP (a)	5	50	100	100	75
	FN(b)	0				
	FP (c)	5				
	TN(d)	15				
Facial recess	TP (a)	5	46	100	100	70
	FN(b)	0				
	FP (c)	6				
	TN(d)	14				
Dural plate	TP (a)	1	50	100	100	95
	FN(b)	0				
	FP (c)	1				
	TN(d)	23				
Sinus plate	TP (a)	1	100	100	100	100
	FN(b)	0				
	FP (c)	0				
	TN(d)	24				

SE: Sensitivity, SP: Specificity, TP: True Positive, FN: False Negative, FP: False Positive, TN: True Negative

Table-3: Comparison of HRCT and intraoperative findings according to soft tissue attenuation

On analysing the ossicle erosion, there was a high sensitivity (%) and specificity (%) in detecting no Incus erosion with HRCT temporal bone. Majority of the erosions were seen in the malleus and the least eroded ossicles were Incus. Distribution of the study subjects based on ossicle erosions observed with HRCT and intraoperatively is shown in Table-4.

Ossicles Erosion	HRCT scan positive findings	Intraoperative positive findings	Parameters	Findings	SE % (Confidence Interval)	SP % (Confidence Interval)	PPV value	NPV value
Malleus	14	12	TP (a)	12	67	86	92	50
			FN (b)	1				
			FP (c)	6				
			TN (d)	6				
Incus	18	15	TP (a)	17	89	100	100	75
			FN (b)	0				
			FP (c)	2				
			TN (d)	6				
Stapes	15	10	TP (a)	12	60	70	80	70
			FN (b)	3				
			FP (c)	3				
			TN (d)	7				

SE: Sensitivity, SP: Specificity, TP: True Positive, FN: False Negative, FP: False Positive, TN: True Negative

Table 4: Comparison of HRCT and intraoperative findings according to involvement of ossicles erosion in cholesteatoma

DISCUSSION

Of the 25 patients, the overall subjects were highest in the age groups of ≤20 years & 21-40 years, followed by the age group 41-60 years. The mean (μ) age was 28±13.92; as shown in table-1.

This was similar to the study conducted by Jose *et al* in which maximum incidence of middle ear inflammatory diseases was found in the 21–30 age group [5].

The maximum subjects were males i.e. 17 (68%), and females were 8 (32%). Therefore, the ratio of Male: Female was 2.125.

In our study we encountered the involvement of cholesteatoma in epitympanum in 100%, Prussak's space in 84%, aditus and antrum in 80%, mesotympanum in 9%, sinus tympanum in 32%, facial recess in 28%, anterior epitympanic recess in 12%, dural and sinus plate in 4%.

In a study by Uz Zaman *et al.*, reveals the Epitympanum/Prussak's space was the most involved site with soft tissue density seen in 60/63 (95.2%) diseased temporal bones, followed by aditus and antrum and mesotympanum, which was seen in 51/63 (80.9%) diseased temporal bones. Soft tissue density was present in the mastoid antrum and air cells in 46/63 (73%) diseased temporal bones and hypotympanum in 20/63 (31.7%) diseased temporal bones. sinus tympani, facial canal recess, were the least involved in 5/63 (7.9%), 4/63 (6.3%), diseased temporal bones, respectively [6].

Erosion of bones is commonly seen in cholesteatoma due to its bone eroding property either due to pressure necrosis and also due to osteoclastic enzymatic and molecular activity. The different structures in middle ear are affected due to its variable pathway.

In our study, maximum erosions were seen in incus in 72%, erosion of stapes in 60%, erosion of malleus in 56%, erosion of scutum in 48%, erosion of tegmen in 8%, erosion of mastoid cortex and sigmoid plate in 4%. These findings are consistent with a study done by Lahel et al, On HRCT, the most common was incus erosion (78%), then stapes erosion (56%), scutum erosion (40%), facial canal erosion (28%), tegmen erosion (6%), external bony canal involvement (6%) and lateral semicircular canal erosion (6%), and malleus erosion (2%) [7].

On comparing the findings of HRCT with that of intra-op findings for involvement of various locations we observed a 100% sensitivity for mesotympanum and erosion of sinus plate and 100% specificity for the invasion of cholesteatoma in Prussack's space, aditus, antrum, sinus tympani, facial recess, sinus plate and dural plate erosions; 100% PPV for invasion of cholesteatoma in epitympanum, Prussack's space, aditus, antrum, sinus tympani, facial recess, sinus plate and dural plate erosions; 100% NPV for mesotympanum and sinus plate erosion.

Whereas we observed a sensitivity of 96% for involvement of aditus and antrum, 87% for Prussack's space and epitympanum, 67% for anterior epitympanic recess and 50% for sinus tympani and erosion of dural plate. Specificity was 94% for mesotympanum and 77% for anterior epitympanic recess. A PPV of 89% for mesotympanum, 81% for epitympanum and 73% for anterior epitympanic recess with a NPV of 78% for epitympanum, 75% for sinus tympani, 71% for anterior epitympanic recess and 67% for aditus and antrum was noticed.

Our findings show good correlation with the findings in a study conducted by Pramod et al showed HRCT has a high sensitivity 95% and specificity 100% in the detection of scutum erosion where in Scutum erosion was seen in 19 cases of which 18 cases were detected by HRCT. False negative was seen associated with soft tissue density in mesotympanum (pars tensa cholesteatoma). Sinus tympani involvement was seen in 2 cases of which 1 case was detected on HRCT and thereby HRCT has less sensitivity 66.6% in the detection of sinus tympani involvement. HRCT showed a high sensitivity of 86.4% and specificity of 88.9% in detecting the cholesteatoma/atticoantral disease [4].

In another study done by Pilakkal et al., showed involvement of sinus tympani was seen in 28 patients (38.9%) facial recess in 25 patients (34.7%). So HRCT scan are very useful in assessing the hidden areas of the middle ear. Tegmen plate erosion was noted in 12 patients on HRCT but only in 10 patients during mastoid exploration surgery. Sensitivity=100%, specificity=96.9%, PPV=83.3% and NPV=100% [8].
Involvement of ossicles erosion in cholesteatoma and observed the sensitivity of HRCT for incus erosion to be 89%, malleus 67% and stapes 60% with 100% specificity for erosion of incus, 92% for malleus and 80% for stapes with 100% PPV for incus erosion, 92% for malleus and 80% for stapes respectively.

These observations were similar to a study done by Pramod et al., [4] with, HRCT has showing a high sensitivity 83.3% and specificity 100% in the detection of incus erosion. In the detection of malleus erosion. HRCT has less sensitivity 60% and specificity 85.7%. HRCT has shown a less sensitivity 72.3% but high specificity 83.3% in the detection of stapes erosion. One false positive was seen involving supra structure of stapes.

Another study done by abdunnasar et al. [8], showed Incus erosion noted in 64 and 66 patients on HRCT and intra-operatively with a sensitivity=96.9% and specificity=100% PPV=97.2% and NPV=96.9%. Erosion of the hande of the malleus was noted in 25 patients on HRCT and 24 patients during surgery. Sensitivity=100%, specificity=98.3%, PPV=96%, NPV=100% and Erosion of the hande of the malleus was noted in 25 patients on HRCT and 24 patients during surgery. Sensitivity=100%, specificity=98.3%, PPV=96%, NPV=100%

Limitations: While this study provides valuable insights into the correlation between HRCT and intraoperative findings in cholesteatoma, it is subject to several limitations. First, the retrospective nature of the study inherently introduces the potential for selection bias and relies heavily on the accuracy and completeness of historical medical records and surgical notes. Second, the sample size of 25 patients is relatively small. This limits the statistical power of the data, particularly when evaluating less frequently observed complications such as dural plate or sinus plate erosions, which were only noted in a single case. Third, as a single-center study, the findings may be influenced by institutional protocols, specific CT scanner resolutions, and the subjective interpretations of individual radiologists and surgeons, which may limit the generalizability of the results. Future prospective, multicenter studies with larger patient cohorts are recommended to validate these findings and further standardize the predictive value of HRCT in preoperative planning.

CONCLUSION

Our study indicates that HRCT of the temporal bone shows strong alignment with intraoperative findings. HRCT temporal bone is valuable in diagnosing and guiding surgical management of cholesteatoma. It precisely delineates the location and extent of the disease, offers critical insights into the intricate anatomical variations of the temporal bone and potential complications associated with the disease, and serves as an indispensable guide for surgeons throughout the procedure.
Thus, integrating HRCT into the preoperative diagnostic process for such cases is recommended to enhance surgical planning.

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