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CHOLESTEATOMA: A STUDY ON PREOPERATIVE HRCT AND INTRAOPERATIVE CORRELATION

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ABSTRACT:

Background: Chronic otitis media (COM) is a preventable cause of hearing loss characterized by persistent inflammation of the middle ear, which can lead to bone destruction, aural polyps, and complications such as cholesteatoma. Cholesteatoma, a destructive keratinizing cyst, often requires surgical intervention due to the lack of effective medical treatments and the potential for serious intracranial complications. High-Resolution Multi-Detector Computed Tomography (HRMDCT) is now essential in preoperative evaluation of COM, providing detailed imaging of temporal bone anatomy to guide safe and effective surgical planning.

Aim of the Study: To compare HRCT findings with intraoperative observations, assess the role of HRCT in patients with cholesteatoma, and determine the extent of cholesteatoma involvement in the temporal bone.

Materials: An observational study was conducted at the Government General Hospital, Anantapuramu, between November 2022 and March 2024, including 100 patients with ear-related complaints such as discharge and hearing loss. Patients with chronic squamosal-type CSOM, recurrent ear discharge, with polyps, granulation tissue, or retraction pockets were included. Data analysed in terms of otoscopy signs, radiological imaging (HRCT), and subsequent surgery. Surgeries of Atticotomy, canal wall-down mastoidectomy done. Preoperative HRCT findings were compared with intraoperative results to assess accuracy and correlation.

Results: In this study, the majority of patients with cholesteatoma were between 31-40 years old (31%), with females (55%) being more affected than males (45%). Common symptoms included ear pain (79%), ear drainage (67%), and hearing loss (57%). Diabetes and hypertension were present in 18% and 16% of patients, respectively. Otoscopy revealed pars tensa perforation (54%) and PSQ retraction (26%). HRCT findings showed bony wall involvement, with Koerner's septum erosion in 55%, scutum erosion in 39%, and tegmen erosion in 18%. Ossicular involvement included incus erosion in 88%, malleus handle erosion in 35%, and stapes erosion in 11%. Canal involvement included facial canal erosion in 28% and lateral semicircular canal erosion in 6%. HRCT showed excellent correlation with intraoperative findings in most cases, with 100% sensitivity in detecting

soft tissue, malleus head erosion, and semicircular canal erosion. Cholesteatoma primarily extended into the antrum, aditus, and epitympanum, with strong statistical correlation between HRCT and intraoperative findings, except for the mesotympanum.
Conclusions: This study demonstrates that **preoperative HRCT** findings show a high correlation with **intraoperative findings**, supporting its utility in assessing the extent of cholesteatoma. HRCT is particularly valuable in identifying **bony erosions**, **ossicular involvement**, and **the extent of disease** in the middle ear. These insights facilitate optimal surgical planning and potentially improve patient outcomes, highlighting HRCT's importance in the management of cholesteatoma.

KEY WORDS; Cholesteatoma, Attic, HRCT, Sinus plate and Mastoidectomy

INTRODUCTION:

Chronic otitis media (COM) is clinically diagnosed and categorized into COM with and without cholesteatoma due to its varying pathological changes. (1) In 1838, Müller first described cholesteatoma as a neoplastic lesion containing keratin flakes resembling cholesterol crystals. (2) Virchow (1855) proposed it as a tumor arising from mesenchymal cell metaplasia, followed by Politzer (1869), who viewed it as a glandular neoplasm of the middle ear mucosa. (3) Finally, Bezold and Habermann (1889) theorized that cholesteatoma results from the migration of epidermis from the external auditory canal into the tympanic cavity through a perforation. (4) **Cholesteatoma** is an abnormal growth of keratinizing squamous epithelium within the tympanic cavity or mastoid, often accompanied by keratin debris and variable inflammation. (5) It is classified as either **congenital** or **acquired**, with the acquired form further divided into **primary** and **secondary** types. (6) Secondary cholesteatoma typically follows tympanic membrane perforation or trauma, while primary cholesteatoma is most widely explained by the **retraction theory**, which attributes it to Eustachian tube dysfunction leading to negative middle ear pressure and tympanic membrane retraction. (7) **Inactive retractions** of the tympanic membrane (pars tensa or pars flaccida) are graded by Sade and Tos classifications respectively, which help predict disease progression. (8) Cholesteatoma incidence varies by population, with higher rates in Caucasians compared to Inuits and Australian Aboriginal populations. Clinically, active cholesteatoma presents with **foul-smelling discharge**, **hearing loss**, and sometimes visible flakes or granulation tissue; microscopic exam is often required for diagnosis, especially when obscured by crusts or aural polyps. (9) **Surgical management** aims to eradicate disease, prevent recurrence, and preserve hearing. Techniques include **canal wall down (CWD)** and **canal wall up (CWU)** mastoidectomy, with minimally invasive endoscopic methods increasingly used. (10) Traditional approaches like **modified radical mastoidectomy** are being supplemented by **atticoantrostomy** and **atticotomy** for smaller lesions, with cartilage reconstruction to minimize cavity size. (11) Preoperative steps involve anesthesia and postauricular incision to expose the mastoid bone, preparing for disease clearance and reconstruction. (12) This study was aimed to compare HRCT findings with intraoperative observations, assess the role of HRCT in patients with cholesteatoma, and determine the extent of cholesteatoma involvement in the temporal bone.

MATERIALS:

100 patients with discharge from the ear, hard of hearing and other ear related complaints who presented to ENT OPD were admitted in the ward of Government General Hospital, Anantapuramu between November 2022 and March 2024 were included. An ethics committee approval was obtained prior to the commencement of the study. AN ethics committee approved consent letter and proforma were used. **Inclusion Criteria:** Patients who were clinically diagnosed as squamosal type of CSOM were included. Patients with CSOM with chronic and recurrent ear discharge were included. Patients presenting with CSOM with polyps, granulation tissue, retraction pockets were included. **Exclusion Criteria:** Patients with Previous history of ear surgeries were excluded. Patients with Previous history of ear trauma were excluded. Patients with Malignant conditions of temporal bone were excluded. Patients with Glomus tumour of the temporal bone were excluded.

Data is collected from the patients who are willing and has taken detailed history, clinical examination and appropriate serological, radiological investigations and proceeding with surgery and following the cases subsequently. surgery was decided after assessing the HRCT Temporal in view of anatomy of temporal bone, extension of the disease and surgery was planned accordingly, varying from atticotomy to canal wall down mastoidectomy. The pre operative HRCT findings were compared with the intra operative findings. the results were done based on these findings.

RESULTS:

This cross-sectional study was conducted on 100 patients with cholesteatoma attending the Department of ENT, Government General Hospital, Anantapuramu. The primary objective was to compare preoperative High-Resolution Computed Tomography (HRCT) findings with intraoperative observations in these patients. **(Table 1)**

Demographic Profile

Table 1: Age-wise distribution of study participants

Age Group	Number	Percentage
≤ 20 years	10	10%
21–30 years	26	26%
31–40 years	31	31%
41–50 years	26	26%
51–60 years	7	7%

Mean Age: 35.2 years

Standard Deviation: 10.8

The most affected age group was 31–40 years, indicating that cholesteatoma is more common in the middle-aged population.

Gender Distribution

Table 2: Gender-wise distribution of the study participants

Gender	Number	Percentage
Male	45	45%
Female	55	55%

Females were slightly more affected than males in this study population. **(Table 2)**

Clinical Presentation

Table 3: Distribution of patients based on chief complaints

Complaints	Number	Percentage
Hearing loss	57	57%
CHL (Conductive Hearing Loss)	42	73.7% (of HL)
Mixed Hearing Loss	15	26.3% (of HL)
Ear drainage (often foul-smelling)	67	67%
Recurrent ear infections	12	12%
Sensation of ear fullness/blockage	28	28%
Tinnitus	26	26%
Ear ache/pain	79	79%

Most common complaints were **ear pain (79%)**, **discharge (67%)**, and **hearing loss (57%)**, **(Table 3).**

Comorbidities

Table 4: Distribution of patients by comorbidity

Comorbidity	Number	Percentage
Diabetes	18	18%
Hypertension	16	16%
No comorbidity	66	66%

Most patients (66%) had no comorbidities. Diabetes and hypertension were the most common among those who did. **(Table 4)**

Otoscopy Findings

Table 5: Otoscopy findings

Otoscopic Finding	Number	Percentage
Pars tensa perforation	54	54%
Attic perforation	18	18%
Attic retraction	19	19%
Granulation tissue	16	16%
Aural polyp	11	11%
PSQ retraction	26	26%

Multiple findings were seen in several patients. The most frequent finding was **pars tensa perforation**. **(Table 5)**

Pure Tone Audiometry

Table 6: Degree of hearing loss

Parameter	Right Ear (dB)	Left Ear (dB)
Mean	38.3	33
Median	38	29
Standard Deviation	10.3	9.82

Mild to moderate hearing loss was the typical audiometric finding. **(Table 6)**

HRCT Findings

Table 7: Bony wall erosion

HRCT Finding	Number	Percentage
Koerner’s septum erosion	55	55%
Scutum erosion	39	39%
Thinning of Tegmen	35	35%
Tegmen erosion	18	18%
Superior/posterior meatal wall erosion	17	17%
Sigmoid sinus plate erosion	16	16%
Mastoid fistula	16	16%

The commonest bony wall involved was Koerner’s septum in 55% cases. **(Table 7)**

Ossicular Chain Involvement

Table 8: Ossicular erosion on HRCT

HRCT Finding	Number	Percentage
Incus erosion	88	88%
Malleus handle	35	35%
Malleus head	28	28%
Stapes head	11	11%

Incus was the most commonly eroded ossicle. **(Table 8)**

Facial Canal and Labyrinth Involvement

Table 9: HRCT findings of canal involvement

Finding	Number	Percentage
Intact facial canal	64	64%
Vertical facial canal erosion	28	28%
Dehiscent facial canal	8	8%
Lateral semicircular canal erosion	6	6%

The facial nerve involvement was detected in 28% of the cases especially in vertical segment. **(Table 9)**

	HRCT findings	Intraoperative findings	Kappa coefficient	P
Soft tissue attenuation	99	99	1	<0.001*
Aditus expansion	61	61	0.958	<0.001*
Sigmoid sinus plate erosion	16	15	0.77	<0.001*
Eroded Koerner's septum	55	55	0.919	<0.001*
Eroded superior and posterior meatal wall	17	16	0.891	<0.001*

HRCT vs Intraoperative Correlation

Table 10: HRCT and intraoperative findings (Kappa values)

Observation

This **table 10** shows an **excellent correlation** (Kappa > 0.8) for nearly all parameters, indicating that HRCT findings were highly reliable in predicting intraoperative results.

Scutum erosion	41	41	0.959	<0.001*
Tegmen erosion	18	17	0.896	<0.001*
Malleus handle erosion	35	34	0.889	<0.001*
Malleus head erosion	28	28	1	<0.001*
Long process of Incus erosion	88	86	0.823	<0.001*
Stapes head erosion	11	10	0.947	<0.001*
Facial canal erosion	28	28	0.95	<0.001*
	16	15		<0.001*

Diagnostic Accuracy

Table 11: Sensitivity, Specificity, PPV, NPV, and Accuracy of HRCT

	Sensitivity	Specificity	Accuracy	PPV	NPV
Soft tissue attenuation	100	100	100	100	100
Aditus expansion	98.4	97.4	98	98.4	97.4
Sigmoid sinus plate erosion	100	91.8	93	68.2	100
Eroded Koerner's septum	96.4	95.6	96	96.4	95.6
Eroded superior and posterior meatal wall	93.8	97.6	97	88.2	98.8
Scutum erosion	97.6	98.3	98	97.6	98.3
Tegmen erosion	94.1	97.6	97	88.9	98.8
Malleus handle erosion	94.1	95.5	95	91.4	96.9
Malleus head erosion	100	100	100	100	100
Long process of Incus erosion	98.8	78.6	96	96.6	91.7
Stapes head erosion	100	98.9	99	90.9	100
Facial canal erosion	96.4	98.6	98	96.4	98.6
Mastoid trabeculae Erosion	100	98.8	99	93.8	100
Lateral Semicrcular canal erosion	100	100	100	100	100

This table confirms high diagnostic performance of HRCT in detecting cholesteatoma-related findings. Sensitivity and specificity values ranged between **88–100%**, depending on the structure involved**. (Table 11)**

Surgical Procedures Performed

Table 12: Type of Surgery

Procedure	Number	Percentage
Modified radical mastoidectomy (CWD)	49	49%
Canal wall up mastoidectomy	30	30%
Atticotomy	21	21%

Modified Radical Mastoidectomy was performed in 49% of the cases. **(Table 12)**

Extent of Disease: HRCT vs Intraoperative

Table 13: HRCT vs Intraoperative – extent of disease

Structure Involved	HRCT (%)	Intraoperative (%)	*p*-value
Hypotympanum	55	52	<0.001*
Epitympanum	98	96	<0.001*
Mesotympanum	55	55	0.325
Protympanum	8	4	<0.001*
Prussak's space	16	12	<0.001*
External auditory canal	9	6	0.002*
Sinus tympani	14	12	<0.001*
Aditus	84	82	<0.001*
Antrum	92	80	<0.001*
Mastoid	24	12	<0.001*
Facial recess	38	32	<0.001*

*Chi-square test significant at $p < 0.05$

Significant correlation was observed in all areas except **mesotympanum**, confirming the reliability of HRCT in preoperative assessment, **(Table 13).**

DISCUSSION

Cholesteatoma, traditionally diagnosed through otoscopic examination, is primarily treated with surgery. The necessity of imaging in uncomplicated cases, however, remains a topic of debate. This study aims to investigate the correlation between preoperative High-Resolution Computed Tomography (HRCT) and intraoperative findings in cholesteatoma patients. It also evaluates the usefulness of HRCT in visualizing middle ear structures affected by cholesteatoma. **Age and Gender Distribution:** The mean age of patients in our study was **35.2 years**, with the **31-40 years age group** being the most affected (31%). The **21-30 years** and **41-50 years** groups followed, each accounting for 26%. Cholesteatoma was observed predominantly in **middle-aged adults**. In terms of gender, **55% of patients were female**, while **45% were male**. These findings align with studies such as those by **Ram B et al.**, (13) which reported a mean age of **39.1 years**, and **Datta G et al.**, (14) with a similar average age of **36.38 years**. The prevalence of cholesteatoma was notably high in the **2nd decade of life** in some studies, while our study had a slightly older population. **Clinical Presentation:** The most common complaints among our patients were **ear pain (79%)**, **ear drainage (67%)**, and **hearing loss (57%)**. Less frequent symptoms included a sensation of ear fullness (28%), tinnitus (26%), and recurrent ear infections (12%). This pattern is consistent with studies by Pradeep S, Dev S, Raju JS, et al, (15) and others, who also found **conductive deafness and otorrhea** to be predominant complaints. Our findings highlight that **ear ache, ear drainage, and hearing loss** were the most significant presenting symptoms. **Laterality of Cholesteatoma:** In our cohort of 100 patients, **50% had right-sided cholesteatoma**, **32% had left-sided**, and **18% had bilateral disease**. These observations are similar to those found in other studies, where **right-sided involvement** was more common. **Comorbidities: 66% of patients** in our study had no

significant comorbidities. Among those with comorbid conditions, **18% had diabetes**, and **16% had hypertension**. This reflects a similar trend seen in other studies, which often report a low incidence of comorbidities in cholesteatoma patients. (16) **Otoscopy Findings:** Otoscopy revealed **pars tensa perforation** in **54%** of cases, followed by **PSQ retraction** (26%). **Attic retraction (19%)**, **attic perforation (18%)**, **granulation tissue (16%)**, and **aural polyp (11%)** were also observed. These findings were consistent with the clinical presentations noted in various studies. (17) **Pure Tone Audiometry (PTA):** The mean **PTA for the right ear** was **38.3 dB** (median 38 dB), while the mean **PTA for the left ear** was **33 dB** (median 29 dB). These findings show a moderate degree of hearing loss, which is typical in cholesteatoma cases. **HRCT Findings: Bony Wall Erosion:** HRCT revealed significant **bony wall erosions** in cholesteatoma patients. The most common findings were:

- **Koerner's Septum erosion (55%)**
- **Scutum erosion (39%)**
- **Thinning of the Tegmen (35%)**
- **Tegmen erosion (18%)**
- **Superior and posterior meatal wall erosion (17%)**
- **Sigmoid sinus plate erosion (16%)**

In some cases, the **sinus plate** was accidentally breached during surgery, and bleeding was controlled using **bone wax**. These findings were similar to those reported by **Ram B et al.**, (13) who noted a high degree of accuracy in detecting **tegmen erosion** through HRCT, with a **kappa value of 1**, indicating complete agreement with intraoperative findings. High-resolution computed tomography (HRCT) is a vital tool for evaluating cholesteatoma and its complications. In our study, HRCT successfully identified bone erosions in 88% of patients, especially the incus, malleus, and stapes. Studies by Pradeep et al. (79) and others showed similar results, with HRCT demonstrating strong sensitivity and specificity in identifying ossicular involvement. Tegmen plate erosion, observed in 13.3% of cases, showed excellent agreement between HRCT and intraoperative findings ($\kappa = 0.859$). Facial canal dehiscence and sinus plate erosion were other key findings, with HRCT proving reliable in detecting these complications. In Ram B et al.'s (13) study, 84.6% of facial canal dehiscence cases were identified by HRCT. However, discrepancies were noted in a few cases where the CT scan falsely indicated erosion. The correlation between HRCT findings and intraoperative results generally showed strong agreement, with kappa values above 0.75, except for some cases of sigmoid sinus erosion. Ossicular chain involvement was prevalent in cholesteatoma patients, with incus erosion being the most common. HRCT demonstrated 91% sensitivity in identifying malleus erosion, while the stapes showed less involvement (11%). In the study by Agarwal et al., (17) the "Icecream Cone Configuration" was used to evaluate ossicular integrity, emphasizing the importance of preoperative HRCT to plan for ossicular reconstruction. Additionally, HRCT played a significant role in assessing canal involvement, including the facial nerve and semicircular canal erosion. Our findings aligned with those of other studies, where facial canal dehiscence was identified with 100% specificity and a sensitivity rate of 86.4%.

Surgical Correlation: HRCT findings strongly correlated with intraoperative results for most complications, particularly in mastoid pneumatization and cholesteatoma extension into the mastoid region. However, HRCT sensitivity for detecting labyrinthine fistulas, facial nerve dehiscence, and sinus plate erosions varied, with some studies reporting 100% sensitivity for certain findings and lower rates for others, such as facial nerve canal dehiscence.

Clinical Implications:

In terms of surgical procedures, canal wall-down mastoidectomy (CWD) was most common in the cases studied. The results demonstrated that HRCT is an essential tool for preoperative assessment, helping surgeons understand the extent of the disease and potential complications, including ossicular erosion and facial nerve involvement.

CONCLUSION:

This study demonstrates that **preoperative HRCT** findings show a high correlation with **intraoperative findings**, supporting its utility in assessing the extent of cholesteatoma. HRCT is particularly valuable in identifying **bony erosions**, **ossicular involvement**, and **the extent of disease** in the middle ear. These insights facilitate optimal surgical planning and potentially improve patient outcomes, highlighting HRCT's importance in the management of cholesteatoma. HRCT offers high diagnostic value in the preoperative evaluation of cholesteatoma, especially in detecting ossicular, facial canal, and sinus plate erosions. The strong correlation between HRCT and intraoperative findings improves surgical planning and reduces the risk of complications.

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