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Original Article

Correlation Between Preoperative Findings of High-Resolution Computed Tomography (HRCT) and Intraoperative Findings of Chronic Otitis Media (COM)

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ABSTRACT

Objective: To determine the association between preoperative findings of high-resolution CT and intraoperative findings of chronic otitis media.

Study Design: Comparative cross-sectional.

Place and Duration of Study: Ear, Nose, and Throat Department of Combined Military Hospital, Rawalpindi, Pakistan, from May to Dec 2024

Methodology: A total of 50 cases of chronic otitis media, aged 8 to 60 years, were selected by a consecutive sampling technique. The high-resolution CT of patients was performed preoperatively, and findings were compared with intraoperative findings regarding cholesteatoma status, middle ear structures, and tympanic membrane.

Results: The comparison showed Incudomalleolar (M-I) joint discontinuity (42.0% vs. 42.0%), tympanic membrane perforation (34.0% vs. 30.0%), incus erosion (32.0% vs. 32.0%), Incudostapedial (I-S) joint discontinuity (34.0% vs. 28.0%), eustachian tube granulations (26.0% vs. 14.0%), stapes erosion (18.0% vs. 14.0%), sigmoid plate erosion (18.0% vs. 12.0%), malleus erosion (14.0% vs. 4.0%), dura exposed (8.0% vs. 8.0%), middle ear mucosa edema (8.0% vs. 4.0%), and facial canal erosion (6.0% vs. 4.0%). Cholesteatoma was equally observed in high-resolution CT and intraoperatively (44.0%), with a significant correlation (p-value <0.001) between cholesteatoma extending preoperatively in high-resolution CT and intraoperatively.

Conclusion: Preoperative high-resolution CT has a significant association with intraoperative findings of chronic otitis media. Preoperative high-resolution CT of the temporal bone has proven its efficacy in the detection of complications before surgery, helping improve the success rate of surgeries and the quality of life of patients.

Keywords: Cholesteatoma, Computed tomography, Otitis media, Preoperative.

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INTRODUCTION

Otitis media (OM) is one of the most common infectious and inflammatory diseases recognized as a major contributor to hearing loss, healthcare visits, and prescriptions of medications.[1,2] This condition, which is often referred to as middle ear inflammation, is a collection of conditions that include otitis media with effusion (OME), chronic otitis media (COM), and acute otitis media (AOM).[3] Chronic otitis media, commonly known as chronic suppurative otitis media (CSOM), is a type of middle ear disease in which chronic infection persists in the absence of an intact tympanic membrane (TM). Persistent inflammation of the middle ear as well as the mastoid cavity is typically the hallmark of chronic otitis media.

COM is an extremely common ear disease, particularly in children, and causes major morbidity worldwide.[5] Worldwide, COM affects 65 to 330 million people, with developing countries bearing most of the burden.[6] The World Report on Hearing, published by the World Health Organization (WHO), reports that by 2050, about two and a half billion people in the world will have some form of hearing loss, and about seven hundred million people will require hearing care and treatment.[7] Therefore, early and appropriate diagnosis of COM is crucial and will aid in appropriate management with surgical intervention to prevent the devastating consequences associated with COM.[8]

The diagnosis of COM is confirmed by clinical examination, either with a microscope or otoscope, hearing examination, bacterial culture testing with antibiotic resistance, facial nerve topography testing, and, most importantly, computed tomography (CT) and magnetic resonance imaging (MRI) of the ear and temporal bones. The importance of middle ear diagnostic imaging is crucial in providing detailed structural information to identify affected ear

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structures.[9] High-resolution computed tomography (HRCT) is commonly used not only for the diagnosis of COM but also for the preoperative surgical preparation of COM. It is the preferred diagnostic modality for the middle ear due to its high spatial resolution as well as its potential to detect significant anatomical structures. High-resolution CT of the temporal bone assesses the soft tissue density and the existence of aeration problems and bone erosions. In patients with COM, especially when cholesterol is present, adjacent bony structures may be eroded, and surgery may be necessary.[10]

This study has been conducted to determine the association between preoperative findings of HRCT and intraoperative findings of COM. Meanwhile, preoperative HRCT imaging of patients with COM is incredibly valuable to surgeons and will help to assess ear anatomy and diagnose ear anomalies that will help to reduce postoperative morbidity in patients requiring surgery for COM.

METHODOLOGY

This comparative cross-sectional study was performed at the Ear, Nose, and Throat (ENT) Department of Combined Military Hospital (CMH), Rawalpindi, Pakistan, from May to Dec12-2024. Study approval was obtained from Ethical Review Committee and the Institutional Review Board via letter serial number [633] dated 30-05-2024. The online Open EPI software was used to calculate a sample size of 50 patients from the Pakistani study. Who reported the 3.36%[11] prevalence of COM with a confidence level (95%) and margin of error (5%). The COM cases were selected from the outpatient department of the ENT department through a consecutive sampling technique during the study period.

Inclusion Criteria: The study included diagnosed cases of Chronic Otitis Media (COM), aged between 8 and 60 years, both male and female participants, who were preoperatively evaluated using High-Resolution Computed Tomography (HRCT).

Exclusion Criteria: The study excluded patients who were unfit for COM surgery, unfit for anesthesia, or not preoperatively evaluated using HRCT, and patients who were not willing to participate in the study.

The World Medical Association Declaration of Helsinki was followed in the execution of the study procedure. The permission for the study was obtained from the College of Physicians and Surgeons, Pakistan (CPSP) Research Evaluation Unit (REU). Finally, the study objective was explained to the patient undergoing COM surgery, and written informed consent was taken. Approval of the ethical review committee of the institute was also obtained.

Chronic otitis media is confirmed by the presence of a perforated tympanic membrane and persistent discharge for ≥ 2 weeks from the middle ear. Before the surgery, the HRCT of the temporal bone without contrast for each COM patient was performed in different slices at one and five minutes. The slices had a thickness of 5 mm with thin slice cuts, and the images were acquired in all planes. These high-resolution CT images were evaluated by radiologists with ≥ 5 years of experience. Intraoperative surgical findings were reported by an otolaryngologist skull-base surgeon with ≥ 5 years of experience. The high-resolution CT findings were compared with the intraoperative findings. The cholesteatoma status, middle ear structures, and tympanic membrane were the comparison parameters.

Data was analyzed by using Statistical Package for Social Science version 25: 00. By contrasting the HRCT results with intraoperative findings, the diagnostic accuracy, sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) of the results were determined. The substantial associations between HRCT and intraoperative data were measured using the chi-square test. The *p*-value of 0.05 or less was considered statistically significant.

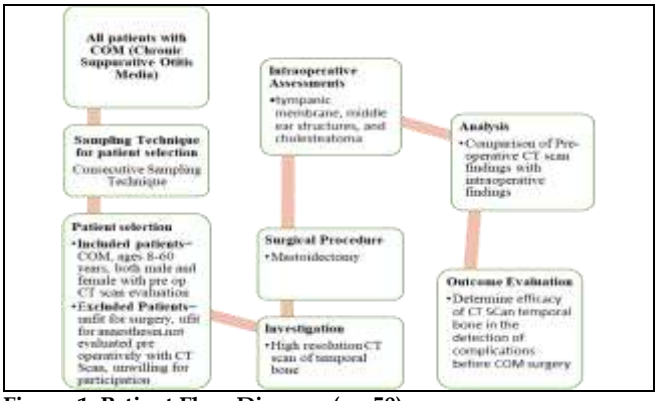

Figure-1: Patient Flow Diagram (n= 50)

RESULTS

The study included 50 chronic otitis media cases; out of those, 54.0% were males (n=27) and 46.0% were females (n=23). The age range was 8–60 years, with a mean age of 32.4±14.7 years. Tympanic (TM) perforation was observed on HRCT in 30.0% (n=15)

patients, compared to 34.0% (n=17) patients intraoperatively. Erosion of the facial canal was observed at HRCT in only 4.0% (n=2) patients, compared to 6.0% (n=3) patients intraoperatively. Similarly, in exposed dura, erosion of incus, and M-I joint discontinuity, both preoperative HRCT and intraoperative findings were similar in 8.0% (n=4), 32.0% (n=16), and 42.0% (21), respectively. When sigmoid plate erosion, dura exposed, incus erosion, stapes erosion, and M-I joint discontinuity were detected, there was a strong correlation (*p*-value <0.001) between the intraoperative and HRCT findings, indicating greater diagnostic accuracy and sensitivity (Table-I).

Cholesteatoma was also equally observed in HRCT and intraoperatively (44.0%), with a significant correlation (*p*-value <0.001) between cholesteatoma status extending preoperatively in HRCT and intraoperatively (Table-II).

DISCUSSION

This study evaluated 50 COM cases, including 27 males (54.0%) and 23 females (46.0%), with a mean age of 32.4±14.7 years; 52.0% (n=26) were aged ≤30 years. The incus was the most commonly eroded ossicle, followed by the stapes and malleus. Preoperative HRCT showed significant correlation with intraoperative findings for incus erosion and stapes erosion (both $p<0.001$), but not for malleus erosion ($p=0.134$). Exposed dura, incus erosion, and M-I joint discontinuity were identified on both HRCT and intraoperatively, with 100% sensitivity, specificity, and diagnostic accuracy. HRCT had low sensitivity for malleus erosion (14.3%), middle ear mucosal edema (25%), eustachian tube granulation (46.2%), and facial canal erosion (66.7%). Despite this, HRCT findings for middle ear mucosal edema, eustachian tube granulation, and facial canal erosion correlated significantly with intraoperative findings (all $p<0.001$), while malleus erosion remained non-significant.

Table-I: Comparison between Intraoperative and High-Resolution Computed Tomography (HRCT) Findings (n=50)

Findings	Intraoperative Findings n (%)	HRCT Findings n (%)	Sn (%)	Sp (%)	PPV (%)	NPV (%)	DA (%)	*p*-value
TM Perforation	17 (34.0)	15 (30.0)	100	94.3	88.3	100	96	<0.001
Facial Canal Erosion	3 (6.0%)	2 (4.0)	66.7	100	100	98	98	<0.001
Sigmoid Plate Erosion	9 (18.0)	6 (12.0)	100	93.2	66.7	100	94	<0.001
Dura Exposed	4 (8.0)	4 (8.0)	100	100	100	100	100	<0.001
Middle Ear Mucosa Edema	4 (8.0)	2 (4.0)	25	97.9	50	93.8	92	<0.001
Malleus Erosion	7 (14.0)	2 (4.0)	14.3	97.7	50	87.5	86	0.134
Incus Erosion	16 (32.0)	16 (32.0)	100	100	100	100	100	<0.001
Stapes Erosion	9 (18.0)	7 (14.0)	100	95.4	77.8	100	96	<0.001
M-I Joint Discontinuous	21 (42.0)	21 (42.0)	100	100	100	100	100	<0.001
I-S joint Discontinuous	17 (34.0)	14 (28.0)	76.5	97	92.9	88.9	90	<0.001
Eustachian Tube Granulation	13 (26.0)	7 (14.0)	46.2	97.3	85.8	83.8	84	<0.001

Sn: Sensitivity; Sp: Specificity; PPV: Positive Predictive Value; NPV: Negative Predictive Value; DA: Diagnostic Accuracy; TM: Tympanic Membrane; M-I: Malleus-Incus; I-S: Incus Stapes, HRCT - High-Resolution Computed Tomography

Table-II: Cholesteatoma Status Comparison Between Preoperative High-Resolution Computed Tomography and Intraoperatively (n=50)

Cholesteatoma Status Extending Preoperatively in HRCT	Cholesteatoma Status Extending Intraoperatively					p-Value
	Mesotympanum-hypotympanum n (% of Total)	In Mesotympanum n (% of Total)	In Mesotympanum & Epitympanum n (% of Total)	No Cholesteatoma n (% of Total)	Total (% of Total)	
Mesotympanum-Hypotympanum	13(26.0)	0(0.0)	0(0.0)	0(0.0)	13(26.0)	<0.001
In Mesotympanum	0(0.0)	6(12.0)	0(0.0)	0(0.0)	6(12.0)	
In Mesotympanum & Epitympanum	0(0.0)	0(0.0)	3(6.0)	0(0.0)	3(6.0)	
Total	13(26.0)	6(12.0)	3(6.0)	28(56.0)	50(100.0)	

**HRCT - High-Resolution Computed Tomography*

Studies like Eroglu et al., reported no significant differences between demographic variables in patients with COM.[12] Aljehani *et al.,* analyzed the high-resolution CT preoperative findings with intraoperative findings of COM and reported the significant correlation between incus erosion (*p*-value = 0.001) and stapes erosion (*p*-value = 0.002) and the non-significant correlation in malleus erosion (*p*-value = 0.348).[13] Cakan *et al.,* also analyzed the high-resolution CT preoperative findings with intraoperative findings of COM, report a similar high prevalence of incus followed by the stapes and malleus, as well as a significant association between incus erosion and stapes erosion.[14]

Mishra *et al.,* evaluate the reliability of high-resolution computed tomography (HRCT) as a preoperative "roadmap" for middle ear surgery in chronic otitis media (squamous type/cholesteatoma).[15] About the exposed dura, incus erosion, and M-I joint discontinuity, the results are in line with those of Lyngwa *et al.,* who similarly state that high-resolution CT has 100% sensitivity and specificity in identifying sigmoid plate erosion, exposed dura, incus erosion, stapes erosion, and discontinuous M-I joint.16 High-resolution CT had 100% sensitivity and specificity in detecting sigmoid and tegmen plate erosion, 100% sensitivity and 95.23% specificity in detecting malleus, and 100% sensitivity and 80.48% specificity in detecting incus, according to Bhagat *et al.*[17]

Altaf et al., reported the 100% sensitivity and specificity of high-resolution CT in detecting malleus erosion and malleus with incus erosion. It reports the 100% sensitivity and specificity of high-resolution CT in detecting sigmoid sinus plate erosion. It reports the 100% sensitivity and diagnostic accuracy of high-resolution CT in detecting soft tissue mass, sclerotic mastoid, and dural and sinus plate erosion. The study further reports the low sensitivity of high-resolution CT in detecting incus with stapes erosion (40%).[18]

In contrast to this study findings, Manik *et al.,* reported the higher sensitivity of high-resolution CT in detecting malleus erosion (78%), edema of the middle ear mucosa (96%), eustachian tube granulation (96%), and facial canal erosion (97.8%).[19] Similarly, Yucel *et al.,* also reported higher sensitivity of high-resolution CT in detecting malleus erosion, edema of the middle ear mucosa, eustachian tube granulation, and facial canal erosion.

The study affirms that Preoperative HRCT plays a valuable role in managing chronic otitis media, as its findings closely align with intraoperative observations. By identifying disease extent, anatomical variations, and potential complications beforehand, HRCT improves surgical planning and reduces intraoperative uncertainty. Its routine use can therefore enhance surgical outcomes and overall patient quality of life.

LIMITATION OF STUDY

It is important to note that this study has certain limitations, the primary one being the limited sample size of the study, 50 diagnosed cases of COM. Furthermore, patients who failed to undergo an HRCT scan before COM surgery were not included in our study, which may have had an impact on the sample size and the validity of our results.

CONCLUSION

Preoperative high-resolution CT has a significant association with intraoperative findings of chronic otitis media. Preoperative high-resolution computed tomography (HRCT) of the temporal bone is beneficial not only for accurate diagnosis of chronic otitis media but also for preoperative detection of problems that enhance surgical success and patient quality of life.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

RK & SA: Data acquisition, data analysis, critical review, approval of the final version to be published.

KZ & HA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

WF & AZ: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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