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Comparison of High-Resolution Computed Tomography and Surgical Findings in Patients with Temporal Bone Cholesteatoma

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ABSTRACT

Objective: The present study aims to investigate the role of high-resolution computed tomography (HRCT) in temporal bone cholesteatoma.
Materials and Methods: Eighty-two patients with a pathological diagnosis of chronic otitis media with cholesteatoma were included in this retrospective study. All patients had a complete preoperative otorhinolaryngologic examination, audiological assessment, and HRCT. Preoperative radiological findings were evaluated together with the findings obtained during surgery.
Results: In HRCT, cholesteatoma was most common in pars flaccida (36.25%). The most common localization of cholesteatoma was holotympanic (36.25%). Erosion was most common in all ossicles (43.75%), but solitary erosion was most common in the incus (35%). The facial nerve canal was intact in 58 (72.5%) of the patients. The diagnostic sensitivities of HRCT in cholesteatoma cases were 97.6% for tissue mass, 97.6% for localization, 100% for malleus erosion, 84.8% for incus erosion, 100% for malleus and incus erosion, 40% for incus and stapes erosion, 94.6% for the erosion of all ossicles, and 100% for facial nerve canal erosion.
Conclusion: Preoperative HRCT evaluation in patients with cholesteatoma may be considered indispensable for the location of the disease and the detection of destructive structures.

Keywords: Cholesteatoma, Diagnostic imaging, Otitis Media, Surgery, Tomography

INTRODUCTION

Chronic otitis media (COM) is defined as inflammation and infection of the middle ear and mastoid cells lasting longer than 3 months, accompanied by perforation of the tympanic membrane, and recurrent or persistent otorrhea (1). Cholesteatoma is defined as a pathological cystic formation that contains keratin residues covered with squamous cell epithelium, spread within the pneumatized spaces in the middle ear and mastoid bone, and may cause bone erosion and related complications (2).

The presence of granulation tissue or cholesteatoma due to inflammation in chronic otitis media disease may lead to progressive destruction of structures in the temporal bone, especially the middle ear ossicles, and may lead to intracranial or extracranial complications, especially progressive hearing loss (1-4). Computed tomography (CT) and magnetic resonance imaging (MRI) methods are used in the preoperative evaluation of COM disease, in the investigation of the presence of complications, and in the determination of the presence of cholesteatoma (4, 5). High-Resolution Computed Tomography (HRCT) allows for determining the extent of the disease that cannot be evaluated by examination, evaluating the surgical landmarks, evaluating the risk of intraoperative complications, evaluating the condition of the temporal bone structures, and determining the complications related to the disease (5). Imaging methods can detect the suspicion of cholesteatoma, however, the definite diagnosis of cholesteatoma is made by pathological evaluation (5, 6).

Chronic otitis media treatment includes medical and surgical methods. Medical treatment includes antibiotics, anti-inflammatory drugs, and frequent aspiration (1-3). Surgical

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treatment is applied in cases that are resistant to medical treatment, have a cholesteatoma, and have complications (1-3). The primary aim of surgical treatment is to obtain a non-inflamed, dry, and well-ventilated middle ear cavity. The secondary aim is to restore hearing loss with an intact tympanic membrane and a repaired sound conduction mechanism (4).

Computed tomography (CT) and magnetic resonance imaging (MRI) methods are used in the preoperative evaluation of COM disease, in the investigation of the presence of complications, and in the determination of the presence of cholesteatoma (4, 5). High-Resolution Computed Tomography (HRCT) allows for determining the extent of the disease that cannot be evaluated by examination, evaluating the surgical landmarks, evaluating the risk of intraoperative complications, evaluating the condition of the temporal bone structures, and determining the complications related to the disease (5).

Tympanoplasty is the name given to the surgery performed to obtain a disease-free middle ear, repair the perforation of the tympanic membrane, and provide sound transmission with ossicular chain reconstruction (7). Mastoidectomy is a surgery performed to clear the inflammation spreading to the mastoid bone, to provide ventilation of the middle ear cavity, to treat COM complications, or to provide the necessary access route for advanced ear surgeries such as cochlear implants and facial nerve decompression (7, 8). Mastoidectomy procedures are divided into two classes, defined according to the extent of the pathology causing the surgery: procedures in which the posterior wall of the external auditory canal is preserved (intact canal (Canal Wall Up-CWU)), and procedures in which the posterior wall of the external auditory canal is downed (Canal Wall Down-CWD) (7, 8).

MATERIALS AND METHODS

This study was approved by the Istanbul University-Cerrahpaşa Clinical Research Ethics Committee (Date: 09.07.2021, No: 133594). Patients admitted to Cerrahpaşa Faculty of Medicine Hospital between June 2021 and June 2022 were included in this retrospective study. This study was conducted by the Declaration of Helsinki and informed consent was obtained from all patients.

Eighty-two patients whose surgical specimens were evaluated as cholesteatoma were included in the study. Patients whose surgery was revision surgery, who did not have an operation video in our archive, who did not have a detailed operation report in their file, whose preoperative radiological examinations were not performed in the radiology department of our hospital, whose preoperative radiology images were not registered in the system, who did not have a preoperative radiology report, and who did not have a postoperative pathology evaluation were excluded from the study.

Radiological evaluations of all patients were performed with HRCT with a section thickness of 1 mm. The presence of soft tissue in the middle ear, cholesteatoma types according to localization, ossicular destructions, and facial nerve canal erosion were evaluated. The operations were performed using a microscope and an endoscope. The surgical procedures performed were CWU and CWD, depending on the extent of the disease. Surgical evaluation of the study parameters was performed with the surgical epicrisis and videos. The correlation between preoperative CT images and surgical findings was investigated.

Statistical Analysis

Statistical analyses were performed using SPSS 23.0 software (IBM, USA). Demographic characteristics of the patients were defined, and sensitivity, specificity, and accuracy of computed tomography were determined.

RESULTS

The demographic characteristics of patients are given in Table 1. Eighty patients (97.6%) had at least one finding related to cholesteatoma in the radiology report (Figure 1, Figure 2). The parameters evaluated in HRCT are presented below.

Table 1: Demographic characteristics of patients

Parameters		Population (n=80)
Gender	**Male, n(%)**	44 (55)
	Female, n(%)	36 (45)
Age (years)	**Mean±SD (min-max)**	38.2±14.341 (8-60)

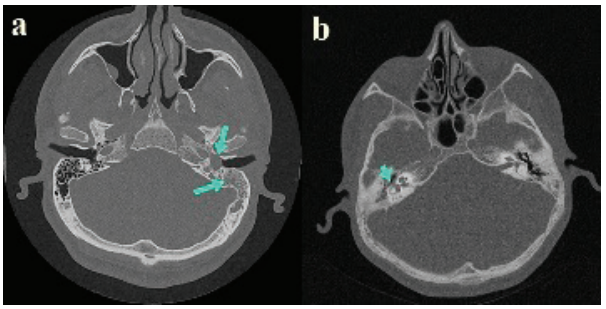

Figure 1a: The mass in soft tissue density in the middle ear and mastoid cavity
Figure 1b: Facial nerve canal defect

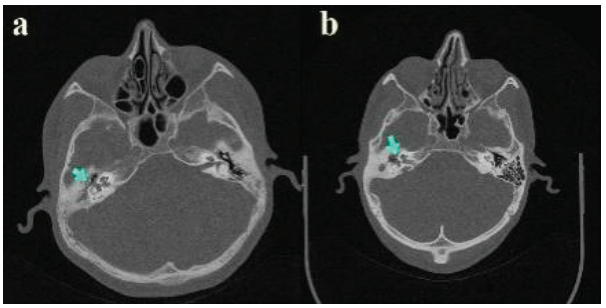

Figure 2a: Intact ossicles within the soft tissue
Figure 2b: The soft tissue accompanying destruction in all ossicles

Type of Cholesteatoma

The distribution of cholesteatoma types is presented in Table 2. Pars flaccida cholesteatoma was the most common type. However, pars tensa cholesteatoma was the least common type.

Table 2: Type of cholesteatoma in the computed tomography

Cholesteatoma type	Number of patients (n)	%
Pars tensa	23	28.75
Pars flaccida	29	36.25
Combined	28	35

Location of cholesteatoma

The locations of cholesteatoma are presented in Table 3. Epitympanic cholesteatoma was the most common, followed by holotympanic cholesteatoma.

Table 3: Locations of cholesteatoma in the computed tomography

Location		Number of patients (n)	%
Epitympanic	Attic	25	31.25
	Attico-antral	15	18.75
Mesotympanic		11	13.75
Holotympanic		29	36.25

Destruction of the ossicular chain

Table 4 shows the erosion of the ossicular chain. All ossicles were damaged most frequently in patients. When we examined the individual ossicles, the incus was the most frequently-eroded bone.

Table 4: Destruction of the ossicular chain in the computed tomography

Eroded ossicles	Number of patients (n)	%
Malleus only	4	5
Incus only	28	35
Malleus+Incus	3	3.75
Incus+Stapes	4	5
All ossicles	35	43.75

The integrity of the facial nerve canal

Table 5 presents the integrity of the facial nerve canal. In most of the patients, the facial nerve canal was intact on HRCT.

Table 5: Integrity of the facial nerve canal in the computed tomography

Facial Nerve Canal	Number of patients (n)	%
Intact	58	72.5
Eroded	22	27.5

Evaluation of computed tomography results

Table 6 shows the correlation between HRCT and intraoperative features. HRCT has the lowest sensitivity in the detection of incus + stapes erosions. The lowest specificity is for the detection of facial nerve canal defects.

Canal Wall-Down surgery was performed in 12 (14.63%) of 82 patients and CWU surgery was performed in 70 (85.37%) of them.

DISCUSSION

Patient history and otoscopic examination are essential for the diagnosis of cholesteatoma. High-resolution computed tomography is the most critical auxiliary examination in the preoperative evaluation in the presence or suspicion of cholesteatoma (9). In this study, preoperative HRCT findings and data obtained during surgery were compared in patients operated on for COM with cholesteatoma. In cases where incus and stapes erosions were together, the diagnostic sensitivity of HRCT was low (40%), and it was high in describing other investigated findings. The diagnostic specificity of HRCT is 100% for almost all parameters examined, whereas it is 96.6% due to false positives in the case of facial nerve canal erosion.

The main pathophysiological mechanism in the development of complications due to cholesteatoma in the middle ear is that the keratinized epithelium, which should not be in the middle ear, proliferates and expands towards the surrounding tissues and causes erosion in these surrounding tissues, both with the effect of compression and the effect of secreted enzymes

Table 6: Correlation between computed tomography and intraoperative features

Findings	Computed Tomography (CT)	Intraoperative Findings	False		Sensitivity of CT	Specificity of CT	Accuracy of CT
			Negative	Positive			
Tissue mass	80	82	2	0	97.6%	NA	97.6%
Location	80	82	2	0	97.6%	NA	100%
Malleus erosion	4	4	0	0	100%	100%	100%
Incus erosion	28	33	5	0	84.8%	100%	93.9%
Malleus+Incus	3	3	0	0	100%	100%	100%
Incus+stapes erosion	4	10	6	0	40%	100%	%92.7
Erosion of all ossicles	35	37	2	0	94.6%	100%	97.6%
Facial Nerve Canal erosion	22	20	0	2	100%	%96.8%	97.6%

NA: Not applicable

(10,11). The equivalent of this pathology in HRCT is the presence of soft tissue in the middle ear and the destruction of structures such as middle ear walls, ossicles, facial nerve canal, and semicircular canals (12). It is known that HRCT is superior to conventional CT in the diagnosis of cholesteatoma and its complications (13). The presence of cholesteatoma can be detected with high accuracy by HRCT (14). In the study by Bozan et al., 21 (91.3%) of 23 cholesteatoma cases, and in the study by Gomaa et al, 52 (92.8) of 56 cases were correctly diagnosed by HRCT (12, 15).

The most common findings related to cholesteatoma in HRCT are ossicular erosion, typical localization of the disease, and soft tissue mass in the middle ear (12). In previous studies, it has been shown that cholesteatoma is the most common type of combined cholesteatoma and pars flaccida cholesteatoma in the HRCT and the most common localization of cholesteatoma is the attic region (12, 15). When HRCT of cholesteatoma patients is evaluated for ossicular erosion, erosion is most common in all bones (no ossicles). However, the ossicle that is most frequently eroded alone is the incus (12). The result of the present study supports the literature.

A defective facial nerve canal is one of the most important causes of facial nerve paralysis, which is one of the intraoperative complications that can occur during chronic otitis media surgery (16). In the literature, the sensitivity of the diagnosis of eroded facial nerve canal in HRCT has been reported as 83.3% (12). In our study, the sensitivity of this diagnosis was found to be 100%. This may be due to the fact that the radiology department of our institute is a very experienced center in neuroradiology. Despite this high sensitivity in diagnosis, we still recommend using neuromonitoring to avoid the complication of facial paralysis.

An undamaged stapes due to COM is the most important parameter for hearing reconstruction (17, 18). The sensitivity of HRCT in the diagnosis of ossicular erosion is high. However, HRCT has low sensitivity to early stapes erosion (12-15). In our study, the sensitivity of the diagnosis of incus and stapes damage in HRCT was found to be 40%. This indicates that HRCT alone is insufficient for planning preoperative hearing reconstruction. Even if stapes damage is not mentioned in HRCT, this situation should be kept in mind, and materials such as total ossicular replacement prosthesis (TORP) should be available in case they can be used in surgery. Otherwise, this unexpected situation may require a second surgery for hearing reconstruction.

Some factors limit the value of this study. The first of these limitations is that our study is a retrospective study. The second limitation is that we did not evaluate all the structures that could be damaged by cholesteatoma, such as semicircular canals, middle ear, and mastoid cavity walls. The third limitation is that we did not have any patients who were misdiagnosed in HRCT, since we included patients with a definite diagnosis of cholesteatoma in our study. The final limitation is the number of patients in our study. Although our center is a tertiary center, the number of patients diagnosed with cholesteatoma during one year is 80. This can be explained by the inability of patients to visit the hospital due to the pandemic.

CONCLUSION

HRCT may be considered an indispensable test in all chronic otitis media cases, especially in cases accompanied by cholesteatoma, to avoid intraoperative complications, to plan hearing reconstruction, and to recognize and plan the repair of disease-related defects before the operation. Prospective studies with larger numbers of patients are needed to support the data we obtained.

Ethics Committee Approval: This study was approved by Cerrahpaşa Faculty of Medicine Clinical Research Ethics Committee (Date: 09.07.2021, No: E-83045809-604.01.02-133594).

Informed Consent: Written informed consent was obtained.

Peer Review: Externally peer-reviewed.

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Conflict of Interest: The authors have no conflict of interest to declare.

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