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High Resolution Computed Tomography Imaging Findings in Chronic Otitis Media With and Without Cholesteatoma

Kolesteatomlu ve Kolesteatomsuz Kronik Otitis Mediada Yüksek Rezolüsyonlu Bilgisayarlı Tomografi Bulguları

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This study was presented as an oral presentation at the 43rd National Radiology Congress (TURKRAD), November 1-5, 2022, Antalya, Türkiye and as an e-poster at the European Congress of Radiology, March 1-5, 2023, Vienna, Austria.

ABSTRACT Objective: To correlate high-resolution computed tomography (HRCT) imaging findings of chronic otitis media (COM) with and without cholesteatoma regarding the presence, site, and severity of bone defects. **Material and Methods:** Temporal bone HRCT images of patients with COM, obtained between 2011 and 2022, were retrospectively reviewed. Patients with a soft tissue mass in the tympanic cavity were allocated into either COM with cholesteatoma (CH+COM) or without cholesteatoma group (CH-COM) based on pathology results and-/or magnetic resonance imaging findings. Computed tomography images were analyzed with regard to the presence, site, and severity of middle ear bone erosions/defects and group comparisons were made. **Results:** A total of 60 patients (CH+COM: 23 patients, CH-COM: 37 patients) were included. Blunting of the scutum, defect of the tegmen tympani, absence/incompleteness of the Körner's septum, erosion of the ossicular chain, and destruction of the medial and lateral tympanic walls were significantly more frequent in the CH+COM group ($p<0.05$). While small bone discontinuities (≤2 mm) of the tegmen tympani or blunting of the scutum were present in both groups, a greater defect of these structures was observed only in the CH+COM group. No significant difference was detected neither regarding the location of the soft tissue masses nor the presence of posterior wall defects ($p>0.05$). **Conclusion:** Radiologists should be aware of bone erosions when evaluating temporal bone HRCT images of patients with COM, even if cholesteatoma is not suspected. Furthermore, reporting the severity of bone destruction could be a helpful hint regarding the presence of cholesteatoma and might impact surgical planning.

Keywords: Computed tomography; otitis media; cholesteatoma

ÖZET Amaç: Çalışmada kolesteatomlu ve kolestatomsuz kronik otitis media (KOM) tanılı olguların yüksek çözünürlüklü bilgisayarlı tomografi (YÇBT) görüntüleme bulgularının kemik defektlerinin varlığı, yeri ve şiddeti açısından karşılaştırılması amaçlanmıştır. **Gereç ve Yöntemler:** 2011-2022 yılları arasında temporal kemik YÇBT ile tetkik edilen KOM hastaların YÇBT görüntüleri retrospektif olarak incelendi. Timpanik boşlukta yumuşak doku kitlesi olan hastalar, patoloji sonuçları ve-/veya manyetik rezonans görüntüleme bulgularına göre kolesteatomlu (K+KOM) veya kolestatomsuz KOM (K-KOM) grubuna ayrıldı. Bilgisayarlı tomografi görüntüleri orta kulak kemik erozyonlarının/defektlerinin varlığı, yeri ve şiddeti açısından değerlendirildi ve grup karşılaştırmaları yapıldı. **Bulgular:** Bu çalışmaya toplam 60 hasta (K+KOM: 23 hasta, K-KOM: 37 hasta) dâhil edildi. Skutumda küntleşme, tegmen timpani defekti, Körner septum yokluğu/devamsızlığı, kemikçik zincirinde erozyon ve medial ve lateral timpanik duvarlarda harabiyet C+COM grubunda anlamlı olarak daha sıktı ($p<0,05$). Tegmen timpanide küçük kemik devamsızlıkları (≤2 mm) veya skutumda küntleşme her iki grupta mevcutken, bu yapılarda sadece K+COM grubunda daha şiddetli defektler gözlendi. Yumuşak doku kitlelerinin yerleşimi ile arka duvar defekti varlığı açısından 2 grup arası anlamlı fark saptanmadı ($p>0,05$). **Sonuç:** KOM'lu olguların temporal kemik YÇBT görüntülerinin değerlendirmesinde radyologların kolesteatom şüphesinden bağımsız olarak olası kemik erozyonları açısından dikkatli olması gerekmektedir. Ayrıca kemik yıkımının şiddetinin bildirilmesi, kolesteatomun varlığına ilişkin ipucu sağlayarak cerrahi planlamada önemli olabilir.

Anahtar Kelimeler: Bilgisayarlı tomografi; otitis media; kolesteatom

Chronic otitis media (COM) is a recurrent or chronic infection of the middle ear and/or mastoid air cells without an intact tympanic membrane. It can be complicated with the development of granulation or a cholesteatoma resulting in conductive and/or sensorineural hearing loss. In cholesteatoma, which is a

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mass formed by the keratinizing squamous epithelium, keratin debris progressively accumulates in the tympanic cavity and/or mastoid.[1] Acquired cholesteatoma is frequently seen in the attic or sinus tympani region and might develop due to tympanic membrane perforation or Eustachian tube dysfunction after previous episodes of middle ear disease.[1] This condition ultimately results in the destruction of adjacent bone structures, which may cause intra- and extracranial complications.[2,3] Albeit less often, adjacent bone destruction may also occur in COM without cholesteatoma due to chronic inflammation.[4,5]

High-resolution computed tomography (HRCT) is an imaging modality that can accurately demonstrate the pathological anatomy in COM owing to its excellent spatial resolution. It is widely accepted as a road map for surgeons to determine the extent of the disease, to plan the appropriate procedure, and to anticipate potential complications during surgery.[6-8]

Hence, in case of suspicion or clinical diagnosis of cholesteatoma or complicated COM, it is recommended to obtain HRCT of the temporal bone to evaluate the presence and extent of bone destruction and to plan adequate surgical management.

To the best of our knowledge, there exist only a few studies comparing COM with and without cholesteatoma regarding the extent of adjacent bone destruction using computed tomography (CT) as a pre-operative diagnostic tool.[4,9]

The aim of this study was first, to enhance that CT findings indicative of bone erosion might be present in COM patients both with and without cholesteatoma and second, to compare temporal bone CT imaging findings between COM patients with and without cholesteatoma not only in terms of presence, site and extent but aso regarding the CT-based severity of bone destruction.

MATERIAL AND METHODS

This study was approved by Ankara University Clinical Research Ethics Committee (date: August 2, 2022, no: 2022000393-2) and was conducted according to the Declaration of Helsinki principles. Due to the retrospective study design, informed consent was waived.

PATIENT SELECTION

Temporal bone HRCT studies of 185 patients (age >18 years) obtained with the diagnosis of COM between August 2011 and March 2022 were retrospectively reviewed using the institutional Radiology Information System/Picture Archiving and Communication System (RIS/PACS; Centricity 5.0 RIS-i, GE Healthcare, Milwaukee, WI, USA). Institutional medical records of these patients were screened to receive information about any previous middle ear surgeries, and histopathology results. Sixty-four patients without any histopathologic assessment of the middle ear soft-tissue mass or concurrent temporal bone magnetic resonance imaging (MRI) including non-echo-planar-diffusion weighted images (non-EPI-DWI), 50 patients with a previous history of middle ear-/mastoid surgery, 6 patients without any soft tissue mass located in the middle ear, and 5 patients whose histopathologic results were nonspecific were excluded from the study. Patients with histopathologically proven cholesteatoma were included in the COM with cholesteatoma (CH+COM) group, and patients whose histopathologic results or non-EPI-DWI revealed the absence of cholesteatoma but were clinically diagnosed with COM, were included in the COM without cholesteatoma (CH-COM) group.

IMAGING TECHNIQUE

Temporal bone HRCT studies were performed in a helical scanning mode using a 320-dedector row-CT scanner (Aquilion ONE, Canon, Japan), a 16-dedector row CT scanner (Somatom Emotion 2007, Siemens, Germany), 64-dedector row CT scanner (Prime Aquillion, Toshiba Medical Systems, Japan), and 16-dedector row CT scanner (GE BrightSpeed S, USA). The acquisition parameters were as follows: tube voltage 120-140 kVp, tube current of 140-440 mAs, slice thickness 0.5-0.625 mm, reconstruction increment 1 mm, and a scan field of view of 15-20 cm. Axial temporal bone HRCT images were obtained parallel to the orbitomeatal line. Coronal images were reformatted from axial slices by multiplanar reconstruction.

MRI studies were obtained with a 1.5 Tesla MR scanner (Siemens Aera, Erlangen, Germany). Temporal bone MRI studies included a non-EPI-DWI sequence [T2 Half fourier Single-shot Turbo spin-Echo (HASTE) DWI] on a coronal plane with the following parameters: TR 2000 msec, TE 103 msec, FOV 220 mm and slice thickness 3 mm.

IMAGING ANALYSIS

Two radiologists with 11 and 3 years of experience in temporal CT imaging, respectively evaluated the CT images retrospectively and blinded to the histopathologic result. Assessment was made in consensus. The following CT findings were evaluated: Location of soft-tissue mass (mastoid antrum, Prussak's space, hypotimpanum, mesotimpanum and epitympanum), enlargement of the aditus ad antrum, presence of mastoid bone sclerosis or mastoid air cell opacification, blunting (erosion of the scutal tip) or complete destruction/defect of scutum, erosion/dehiscence [thinning/irregularity with short segment (≤2 mm) interruption] or a larger defect (>2 mm) of tegmen tympani, absence/incompleteness of Körner's septum, jugular plate erosion, the erosion of medial (facial canal, lateral semisircular canal), lateral and posterior wall of the middle ear, erosion of the ossicles, increased lucency of the ossicles and integrity of incudostapedial joint. Non-EPI-DWI of temporal bone was assessed by a radiologist with 10 years of experience in temporal MRI. A high signal intensity of the soft-tissue mass consistent with diffusion restriction on non-EPI-DWI was considered indicative of cholesteatoma.

STATISTICAL ANALYSIS

All statistical analyses were performed using SPSS for Windows v.22 (IBM Corp., New York, NY). The assumption of normality was assessed using the Shapiro-Wilk test. Statistical parameters were expressed with mean±SD and median (25% quartile-75% quartile). Categorical variables were summarized as count (n) and percentages (%). Group comparisons were made by using the Mann-Whitney U test for continuous variables and Fisher's exact and Pearson's chi square tests for categorical variables. Statistical significance was accepted at a p value <0.05.

RESULTS

A total of 60 patients, each with one temporal bone HRCT study, were included (Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6). Forty patients

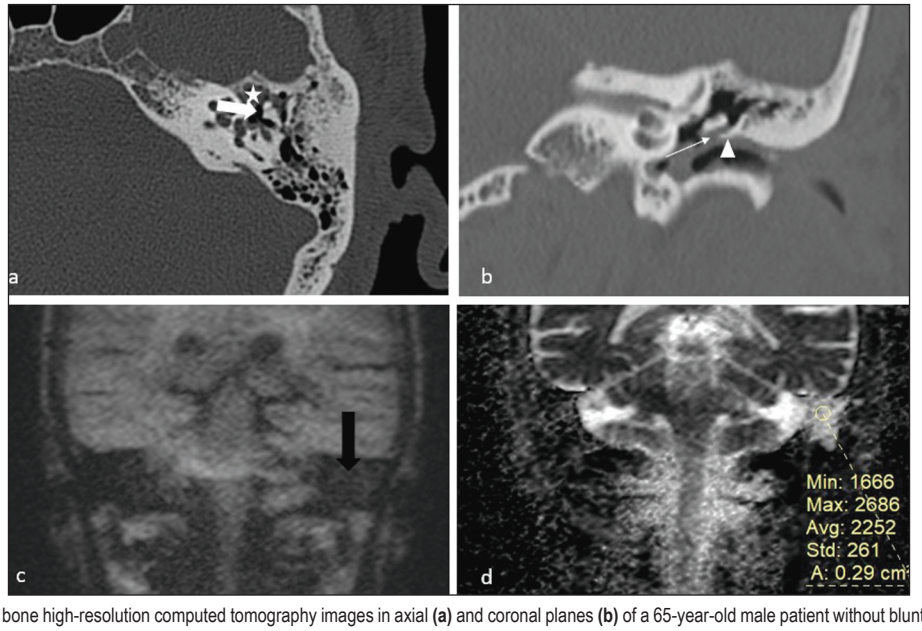

FIGURE 1: Temporal bone high-resolution computed tomography images in axial **(a)** and coronal planes **(b)** of a 65-year-old male patient without blunting of scutum (arrow head) and destruction of ossicles (thick white arrow). In non- echo-planar imaging diffusion-weighted images **(c)** and the corresponding apparent diffusion coefficient map **(d)** of the same patient, there is no diffusion restriction.

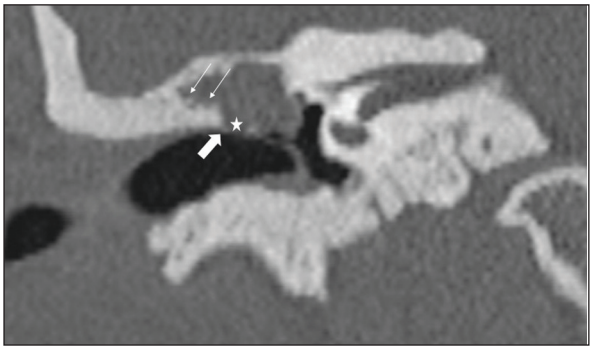

FIGURE 2: Temporal bone high-resolution computed tomography image (coronal plane) of a 21-year-old male patient with destruction of scutum (thick white arrow) and lateral wall destruction (thin white arrows). Histopathology revealed a cholesteatoma.

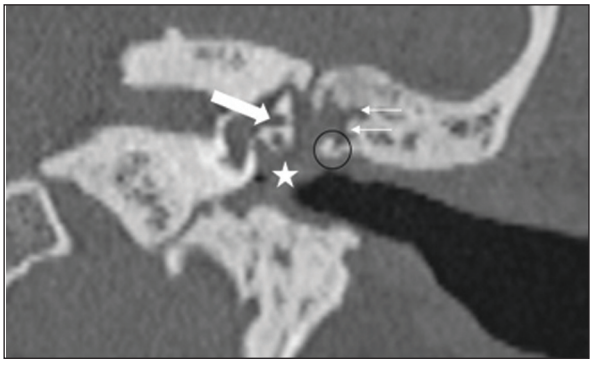

FIGURE 3: Temporal bone high-resolution computed tomography image (coronal plane) of a 36-year-old male patient with erosion of the lateral wall (thin white arrows), destruction of scutum (black circle) and ossicles (thick white arrow). Histopathology revealed a cholesteatoma.

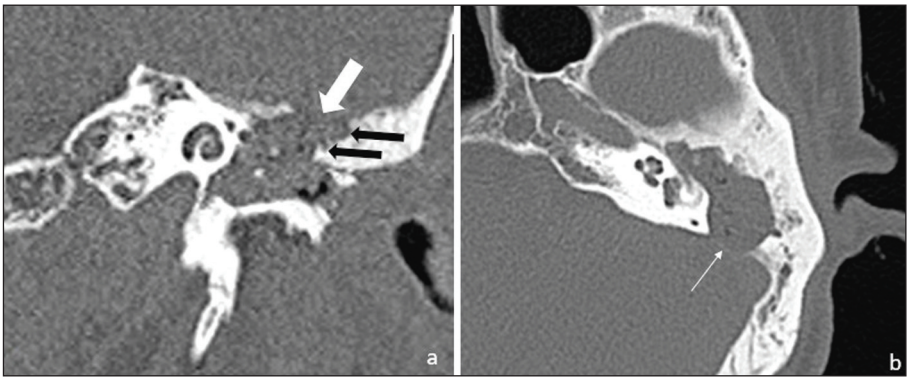

FIGURE 4: Temporal bone high-resolution computed tomography images in the coronal **(a)** and axial planes **(b)** of a 47-year-old male patient with tegmen tympani destruction (thick white arrows), destruction of the lateral wall (thick black arrow) and jugular plate erosion (thin white arrow). Histopathology revealed a cholesteatoma.

were male (17 in CH+COM and 23 in CH-COM) and 20 patients were female (6 in CH+COM and 14 in CH-COM). The median age was 36±15.8 years in CH-COM and 57±11.8 years in CH+COM (Table 1). While there was no statistically significant difference between the groups in terms of gender (p=0.348), the patients in CH+COM were significantly younger (p<0.001).

Regarding the presence of mastoid bone sclerosis and mastoid air cell opacification, there was no statistically significant difference between the groups (p=0.362 and p=0.640, respectively) (Table 2). Aditus ad antrum enlargement was statistically more frequent in the CH+COM group than in the CH-COM group (73.9% vs 24.3%, respectively) (Table 2).

When comparing the location (mastoid antrum, Prussak's space, hypotympanum, mesotympanum and epitympanum) of the soft-tissue mass, there was no significant difference between the groups (Table 3).

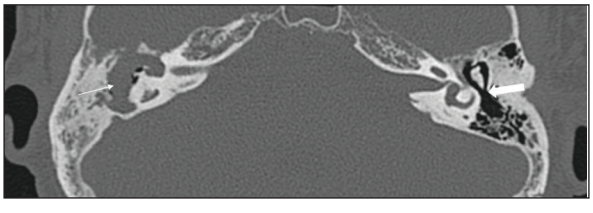

FIGURE 5: Temporal bone high-resolution computed tomography image (axial plane) of a 57-year-old male patient. Aditus ad antrum is enlarged on the right ear (thin white arrow) compared to the normal left ear. Histopathology revealed a cholesteatoma.

Blunting of scutum was more frequently noted in the CH+COM group [n=11 (47.8%) vs. n=4 (10.8%), p<0.001] (Table 4). While erosion/dehiscence of tegmen tympani was noted in both groups, a tegmen tympani defect larger than 2 mm was observed only in the CH+COM group [n=4 (17.4%) and

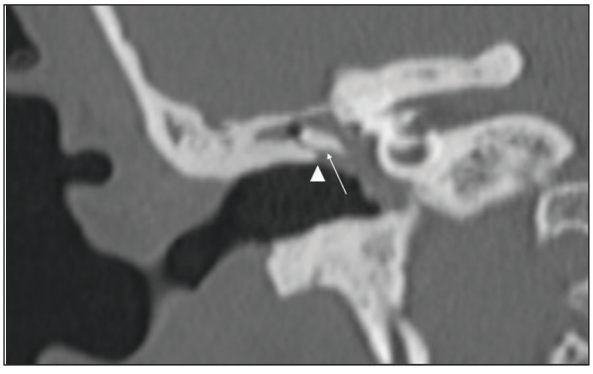

FIGURE 6: Temporal bone high-resolution computed tomography image (coronal plane) of a 41-year-old female patient from the CH-COM group shows blunting of scutum (arrow tip) and soft tissue mass (arrow) in Prussak's space.

TABLE 1: Comparison of gender and age between groups.

	C+COM n (%)	C-COM n (%)	p value
Gender			
Female	6 (26.1)	14 (37.8)	0.348
Male	17 (73.9)	23 (62.2)	
Age (years)			
Median (minimum-maximum)	36 (18-65)	57 (34-72)	0.001

COM: Chronic otitis media.

TABLE 2: Mastoid bone sclerosis/mastoid air cell opacification, enlargement of the aditus ad antrum, and Körner's septum: Comparison between groups.

	C-COM n (%)	C+COM n (%)	p value
Presence of mastoid bone sclerosis /mastoid air cell opacification			0.640
Yes	33 (89.2)	22 (95.7)	
No	4 (10.8)	1 (4.3)	
Enlargement of the aditus ad antrum			<0.001
Yes	9 (24.3)	17 (73.9)	
No	28 (75.7)	6 (26.1)	
Absence/incompleteness of Körner's septum		0.041	
Yes	11 (29.7)	12 (52.2)	
No	26 (70.3)	11 (47.8)	

COM: Chronic otitis media.

an intact tegmen tympani was more frequently detected in the CH-COM group (p=0.043)] (Table 4).

While the scutum was destroyed in 8 (34.8%) patients in the CH+COM group, none of the CH-COM cases had a completely defective scutum (Table 4).

TABLE 3: Location of soft tissue mass: Comparison between groups.

Location of soft tissue mass	C-COM n (%)	C+COM n (%)	p value
Antrum			0.391
Yes	27 (73.0)	19 (82.6)	
No	10 (27.0)	4 (17.4)	
Prussak's space			0.460
Yes	30 (81.1)	21 (91.3)	
No	7 (18.9)	2 (8.7)	
Hypotympanum			0.379
Yes	15 (40.5)	12 (52.2)	
No	22 (59.5)	11 (47.8)	
Mesotympanum			1.000
Yes	33 (89.2)	20 (87.0)	
No	4 (10.8)	3 (13.0)	
Epitympanum			0.552
Yes	36 (97.3)	21 (91.3)	
No	1 (2.7)	2 (8.7)	

COM: Chronic otitis media.

TABLE 4: Scutum and tegmen tympani integrity: Comparison between groups.

	C-COM n (%)	C+COM n (%)	p value
Scutum			<0.001
Intact	33 (89.2)	4 (17.4)	
Blunt	4 (10.8)	11 (47.8)	
Complete defect	0	8 (34.8)	
Tegmen tympani			0.043
Intact	18 (48.6)	9 (39.1)	
Defective	19 (51.4)	14 (60.1)	
Erosion/dehiscence (≤2 mm)	19 (51.4)	10 (43.5)	
Defect (>2 mm)	0	4 (17.4)	

COM: Chronic otitis media.

Absence/incompleteness of Körner's septum was statistically more frequent in the CH+COM group than in the CH-COM group (p=0.041) (Table 2). Juguler plate erosion was noted in 1 patient in the CH+COM group, whereas this finding was not observed in the CH-COM group.

Erosion of the medial and lateral walls of the middle ear was statistically more frequent in the CH+COM group than in CH-COM group (p=0.01, <0.001; respectively), while the presence of posterior wall erosion did not differ significantly (p=0.095) (Table 5).

With regard to ossicle erosion, the incus (82.6%) was the most commonly affected ossicle followed by

TABLE 5: Erosion of middle ear walls: Comparison between groups.

	C-COM n (%)	C+COM n (%)	p value
Erosion of posterior wall of the middle ear			0.095
Yes	2 (5.4)	5 (21.7)	
No	35 (94.6)	18 (78.3)	
Erosion of lateral wall of the middle ear			<0.001
Yes	3 (8.1)	16 (69.6)	
No	34 (91.9)	7 (30.4)	
Erosion of medial wall of the middle ear			0.010
Yes	1 (2.7)	6 (26.1)	
No	36 (97.3)	17 (73.9)	

COM: Chronic otitis media.

TABLE 6: Destruction of middle ear bones, incudostapedial joint integrity, and ossicle lucency: Comparison between groups.

	C-COM n (%)	C+COM n (%)	p value
Destruction of malleus			<0.001
Yes	2 (5.4)	13 (56.5)	
No	35 (94.6)	10 (43.5)	
Destruction of incus			<0.001
Yes	2 (5.4)	19 (82.6)	
No	35 (94.6)	4 (17.4)	
Destruction of stapes			<0.001
Yes	1 (2.7)	9 (39.1)	
No	36 (97.3)	14 (60.9)	
Loss of incudostapedial joint integrity			<0.001
Yes	5 (13.5)	17 (73.9)	
No	32 (86.5)	6 (26.1)	
Increased lucency of the ossicles			0.024
Yes	15 (40.5)	3 (13.0)	
No	22 (59.5)	20 (87.0)	

COM: Chronic otitis media.

malleus (56.5%) and stapes (39.1%) in CH+COM group (Table 6). In the CH-COM group, incus (5.4%) and malleus (5.4%) were equally involved, while the stapes involvement (2.7%) was less observed (Table 6). Each ossicle was more frequently involved in the CH+COM group (p<0.001).

While the loss of integrity in the incudostapedial joint was seen in 17 (73.9%) CH+COM patients, this finding was noted in only 5 (13.5%) patients in the CH-COM group (p<0.001) (Table 6).

Increased lucency of the ossicles was detected more frequently in patients without cholesteatoma than in those with cholesteatoma (40.5% vs. 13%, respectively; p=0.024) (Table 6).

DISCUSSION

Chronic otitis media may lead to cholesteatoma and is one of the main causes of preventable and treatable hearing loss.

In our study, bone destruction was present in COM cases with and without cholesteatoma. This finding was in accordance with previous studies reporting bone resorption in COM and might be explained by the activation of the receptor activator of nuclear factor kappa B ligand (RANKL)-osteoprotegerin (OPG)-receptor activator of the nuclear factor kappa B (RANK) cascade regulated by proinflammatory cytokines due to chronic inflammation.[4,9,10]

Even though bone erosion was also present in the COM group without cholesteatoma, CT findings indicative of adjacent wall destruction of the tympanic cavity and ossicular chain erosion were more frequently noted in the cholesteatoma group. In accordance, previous studies also reported higher bone destruction frequency rates in COM with cholesteatoma with the exception of a study by Wiatr et al., who observed higher bone destruction rates of the skull base with granulation than with cholesteatoma, while they found the ossicles to be more frequently affected in the cholesteatoma group.[4,5,9,11]

The underlying cause for the relatively high frequency of bone destruction in cholesteatoma cases compared to simple COM might be the keratinizing stratified squamous epithelium and its debris offering a breeding ground for a persistent bacterial infection.[9]

Additionally, in the non-cholesteatoma groups of the aforementioned studies, middle ear soft tissue masses leading to bone erosions were found to be granulation or polyps, which have been shown to be associated with an increase in plasma cells, T and B lymphocytes, and other cells from the monocytic-macrophage lineage producing large amounts of pro-inflammatory cytokines activating the aforementioned RANKL-OPG-RANK cascade.[4,5,9,12-14] However, our CH-COM group was not further evaluated histopathologically, and temporal bone HRCT

imaging is not capable for specifying the middle ear soft tissue mass. Thus, in our study, the CH-COM group may also include non-granulomatous/ non-polipoid inflammatory tissue presenting as a middle ear soft tissue mass on CT images.

In our study, the incus was the ossicle to be most frequently rated eroded among the ossicles, in both CH-COM (5.4%) and CH+COM (82.6%) groups. This is correlating with several other previous studies.[9,11,14,15] Furthermore, in our study, similar to several previous studies, the second and third most frequently affected ossicles were malleus and stapes, respectively, while in the study of Sadé and Halevy et al., the malleus and stapes were equally involved.[9] Stapes was found to be the least affected ossicle in the study by Gaurano et al.[14]

Since the long process of the incus is the quickest to erode, we also assessed the incudostapedial joint and found it to be affected in most of the cases with cholesteatoma (73.9%), whereas it was most frequently unaffected in the C-COM group (13.5%).[12,15]

While Gaurano and Joharjy observed a blunting of the scutum more frequently than a defect (62.5% vs 23.4%, respectively) in the CH+COM group, as it is the case in our study (47.8% vs 34.8%, respectively), Gomaa et al. noted more frequently a defective than a blunted scutum (64.2% vs 17.8%, respectively).[14,16]

In accordance with other studies, in the CH+COM group, we detected a defective tegmen tympani also more frequently than a dehiscence of this bone wall.[14,16] When we compared both groups regarding the CT-based severity of bone destruction, we observed a complete destruction but not just a blunting of the scutum and a defect larger than 2 mm of tegmen tympani only in the cholesteatoma group, while blunting of the scutum and erosion/dehiscence (≤2 mm) of tegmen tympani was noted in both groups. To the best of our knowledge, this is the first study to assess COM cases with and without cholesteatoma by grading the severity of bone erosion (thinning/blunting/ erosion vs. complete destruction/larger defect) with CT imaging.

Körner's septum is a developmental remnant showing the persistence of the petrosquamosal suture.[17,18]Wojciechowski et al. found its prevalence to be 62.5% and reported that it consisted of three portions.[18] A part of this septum might be missing and thus is incomplete with a reported range of 33-75%.[18,19] This thin structure is usually eroded by an antral cholesteatoma. It was eroded in 89% of cholesteatoma cases by Gaurano and Joharjy and in 64.2% by Gomaa et al.[14,16] In our study, we evaluated this structure regarding its absence or incompleteness but did not differentiate it from erosion since it is difficult to distinguish destruction from incompleteness/absence via CT imaging alone.[14,16] We suggest to be suspicious of destruction rather than incompleteness, if it is associated with an enlargement of the aditus ad antrum in CT images.

Our study has some limitations. First, CT findings were not correlated with intraoperative findings regarding the presence, extent, and severity of bone destruction. Second, histopathology results were only available for patients with cholesteatoma.

Third, the sample size was small and larger multidisciplinary studies will be required to further investigate our findings.

CONCLUSION

Radiologists should be aware of bone erosions when evaluating temporal bone HRCT images of patients with COM even if cholesteatoma is not suspected, because chronic inflammation in COM might cause bone destruction without cholesteatoma being present. Furthermore, reporting the severity of bone destruction could be a helpful hint regarding the presence of cholesteatoma and might impact surgical planning.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise,

working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Melahat Kul;* ***Design:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu;* ***Control/Supervision:*** *Melahat Kul;* ***Data Collection and/or Processing:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu;* ***Analysis and/or Interpretation:*** *Melahat Kul, Funda Seher Özalp Ateş, Sezer Nil Yılmazer Zorlu;* ***Literature Review:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu;* ***Writing the Article:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu;* ***Critical Review:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu, Sena Ünal;* ***References and Fundings:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu;* ***Materials:*** *Melahat Kul, Sezer Nil Yılmazer Zorlu, Sena Ünal.*

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