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Preoperative tomography evidence vs surgical findings; A reliable guidance for middle ear surgery?

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Abstract

Our study aimed to determine the accuracy of computed tomography (CT) scan by comparing the preoperative CT findings with the perioperative findings in patients with chronic otitis media (COM). In this study, preoperative CT evidence of 208 patients, who underwent tympanomastoidectomy for COM in Afyonkarahisar Health Sciences University, Otolaryngology Clinic between September 2009 and May 2018, were compared with their surgical findings. When we compared preoperative computed tomography findings with perioperative findings of patients; CT could determine cholesteatoma in mastoid and middle ear space with 74% sensitivity, 64% specificity, 85% positive predictive value (PPV) and 24% negative predictive value (NPV), respectively. Considering ossicular defect, CT could demonstrate the destruction of malleus with 83% sensitivity, 71% specificity, 67% PPV and 66% NPV, destruction of incus with 74% sensitivity, 87% specificity, 92% PPV and 40% NPV, destruction of stapes with 69% sensitivity, 52% specificity, 59% PPV and NPV 51%, respectively. In determining ossicular chain destruction in patients with cholesteatoma, we reached the conclusion that findings of ossicular chain destruction in CT could be judged in favor of cholesteatoma with values of 81% sensitivity, 75% specificity, 93% PPD and 48% NPV. As a result, despite limitations, radiological scanning of the temporal bone with CT is a reliable guide for surgical management of COM with an expert evaluation.

Keywords: Chronic otitis media, tomography, ossicular chain status, tympanomastoidectomy

Introduction

Chronic otitis media (COM) is the inveterate infection and inflammation of the middle ear and mastoid cells. COM treatment can be both medical and surgical. Surgical treatment for the middle ear and mastoid cells can be applied in COM cases that do not respond to medical treatment to eradicate the infection and eliminate the pathology that prevents the contactof the middle ear and mastoid cells [1]. In chronic otitis surgery, radiological diagnosis methods are frequently used to detect the extent of the disease before the treatment and to determine the ossicular status. Computed tomography (CT) has been used in the imaging of the temporal area since the 1980s. CT provides important advantages in determining the extent of pathology, which cannot be evaluated by otoscopic examination, especially in COM, in evaluating the preoperative anatomy and complications, and in selecting the treatment modality to be applied [2,3].

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This study aims to compare the preoperative temporal bone CT findings and operation findings of 208 patients who underwent surgery in a tertiary hospital,with the current literature.

Material and Methods

FIn this retrospective study, preoperative high-resolution temporal bone CT findings and operation findings were compared for 208 patients who had tympanomastoidectomy in a tertiary hospital, between September 2009 and May 2018. Age, gender, complaints, history, physical examinations and operation notes of all patients were scanned and recorded. Preoperative non-contrast temporal high-resolution computerized tomography was performed in all patients enrolled in the study. Patients included in the study had high-resolution temporal bone sections with 6th generation 6-row spiral multislice CT device branded “Philips Brilliance 6 Amsterdam, The Netherlands” at the Department of Radiology of same tertiary hospital. Images were taken as 120 kV, 200 mAs / section, collimation 6x0.75, pitch 0.417, rotation time 0.75 sec, image thickness 200 mm, matrix 512 thickness. Tomography findings were evaluated and reported by the same radiologist. Patients who were operated for chronic otitis but did not undergo mastoidectomy or atticotomy, and who underwent revision surgery were not included in the study. The findings detected and recorded during the surgery and the high-resolution temporal bone CT findings obtained preoperatively were compared. The ossicular damage was identified as any destruction for the integrity of malleus,incus and stapes as for surgically and the statement of radiologist's written report as for radiolologically. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated following the appropriate formulas.

Results

107 (51%) of the patients were female and 101 (49%) were male. The youngest of the patients with an average age of 36 was 7 and the oldest was 70 years old. 36 of the operations performed on patients were radical mastoidectomy, 103 were modified radical mastoidectomy, 42 were tympanoplasty with simple mastoidectomy and 27 were inside out atticotomy.

174 patients' CT were requested 1 week before surgery, 23 patients' CT were requested 2 weeks before surgery, 7 patients' CT 1 month before surgery and 4 patients' CT were requested one day before the surgery.

During the operation, cholesteatoma was found in 140 (67%) patients. Soft tissue was determined in the middle ear or mastoid in all of these patients. When the tomography findings were examined, cholesteatoma was found in 123 (59%) patients. Partial or complete ossicular chain destruction was determined in all 140 patients with cholesteatoma, while 36 (53%) of 68 patients without cholesteatoma had partial or complete ossicular chain destruction. Of the 176 patients with ossicular chain destruction, 140 (79.5%) had cholesteatoma, and 81% sensitivity, 75% specificity, 93% PPD, and 48% NPD were detected for CT in detecting ossicular chain destruction ofsubjects with cholesteatoma.

When the ossicular status of patients was examined during operation, the most ossicular destruction was seen in the incus in 164 patients (79%). Considering the tomography findings, the most ossiculardestruction was seen in the incus with 132 patients (63%). Malleus was detected as destructed in 120 patients (58%) on CT and 108 patients (52%) in operation. Stapes was detected as destructed in 118 patients (57%) on CT and 102 patients [49%] in operation (Table 1) (Figure 1,2,3).

The correct positivity/negativity and false positivity/negativity distribution of the preoperative temporal CT and operation findings of the cases are displayed in Table 2, and the validity and predictive values of temporal CT are displayed in Table 3.

Table 1. Distribution of destrucion for ossicular chain

Destruction of incus Perop	164	79%
Destruction of incus CT	132	63%
Destruction of malleus Perop	108	52%
Destruction of malleus CT	120	58%
Destruction of stapes Perop	102	49%
Destruction of stapes CT	118	57%

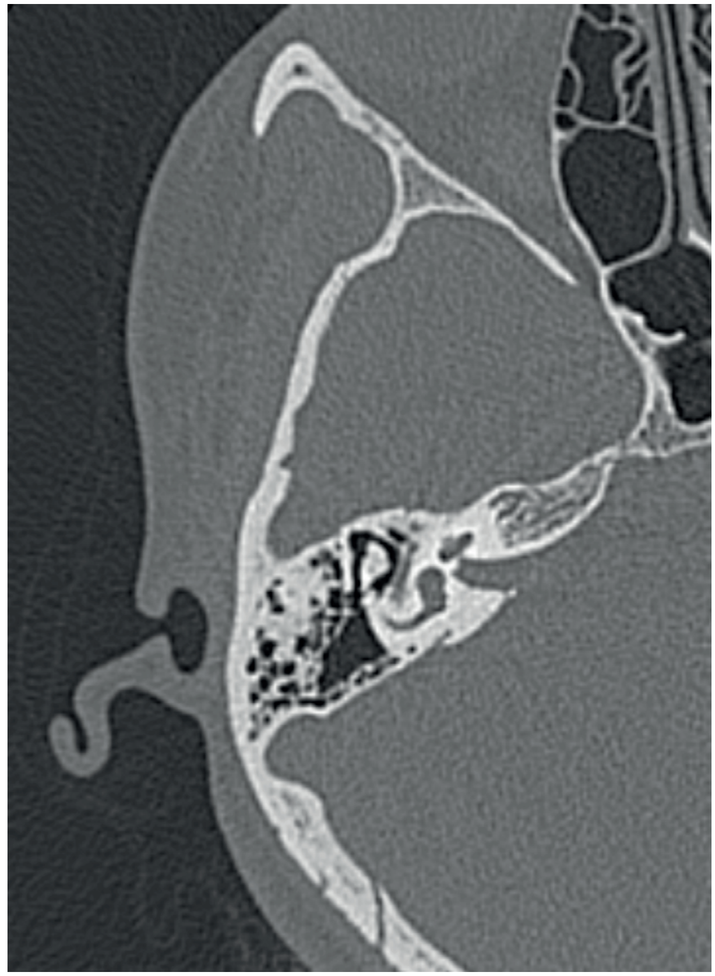

Figure 1. In the axial plan, malleus head and incus body are seen as ice cream cones in the middle ear cavity

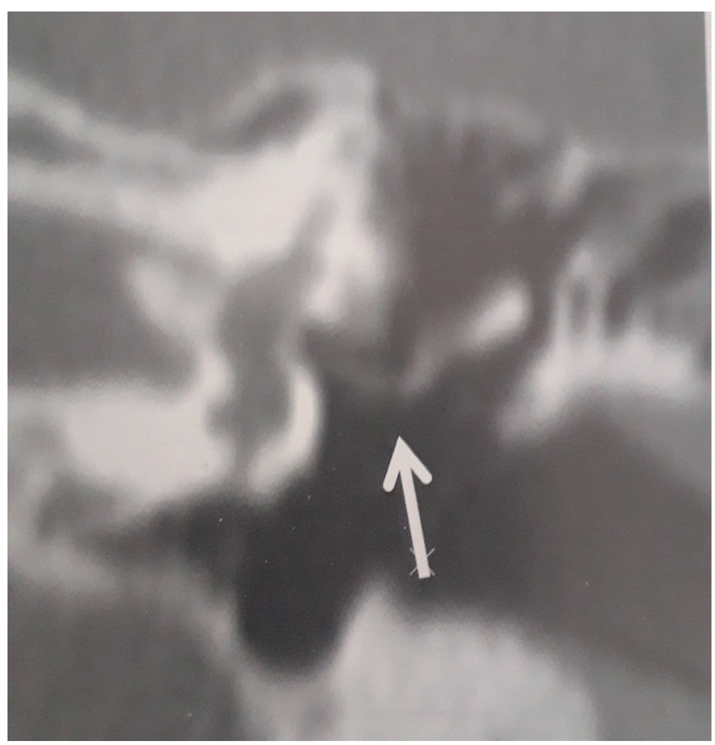

Figure 2. Damage in the long arm of the incus

Figure 3. Impaired malleoincusidial joint relationship

Table 2. The distribution of correct positivity / negativity and false positivity / negativity values of preoperative temporal CT and operative findings

Parameter examined in temporal CT	CT finding	Operative finding	CP	FP	CN	FN
Cholestatoma in middle ear or mastoid	123	140	104	19	34	36
Malleus destruction	120	109	90	30	72	19
İncus destruction	132	164	122	10	66	42
Stapes destruction	118	102	70	48	52	32

Table 3. Sensitivity, specificity, (+) and (-) predictivity rates of CT

	sensitivity	specifity	(+) predictivity	(-) predictivity
Cholestatoma in middle ear or mastoid	74%	64%	85%	24%
Malleus destruction	83%	71%	67%	66%
İncus destruction	74%	87%	92%	40%
Stapes destruction	69%	52%	59%	51%

Discussion

COM is generally manifested by muco-purulant discharge and hearing loss. Tinnitus, dizziness, pain can also be found among the complaints. Briefly, the pathogenesis of COM develops as described. Otitis mediamay induce irreversible inflammatory changes in the middle ear and mastoid known as chronic otomastoiditis [4,5]. Destruction and complications occur because COM is clinically characterized by ossicular destruction. Although ossicular destruction is also seen in COM without cholesteatoma, ossicular injury is a general feature of COM with cholesteatoma in general [6]. Epidermoid inclusion cysts in the middle ear and mastoid are among the important complications of chronic otitis media leading to a high morbidity rate and it is termed as cholesteatoma [7]. One-third of chronic otitis media is related to cholesteatoma. Clinical manifestations of cholesteatoma can extent from the asymptomatic state to the life-threatening phase [8]. Surgery is the only treatment option for the eradication of cholesteatoma to avoid the complications. and secondary restoration of the middle ear [9]. Surgical complications are harming dura,vascular and neurological structures,causing infection, recurrence, and treatment failure [10,11]. To avoid these complications, pre-operative radiological imaging, especially CT scan, for determination of size and spread of cholesteatoma, and the status of mastoid cavity and ossicles have been considered essential and useful [12-15]. Some studies concluded CT provides a high degree of accuracy for ossicular chain and inner ear statuswhilesome have reported that CT has low accuracy for detecting cholesteatoma [16].

Taking the temporal bone tomography in both axial and coronal sections is necessary and important in terms of revealing the pathology of the ear and mastoid cavity in detail [17,18]. While coronal evaluations are useful in observing the scutum, Prussac cavity, tegmen tympani, the ossicles and the horizontal part of the facial canal, axial sections are useful in the evaluation of the vertical part of the sinus tympani, facial recess, lateral semicircular canal, facial canal [19]. In our study, tomography findings were evaluated both axially and coronally, and the most accurate result was tried to be reached.

According to a study conducted by Sade and Halevy, ossicular destruction was found in 95% of COMs with cholesteatoma [20]. Also, in a study conducted by Tos, only 37% of 1100 COM cases were detected with an intact ossicular chain [21]. In our study, 32 (15%) patients had an intact ossicular chain and none of these patients had cholesteatoma. Also in our study, 140 patients had cholesteatoma and all of them had ossicular chain destruction partially or fully.

CT cannot clearly distinguish cholesteatoma, granulation, mucosal lesions and effusion [22,23]. In a study conducted by Jacks; cholesteatoma was found in 33.3% of patients according to CT findings and 78.6% of the patients according to operation findings. [19]. In our study, we detected cholesteatoma in 123 (59%) cases in CT and 140 (67%) cases in operation. This difference is likely because of the inability of CT to accurately distinguish between cholesteatoma and granulation tissues [24]. In the studies conducted by Park's and Akduman's, 92.5%, 0% and 71.6%, 60.1% values were found for the sensitivity and specificity of CT for cholesteatoma, respectively [25,26]. In our study, the values found for the sensitivity and specificity of CT for cholesteatoma were 74% and 64%, respectively. In our study, however, the fact that ossicle destruction in CT is more common in patients with cholesteatoma indicates that ossicle destruction may be used as a criterion to indicate the presence of cholesteatoma in CT.

Although displacement in the middle ear ossicles is an early finding for cholesteatoma, erosion or destruction in the ossicles has almost complete diagnostic accuracy [16]. In our study, however, we detected 81% sensitivity, 75% specificity, 93% PPV, and 48% NPV for CT in detecting ossicular chain destruction in patients with cholesteatoma.

Considering the rates found in preoperative CT detection of malleus damage, Chee et al. determined the sensitivity of CT to be 87.5% and specificity as 90% in the series of 36 cases operated for cholesteatoma [27]. In his study of 54 cases, Derundere determined that the sensitivity of CT for malleus damage was 88% and its specificity as 94% [28]. In their study, Park et al. determined that the sensitivity of CT was 97.7% and the specificity was 62.5% for malleus damage [25]. In our study, the sensitivity of CT was 83% and the specificity was 71% for malleus damage.

For incus, Chee et al. determined the sensitivity of CT as 97.5% and specificity as 90% in the series of 36 cases operated due to cholesteatoma [27]. In his study of 54 cases, Derundere determined that the sensitivity of CT for incus damage was 80% and its specificity was 83% [28]. In their study, Park et al. determined the sensitivity of CT to 100% and specificity to 25% for incus damage [25]. In our study, the sensitivity of CT for incus damage was 74% and specificity was 87%.

For stapes, Chee et al. reported the absence of stapes in 11 patients of 36-cases series operated for cholesteatoma. In all 11 cases, they reported that either stapes did not appear on CT or evaluated as eroded. They determined the specificity of CT for stapes damage as 94% [27]. In the study of Derundere, it was determined that the sensitivity of CT for stapes damage was 100% and its specificity was 96% [28]. In their study, Park et al. determined that the sensitivity of CT for stapes damage was 97.1% and its specificity was 75% [25]. In our study, the sensitivity of CT was 69% and specificity was 52% for stapes damage.

Conclusion:

Many authors such as Schuller, Stenvers, Owen, Mayer, Town have defined x-ray techniques to display the temporal bone since the early 1900s. Later, with the development of computed tomography, high-resolution tomographies became frequently used in the imaging of the temporal bone after the 1980s (29). Also, magnetic resonance imaging (MRI) shows superiority to CT in imaging soft tissue anatomical structures. MRI is the imaging method to be selected for imaging neural structures, membranous labyrinth, and fluid-containing parts of the temporal bone. However, although MRI is better in showing soft tissue structures, it is often nonspecific in distinguishing middle ear soft tissues. Since air, cortical bone, and calcifications contain small amounts of protons, they appear as dark areas that do not emit signals. As a result, bone contours are often indistinguishable from the pneumatic cell system. It is difficult to distinguish cholesteatoma from mucosal edema, granulation tissue, and fluid accumulation. Blood, fluid, and soft tissues within the temporal bone appear as abnormal tissues with high signal intensity. However, it is not possible to determine to what extent the pathology affects bone structures such as ossicles, scutum, and labyrinthine capsule. For this reason, CT is the preferred imaging method in evaluating infratemporal pathologies other than the petrotic apex (30).

In conclusion, in light of current literature, our results indicate that CT has a high level of sensitivity in demonstrating soft tissue presence and ossicular chain erosion. As a result, we found out CT had a higher rate of sensitivity in showing the damage of malleus and incus rather than stapes. On the other hand, we concluded that CT was not enough to demonstrate minimal ossicular erosions.

Besides, the visualization of each of the ossicles in a different draft plan on CT makes it difficult to evaluate them. Therefore, it is beneficial for the specialist who will interpret the CT radiologically to be experienced. As with any disease, informing the radiologist about the patient's clinic in detail while making radiological interpretation in COM will make the evaluation more accurate. We recommend feedback to the radiologist will contribute to the radiologist for further evaluations when the surgery findings and preoperative CT findings do not match. We also think that it will be very beneficial for physicians dealing with autology and ear surgery, by comparing the surgeon's self-evaluation of CT with both radiologist report and perioperative findings. Although we evaluated a large series of cases, since our study was retrospective, we were unable to interpret both the feedback of the radiologist on the findings of the surgery and the surgeon's self-evaluation. Our study showed that CT comments and surgical results may be different. The main limitations of the study were as follows: first, CT scan can be performed in different ways. It is not likely that these scans were performed in the most accurate way for scientific purpose since they were performed for clinical use. CT cannot be relied upon completely, as there are discrepancies between CT and intraoperative findings that include both underdiagnoses and overdiagnosis on CT. We concluded that the studies to be made based on these findings will make a great contribution to the literature.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
The financial support no have.

Ethical approval
All procedures performed in this study were in accordance with the ethical standards of the Afyonkarahisar Health Sciences University Ethical Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Bluestone CD, Klein OJ. Otitis media in infants and children. Third Edition. Philadelphia, W.B Saunders Company. 2001:pp 326-7.
2. Banerjee A, Flood L.M, Yates P, et al. Computed tomography in suppurative ear disease: does it influence management? J Laryngol Otol. 2003;114:454-8.
3. Watts S, Flood L.M, Klifford K. A systematic approach to the interpretation of computed tomography scans before surgery of middle ear cholesteatoma. J laryngol Otol. 2000;114:248-53.
4. Ueda H, Nakashima T, Nakata S. Surgical strategy for cholesteatoma in children. Auris Nasus Larynx. 2001;28:125- 9.
5. Daly KA, Brown WM, Segade F, et al. Chronic and recurrent otitis media: a genome scan for susceptibility. Am J Hum Genet. 2004;75:988-97.
6. Jong Woo C, Tae Hyun Y. Different Production of Interleukin-1a, Interleukin- 1ß and Interleukin -8 from Cholesteatomatous and Normal Epithelium. Acta Oto- Laryngologica. 1998;118;386–91.
7. Kuczkowski J, Babinski D, Stodulski D. Congenital and acquired cholesteatoma middle ear in children. Otolaryngol Pol. 2004;58:957-64.
8. Lan MY, Lien CF, Liao WH. Using high resolution computed tomography to evaluate middle ear cleft aeration of postoperative Cholesteatoma ears. J Chin Med Assoc. 2003;66:217-23.
9. Zelikovich EI. Potentialities of temporal bone CT in the diagnosis of chronic purulent otitis media and its complications. Vestn Rentgenol Radiol. 2004;1:15-22.
10. Singh B, Maharaj TJ. Radical mastoidectomy: its place in otitic intracranial complications. J Laryngol Otol. 1993;107:1113-8.
11. Dhooge IJ, Vandenbussche T, Lemmerling M. Value of computed

tomography of the temporal bone in acute otomastoiditis. Rev Laryngol Otol Rhinol. 1998;119:91-4.

12. Taylor MF, Berkowitz RG. Indications for mastoidectomy in acute mastoiditis in children. Ann Otol Rhinol Laryngol. 2004;113:69-72.
13. Reisser C, Schubert O, Forsting M, et al. Anatomy of the temporal bone: detailed three-dimensional display based on image data from high-resolution helical CT: a preliminary report. Am J Otol. 1996;17:473-9.
14. Migirov L.Computed tomographic versus surgical findings in complicated acute otomastoiditis. Ann Otol Rhinol Laryngol. 2003;112:675-7.
15. Falcioni M, Taibah A, De Donato G, et al. Preoperative imaging in chronic otitis surgery. Acta Otorhinolaryngol Ital. 2002;22:19-27.
16. O'Donoghue GM, Bates GJ, Anslow P, et al. The predictive value of high-resolution computerized tomography in chronic suppurative ear disease. Clin Otolaryngol Allied Sci. 1987;12:89–96.
17. Zonneveld F. The value of non-reconstructive multiplanar CT for the evaluation of the petrous bone. Neuroradiol. 1983;25:1-10.
18. Chakeres D, Spiegel P. A systematic technique for comprehensive evaluation of the temporal bone by computed tomography. Radiol. 1983;146:97-106.
19. Jackler RK, Dillon WP, Schindler RA. Computed tomography in suppurative ear disease: a correlation of surgical and radiographic findings. Laryngoscope. 1984; 94:746-52.
20. Sade J. Treatment of cholesteatoma. Am J Otol. 1987;8:524-33.
21. Tos M. Pathology of the ossicular chain in various chronic middle ear diseases. J Laryngol Otol. 1979;93:769-80.
22. Phelps PD, Wright A. Imaging cholesteatoma. Clin Radiol. 1990;41:156-62.
23. Leighton SEJ, Robson AK, Anslow P. The role of CT imaging in the management of chronic suppurative otitis media. Clin Otolaryngol. 1993;18:23-9.
24. Kenna MA. Etiology and pathogenesis of chronic otitis media. Ann Otol. 1998;97:16-7.
25. Hun Park K, İl Park S, Kwon J, et al. High-resolution computed tomography of cholesteatomatous otitis media: significance of preoperative ınformation. Yonsei Med J. 1998;29:4-10.
26. Akduman D, Kılıçarslan Y, Durmuş R. preoperative ossicular chain assessment with high resolution computed tomography in chronic otitis media. KBB ve BBC Derg. 2012;20:59-65.
27. Chee NWC, Tan TY. The value of preoperative high-resolution CT scans in cholesteatoma surgery. Singapore Med J. 2001;42:155-9.
28. Derundere Ü. Diagnostic value of HRCT in patients with chronic otitis media with cholesteatoma. Md. D. thesis, İstanbul Education and Training Hospital, İstanbul, 2005.
29. Swartz J.D. The temporal bone imaging considerations. Crit Rev Diagn Imaging. 1990;30:341-417.
30. Haaga JR, Lanzieri CF, Gilkeson RC. CT and MR Imaging of the Whole Body,4th edition. St. Louis, Mosby Inc. 2003:495-514.