



Comparison of Preoperative Temporal Bone HRCT and Intraoperative Findings in Patients with Chronic Otitis Media

Gülay Madan¹, Ozan Turamanlar¹, Abdülkadir Bucak², Mehtap Beker Acay³, Yücel Gönül¹, Erkan Yıldız², Yusuf Gülsarı¹

ORIGINAL
INVESTIGATION

ABSTRACT

Objective: The aim of the present study was to investigate the diagnostic confidence level of preoperative 160-slice computed tomography (CT) findings compared with that of perioperative findings about anatomic variations in the structure of the facial canal, lateral semicircular canal, and dural plate.

Materials and Methods: Fifty-five patients who presented with middle ear pathology to Department of Otolaryngology, Afyon Kocatepe University Faculty of Medicine were included in the study, and the mean age was 42 (± 15.55) years. Preoperative CT images of the temporal bone were obtained by an 80-detector row CT scanner.

Results: The sensitivity, specificity, and positive and negative predictive values of preoperative high-resolution CT (HRCT) were 52%, 88%, 73%, and 75%, respectively, for determining the presence of facial canal dehiscence; 50%, 89%, 71%, and 76%, respectively, for determining the presence of tympanic segment dehiscence; 71%, 96%, 71%, and 96%, respectively, for determining the presence of lateral semicircular canal dehiscence; and 100%, 96%, 50%, and 100%, respectively, for detecting the presence of dural plate defects.

Conclusion: The compatibility of HRCT findings with surgical findings in determining the presence of dehiscence of the facial canal and its tympanic segment was moderate, while it was good in determining the presence of dehiscence of the lateral semicircular canal and the defect of the dural plate.

Keywords: Facial canal dehiscence, lateral semicircular canal dehiscence, dural plate defect, HRCT

INTRODUCTION

Anatomical variation of the temporal bone is a significant source of concern in otologic and neuro-otologic surgery, and facial canal dehiscence (FCD) is one of the most commonly seen variations. In ear surgery, the preoperative assessment of the facial canal, lateral semicircular canal (LSC), and dural plate structures is important to avoid many complications. In patients requiring surgery, temporal bone computed tomography (CT) is used to assess the disease and to develop the treatment strategy (1-5).

Facial canal dehiscence, LSC dehiscence, and dural plate defect can be seen in patients who have chronic otitis media (COM) with or without cholesteatoma. The close proximity of the facial nerve to the surgical area increases the probability of damage during middle ear surgery. While LSC dehiscence increases the risk of developing labyrinthitis, dural plate dehiscence raises the probability of spreading the pathology to the brain. FCD is more common in the tympanic segment. Having preoperative comprehensive knowledge of the anatomy and anomalies of the facial nerve (i.e., FCD) is crucial for preventing postoperative morbidity in patients who require surgery due to middle ear disorder (5-7).

High-resolution CT (HRCT) is a type of assessment in which thin sections and high-resolution reconstructive algorithms are used. Multislice CT uses very thin slices of the temporal bone, so it provides significant advantages in terms of delivering a lower radiation dose and differentiating between the bone and soft tissue in high contrast images (5).

We think that preoperative imaging obtained using HRCT is extremely beneficial for surgeons. Therefore, we aimed to assess the efficacy of HRCT by comparing perioperative findings and HRCT results (FCD, LSC dehiscence, and dural plate defects).

MATERIALS and METHODS

A total of 55 patients who presented to Afyon Kocatepe University School of Medicine Department of Otolaryngology with middle ear pathology were included in our study. Study approval was obtained from Afyon Kocatepe

¹Department of Anatomy,
Afyon Kocatepe University
Faculty of Medicine,
Afyonkarahisar, Turkey

²Department of
Otolaryngology, Afyon
Kocatepe University Faculty of
Medicine, Afyonkarahisar, Turkey

³Department of Radiology,
Afyon Kocatepe University
Faculty of Medicine,
Afyonkarahisar, Turkey

Submitted
08.07.2015

Accepted
29.07.2015

Correspondance

Gülay Madan,
Afyon Kocatepe
Üniversitesi Tıp Fakültesi,
Anatomi Anabilim Dalı,
Afyonkarahisar, Türkiye
Phone: +90 272 213 76 68
e.mail:
fzt.gulay@hotmail.com

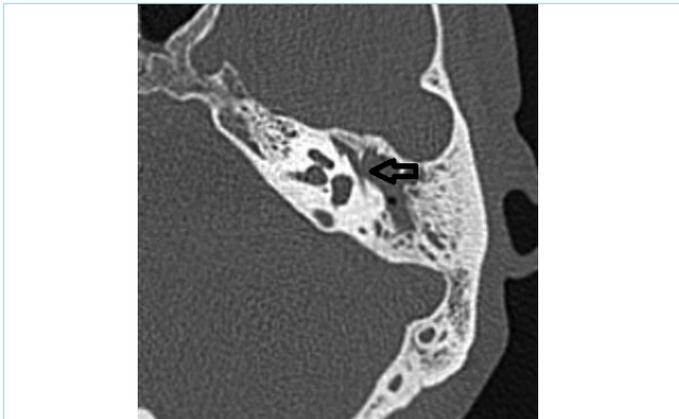
Table 1. Patient profiles according to the diagnosis

Pathology	n	%
COM without cholesteatoma	42	76.4
COM with cholesteatoma	13	23.6
Total	55	100.0

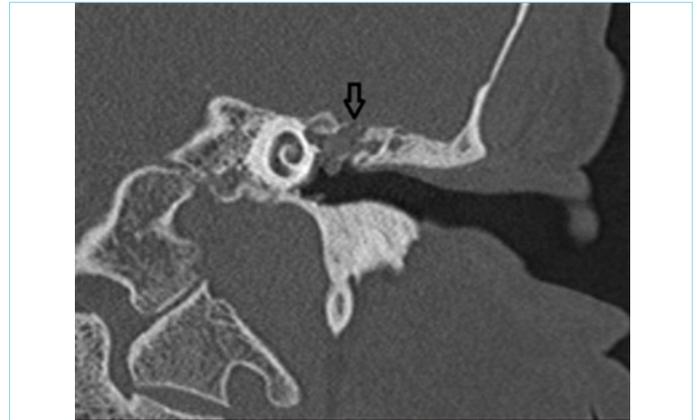
COM: chronic otitis media

Table 2. Patient profiles according to surgical operations

Surgical operation	n	%
Canal wall down mastoidectomy	26	47.3
Radical mastoidectomy	20	36.4
Tympanomastoidectomy	7	12.7
Inside out mastoidectomy	2	3.6
Total	55	100.0

**Figure 1.** FCD seen in the tympanic segment (Case 8)
FCD: facial canal dehiscence**Figure 2.** FCD seen in the tympanic segment (Case 48)
FCD: facial canal dehiscence

University Ethical Committee for Noninvasive Clinical Research on January 29 2015 (2105/02-72). Preoperative HRCT images of the patients were acquired using an 80-detector row CT (160-slice) scanner (Aquilion Prime, Toshiba Medical Systems, Nasu, Japan) on the axial plane with a slice thickness of 0.5 mm. Coronal multiplanar reformatted images with a slice thickness of 1 mm were

**Figure 3.** Dural plate defect (Case 22)

reconstructed. Adaptive iterative dose reduction 3D (AIDR 3D) was used as an iterative dose reduction software, and Sure Exposure 3D was used as an mA modulation software for all the examinations. Two-dimensional temporal bone images were evaluated by a radiologist (MBA) with five years of experience.

Temporal bone CT images and perioperative surgical findings were evaluated using the following parameters:

- 1- FCD
 - a) Tympanic segment
 - b) Mastoid segment
- 2- LSC dehiscence
- 3- Dural plate defect

Statistical analysis

For the comparison of CT and surgical findings, cross tables were generated, and Kappa reliability coefficient (Cohen's Kappa) was calculated for each parameter. A p-value of less than 0.05 was considered to be significant. Considering the surgical findings as the gold standard for each of the parameters, sensitivity, specificity, and positive and negative predictive values were calculated. Statistical analyses were performed by SPSS (version 15.0, SPSS Inc.; Chicago, IL, USA).

RESULTS

Fifty-five patients whose ages ranged from 18 to 78 years and mean age was 42 (± 15.55) years were recruited to the study. Twenty-nine (52.7%) of them were women. Patient profiles are shown in Table 1 and 2. Patients who showed FCD and dural plate defects by HRCT imaging are shown in Figures 1, 2, and 3.

High-resolution CT findings showed a moderate agreement with surgical findings in determining the presence of facial nerve canal dehiscence ($k=0.430$, $p=0.001$) (Table 3).

High-resolution CT findings showed a moderate agreement with surgical findings in determining the presence of tympanic segment dehiscence ($k=0.412$, $p=0.002$) (Table 4).

High-resolution CT findings showed a weak agreement with surgical findings in determining the presence of mastoid segment dehiscence ($k=0.373$, $p=0.005$) (Table 5).

Table 3. Comparison of perioperative findings with HRCT findings of the facial nerve canal

		Surgical findings		
		Dehiscence (+)	Intact	Total
HRCT findings	Dehiscence (+)	11	4	15
	Intact	10	30	40
	Total	21	34	55

Sensitivity 52%, specificity 88%, positive predictive value 73%, negative predictive value 75%
HRCT: high-resolution computed tomography

Table 4. Comparison of HRCT findings with perioperative findings of the tympanic segment

		Surgical findings		
		Dehiscence (+)	Intact	Total
HRCT findings	Dehiscence (+)	10	4	14
	Intact	10	31	41
	Total	20	35	55

Sensitivity 50%, specificity 89%, positive predictive value 71%, negative predictive value 76%
HRCT: high-resolution computed tomography

Table 5. Comparison of HRCT findings with perioperative findings of the tympanic segment

		Surgical findings		
		Dehiscence (+)	Intact	Total
HRCT findings	Dehiscence (+)	1	2	3
	Intact	1	51	52
	Total	2	53	55

Sensitivity 50%, specificity 96%, positive predictive value 33%, negative predictive value 98%
HRCT: high-resolution computed tomography

High-resolution CT findings showed a good agreement with surgical findings in determining the presence of LSC dehiscence ($k=0.673$, $p<0.001$) (Table 6).

High-resolution CT findings showed a good agreement with surgical findings in determining the presence of dural plate defects ($k=0.650$, $p<0.001$) (Table 7).

DISCUSSION

Temporal bone CT is reported to be the most important imaging method in terms of assessing the hypotympanic region; facial recess; the condition of the labyrinth canal, which cannot be evaluated by otomicroscopy; and for the possible variations and prevention of potential complications (8). It has a much better guiding quality for surgeons, especially for complex cases and revision surgery (9, 10).

Numerous studies have shown various consistency levels between CT findings regarding the presence of dehiscence in the facial canal and perioperative findings, which are considered as the gold standard.

Table 6. Comparison of HRCT findings with perioperative findings of the lateral semicircular canal

		Surgical findings		
		Dehiscence (+)	Intact	Total
HRCT findings	Dehiscence (+)	5	2	7
	Intact	2	46	48
	Total	7	48	55

Sensitivity 71%, specificity 96%, positive predictive value 71%, negative predictive value 96%
HRCT: high-resolution computed tomography

Table 7. Comparison of HRCT findings and perioperative findings of the dural plate

		Surgical findings		
		Dehiscence (+)	Intact	Total
HRCT findings	Dehiscence (+)	2	2	4
	Intact	0	51	51
	Total	2	53	55

Sensitivity 100%, specificity 96%, positive predictive value 50%, negative predictive value 100%
HRCT: high-resolution computed tomography

In the study by Özbay et al. (11) who assessed 50 patients, one out of four patients who was reported as having FCD with CT was confirmed during the surgery; on the other hand, dehiscence was found during surgery in five patients, despite being reported as intact with CT imaging. Gerami et al. (12) evaluated 80 patients and reported that none of the 12 patients whose FCD was found at surgery were preoperatively identified using HRCT. The study by Keskin et al. (13) who assessed 56 patients showed that facial canal irregularity was preoperatively demonstrated in four patients using CT among six patients who were diagnosed during surgery. CT demonstrated FCD in only one out of four patients in the study by Yildirim-Baylan et al. (14) who evaluated 56 patients diagnosed with COM. None of the four FCD patients were preoperatively identified using CT in the study by Tatlipinar et al. (15) who assessed 50 patients. Mahmutoğlu et al. (16) found two patients with FCD during surgery among 71 patients. These two patients were also preoperatively identified with CT imaging; on the other hand, two other patients who were preoperatively identified with dehiscence were found to be intact during surgery. Furthermore, all patients reported as intact with CT imaging were also confirmed during surgical intervention (16). Payal et al. (17) studied 60 patients who were diagnosed with chronic suppurative otitis media (CSOM) and found that CT had low efficacy in identifying FCD. In a retrospective study evaluating 31 patients (32 ears), Ng et al. (18) reported that 11 dehiscence patients were identified with CT imaging among 14 patients diagnosed with FCD during surgery. Three patients who were reported as having an intact canal were diagnosed with dehiscence in surgery (18). Among 350 patients with CSOM, FCD was identified with a CT scan in 5 out of 30 patients who were perioperatively diagnosed with dehiscence, while surgery did not confirm diagnosis in four patients reported as having dehiscence with a CT scan in the study by Gül et al (9).

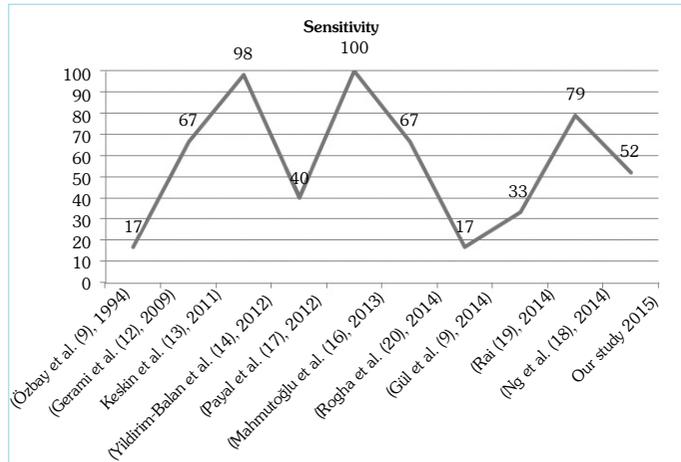


Figure 4. Sensitivity levels in different studies of CT findings regarding the presence of FCD

FCD: facial canal dehiscence; CT: computed tomography

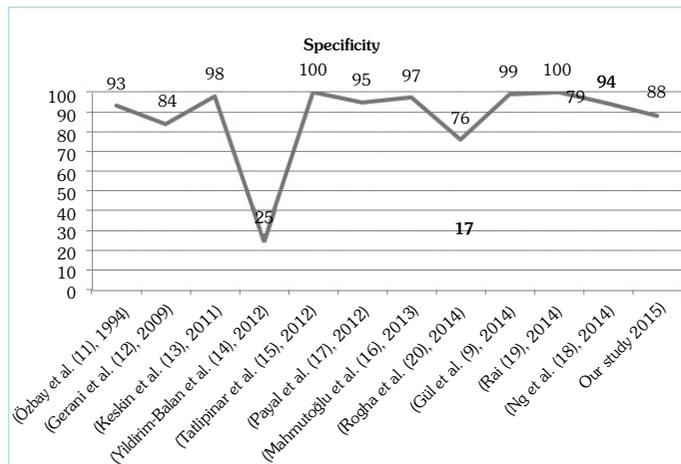


Figure 5. Specificity levels in different studies of CT findings regarding the presence of FCD

FCD: facial canal dehiscence; CT: computed tomography

In our study on 55 patients, 11 out of 21 patients with FCD and 30 out of 34 patients with an intact canal were accurately predicted with HRCT findings. HRCT findings were demonstrated to be moderately consistent with surgical findings in identifying FCD.

Even though imaging methods had considerable improvements with technological advancement, the sensitivity of CT did not demonstrate similar progress in the same direction; various sensitivity and specificity values were reported by researchers (Figure 4-7). Our results did not show any difference from the results previously reported.

Most studies regarding FCD reported that a vast majority of dehiscence was located in the tympanic segment. Gül et al. (9) noted that all FCD found during surgery were on the tympanic segment. According to the study by Yu et al. (3), 67 (88.2%) CT findings obtained from 76 ears were confirmed with surgery; 34 out of 38 FCD patients and 33 out of 38 intact patients were accurately predicted with a CT scan. The researchers concluded that analyzing multiplane images would increase the accurate identification of FCD in the tympanic segment (3).

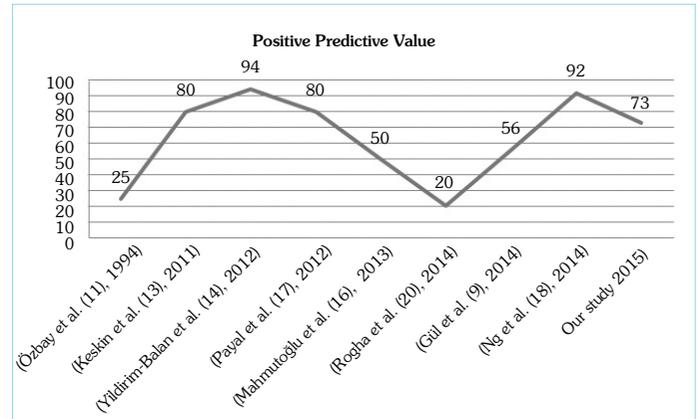


Figure 6. Positive predictive values in different studies of CT findings regarding the presence of FCD

FCD: facial canal dehiscence; CT: computed tomography

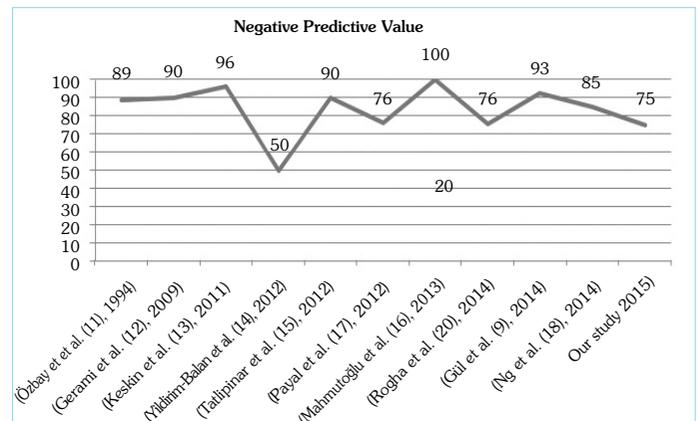


Figure 7. Negative predictive values in different studies of CT findings regarding the presence of FCD

FCD: facial canal dehiscence; CT: computed tomography

In our study, 10 out of the 20 patients diagnosed with tympanic segment dehiscence and 31 out of 35 patients identified with an intact canal during surgery were accurately predicted in the radiological evaluation.

The evaluation of previous research regarding LSC dehiscence demonstrated that studies mostly focused on fistulas. We discussed LSC dehiscence since patency in the anatomical structure of LSC was examined in the present study. The best images of LSC are obtained from axial slices (19). Özbay et al. (11) reported 97.8% sensitivity and 50% specificity in identifying LSC fistula with a CT scan. Tatlıpınar et al. (15) reported 0% sensitivity and 93.6% specificity. Payal et al. (17) reported 66.67% sensitivity and 83.33% specificity. Mahmutoğlu et al. (16) found an excellent compatibility between CT and surgical findings and reported 100% sensitivity and 100% specificity. Gül et al. (9) showed 100% sensitivity and 99.7% specificity in identifying LSC dehiscence with CT. Rogha and Hashemi (20) demonstrated that CT findings were moderately compatible with surgical observations. They reported that CT had 75% sensitivity and 87.5% specificity in identifying LSC dehiscence. Rai (21) calculated the sensitivity of CT as 25% in identifying LSC dehiscence. Ng et al. (18) reported an excellent compatibility between CT and surgical findings. They calculated the sensitivity of CT as 100% and the specificity as 96%. In our

study, 5 patients whose dehiscence was confirmed during surgery were accurately predicted with radiological methods. On the other hand, 46 out of 48 patients evaluated as having an intact canal during surgery were accurately predicted with CT. HRCT was found to be very compatible with surgery in identifying the presence of LSC dehiscence; sensitivity was reported to be 71% and specificity was reported to be 96%. Most patients with LSC dehiscence were also diagnosed with FCD (86%); therefore, it can be concluded that LSC dehiscence is considered as a risk factor for concomitant FCD. Similarly Chen et al. (22) stated that LSC fistula should be assumed as a risk factor for the presence of FCD.

Özbay et al. (11) calculated the sensitivity of CT in identifying dural plate defects as 25% and specificity as 83.3%. These were reported as 98% and 25%, respectively, in the study by Yildirim-Baylan et al. (14).

The two patients who were perioperatively diagnosed with dural plate defects were accurately predicted with radiological methods in our study. Moreover, 51 out of 53 patients evaluated as having a normal anatomical structure were accurately predicted with radiology. HRCT was seen to be very compatible with surgery in identifying the presence of dural plate defects. The sensitivity 100% and specificity was 96%.

CONCLUSION

While HRCT and surgical findings were found to be highly compatible for LSC dehiscence and dural plate defects, the compatibility was moderate for FCD and tympanic segment dehiscence and mild for mastoid segment dehiscence in our study. The most common location for FCD was the tympanic segment. FCD was found in most patients who were also diagnosed with LSC dehiscence. The tortuous nature of the facial canal makes it difficult to obtain accurate radiological images even with HRCT. However, LSC dehiscence and dural plate defects seen with HRCT can indicate probable FCD. Being crucial in preventing potential complications during surgery, the preoperative identification of anatomical variations is highly possible with the use of HRCT. Because the course of the facial nerve is easily distinguished in the temporal bone in the event that thin-slice HRCT images are obtained, HRCT can be useful in localizing potential dehiscence.

Ethics Committee Approval: Ethics committee approval was received for this study.

Informed Consent: Written informed consent was not obtained due to the retrospective nature of this study.

Peer-review: Externally peer-reviewed.

Authors' Contributions: Conceived and designed the experiments or case: GM, OT. Performed the experiments or case: GM, AB, MBA, EY. Analyzed the data: GM, AB, MBA, YG. Wrote the paper: GM, OT, YG, YG. All authors have read and approved the final manuscript.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

- Bucak A, Ulu S, Yucedag F, Okur E, Kemal Kahveci O, Said Tekin, M, et al. Facial Canal Dehiscence and Tympano-mastoid Surgery. *J Int Adv Otol* 2013; 9(3): 319-26.
- Lin JC, Ho KY, Kuo WR, Wang LF, Chai CY, Tsai SM. Incidence of dehiscence of the facial nerve at surgery for middle ear cholesteatoma. *Otolaryngol Head Neck Surg* 2004; 131(4): 452-6. [\[CrossRef\]](#)
- Yu Z, Wang Z, Yang B, Han D, Zhang L. The value of preoperative CT scan of tympanic facial nerve canal in tympanomastoid surgery. *Acta Otolaryngol* 2011; 131(7): 774-8. [\[CrossRef\]](#)
- Măru N, Cheiță AC, Mogoantă CA, Prejoiu B. Intratemporal course of the facial nerve: morphological, topographic and morphometric features. *Rom J Morphol Embryol* 2010; 51(2): 243-8.
- Egeli E, Arslan H, Akkaya S. Comparison of the Computed Tomography and Surgical Findings in Chronic Otitis Media. *Türk Otolaren-goloji Arşivi* 1999; 37(3-4): 117-20.
- Sancak B, Cumhuri M, Vakfı OG. Fonksiyonel anatomi: baş-boyun ve iç organlar. *ODTÜ Geliştirme Vakfı*; 2002.
- Magliulo G, Colicchio MG, Ciniglio M. Facial nerve dehiscence and cholesteatoma. *Ann Otol Rhinol Laryngol* 2011; 120(4): 261-7. [\[CrossRef\]](#)
- Şen A, İynen İ, Şan İ, Bozkuş F, Çeçe H. Kronik Otitis Media Tanısı ile Opere Edilen Olgularda Preoperatif Bilgisayarlı Tomografi Bulguları ile Operasyon Bulgularının Karşılaştırılması. *KBB ve BBC Derg* 2010; 18(3): 104-11.
- Gül A, Akdağ M, Kınış V, Yılmaz B, Sengül E, Teke M, et al. Radiologic and surgical findings in chronic suppurative otitis media. *J Craniofac Surg* 2014; 25(6): 2027-9. [\[CrossRef\]](#)
- Blevins NH, Carter BL. Routine preoperative imaging in chronic ear surgery. *Am J Otol* 1998; 19(4): 527-35; discussion 535-8.
- Özbay S, Sütbeyaz Y, Okur A, Selimoğlu E, Aktan B, Ertaş A. The value of preoperatively computed tomography in chronic suppurative otitis media. *KBB ve Baş Boyun Cerrahisi Derg* 1994; 2(2): 106-10.
- Gerami H, Naghavi E, Wahabi-moghadam M, Forghanparast K, Akbar MH. Comparison of preoperative computerized tomography scan imaging of temporal bone with the intra-operative findings in patients undergoing mastoidectomy. *Saudi Med J* 2009; 30(1): 104-8.
- Keskin S, Cetin H, Tore HG. The Correlation of temporal bone CT with surgery findings in evaluation of chronic inflammatory diseases of the middle ear. *Eur J Gen Med* 2011; 8(1): 24-30.
- Yildirim-Baylan M, Ozmen CA, Gun R, Yorgancilar E, Akkuş Z, Topcu I. An evaluation of preoperative computed tomography on patients with chronic otitis media. *Indian J Otolaryngol Head Neck Surg* 2012; 64(1): 67-70. [\[CrossRef\]](#)
- Tatlipinar A, Tuncel A, Öğredik EA, Gökçeer T, Uslu C. The role of computed tomography scanning in chronic otitis media. *Eur Arch Otorhinolaryngol* 2012; 269(1): 33-8. [\[CrossRef\]](#)
- Mahmutoğlu AS, Celebi I, Sahinoğlu S, Cakmakçı E, Sözen E. Reliability of preoperative multidetector computed tomography scan in patients with chronic otitis media. *J Craniofac Surg* 2013; 24(4): 1472-6. [\[CrossRef\]](#)
- Payal G, Pranjal K, Gul M, Mittal MK, Rai a K. Computed tomography in chronic suppurative otitis media: value in surgical planning. *Indian J Otolaryngol Head Neck Surg* 2012; 64(3): 225-9. [\[CrossRef\]](#)
- Ng JH, Zhang EZ, Soon SR, Tan VYJ, Tan TY, Mok PKH, et al. Pre-operative high resolution computed tomography scans for cholesteatoma: has anything changed? *Am J Otolaryngol* 2014; 35(4): 508-13. [\[CrossRef\]](#)
- Gün R. Kronik Süpüratif Otitis Mediyada Preoperatif Temporal Kemik Tomografisinin Tanı Ve Tedavideki Yeri [Internet]. library.cu.edu.tr. [Adana]: Çukurova Üniversitesi; 2005 [cited 2014 Dec 14].
- Rogha M, Hashemi SM, Mokhtarinejad F, Eshaghian A. Comparison of Preoperative Temporal Bone CT with Intraoperative Findings in Patients with Cholesteatoma. *Iran J Otorhinolaryngol* 2014; 26(74): 7-12.
- Rai T. Radiological study of the temporal bone in chronic otitis media: Prospective study of 50 cases. *Indian J Otol* 2014; 20(2): 48. [\[CrossRef\]](#)
- Chen G, Xie D, Xu H, Wu W, Liu Q. The incidence of facial nerve dehiscence at mastoidectomy and its risk factors. *J Clin Otorhinolar- yngol Head, Neck Surg* 2009; 23: 289-92.