

Why Do We Not Need CT in Patients Who Undergo Type I Tympanoplasty?

Original Investigation

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Abstract

Objective: High-resolution computed tomography (HRCT) has gained wide acceptance in diagnostic work-up of suppurative chronic otitis media. Most ear surgeons order HRCT to make a rational operative plan, especially in the presence of symptoms, such as refractory otorrhea with bad odor, epithelial debris at retraction pockets, and defects in bony walls of the middle ear. The aim of this study was to show the lack of necessity of preoperative HRCT by evaluating its predictive value in patients who underwent type I tympanoplasty.

Methods: The study included a patient group who underwent tympanoplasty with dry perforation and normal middle ear mucosa. The intraoperative findings of 43 patients were compared with preoperative HRCT and audiogram findings.

Results: There was no significance between preoperative air conduction threshold and existence of ossicular ero-

sion in HRCT. HRCT incorrectly predicted the presence of cholesteatoma in two patients. The positive predictive value of HRCT in detecting soft or granulation tissue was 4/14 (28.57%). The sensitivity and specificity of HRCT in the diagnosis of ossicular chain status were 9.09% and 90.62%, respectively.

Conclusion: HRCT plays an important role in the assessment of patients with suppurative chronic otitis media and cholesteatoma. However, preoperative HRCT in patients who have undergone type I tympanoplasty is not necessary. It has no benefit and also leads patients to unnecessary radiation exposure.

Key Words: Suppurative otitis media, tympanoplasty, computed tomography

Introduction

Since its advent in the 1980s, high-resolution computed tomography (HRCT) of the temporal bone has played an important role in the evaluation of chronic otitis media (COM) (1). It provides a detailed assessment of complex bony structures of the middle ear and mastoid cavity; thus, surgeons can visualize the extent of disease, status of the ossicular chain, presence of bony erosion, or existing cholesteatoma prior to surgery (2, 3). HRCT has gained wide acceptance in the diagnostic work-up of suppurative COM. Most ear surgeons order HRCT to make a rational operative plan, especially in the presence of symptoms, such as refractory otorrhea with bad odor, epithelial debris at retraction pockets, and defects in bony walls of the middle ear.

Previous studies showed contradictory results with regard to the sensitivity and specificity of the preoperative HRCT scan. A preoperative HRCT scan was suggested to underestimate the actual pathology in the middle ear and was unreliable in some of the articles (4, 5). The study group in those studies included patients with diverse clinical findings and different surgical plans, including tympanomastoidectomy or open cavity mastoidectomy. This diversity of patient groups may cause certain shortcomings in the assessment of the necessity for preoperative HRCT.

It is a common belief that preoperative HRCT is not necessary in patients with dry perforation

and mild hearing loss in the absence of destructive middle ear pathology. But, unfortunately, few surgeons insist on ordering HRCT prior to tympanoplasty in their daily practice. This malpractice leads patients to exposure to avoidable radiation. Although there is almost a consensus that HRCT prior to surgery is unnecessary in these patients, it has not been proven yet objectively. Thus, we aimed to show the lack of necessity of preoperative HRCT by assessing its predictive value in patients who undergo type I tympanoplasty.

Methods

This retrospective study with data collection was conducted at department of Otolaryngology in Uludağ University. The study group was selected from patients who underwent tympanoplasty with or without ossicular reconstruction with a diagnosis of chronic otitis media between August 2010 and February 2013. The inclusion criteria were as follows: i) presence of tympanic membrane perforation, ii) no refractory ear drainage, iii) dry ear for at least 3 months, iv) no cholesteatoma on microotoscopic examination, and v) no bony erosion or retraction pocket. At our institution, we certainly do not order preoperative CT in patients who undergo type I tympanoplasty. However, we have other patients who were referred by other colleagues for surgery with a prior HRCT. We had 43 patients who fulfilled the aforementioned criteria with a prior HRCT in the study group. The mean age of the study group was 32.44±13.78

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years (14-58). The study was approved by the ethical committee of the medical school, with approval number 2013-2/10.

The operative data of the patients were retrieved from the patients' files. Intraoperative findings, such as presence of cholesteatoma or granulation tissue and ossicular chain defects (incus necrosis, defects, or absence of malleus and stapes), were used as clinical parameters. Subsequently, the HRCT scan obtained on the coronal and axial planes was evaluated by the same senior radiologist. The radiological findings regarding ossicular chain status, existence of bony erosion, soft tissue thickening, and cholesteatoma were all noted. Finally, the intraoperative findings were compared to both the audiogram findings and HRCT to assess their value in predicting actual pathology. Furthermore, other abnormal operative findings, such as tegmen tympani erosion, sigmoid sinus or facial nerve dehiscence, and ossicular dislocation or fixation were also noted. Pure tone audiogram was performed at 0.5, 1, 2, and 4 kHz to evaluate preoperative air-bone gap and air conduction thresholds.

Statistical Analysis

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) v.13.0 for Windows (SPSS inc., Chicago, USA). Comparisons of more than two independent groups were analyzed by Kruskal-Wallis test. Mann-Whitney U-test was used to compare dual independent groups. Pearson chi-square and Fisher's exact chi-square tests were used to compare categorical variables. P values smaller than 0.05 were considered statistically significant.

Results

Among 43 patients in the study group, 17 were male and 26 were female. Tympanoplasty was performed in 22 cases in the left ear and in 21 cases in the right ear. The ossicular chain was non-eroded in 32 patients according to the intraoperative findings. Among 11 patients with ossicular erosions, 8 had an isolated incus defect, 2 had an isolated malleus defect, and 1 had both malleus and incus defects.

The mean preoperative air conduction threshold was 39.55 ± 16.46 dB, and the air bone gap was 25.16 ± 10.20 dB. The median air conduction threshold and air bone gap of patients who had ossicular chain defects were 46.0 dB (25.0-70.0) and 26.0 dB (17.0-46.0), respectively. These thresholds were 33.0 dB (20.0-80.0) and 21.0 dB (5.0-44.0) for those with non-eroded ossicular chains. There was a significance between preoperative air conduction thresholds of these two groups ($p=0.037$). The air conduction threshold and air bone gap of patients whose preoperative HRCT scans indicated ossicular erosion were 54.0 dB (40.0-60.0) and 37.0 dB (30.0-46.0), respectively. These thresholds were 35.0 dB (20.0-80.0) and 22.0 dB (5.0-44.0) for patients with no ossicular chain erosion in the HRCT. There was significance between preoperative air bone gaps of these two groups ($p=0.018$) (Table 1).

HRCT incorrectly predicted the presence of cholesteatoma in 2 patients (positive predictive value; 0/2). However, it correctly excluded cholesteatoma in 39/41 of patients (negative predic-

Table 1. Air conduction thresholds and air bone gaps in patients with eroded or non-eroded ossicles according to intraoperative and HRCT findings. The given values are in dB, and data are presented as median (min-max.)

Ossicular chain	Air conduction	p value	Air-bone gap	p
HRCT finding				
Defective	54.0 (40.0-60.0)	0.083	37.0 (30.0-46.0)	0.018
No defect	35.0 (20.0-80.0)		22.0 (5.0-44.0)	
Intraoperative finding				
Defective	46.0 (25.0-70.0)	0.037	26.0 (17.0-46.0)	0.072
No defect	33.0 (20.0-80.0)		21.0 (5.0-44.0)	

HRCT: High Resolution Computed Tomography

tive value; 95.12%). There was cholesteatoma in the middle ear in 2 patients despite negative HRCT findings. We found the sensitivity and specificity of HRCT for detecting cholesteatoma to be 0% and 95.12%, respectively. The positive predictive value of HRCT in detecting soft or granulation tissue was 4/14 (28.57%), and the negative predictive value was 27/29 (93.10%). In 2 patients, granulation tissue was present, although it was excluded by HRCT. The sensitivity and specificity of HRCT for detecting soft or granulation tissue were 66.67% and 72.97%, respectively. Among 4 patients in whom HRCT predicted ossicular chain erosion, only 1 had a defect in the ossicles (positive predictive value; 25%). The negative predictive value of HRCT in detecting ossicular chain defects was 29/39 (74.36%). The sensitivity and specificity of HRCT in the diagnosis of ossicular chain status were 9.09% and 90.62%, respectively (Table 2).

The correspondence between HRCT and the intraoperative findings in regard to cholesteatoma and ossicular chain were $p=1.000$ and $p=0.092$, respectively, and for granulation tissue, it was $p=0.039$ by chi-square analysis.

Discussion

HRCT scan of the temporal bone is the standard imaging technique in the assessment of middle ear pathologies. However, there are still many controversies regarding the predictive value and reliability of this scan. Alzoubi et al. (4) evaluated the accuracy of a preoperative CT scan in detecting the extent and type of middle ear disease in patients with COM. They pointed out that CT incorrectly predicted the presence of cholesteatoma in 13 patients (positive predictive value 20/33, 60.6%). The authors also suggested that CT could not be relied on to differentiate cholesteatoma from chronic mucosal disease (the sensitivity and specificity were 80% and 48%). But, they mentioned that ossicular status was diagnosed correctly in most cases (24/31). Tatlipinar et al. (1) assessed the role of routine CT scan before COM surgery in patients who underwent tympanoplasty with or without mastoidectomy. They reported that among 31 patients with predictive findings in CT for cholesteatoma, 19 patients (61.3%) showed cholesteatoma intraoperatively. In their study, the sensitivity and specificity of CT in predicting cholesteatoma were 82.6% and 55.6%, respectively. Ossicular chain defects were correctly excluded in 14/18 patients with 77.8% specificity. The positive pre-

Table 2. Positive and negative predictive values of HRCT in comparison to intraoperative findings (ossicular chain status, existence of cholesteatoma, and soft tissue in the middle ear)

HRCT findings	Intraoperative findings					
	Cholesteatoma		Soft tissue		Ossicular defect	
	(+)	(-)	(+)	(-)	(+)	(-)
(+)	0	2	4	10	1	3
(-)	2	39	2	27	10	29

HRCT: High Resolution Computed Tomography

dictive value of CT in detecting ossicular chain erosion was 28/32 (87.5%). They suggested that CT scan has some limitations, but it is still a useful adjunct in preoperative surgical decision-making. Vlastarakos et al. (5) also searched for the answer of a similar question, "How reliable is the preoperative radiological assessment in patients with COM?". They measured the strength of agreement between CT and intraoperative findings regarding middle ear structures and pathologies. There was fair agreement between the CT and intraoperative findings regarding malleus-incus but very strong agreement for mastoid air cell aeration. The preoperative CT scan was highly sensitive in detecting abnormalities in mastoid air cells (93.6%) in that study.

In the studies above, the authors enrolled every patient with COM into the study group, disregarding the preoperative clinical findings and extent of surgery. Furthermore, the study group did not exclude patients who underwent mastoidectomy in those studies. However, assessing the role of preoperative HRCT in such a diversified patient group may cause some flaws. We believe that preoperative CT in patients undergoing tympanoplasty is inessential. CT scan also causes additional cost and unnecessary radiation exposure to these patients. Therefore, we formed a homogenous group of patients with dry perforation in the absence of mucosal disease or cholesteatoma on inspection. Thus, we aimed to show the lack of necessity of preoperative HRCT in these patients. The results of this study may remind our colleagues of the importance of an otologic examination in this particular patient group. In our study, the preoperative HRCT scan excluded cholesteatoma and ossicular chain erosion accurately with high specificity. However, its positive predictive values were very poor (0% and 25%, respectively). The HRCT scan was unable to detect cholesteatoma and ossicular erosion accurately, if present. Based on these findings, we suggest that ordering HRCT before tympanoplasty is not necessary. It underestimates the actual pathology and has no contribution to operative decision-making.

The preoperative pure tone audiogram is a valuable indicator of ossicular chain status. Air conduction threshold and air bone gap are used to determine whether or not the ossicular chain discontinues. Chrobok et al. (6) showed that patients with an intact ossicular chain had better pre and postoperative hearing levels compared to patients suffering from ossicular defects. Similarly, Felek et al. (7) reported that the pure tone average and air bone gap increased in accordance with the ossicular defect by

using the Austin-Kartush classification. On the contrary, Jeng et al. (8) showed a nonsignificant correlation between air bone gap and ossicular discontinuity. They argued that cholesteatoma and granulation tissue in the middle ear might have served as a bridge for the transmission of sound energy, ignoring the ossicular discontinuity. Hol et al. (9) indicated that the mean air conduction threshold in patients with an intact ossicular chain and retracted malleus was better compared to patients with incus erosion before surgery but not an air bone gap. Besides ossicular integrity, there are other determinants of hearing loss in dry perforated ears, such as middle ear volume and area of perforation. Mehta et al. (10) showed that hearing loss increases with increasing perforation size but that the location of the perforation had no effect. They also mentioned that hearing threshold had an inverse relation with middle ear volume. In our study, there was significance between air conduction threshold and the existence of ossicular erosion, which indicated the reliability of pure tone audiometry in the preoperative assessment of COM patients. Furthermore, it also helps surgeons to predict the need for replacement prosthesis or bone cement before surgery.

Connor et al. (11) reported that among 36 ears with incudo-stapedial discontinuity demonstrated on CT, incus defect could be detected by otoscopic examination in 5 ears. They also mentioned that in 8 of 12 ears that were operated on, an incudo-stapedial defect was reported in the surgical notes. These contradictory results may be related with inadequate exposure of the long process of the incus and incudo-stapedial joint or inexperience of the surgeon. We believe that surgeons may gain more benefit from a detailed microotoscopic examination combined with pure tone audiometry than from an HRCT scan in most tympanoplasty cases.

On the other hand, ordering HRCT for whom this scan is useless exposes these patients to unnecessary radiation. In a routine head CT, the patients receive about 0.3-6 mSV dose of radiation (12). Ionizing radiation exposure due to CT scan was reported to cause an increase in total cancer risk (13). The adverse effects of radiation may be even worse in children. The risk of leukemia was indicated to be higher in children under 5 years of age who underwent CT scan for the head region (14). There are also long-term side effects of radiation in the treatment of pediatric head-neck cancers, such as growth retardation of maxillofacial bones, severe facial deformities, and skin cancers (15, 16).

Conclusion

Computed tomography of the temporal bone plays an important role in the assessment of patients with suppurative COM and cholesteatoma by giving the opportunity of a virtual tour of the closed spaces of the middle ear prior to surgery. However, in patients who have undergone tympanoplasty, preoperative HRCT is not necessary. It has low sensitivity and a low positive predictive value and gives no benefit to patients, except unnecessary radiation exposure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Uludağ University Faculty of Medicine, 2013-2/10.

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