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Differences Between Neurotologist and General Radiologist in Reporting High-Resolution Computed Tomography for Otosclerosis

ABSTRACT

Background: To compare the reporting of high-resolution computed tomography of temporal bones for otosclerosis by general radiologists and a neurotologist within a tertiary-care hospital.

Methods: A retrospective review of temporal bone high-resolution computed tomography reports of surgically confirmed otosclerosis patients obtained between 2011 and 2020 was performed at a single tertiary-care center. For comparison, the high-resolution computed tomography reports of all patients performed by the general radiologists and the preoperative patient image evaluation notes of the senior neurotologist were reviewed from the medical records. The main outcome measure was the correct identification of otosclerosis on HRCT.

Results: A total of 42 patients (47 ears) were included in the study. The neurotologist correctly diagnosed otosclerosis in 31 of 47 images (66.0%) and the general radiologists correctly diagnosed otosclerosis in only 3 of 47 images (6.4%). The number of correct diagnoses were significantly different when made by the neurotologist and the general radiologist ($\chi^2 = 25.14$, $P < .001$, McNemar test).

Conclusion: The results of this study show that a radiologist without sufficient experience in the field of neurotology may have a low detection rate of otosclerosis in high-resolution computed tomography of the temporal bone, as is consistent with the literature. In the light of this study, it can be concluded that more experienced eyes (neuroradiologist, neorotologist) are required to diagnose otosclerosis in HRCT than a general radiologist.

Keywords: Computed tomography, diagnosis, neurotologist, otosclerosis, radiologist

INTRODUCTION

Otosclerosis is a rare condition that affects the endochondral bone of the otic capsule in humans and is histologically characterized by abnormal bony remodeling, including bone resorption, new bone deposition, and vascular proliferation.[1] The main audiological findings of the disease are progressive hearing loss, absent stapedial reflexes, Carhart's notch, and type A or As tympanogram.[2] Diagnosis is traditionally based on the presence of classic audiological findings with a normal tympanic membrane. However, there are other middle ear pathologies that may mimic otosclerosis, such as congenital ossicular fixation, ossicular discontinuity, congenital cholesteatoma, and tympanosclerosis. The exact diagnosis can only be confirmed intraoperatively by evaluating the limitation of movement in the stapes footplate. However, greater precision preoperatively rather than intraoperatively would be useful to rule out other pathologies that may mimic otosclerosis, in which the chance of achieving effective hearing restoration is much lower than in otosclerosis, and, if necessary, to refer patients to a different alternative for hearing restoration. Therefore, when clinical symptoms are not sufficiently indicative, high-resolution computed tomography (HRCT) scanning can be used as an additional diagnostic tool for distinguishing alternative pathologies with audiological findings similar to those of otosclerosis.[3] High-resolution computed tomography findings are also useful for determining the extent of the disease, some inner-ear malformations, preventing intraoperative complications, and creating realistic expectations for possible outcomes during procedures for otosclerosis.[4]

Alper Koycu[1]
Omer Vural[2]
Levent Naci Ozluoglu[1]

[1]Department of Otolaryngology Head and Neck Surgery, Başkent University Faculty of Medicine, Ankara, Turkey
[2]Department of Otolaryngology, Bingöl State Hospital Head and Neck Surgery, Bingöl, Turkey

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Corresponding author:
Omer Vural
Email: *ovural25@gmail.com*
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According to current literature, the diagnostic efficacy of HRCT imaging in suspected otosclerosis varies greatly, ranging from 10% to 100%.[5,6] The imaging technique, slice thickness, the specialist evaluating the images, and the evaluation protocol are undoubtedly the factors that affect this difference. Kanona et al[5] showed that radiological detection on HRCT of otosclerotic changes of the temporal bone is significantly better when evaluated by a dedicated neuroradiologist than by a general radiologist (GR). A reasonable number of otolaryngologists dealing with otology can perform stapes surgery in district general hospitals. However, in many district general hospitals, CT images of the temporal bone are reported by a GR rather than a neuroradiologist. The impact of the temporal bone HRCT assessment by an otologist/neurotologist (NO) is high. Although clinical and audiological findings are sufficient for a diagnosis of otosclerosis, the imaging results may directly influence the treatment decision.

To date, no study has evaluated the potential difference between GR and NO in terms of temporal bone HRCT reporting in patients with suspected otosclerosis. The aim of this study was to compare the reporting of HRCT of temporal bones for otosclerosis by GR and NO within a tertiary-care hospital.

MATERIAL AND METHODS

Patients

The study protocol was approved by the Başkent University Research Ethics Committee (date of approval 29.06.2021, project number: KA21/300), and written informed consent was obtained from all patients. After obtaining Institutional Review Board approval, a retrospective review of the medical records of patients who had undergone otosclerosis surgery between 2011 and 2020 at a single tertiary-care center was conducted. The intraoperative confirmation of otosclerosis was made by the presence of fixation of the stapes footplate with a mobile malleus and incus. The temporal bone HRCT images included in the study were those of patients who were referred to radiology for a differential diagnosis of possible otosclerosis. Patients who were referred to radiology not specifically for the differential diagnosis of otosclerosis but for general conductive hearing loss or similar pathologies were excluded from the study. Since the inclusion criteria were the presence of intraoperative stapes fixation, both ears were included in the study in patients with bilateral hearing loss if both ears were operated on in our clinic.

MAIN POINTS

- The diagnosis of otosclerosis is traditionally based on the presence of classic audiological findings with a normal tympanic membrane.
- High-resolution computed tomography (HRCT) *scanning* can be used as an additional diagnostic tool for otosclerosis.
- The diagnostic efficacy of HRCT imaging in suspected otosclerosis varies greatly, ranging from 10% to 100%.
- Radiological detection of otosclerosis on HRCT of the temporal bone is significantly better when evaluated by an experienced neurotologist than by a general radiologist.

In patients with bilateral hearing loss with 1 ear operated on in another hospital, the images of the ear operated on in our clinic were included in the study. Patients were excluded from the study if they had been operated on in our clinic but the tomography had been performed in another hospital.

High-Resolution Computed Tomography Scans and Image Review

Temporal bone CT scans were obtained with a 192-slice DSCT system (SOMATOM Force, Siemens Medical Solutions, Forchheim, Germany) with the following parameters: 0.6 mm slice thickness, 114 reference mAs, tube current at 120 kV tube voltage, 0.5 pitch. Sections were aligned parallel to the orbitomeatal line. Axial views were obtained and reformatted coronally and sagittally. All examinations were obtained with identical protocols in all patients and performed without contrast material, and imaging included the entire temporal bone. Images were assessed using the ClearCanvas Workstation system (ClearCanvas Inc., Toronto, Canada).

For comparison, the HRCT reports of all patients performed by the GR and the preoperative patient image evaluation notes of the senior NO were reviewed from the medical records. The radiologists who evaluated the GRs' arm of the study were not a specific group of radiologists, but the radiologists who examined the images of the head and neck region in the radiology clinic at the time the imaging was performed. The otolaryngologist who evaluated the NO arm of the study was a senior NO with 40 years of experience.

Main Outcome Measures and Statistical Analysis

The main outcome measure was the correct identification of otosclerosis on HRCT. The association between the radiology reports and the NO reports were calculated using the McNemar test. A value of $P < .05$ was considered statistically significant.

RESULTS

A total of 84 patients (96 ears) underwent otosclerosis surgery in our clinic in the last 10 years.

Of these, 42 were excluded from the study because they did not meet the inclusion criteria, so evaluation was made of 42 patients (47 ears). These 42 patients comprised 13 males and 29 females (Male : Female ratio of 1 : 2.2) with a mean age, independent of gender, of 42 years (range, 25 to 63 years). The GR correctly diagnosed otosclerosis in 3 of 47 images (6.4%) and the NO correctly diagnosed otosclerosis in 31 of 47 images (66.0%) (Table 1). The number of correct diagnoses was significantly different when made by the GR and the NO ($\chi^2 = 25.14$, $P < .001$, McNemar test). All 3 patients who were diagnosed correctly by the GR were also correctly diagnosed by the NO.

DISCUSSION

Otosclerosis is one of the well-known causes of conductive hearing loss and affects the endochondral bone of the otic capsule in humans. Abnormal bony resorption and reformation constitute the basic pathophysiology of the disease.[1] The diagnosis of otosclerosis is traditionally based on the presence of classic audiological findings with a normal tympanic membrane. However, there are other middle ear pathologies in which the

Table 1. Comparison of Reported Outcomes Between the General Radiologist and the Neurotologist

	General Radiologist		
Otolaryngologist	Negative for Otosclerosis (n)	Positive for Otosclerosis (n)	Total n (%)
Negative for otosclerosis (n)	16	0	16 (34.0)
Positive for otosclerosis (n)	28	3	31 (66.0)
Total n (%)	44 (93.6)	3 (6.4)	47 (100.0)

physical examination and audiological findings can be confused with otosclerosis. It is important to distinguish otosclerosis from these pathologies, for which the surgical results may not be as satisfactory as desired in terms of informing patients before the operation and even offering non-surgical treatment alternatives if necessary. High-resolution CT scanning can be used as an additional diagnostic tool for distinguishing alternative pathologies with audiological findings similar to those of otosclerosis when clinical symptoms are not sufficiently indicative.

The use of HRCT in the diagnosis of otosclerosis has been increasing in recent years. Together with this development, many studies have begun to investigate the specificity and sensitivity of HRCT in the diagnosis of otosclerosis. High-resolution CT is considered by some authors as the gold standard modality in the diagnosis of otosclerosis.[7,8] However, according to current literature, the diagnostic efficacy of HRCT imaging in suspected otosclerosis varies greatly, ranging from 10% to 100%.[5,6] The underlying reason for this wide range may be the differences between slice thicknesses of the images in the studies, the image quality and the specialist evaluating the images, and the evaluation protocol.

Virk et al[9] examined the role of radiological imaging in the diagnosis and treatment of otosclerosis in a systematic review. In that review, 37 articles were examined in which imaging evaluation was performed by otolaryngologists, GR, and neuroradiologists, and it was shown that the sensitivity of HRCT in the diagnosis of otosclerosis varies between 34% and 95%. In another study, Kanona et al[5] retrospectively examined the HRCT of 40 surgically confirmed otosclerosis patients. In that study, images which were previously reported by a group of GRs were re-evaluated by an experienced neuroradiologist, and the rate of correct diagnosis of otosclerosis by the GRs and the experienced neuroradiologist was compared. According to the study results, if the images were reviewed and reported by a neuroradiologist rather than a GR, the probability of obtaining the correct diagnosis was 90% higher. While the GRs made the correct diagnosis in 10% of the cases, the rate of correct diagnosis by the neuroradiologist was found to be 100%.

In the current study, the rate of correct diagnosis of otosclerosis on high-resolution CT images was statistically significantly higher for NO than GR. As in the study by Kanona et al,[5] the rate of correct diagnosis by GR was found to be quite low in the current study. These results are important in clinical practice, considering that many district general hospitals do not have neuroradiologists. Furthermore, these results are even more impressive because in the present study, the GR used a 5-megapixel diagnostic medical monitor to evaluate the images, while the otolaryngologist used a 1.3-megapixel monitor.

Evaluation of imaging studies of some diseases requires specific knowledge and training. For those who frequently encounter otosclerosis, such as otologists and neuroradiologists, diagnosing otosclerosis may be easy, but it may be more difficult for those still in training or who do not often encounter otosclerosis. The low rate of correct diagnosis by GR may be due to a lack of the specific training required to diagnose otosclerosis. Brown et al[10] presented a checklist to facilitate the diagnosis of otosclerosis on HRCT in their study. Preparing such systematic checklists and practical guidelines can improve one's ability to diagnose otosclerosis on HRCT.

According to the literature, the diagnostic efficacy of HRCT imaging in otosclerosis patients reaches 90%-100%. However, in the studies with these high diagnostic rates, image evaluation has been performed on high-quality monitors. In the current study, the correct diagnosis rate of 66% can be explained by the difference between the monitors used in image evaluation. In many centers, radiology departments use better quality medical monitors and medical imaging software for image evaluation than other departments.

There were some limitations to this study, primarily that only surgically confirmed otosclerosis patients were included, and there was no control group. If patients with normal middle ear anatomy without a diagnosis of otosclerosis had formed a control group, the results could have been more reliable. However, for definite otosclerosis exclusion, stapes mobilization should have been demonstrated by exploratory tympanotomy of the patients in the control group. This is a method that is not very common in clinical practice and is applied in very rare diseases such as suspected perilymph fistula. Another limitation of the study was that the quality of the monitors used by the GR and NO to evaluate the images was different. Evaluations made under the same conditions would ensure more reliable results. Furthermore, the radiologists who evaluated the GRs arm of the study were not a specific group of radiologists, but the radiologists who examined the images of the head and neck region in the radiology clinic at the time the imaging was performed. Due to the retrospective character of our study, it was not possible to create a specific GR group. The results would have been more reliable if a single radiologist had been involved in the radiology arm of the study.

The results of this study show that a radiologist without sufficient experience in the field of neurotology may have a low detection rate of otosclerosis in HRCT of the temporal bone, as consistent with the literature. From the medicolegal point of view, radiology reports are important. In light of this study, it can be concluded that more experienced eyes (neuroradiologist, NO) are required to diagnose otosclerosis in HRCT than a GR.

Ethics Committee Approval: This study was approved by the Ethics Committee of Başkent University (approval no: KA21/300; date: 29.06.2021).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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