RESEARCH ARTICLE / *Araştırma Makalesi*

Evaluation of Cochlear Nerve Diameter with MRI in Patients with Idiopathic Unilateral Sensorineural Hearing Loss

İdiyopatik Tek Taraflı Sensörinöral İşitme Kayıplı Hastalarda Kohlear Sinir Çapının Manyetik Rezonans Görüntüleme ile Değerlendirilmesi

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Abstract

Objective	The aim of this study was to evaluate the cochlear nerve diameter in patients with unilateral sensorineural hearing loss and to compare the diameter of the normal side with the hearing loss side.
Materials and Methods	A total of 36 patients with idiopathic unilateral sensorineural hearing loss were included in the study. Magnetic resonance imaging (MRI) and pure sound audiogram were performed on all the patients. Both cochlear nerve diameters were measured on axial thin-section constructive interference in steady state (CISS) sequences.
Results	The patients were comprised of 16 males and 20 females with a mean age of 52.3±13.7 years. Hearing loss was in the right ear in 11 patients, and in the left ear in 25. The average cochlear nerve diameter on the side with hearing loss was 0.13 cm while it was 0.19 cm on the normal side. There was a statistically significant difference between the two sides ($p < 0.001$).
Conclusion	In patients with unilateral sensorineural hearing loss, MRI allows the assessment of the cochlear nerve with anatomic detail, and enables the exclusion of possible organic pathologies. Demonstration of decreased cochlear nerve diameter in idiopathic sensorineural hearing loss will contribute to elucidating the etiology of this disease in the future.
Keywords	cochlear nerve; sensorineural hearing loss; magnetic resonance imaging

Öz

Amaç	*Bu çalışmanın amacı, tek taraflı idiyopatik sensörinöral işitme kaybı bulunan hastalarda kohlear sinir çapını değerlendirmek ve normal taraf ile işitme kaybı bulunan tarafın çaplarını karşılaştırmaktır.*
Gereç ve Yöntemler	*Tek taraflı idiyopatik sensörinöral işitme kaybı bulunan toplam 36 hasta çalışmaya dahil edildi. Tüm hastalara manyetik rezonans görüntüleme (MRG) ve saf ses odyometrisi uygulandı. Her iki taraftaki kohlear sinir çapları ince kesit aksiyal "constructive interference in steady state (CISS)" sekansından sekansından elde edilmiş sagittal reformat görüntüler üzerinden ölçüldü.*
Bulgular	*Hastaların 16'sı erkek 20'si kadındı ve yaş ortalamaları 52.3±13.7 idi. 11 hastada sağ tarafta, 25 hastada ise sol tarafta işitme kaybı vardı. Ortalama kohlear sinir çapı işitme kaybı olan tarafta 0,13 cm iken normal tarafta 0,19 cm idi. İki taraf arasında anlamlı farklılık mevcuttu ($p < 0.001$).*
Sonuç	*Tek taraflı sensörinöral işitme kaybı bulunan hastalarda MRG kohlear sinirin anatomik açıdan detaylı incelenmesine olanak sağlar ve olası organik patolojilerin dışlanmasına yardımcı olur. Tek taraflı idiyopatik sensörinöral işitme kaybında kohlear sinir çapının daha az olduğunun gösterilmesi gelecekte hastalığın etiyolojisinin aydınlatılmasına katkı sağlayacaktır.*
Anahtar Kelimeler	*kohlear sinir; sensörinöral işitme kaybı; manyetik rezonans görüntüleme*

INTRODUCTION

Sensorineural hearing loss develops associated with a pathology in the inner ear, retrocochlear region, vestibulocochlear nerve or the intracranial region.[1] Imaging is applied to these patients to exclude congenital, infectious, inflammatory or tumoral pathologies.[2] However, in some cases no underlying cause can be found. The preferred imaging method is magnetic resonance imaging (MRI) as it does not include ionizing radiation and has high contrast resolution in the images.[3,4] In recent years, it has become possible to evaluate the anatomic details of the cerebellopontine angle, the internal acoustic canal and the cochlear nerve, especially with the "constructive interference in steady state (CISS)" sequence on MRI. [5-7]

The aim of this study was to evaluate the cochlear nerve diameter in patients with idiopathic, unilateral sensorineural hearing loss, and to compare the diameter of the hearing loss side with the unaffected side, thereby revealing any relationship between sensorineural hearing loss and cochlear nerve diameter.

MATERIALS and METHODS

Approval for this descriptive cross-sectional study was granted by the Erzincan University Local Ethics Committee (15.05.2018-24/07). Written informed consent was not obtained from the patients since this was a retrospective study conducted from the medical records and magnetic resonance images of the patients.

The study included 36 patients, aged > 18 years, who were diagnosed with unilateral idiopathic sensorineural hearing loss at our hospital between January 2015 and December 2017. Of the 48 patients diagnosed with sensorineural hearing loss, 12 patients with organic etiology and sudden hearing loss were excluded from study. All the patients were applied with ear MRI on a 1.5T scanner (Siemens Aera; Siemens Medical Systems, Erlangen, Germany). The measurement of the cochlear nerve diameter in both ears was made on the sagittal reformatted image formed from the CISS sequence on MRI (Figure 1). The widest diameter of the cochlear nerve in internal acoustic canal was recorded.

The bone pathway hearing thresholds were defined with pure tone audiometry (PTA) applied at 500, 1000, 2000, and 4000 Hz separately in both ears. All the audiometric examinations were made in the same department using the same equipment (Clinical Audiometer AC33 Interacoustics A/S; Assens, Denmark). Normal hearing was accepted as a hearing level of <25 Db on PTA. When there was normal hearing (<25 Db HL PTA) in one ear with unilateral hearing loss, at least a mild level of sensorineural hearing loss (>25 Db HL PTA) was defined in the other ear. Patients with external auditory pathway pathology, tympanic membrane perforation, and conductive type or mixed type hearing loss were excluded from the study.

Statistical Analysis

Data obtained in the study were analyzed statistically using MedCalc ver. 12 software (Medcalc; Ostend, Belgium). Descriptive statistics for categorical variables were stated as number and percentage and continuous variables were stated as mean ± standard deviation (minimum-maximum) values. According to the assessment of conformity to normal distribution made with the Kolmogorov-Smirnov and Shapiro-Wilk tests, continuous variables were compared with non-parametric tests (Wilcoxon Signed Rank test) and parametric tests (Paired Samples t-test). A value of $p<0.05$ was accepted as statistically significant.

RESULTS

The patients comprised 20 males (55.5%) and 16 females (44.5%) with a mean age of 52.3±13.7 years. No significant difference was determined between the genders in respect of cochlear nerve diameter on the normal side ($p=0.153$) and the side with hearing loss ($p=0.463$). Hearing loss was determined in the right ear of 11 (30.6%) patients and in the left ear of 25 (69.4%). No difference was determined between the cochlear nerve diameter values according to the affected side ($p=0.843$). No significant correlation

was determined between age and cochlear nerve diameter on the normal side (p=0.06) or on the hearing loss side (p=0.441). The diameter of the cochlear nerve was determined as mean 0.13±0.02 cm on the hearing loss side and as mean 0.19±0.03 cm on the normal side. The difference between the two sides was statistically significant (p<0.001) (Table 1). The results of the ROC analysis applied showed that cochlear nerve diameter of ≤0.15 cm had 88.9% sensitivity and 77.8% specificity in the determination of idiopathic sensorineural hearing loss (p<0.001, area under curve (AUC)=0.882).

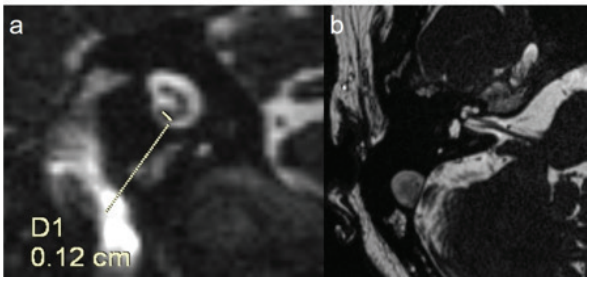

Figure 1: The measurement of cochlear nerve diameter on the reformatted sagittal image (a) obtained from the axial constructive interference in steady state (CISS) image (b).

Table 1: The cochlear nerve diameter values of the ears with normal hearing and hearing loss.

	Cochlear Nerve Diameter (cm)					
	Mean	Standard Deviation	Median	Min.	Max.	p*
Normal	0.19	0.03	0.19	0.13	0.26	< 0.001
Hearing Loss	0.13	0.02	0.14	0.10	0.19	

*: Wilcoxon signed rank test

DISCUSSION

The results of this study showed a statistically significant difference in the cochlear nerve diameter between the ear with hearing loss and the ear with normal hearing in patients with idiopathic, unilateral, sensorineural hearing loss. In a study by Russo et al., the cochlear nerve surface areas were compared in pediatric patients with idiopathic hearing loss and loss associated with connexin26 gene mutation, and those with normal hearing.[8] Similar to the findings of the current study, the cochlear nerve surface area of the patients with idiopathic hearing loss and loss associated with connexin26 gene mutation was determined to be smaller than that of the ears with normal hearing. Nakano et al. evaluated the computed tomography (CT) findings of children with congenital hearing loss, and again similar to the findings of the current study, the cochlear nerve canal was found to be smaller in children with hearing loss.[9]

In studies which include adult patient group, there are some different findings. In a study by Sildiroglu et al., the cochlear nerve surface area was evaluated on MRI in patients aged >60 years with age-related hearing loss, but no difference was found between these values and those of a control group.[10] These results were in contrast to the findings of the current study. The reason for the difference could be that in the previous study the number of patients was low and in the diagnosis of hearing loss, the only criteria used was <90% speech discrimination score.[10] In a more recent study by Naguib et al., patients with long-term bilateral hearing loss and a control group with normal hearing were compared in terms of cochlear nerve surface area and the values of those with hearing loss were found to be significantly smaller, which was a similar result to that of the current study.[11] The most important difference between the current study and these two previous studies is that in the current research, the cochlear nerve diameter was compared between the two ears of patients with unilateral hearing loss.

When there is normal hearing in one ear of a patient with unilateral hearing loss, there is sensorineural hearing loss of ≥25 dB in the other ear. The prevalence of unilateral hearing loss in adults has been reported in the USA as 7.2%, or 18 million individuals.[12] Hearing loss can vary from a mild to a very advanced degree. Just as unilateral hearing loss can be congenital, it may also emerge later as an acquired condition. Viral causes are the most frequently seen responsible acquired etiological agents (25%), and other agents may be meningitis, sudden hearing loss, ototoxic

drugs, hearing neuropathy, inner ear anomalies or vestibular tumors. In the evaluation of patients with unilateral hearing loss, the selection of which method to use is controversial. While high-resolution CT shows bone anomalies better, MRI provides the possibility of better examination, especially of the cochlear nerve. MRI is used in clinical practice to be able to discount cochlear pathologies in particular in cases of unilateral hearing loss.[13]

In the current study, measurements were made on the CISS sequence, which is a 3-dimensional gradient echo sequence used for anatomic details that cannot be evaluated with routine sequences. Image contrast varies according to the T2/T1 ratio of the tissue. A high T2/T1 ratio has high fat and water signal intensity. Therefore, a significant contrast emerges between cerebral spinal fluid (CSF) and the surrounding structures. The most important advantages of CISS sequencing are the high signal-noise ratio, high contrast noise ratio and that it is relatively insensitive to movement artifacts. The CISS sequence has an important role in the evaluation of the cerebellopontine angle, the internal acoustic canal and inner ear structures.[14] Previous studies have shown CISS to be the most successful sequence in the imaging of the cerebellopontine angle and the internal acoustic canal.[15]

There were some limitations to this study. Primarily, it was retrospective and the number of patients was low. Besides, as all the measurements were taken by a single radiologist, there was no examination of intra-observer agreement. However, further studies on this subject can be conducted.

Conclusion

In conclusion, MRI allows the evaluation of the cochlear nerve in patients with unilateral sensorineural-type hearing loss with the discounting of potential organic pathologies and the provision of anatomic details. The results of this study has shown that the diameter of the cochlear nerve is reduced in idiopathic sensorineural hearing loss could contribute to the clarification of this disease in the future.

Conflict of Interest:

The authors declare that they have no conflict of interest.

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