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Does Cochlear Nerve Size Differ Among Societies?

ORIGINAL INVESTIGATION

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ABSTRACT

Objective: Cochlear nerve size is a prognostic factor for successful cochlear implantation. Reports about the cochlear nerve size in normal-hearing patients and differences among societies in the cochlear nerve size are not satisfactory. The purpose of this study was to determine the average cochlear nerve size in normal-hearing adults and to investigate whether there is a difference among societies on the basis of literature data.

Materials and Methods: This retrospective study included 21 patients (38 ears) who underwent Magnetic Resonance Imaging (MRI) because of either vertigo and/or tinnitus complaints. Measurements were conducted on parasagittal constructive interference in steady state (CISS) sequence MRI. Vertical and horizontal diameters and cross-sectional area (CSA) were evaluated at the fundus of the internal auditory canal. Differences in the cochlear nerve size between the right and left ears and gender were evaluated. The difference in the cochlear nerve size among societies was compared with a z-test using data from literature.

Results: The average vertical diameter, horizontal diameter, and CSA were 1.11 mm, 1.10 mm, and 0.96 mm^2, respectively. No difference was found between the right and left ears and gender and among societies.

Conclusion: This study shows that the mean normal size of the cochlear nerve does not change between right and left ears and gender and among societies.

Keywords: Cochlear nerve, cochlear implants, magnetic resonance imaging

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INTRODUCTION

New imaging techniques in Magnetic resonance imaging (MRI) have permitted the visualization of the nerves in the internal auditory canal (IAC). Several studies have found an association between cochlear deficiency and poor performance of cochlear implants (1-4). A small cochlear nerve size may negatively affect the success of cochlear implantation. Therefore, knowledge about the normal cochlear nerve size is important. The mean CSA of the cochlear nerve in normal-hearing ears was reported to change from 0.98 mm^2 to1.1 mm^2 (5-7), but in another report, it was 2.52 mm^2 (8). This discrepancy may be due to a difference among societies. The purpose of this study was to determine the average cochlear nerve size in normal-hearing adults and to look for the difference among societies on the basis of literature data.

MATERIALS and METHODS

Study approval was obtained from the Institutional Review Board. MRIs of 21 patients were retrospectively evaluated. All the patients had complaints of vertigo and/or tinnitus and had normal audiometry findings. Audiometric tests were performed for each ear with AC40 clinical audiometry. Hearing loss was evaluated at 250, 500, 1,000, 2,000, 4,000, and 6,000 Hz frequencies. All MRI studies were performed on a 1.5-T (Magnetom Symphony, Siemens, Germany, 2007) MRI. Measurements were conducted on high resolution 3D CISS sequence MRI images in the parasagittal plane perpendicular to the long axis of the cochlear nerve. The 3D CISS sequence MRI was obtained using the following parameters: 821/146 (TR/TE); matrix, 192 × 160; echo train length, 23; field of view, 83 mm; slice thickness, 0.5 mm; flip angle, 170°. Contrast material was not used in MRIs. Superior-inferior (vertical-V-) diameter, anterior-posterior (horizontal-H-) diameter, and CSA were evaluated at the fundus of IAC (Figure 1). CSA was calculated with the following formula: π (V/2) (H/2).

Statistical analysis

An SPSS 17 statistical package (Chicago, IL, USA) was used for the statistical analysis. The differences in the cochlear nerve size between gender and the right and left ears were determined with a t-test. The difference in the cochlear nerve size among societies was compared with a z-test using data from literature. A P-value of <0.05 was considered statistically significant.

RESULTS

The patients ranged in age from 20 to 64 years (mean: 42.0±9.7). Nine patients were female (mean age 41.22±10.56) and 12 were male (mean age 42.58±9.43). The average superior-inferior diameter, anterior-posterior diameter, and CSA were 1.11±0.08 mm, 1.10±0.08 mm, and 0.96±0.14 mm^2, respectively. No difference was found between the right and left ears and gender and among societies ($p>0.05$).

DISCUSSION

A small cochlear nerve is a relative contraindication; on the other hand, a truly absent cochlear nerve is an absolute contraindication to cochlear implantation (9). Therefore, the presence and size of the cochlear nerve is important.

In early studies, cochlear nerve size assessment was conducted using a comparative method (10). This method is generally acknowledged, but this is the qualitative way for the evaluation of nerve size. Diseases affecting the cochlear nerve can also affect both the facial and vestibular nerves or only facial or vestibular nerves. In this case, the comparative method may be misleading. Therefore the quantitative assessment of normal cochlear nerve size, which was firstly made in 2009, is crucial (5).

Jaryszak et al. (5) evaluated the cochlear nerve size in 45 audiometrically normal-hearing ears using a CISS-sequence MRI. The average superior-inferior diameter, anterior-posterior diameter, and CSA of the cochlear nerve were 1.4 mm±0.21 mm, 1.0 mm±0.15 mm, and 1.1±0.26 mm^2, respectively, in their study. Kang et al. (7) evaluated the size of cochlear and facial nerves in normal-hearing ears with 3-T MRI. They have found that the cochlear nerve size is bigger than facial nerve size and that aging does not affect the cochlear nerve size. The average superior-inferior diameter, anterior-posterior diameter, and CSA of the cochlear nerve were 1.10±0.21 mm, 1.11±0.20 mm, and 0.98±0.33 mm^2, respectively, in their study. Herman et al. (6) evaluated the differences in the cochlear nerve size between normal-hearing and postlingually deafened patients by MRI. There were seven normal-hearing adults in their study. The average superior-inferior diameter, anterior-posterior diameter, and CSA of the cochlear nerve were 1.07±0.17 mm, 1.10±0.17 mm, and 0.94±0.28 mm^2, respectively, in their study. No size difference was found between these studies and our study that used a z-test ($p>0.05$) (Table 1). Additionally, Nadol and Xu (3) reported a maximum cochlear diameter of 1.04 mm in five normal-hearing cadavers, which compares well with our study. Similar to our study, no size difference was found between gender (3, 7, 8) or between the right and left ears (7, 10).

Sildiroglu et al. (8) reported a mean CSA of 2.52 mm^2 (min: 2.32 and max: 5.32) in 28 normal-hearing ears. They used a special software for measurements. Additionally, the measurements were conducted in IAC where the cochlear nerve was best seen. They did not indicate the exact localization of the measurements. We think that these factors are reason for this discrepancy.

The drawbacks of this study are as follows: firstly, the number of patients included in this study is small, but we think that a large number cannot change the mean size of the cochlear nerve because the size is very close in each study for each ear and results match well with the previously reported studies. Secondly, the evaluations were performed with 1.5-T MRI. Measurements can be conducted more accurately using 3.0-T MRI, but we think that images obtained with 1.5-T MRI are good enough to evaluate the cochlear nerve size. The results of Jaryszak et al. (5) and Kang et al. (7), who used 1.5- and 3.0-T MRI, respectively, support our results. Additionally, measurements in cadavers (3) compared well with both these studies. However, further correlative studies that evaluate the concordance between 1.5- and 3.0-T MRI for the evaluation of the cochlear nerves are needed.

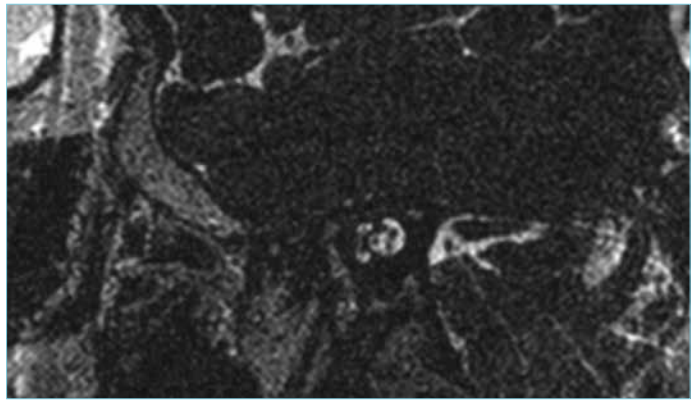

Figure 1. The measurements were evaluated at the fundus of the internal auditory canal on a parasagittal CISS image. Left is the anterior and right is the posterior of the patient

Table 1. Cochlear nerve size in four different studies

	Jaryszak et al. (5)	Herman et al. (6)	Kang et al. (7)	Our study
V	1.4±0.21	1.07±0.17	1.10±0.21	1.11±0.09
H	1.0±0.15	1.1±0.17	1.11±0.20	1.10±0.08
CSA	1.1±0.26	0.94±0.28	0.98±0.33	0.96±0.14

V: Vertical diameter (mm), H: horizontal diameter (mm), CSA: cross-sectional area (mm^2)

CONCLUSION

This study shows that the mean normal size of the cochlear nerve does not change among societies and that these data may be useful for the preoperative assessment of cochlear implant candidates.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Cumhuriyet University. Decision number: 2012-06/14

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Authors' contributions: Conceived and designed the experiments or case: Hİ, MFE, MD, KD, EM, ÜEV. Performed the experiments or case: Hİ, MFE, MD, KD, EM, ÜEV, EIA. Analyzed the data: Hİ, MFE, MD, KD, EM, ÜEV, EIA. Wrote the paper: Hİ, MFE, MD, KD, EM, ÜEV, EIA. All authors read and approved the final manuscript.

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