A Comparison of Cochlear Nerve Size in Normal-Hearing Adults Using MRI

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INTRODUCTION

The prognostic relevance of cochlear nerve size on cochlear implantation is currently not well-established. Increasing evidence is emerging that cochlear nerve hypoplasia is a predictor of poor outcome post cochlear implantation, and that cochlear nerve size correlates with duration of hearing loss[1,2,3,4]. Measuring the size of the cochlear nerve before cochlear implantation may be helpful in preoperative counselling of the patients as well as in potentially determining the eligibility and timing for the operation [2].

The present study investigates the currently unproven hypothesis that there is no difference in cochlear nerve size between the two ears in normal-hearing adults.

MATERIALS AND METHODS

All patients with tinnitus requiring MRI to exclude a cerebellopontine angle lesion presenting to an Ear, Nose and Throat (ENT) outpatient clinic between January 2012 and August 2013 were retrospectively assessed to select study subjects with normal hearing and no nerve pathology. Patient demographics, pure tone audiometry (PTA) averages at frequencies of 500 Hz, 1 kHz, 2 kHz, and 4 kHz, side of the tinnitus, and any predisposing factors for cochlear or facial nerve disorders were recorded.

Exclusion criteria were abnormal hearing, described as average PTA scores equal to or greater than 30 at the four measured frequencies, history of facial nerve palsy, previous ear surgery, and demyelinating disease (Table 1).

Exclusion criterion	Number of patients
Abnormal hearing on PTA	48
Facial nerve palsy / previous inner ear surgery	2
Demyelinating disease	1
No MRI scan	2

Table 1. Exclusion criteria in a cohort of patients with normal hearing and unilateral tinnitus

	Right cochlear nerve	Left cochlear nerve	p
Mean±SD, mm ²	1.16±0.34	1.16±0.30	0.827
Range, mm ²	0.75-2.30	0.71-1.90	
	Right facial nerve	Left facial nerve	p
Mean±SD, mm ²	0.84±0.23	0.86±0.25	0.723
Range, mm ²	0.58-1.68	0.51-1.62	

Table 2. Cochlear and facial nerve size in normal-hearing adults with tinnitus

Figure 1 Para sagittal CISS MRI of Internal Acoustic Meatus (IAM) of patient with normal hearing

RESULTS

During the study, 151 patients had undergone MRI scans; 53 had some cause for exclusion (see Table 1). Of the 98 patients whose MRIs were reviewed for the study, scans of 37 (38%) patients were considered of adequate quality to visualize and measure the Cross-sectional area (CSA) of cochlear and facial nerves bilaterally.

The Intraclass correlation coefficient (ICC) of nerve size measurements between the two observers (CH and LZ) was >0.85 in all measurement groups, indicating an almost perfect agreement. For the purpose of this study, measurements of the first observer are provided.

There was no statistically significant difference between right and left ears of either the cochlear nerve or the facial nerve sizes, p-values 0.827 and 0.723, respectively (Table 2).

No significant differences in nerve size were found between genders, between scans on different strength MRI scanners, age or side of tinnitus.

DISCUSSION

The current study demonstrates that sizes of the cochlear and facial nerves are symmetrical in normal-hearing adults. There was very good inter-rater agreement between the measurements of the two observers, and the mean nerve sizes in this study were comparable to normal diameters previously published [6,7]. Previous research has demonstrated that hearing loss may cause anatomical and histological changes in the auditory pathway [8, 9]. Clearly, these results hinge on whether the nerves are symmetrical in “normal” ears, which we have now proven.

One of the limitations of our study was poor quality of the MRI images, requiring exclusion of >50% of study individuals. The main reasons the nerve sizes could not be measured adequately were movement artefact, nerve clustering in the internal auditory meatus (IAM) or adherence to the walls of the IAMs.

CONCLUSION

This study establishes that cochlear and facial nerve sizes are symmetrical in normal-hearing adults and are not affected by age or gender. The adequacy of the MRI imaging to allow nerve size measurement remains quite poor currently, but as quality of scans and the software used to interpret them improves, so should our ability to assess nerve size. Nerve size assessment should remain an active area of research in otological disease particularly in the context of potential cochlear implants.

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