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Hearing in Static Unilateral Vestibular Schwannoma Declines More Than in the Contralateral Ear

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Abstract

Objective—To determine the effect of static vestibular schwannomas on hearing.

Study Design—Retrospective review of audiometric measures in 15 patients with documented nongrowth of internal auditory canal and cerebellopontine angle enhancing masses.

Methods—Data from patients seen in an ambulatory tertiary care setting between the years of 2002 and 2012 with a diagnosis of acoustic neuroma or vestibular schwannoma were reviewed. Exclusion criteria included preexisting otologic disease, prior therapy for the schwannoma, and tumor growth. Radiology reports were reviewed to ensure nongrowth and were confirmed by taking magnetic resonance imaging (MRI) measurements ourselves. Audiologic measurements included pure tone average, enhanced pure tone average (average of .5, 1, 2, and 4 KHz thresholds), 4 KHz threshold, 8 KHz threshold, and speech discrimination. The data were analyzed using mixed effect model with unstructured variance-covariance structure.

Results—Difference in audiometric measures between ears significantly ($P < .05$) increased for all measures except 8 KHz.

Conclusion—Spontaneous decline in hearing relative to time is exaggerated in the affected ear despite no vestibular schwannoma growth. This finding can be useful for patient counseling and treatment decision making.

Keywords

static acoustic neuroma; nongrowing acoustic neuroma; static vestibular schwannoma; static acoustic neuroma

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Declaration of Conflicting Interests

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Introduction

Acoustic neuromas (AN), or vestibular schwannomas (VS), represent benign, often slow growing tumors of the eighth cranial nerve that may present with unilateral hearing loss, tinnitus, dizziness, or increasingly, as incidental findings on magnetic resonance imaging (MRI). The rate of incidence is about 1.1 per 100 000 people. Advances in imaging have made it possible to identify small, asymptomatic neuromas. The early detection of developing neuromas offers new challenges in determining the best method or methods of treatment. Current treatments for acoustic neuromas include various surgical approaches as well as radiosurgery.[1] Since the 1980s, conservative management using serial MRIs to monitor tumor growth has increased in popularity.[2]

Recent publications have confirmed that many enhancing internal auditory canal/cerebellopontine angle (IAC/CPA) masses do not increase in size on serial MRI.[3,4] Little information is available, however, regarding the deterioration of hearing in these static acoustic neuromas. One study warns of a "significant risk of useful hearing loss with conservative management of non-growing acoustic neuromas."[5] However, the audiometric assessments were based on the "50/50"[6] and "70/30"[7] rules. As a result, there were not sufficient data for statistical analysis. In addition, no account was taken of the natural decline in hearing over time, as is seen with presbycusis.

This study looks more closely at the problem of hearing deterioration of nongrowing IAC/CPA masses by studying the lack of change in vestibular schwannoma size compared to the spontaneous change of hearing in both ears over time. Radiologists' reports of stable tumor size on MRI of the IAC/CPA were confirmed by the authors' own review of the imaging. Multiple audiometric measures (pure tone thresholds and speech discrimination), taken at yearly intervals, were assembled in a retrospective review of patient medical information. The hearing in the affected ear was compared to the hearing in the nonaffected ear as its own control, and the value difference for each audiometric measure was recorded. Finally, sufficient numerical measurements were obtained in order to perform a rigorous statistical analysis. The hypothesis that the presence of an IAC/CPA mass per se is associated with more rapid hearing decline in the affected ear compared to the contralateral ear was confirmed.

Materials and Methods

This study was approved by our Institutional Review Board.

Subjects

Patients with a diagnosis of AN or VS who had been seen by the otolaryngology department between 2002 and 2012 were identified in the electronic medical record. One hundred fifty patient charts were reviewed. Patients with static ANs were identified by reviewing radiology reports of MRI studies that were read as "no growth," and these readings were confirmed with our own measurements of both the IAC and CPA components of the tumor on both axial and coronal views. Nongrowth was defined as less than 1 mm size difference, in all dimensions, between data points. Patients with a history of otologic operations or a

history of ear disease such as otosclerosis were excluded. Patients who eventually chose resection or stereotactic surgery were included in the study but only for the time period that they were followed prior to intervention. Patients who ultimately progressed to tumor growth were also included but only during their time period of no growth. After all patient charts were reviewed, 15 patients were included in the study (N = 15).

Radiographic Measurements

Radiologists' readings of no tumor growth were confirmed by reviewing the MRI imaging on a General Electric Centricity PACS system. Measurements were first taken of the intracanalicular and extracanalicular portion of the IAC/CPA mass parallel to the IAC on axial view. Another measurement was taken at the largest dimension of the extracanalicular portion of the mass parallel to the cerebellar plate on axial view. A final measurement was taken in the coronal view of the largest inferior to superior component of the extracanalicular portion of the tumor. These surveillance MRIs were taken over a range of follow-up of 1 to 6 years.

Audiometry

All patients underwent audiometric testing within the audiology department of the author's home institution and multiple audiologic measurements were obtained. Speech discrimination scores were obtained with monitored live voice testing. The difference between the affected and unaffected ear was calculated for each measurement. Pure tone averages were measured by averaging the hearing thresholds (dB) at 500 Hz, 1 kHz, and 2 kHz. In order to incorporate another natural speech frequency, enhanced pure tone averages were also calculated by taking the average hearing thresholds (dB) at 500 Hz, 1 kHz, 2 kHz, and 4 kHz. Hearing level was also recorded for the isolated frequencies of 4 kHz and 8 kHz. Lastly, speech discrimination scores were obtained from the audiogram. These audiograms were taken at yearly intervals with a range of 1 to 6 years of follow-up.

Statistical Analysis

Statistical analysis was performed using a mixed effect model with unstructured variance-covariance structure. This method primarily identifies longitudinal rates of change over time of individuals' dependent variables and then analyzes the cluster of these individuals' trends.

Results

Fifteen patients met criteria for inclusion. Age at diagnosis ranged from 32 to 78 years old. There was a male to female ratio of 4:11. All patients had tumors involving the IAC, and 5 had additional involvement of the CPA. The extent of IAC tumor involvement ranged from 3 to 14 mm. The CPA dimensions ranged from 3 to 15 mm.

The difference in audiometric measures between the unaffected and the affected ear significantly increased ($P < .05$) for most measures. At 8 kHz, the difference between the 2 ears increased over time but not statistically significantly. Table 1 shows the specific value of the difference between ears for each of the acoustic measurements as time intervals progress. Table 2 shows the comparison of audiometric measurements between ears over time: the

range of differences between ears, the average difference between ears, and the *P* values for the difference between ears. The average difference in PTA and enhanced-PTA between ears increased by 10.5 and 9.4 dB, respectively, with a maximum increase in difference of 33 and 29 dB, respectively. The average difference in 4 kHz levels between ears increased by 10.9 dB with a maximum increase in difference of 45 dB. The average difference in speech discrimination between ears increased by 24% with a maximum increase in difference of 100%. The only nonsignificant difference, which was at 8 kHz, had an average increase of only 4 dB and a maximum increase in difference of 60 dB. Patients 2 and 13 showed a widening of the difference in speech discrimination scores, which partially recovered. Patients 5 and 8 transient improvements in the difference in speech discrimination. It should be noted that while there were a few patients who maintained stable hearing over time in some measures, the majority worsened. Those with stable hearing were included in our statistical analysis that found statistically significant hearing reduction overall.

Discussion

The goal of our study was to determine the natural course of hearing in patients with nongrowing ANs. To establish how much of the threshold changes over time were not due to other conditions, such as presbycusis, acoustic measurements of the affected ear were compared to the same measurements at the same time point of the unaffected ear, thus using the normal ear as a control. These data show that hearing thresholds and speech discrimination progressively diminish in the ear with a static AN when compared to the opposite ear. Specifically, the difference in speech discrimination scores tended to widen with some patients showing transient narrowing or widening of the difference. The unstructured covariance matrix analysis accommodates these independent fluctuations of values. When the patient is deciding which treatment to pursue, this information gives a realistic view regarding the choice of conservative observation: hearing and speech discrimination will decrease in the ear with the AN, even if the schwannoma is not growing.

Large series of hearing in observed acoustic neuromas are available for comparison with our study.[8–10] One study found that speech initial speech discrimination scores better than 70% would remain better than 70% in about 60% of patients over 5 years.[8] Another clearly establishes that good initial PTAs and speech discrimination scores are favorable prognostic indicators for hearing maintenance.[9] The third series confirms these findings, adding that the larger tumors and the ones that were growing were more likely to have worse hearing measures.[10] These previous findings are in complete agreement with our study. However, our study adds these 3 additional components of information. We only looked at nongrowing tumors, a subclass that was not specifically targeted in the other studies, although referred to graphically in 1 study.[10] Another key component is that the affected and unaffected ears were tracked in parallel, a technique that was used in only 1 study[10]; however, these comparisons were for all tumors whether growing or not.

Finally, in contrast to previous studies, this study does not use the AAO-HNS class groupings (A, B, C, D) as measures of hearing since these are less precise (eg, class A has 100%–70% speech discrimination range). Instead, this study tracks specific audiometric measures for a more precise description of hearing deterioration. Alternatively, previous

studies have used the 50–50 or 70–30 rules. However, in this study, the PTA, enhanced-PTA, 4 kHz, 8 kHz, and speech discrimination values were analyzed for both ears in our study. (It can be noted here that the range of speech discrimination for test-retest variability as recorded by Thronton and Raffin[11] tend to be wider than many of the speech discrimination differences and changes recorded here. Nonetheless, the differences found here were statistically significant.) We were careful to account for natural progression of hearing by comparison with the unaffected ear and eliminating all subjects with prior ear disease or otologic operations. We do realize that our subject number poses a limitation on our study; however, we feel this was required in order to control for confounding factors and also provides a direction for future studies.

Conclusion

Patients with static IAC/CPA enhancing masses should be aware that though they may maintain “serviceable hearing” based on prior classifications,[8] their hearing ability will still likely deteriorate over time based on the specific measures addressed in this study. They should also clarify with the patient the importance of both hearing thresholds and speech discrimination as these both affect patients in different manners. Clinicians should be prepared to have an in-depth discussion regarding treatment options and potential outcomes, with or without treatment, as these may impact patients’ decision making over their treatment course.

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Table 1

The Difference Between Ears for Each Audiometric Measurement for Each Patient Studied as Time Intervals Progress.

Patient ID	Time Interval (years after baseline)	PTA Difference (dB)	Enhanced PTA Difference (dB)	4K Difference (dB)	8K Difference (dB)	Speech Discrimination Difference (%)
1	0	0	0	0	0	0
1	1	4	3	5	0	4
1	3	0	0	0	0	0
1	5	2	3	5	0	0
2	0	11	19	40	40	8
2	4	50	53	60	30	100
2	5	32	36	50	20	36
3	0	32	25	5	0	48
3	1	64	56	35	30	100
3	2	42	40	35	15	100
3	5	47	48	50	40	100
4	0	12	19	41	90	0
4	2	30	40	70	90	44
5	0	22	25	35	30	76
5	2	40	40	40	30	76
5	3	45	43	40	30	60
5	4	43	42	35	20	88
6	0	0	0	0	0	0
6	1	0	0	0	0	0
7	0	22	34	70	70	2
7	1	27	41	75	70	24
8	0	29	28	25	20	54
8	1	34	30	20	10	40
8	2	35	32	20	25	68
9	0	5	1	0	20	0
9	1	3	6	15	40	56
10	0	10	6	−5	65	0
10	1	43	35	20	60	96

Patient ID	Time Interval (years after baseline)	PTA Difference (dB)	Enhanced PTA Difference (dB)	4K Difference (dB)	8K Difference (dB)	Speech Discrimination Difference (%)
11	0	62	59	40	35	60
11	2	53	50	40	25	70
12	0	20	26	45	20	16
12	1	35	40	55	35	20
13	0	0	4	0	20	0
13	1	7	5	0	0	0
13	2	21	17	5	0	24
13	3	17	12	5	5	0
14	0	0	0	10	10	0
14	1	0	0	10	0	12
15	0	0	0	0	0	0
15	4	0	0	5	60	8
15	6	3	5	5	60	0

Table 2

The Comparison of Audiometric Measurements Between Ears Over Time: The Range of Differences Between Ears, the Average Difference Between Ears, and the *P* Values for the Difference Between Ears.

Measure	Increase of Difference Between Ears Over Time	Average Increase of Difference Between Ears Over Time	*P* Value
Pure tone average, dB	0–33	10.5	.0055
Enhanced pure tone average, dB	0–29	9.4	.0047
4 kHz, dB	0–45	10.9	.0041
8 kHz, dB	0–60	4	.1095
Speech discrimination, %	0–100	24	.0256