Hearing Preservation Surgery in Acoustic Neuroma Patients with Normal Hearing

ABSTRACT—Acoustic neuroma (AN) patients who had normal hearing accounted for 7% of all our AN cases. It is important to identify AN patients who have normal hearing but are suffering from tinnitus, dizziness, or vertigo, or a combination of these symptoms (without hearing loss), in order to make an early diagnosis. Patients who experience sudden hearing loss and recover completely should also be thoroughly examined in order to rule out AN. In this article, we describe an investigation of the clinical features and results of hearing preservation surgery in AN patients with normal hearing. The overall hearing preservation rate was 57%. The hearing preservation rate did not depend on the auditory brainstem response (ABR) pattern, tumor size, or the origin of the tumor. We think that patients must be properly informed concerning all aspects of the surgery, including the possibility that hearing and/or facial nerve function cannot be preserved.

Hearing loss and tinnitus are the most common initial symptoms of acoustic neuroma (AN) patients.¹ Besides these symptoms, however, dizziness or vertigo and fullness of the ear have been reported as an initial symptom in patients with a small AN,²⁻⁶ as well as sudden hearing loss.⁷⁻¹³ In some AN patients presenting with sudden hearing loss, the hearing recovers to normal with conservative treatments.¹²

Indications for attempted hearing preservation surgery could depend on the tumor growth rate, the prognosis of normal hearing, the hearing preservation rate, and the quality of preserved hearing. In this article, we report the clinical features and the results of hearing preservation surgery in AN patients with normal hearing.

MATERIALS AND METHODS

Twenty-eight of 400 patients who had received a histologically verified diagnosis of vestibular schwannoma presented with normal preoperative hearing. Seventeen were males and 11 were females. Ages ranged between 20 and 60 years (average, 41 years). In 13 of 28 cases, hearing loss appeared suddenly, followed by complete recovery. There were four cases of subjective hearing loss, four cases of tinnitus, and four cases of dizziness as an initial symptom (Table 1).

These patients were operated on by a team of neurotologists and neurosurgeons at Keio University Hos-

Table 1. Initial Symptoms in 28 Patients with Normal Hearing

<i>Initial Symptoms</i>	<i>Patients</i>
Sudden hearing loss with complete recovery	13
Subjective hearing loss	4
Tinnitus	4
Dizziness	4
Vertigo	2
Fullness of the ear	2
Gait disturbance	1
Headache	1
Hemifacial pain	1
No symptom	1

pital during the past 11 years. The surgical technique incorporated either the middle cranial fossa (MCF) or the extended MCF (EMCF) type III approach.¹⁴ In the latter, the superior petrosal sinus and cerebellar tentorium were sectioned in addition to the procedures of the MCF approach. Generally, the EMCF type III was used in cases in which a tumor extended 10 mm or more into the posterior fossa. In some cases involving a tumor less than 10 mm in size, however, the EMCF type III approach was applied in order to monitor the compound action potential of the cochlear nerve.

In this study, normal hearing was defined as follows; (1) Pure-tone hearing levels at six frequencies from 250 to 8000 Hz were all less than 25 dB or (2) hearing levels between 250 and 4000 Hz were less than 25 dB and an interaural difference in hearing level at 8000 Hz was less than 10 dB.

Auditory brainstem response (ABR) was elicited by click stimuli delivered at a rate of 20/s. Interaural difference of wave V (IT5) was used as a parameter of ABR.

Tumor size was measured using magnetic resonance imaging (MRI) and computed tomography (CT), and was confirmed during surgery. Tumor size in the posterior fossa was measured along the longitudinal axis of the internal auditory canal.

Postoperative follow-up examinations were conducted over a period of from 3 to 10 years (average, 4.8 years). Tumor recurrence was monitored by MRI every

6 months in the first postoperative year and then every year afterward.

Postoperative hearing results were evaluated using the classification set by the American Academy of Otolaryngology, Head and Neck Surgery (Table 2).¹⁵ Postoperative facial nerve function was evaluated with the House-Brackmann grading system.

Statistically significant differences were tested using a nonparametric test (Spearman's rank correlation test).

RESULTS

Hearing Preservation

Hearing Preservation Rate and Quality of Preserved Hearing

Among the patients who had normal preoperative hearing, measurable hearing was preserved in 16 cases. The overall hearing preservation rate was 57%. Class A hearing was preserved in 10 cases (36%), Class B hearing in four cases (14%) and Class D hearing in two cases (7%) (Tables 3 and 4).

Of the 25 patients with Class A (except normal) preoperative hearing, on the other hand, Class A hearing was preserved in five (20%); Class B hearing in six (24%); and Class D hearing in five (20%) (Table 2). There was no significant difference in postoperative hearing between each group.

Audiometric Pattern in Patients Presenting with Sudden Hearing Loss

In 8 out of 13 patients showing complete recovery from sudden hearing loss, the initial audiometric pattern was a trough-type or its variations. No characteristic audiometric pattern was found in relation to hearing preservation (Table 5).

ABR Findings

Of six patients showing normal ABR (IT5 less than 0.2 ms), hearing was preserved in four (67%). Hearing was preserved in 10 of 18 patients (56%) with prolonged

Table 2. AAO-HNS Classification Postoperative Hearing

	<i>Pre-Op</i>		<i>No. Cases</i>	<i>HP Rate(%)</i>	<i>Post-Op</i>			
	<i>PT</i>	<i>SDS</i>			<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Normal hearing			28	57	10	4	0	2
Class A*	≤30	≥70	25	64	5	6	0	5
Class B	30~50	≥50	26	35	0	4	0	5
Class C	>50	≥50	9	56	0	0	3	2
Class D		<50	10	30	0	0	0	3
Total		98	98	50	15	14	3	17

AAO-HNS: American Academy of Otolaryngology, Head and Neck Surgery; PT: pure-tone hearing level (dB); SDS: speech discrimination score (%), HP rate: hearing preservation rate

*In this series, classification of patients in Class A excluded those with normal hearing.

Table 3. Cases in Which Hearing Was Preserved

Case No.	Tumor Size (mm)	Pre-Op		Post-Op		Class	Post-Op H-B Grade	Year
		PT (dB)	SDS (%)	PT (dB)	SDS (%)			
1	12	23	80	40	80	B	III	1986
2	10	13	92	30	90	A	I	1988
3	10	20	78	87	40	D	I	1989
4	20	13	92	28	60	B	I	1989
5	IC	13	92	23	90	A	I	1990
6	IC	15	94	25	92	A	I	1990
7	8	19	94	92	14	D	I	1991
8	15	10	96	18	94	A	II	1991
9	25	10	90	38	74	B	I	1992
10	IC	7	9	20	85	A	I	1994
11	IC	8	96	7	98	A	I	1994
12	10	22	92	28	72	A	II	1994
13	10	10	78	25	90	A	I	1994
14	5	15	92	25	90	A	I	1994
15	10	15	100	32	90	B	I	1995
16	8	20	96	23	90	A	I	1995

IC: intracanalicular tumor, PT: pure-tone hearing level (dB), SDS: speech discrimination score (%), H-B grade: House-Brackmann's grading system, Year: year of surgery.

Table 4. Patients in Whom Hearing Was Not Preserved

Case No.	Tumor Size (mm)	Pre-op		Post-op H-B Grade	Year
		PT (dB)	SDS (%)		
1	6	23	88	II	1985
2	20	6	96	II	1989
3	IC	12	96	I	1990
4	IC	15	96	I	1990
5	IC	13	98	I	1990
6	10	23	92	I	1992
7	10	13	92	III	1992
8	IC	25	94	III	1993
9	12	15	98	I	1993
10	IC	22	92	III	1993
11	IC	18	94	I	1993
12	10	17	88	III	1993

IC: intracanalicular tumor, PT: pure-tone hearing level (dB), SDS: speech discrimination score (%), H-B grade: House-Brackmann's grading system, Year: year of surgery.

IT5, and in two of three patients (67%) in whom wave V was not identified (Table 6). There was no correlation between the ABR findings and hearing preservation.

Tumor Size

The hearing preservation rate was 44% in nine patients with an intracanalicular tumor, 62% in 13 patients with a tumor smaller than 10 mm, and 67% in six patients with a tumor larger than 11 mm (Table 7). There was no significant differences in the hearing preservation rate between these groups.

Nerve of Origin

The original nerve was identified during surgery in 24 cases. Seventeen cases originated from the inferior vestibular nerve and 7 from the superior vestibular nerve. There was no relationship between the original nerve and hearing preservation.

Surgical Approach

Hearing was preserved in six of 11 patients (54%) with use of the MCF approach and in 10 of 17 patients (59%) with the EMCF approach.

Table 5. Audiometric Patterns of Patients with Sudden-Onset Hearing Loss

Audiometric Pattern	Hearing Preserved	Hearing Not Preserved	Total
Low tone-type	1	0	1
Trough-type	4	4	8
C ₅ dip-type	1	0	1
Others	3	0	3
Total	9	4	13

Table 6. ABR Pattern and Hearing Preservation
(One patient who had conductive hearing loss
in the nontumor side was excluded.)

ABR Pattern	Hearing Preserved	Hearing Not Preserved	Total
IT5 ≤ 0.20 ms	4	2	6
0.21–0.50 ms	3	3	5
0.51–0.80 ms	2	2	5
≥ 0.81 ms	5	3	8
Wave I only	1	0	1
No response	1	1	2
Total	16	11	27

ABR, auditory brainstem response

Table 7. Tumor Size and Hearing Preservation

Tumor Size	Hearing Preserved	Hearing Not Preserved	Total
IC	4	5	9
≥ 5 mm	1	2	3
6–10 mm	7	3	10
11–15 mm	2	0	2
16–20 mm	1	2	3
≥ 21 mm	1	0	1
Total	16	12	28

Long-term Follow-up of Preserved Hearing

Postoperative follow-up examinations were conducted over a period of from 3 to 10 years (average: 4.8 years). In all cases except for one recurrence, the postoperative hearing has been maintained without any deterioration.

Facial Nerve Preservation

In 16 patients whose hearing was preserved, postoperative facial nerve function was labeled as grade I in 13 cases, grade II in two cases and grade III in one case. In 12 patients whose hearing was not preserved, six cases were grade I, two cases grade II, and four cases grade III.

DISCUSSION

Incidence of AN Cases in Patients with Normal Hearing

In our series, the incidence of AN in patients with normal hearing was approximately 7% (28 out of 400 patients). The category varies according to the definition of normal hearing^{3,4}; however, this rate corresponds to 5% (21 of 408 patients) in Beck's series,³ and 6% (38

of 614 patients) in Roland's series,⁴ and 12.5% in Saleh's recent series.⁶

Initial Symptoms

An increasing number of AN cases presenting as sudden hearing loss have been reported recently.^{7–13} The prevalence of these cases varies from 0.8 to 3.0%.¹¹ Mid-frequency hearing loss or trough-type loss was observed frequently in these patients.^{9,12,16,17} This type of deafness was often seen in patients with small tumors,^{9,10} in whom hearing loss recovered spontaneously or with treatment.¹³ Therefore, AN should be strongly suspected when a patient presents with sudden hearing loss having this type of audiometric pattern.

Four patients complained of subjective hearing loss even though their pure-tone hearing levels and speech discrimination scores were within normal range. We recommend that subjective hearing loss be further examined by ABR and MRI. Similarly, in cases in which there are only tinnitus and/or dizziness and/or fullness in the ear, AN should also be ruled out. Beck³ reported initial symptoms in normal-hearing patients including disequilibrium, tinnitus, headache, facial numbness, nausea and vomiting, diplopia, and otalgia. Roland⁴ reported fullness of the ear, vertigo, and facial numbness as an initial symptom.

ABR Findings

IT5 less than 0.2 ms has been regarded as normal in patients with averaged hearing level of less than 70 dB at 4 kHz and 8kHz.¹⁸ Normal IT5 was seen in 23% of patients with normal hearing, indicating the true positive rate of ABR in normal-hearing AN patients was 77%. This rate was much lower than the more than 93 to 97% true positive rate reported in other series.^{6,18} Therefore, an MRI examination should be performed if a small tumor is suspected in a patient with normal ABR.

Tumor Size

Average tumor size was 7.5 mm in patients with normal hearing, whereas the size was 17.4 mm on average in the other 372 patients in our series. In Roland's series, the tumor size covered a wide range, from 0.4 to 4.5 cm, and small tumors were found in only 25 % of all cases.⁴ In our series, the tumor size was less than 20 mm in all cases except one. In 22 of 28 cases (79%), the tumor size was less than 10 mm. The difference in the incidence of small tumors may be due to the incidence of early diagnosed cases, the location from where the tumor originated, and the direction of tumor growth.

Hearing Preservation Rate

There are few reports on hearing preservation surgery performed on patients with normal hearing. The hearing preservation rate was 57% in our series—not significantly higher than the 50% for all cases.¹⁹ Patients with normal hearing before surgery had higher hearing preservation rates afterwards than those who had hearing loss before surgery. Though no statistically significant difference was found in postoperative hearing between the patients with normal hearing and those with Class A (except normal) hearing, there were more patients with postoperative Class A hearing among patients with normal hearing.

The hearing preservation rate and quality of postoperative hearing did not depend on the ABR findings, the tumor size, the nerve of origin, nor the type of surgical approach.

Indications for Hearing Preservation Surgery and Informed Consent

The decision to perform surgery on patients with normal hearing is controversial among surgeons because they cannot guarantee hearing will be preserved after surgery. At present, we inform patients about the functional preservation rate of the cochlear and facial nerves and possible cranial nerve and brain complications; then patients have to make the final decision whether or not to have surgery.

Patients who experienced sudden hearing loss followed by complete recovery often opted for surgery, mostly because they understood that hearing loss may recur—with the possibility of losing hearing permanently in that ear. For similar reasons, most patients suffering from dizziness or vertigo accepted surgery because of their fear of these symptoms. Patients whose initial symptoms were only tinnitus or subjective hearing loss more commonly refused surgery. In such cases, we monitor the hearing and the growth of the tumor by MRI.

In order to establish the indications for hearing-preservation surgery in AN, it will be crucial to clarify the long-term outcome of hearing in AN patients and the factors affecting the growth of the tumor.

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