Published in final edited form as:

Otol Neurotol. 2017 March ; 38(3): 392–399. doi:10.1097/MAO.0000000000001292.

Multifactor Influences of Shared Decision-Making in Acoustic Neuroma Treatment

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Abstract

Objective—To identify factors associated with treatment modality selection in acoustic neuromas.

Study Design—Prospective observational study

Setting—Tertiary care neurotology clinic

Patients—Data was prospectively collected from patients initially presenting to a tertiary care neurotology clinic between 2013 and 2016. Patients who did not have MRI, demographic, psychometric, or audiometric data were excluded from analysis.

Intervention—Demographic information, clinical symptoms, tumor characteristics, and psychometric data were collected to determine factors associated with undergoing acoustic neuroma surgical resection using univariate and multiple logistic regression analysis.

Main Outcome Measure—The decision to pursue acoustic neuroma surgical resection versus active surveillance.

Results—A total of 216 patients with acoustic neuroma (mean age 55 years, 58% female) were included. 98 patients (45.4%) pursued surgical resection, 118 patients (54.6%) pursued active surveillance. Surgical treatment was significantly associated with patient age < 65, higher grade tumors, growing tumors, larger volume tumors, lower word discrimination scores, Class D hearing, headache and vertigo as presenting symptoms, higher number of total symptoms, and higher headache severity scores ($p < 0.05$). There was no significant association between surgical intervention and preoperative quality of life, depression, and self-esteem scores. On multiple logistic regression analysis, the likelihood of undergoing surgical resection significantly decreased for patients older than age 65 (OR 0.19; 0.05-0.69) and increased in patients with medium (OR 4.34; 1.36-13.81), moderately large (OR 33.47; 5.72-195.83), large grade tumors (OR 56.63; 4.02-518.93), tumor growth present (OR 4.51; 1.66-12.28), Class D hearing (OR 3.96; 1.29-12.16), and higher headache severity scores (OR 1.03; 95% CI 1.01-1.05). The likelihood of undergoing surgical resection was completely predictive for giant grade tumors and not significant for small grade tumors and Class B or C hearing.

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Conflicts of Interest and Source Funding: Nothing to disclose

Conclusions—Non-elderly acoustic neuroma patients with larger tumors, growing tumors, significant hearing loss, and worse headaches are more likely to pursue surgical resection rather than active surveillance. Psychological factors such as quality of life, depression, and self-esteem do not seem to influence decision-making in this patient population.

Introduction

Acoustic neuromas (ANs; also known as vestibular schwannomas) are benign, typically slow growing, tumors with an incidence of 1 per 100,000 persons per year.¹ Patients may present with tumors incidentally discovered on magnetic resonance imaging (MRI) or with symptoms, which include unilateral hearing loss, tinnitus, vertigo, and imbalance.² Currently, management options for acoustic neuromas include active surveillance, stereotactic radiation, and microsurgical resection, with treatment strategy trends shifting over the past decades.^{3, 4} Furthermore, three surgical approaches are routinely utilized for acoustic neuroma resection: retrosigmoid, translabyrinthine, and middle fossa approaches.⁵

With the goal of reducing morbidity and mortality, surgeons consider various patient factors including health status, age, clinical symptoms, hearing status, tumor size and location, tumor growth status, and overall surgical risk when recommending surgical intervention.^{6–8} Furthermore, surgeons consider the natural course of these benign, slow growing tumors while incorporating patient values, preferences, and expectations.⁷ While there are a few strong indications for acoustic neuroma surgery, including obstructive hydrocephalus and significant brainstem compression, these cases are rare. When presenting for surgical evaluation, patients engage in a shared-decision making process with the surgical team gauging the risks and benefits of each management strategy.⁹

Shared-decision making in surgery involves a progression from a paternalistic to a patient-centered approach when discussing treatment options with patients.¹⁰ This process has been shown to result in greater patient satisfaction, compliance, and outcomes as physicians address patient concerns and preferences rather than arbitrarily assigning treatment.^{11–13} Furthermore, the application of this approach increases patients' confidence in the final decision and enhances both patient and physician comfort in proceeding with surgery involving potential risks.^{14, 15} Thus, patient concerns, preferences, and the perceived impact of treatment on quality of life must be considered when discussing treatment options to improve patient satisfaction with the shared treatment decision.

Prior studies have investigated the effect of acoustic neuroma surgery on patients' health-related quality of life.^{16–18} These studies have characterized treatment strategies and the differences in outcomes between surgery, radiation, and active surveillance. In addition to tumor control, prevention of malignancy, and preservation of cranial nerve function, the impact of treatment on quality of life is an important factor when deciding on treatment modality.¹⁹ However, there is a lack of evidence regarding the effect of quality of life, psychological factors, and patient-reported measures on treatment decision-making at initial presentation. With an improved understanding of these factors, providers could better engage in patient-centered treatment discussions. This may result in higher patient satisfaction when deciding on acoustic neuroma treatment modality.

The aim of the present study was to better understand the differences in demographic, clinical, tumor, and psychological factors between patients electing for active surveillance versus surgical intervention. Moreover, the study sought to characterize the relationship between these patient factors and the decision to pursue acoustic neuroma surgical resection.

Methods

Patient Population and Study Overview

Institutional review board approval was received for this prospective observational study. Patients initially presenting for acoustic neuroma surgical evaluation were prospectively enrolled from October 2013 to March 2016 at a single tertiary care hospital including seven neurotologists. All patients, ages 18 and older and English speaking, presenting with unilateral vestibular schwannoma were eligible. Written informed consent was obtained from all study participants. Patients with prior acoustic neuroma surgical resection or radiation, neurofibromatosis type 2, other suspected diagnoses (e.g. meningiomas, facial schwannoma, malignancy, and epidermoid tumors) and those unable to independently complete questionnaires were excluded from enrollment. Patients who did not have MRI, demographic, psychometric, or audiometric data were excluded from the regression model analysis.

Data Collection

Demographic information, clinical symptoms, audiometric data, and magnetic resonance imaging (MRI) data were collected by trained study personnel. Demographic data included age, sex, race, marital status, dominant hand, highest level of education, and socioeconomic status. Patients 65 years or older were defined as older patients.⁷ Clinical symptom data included the presence or absence of hearing loss, tinnitus, vertigo, imbalance, facial weakness, facial numbness, difficulty swallowing liquids, difficulty swallowing solids, change in voice, double vision, bladder or bowel incontinence, or headache. Headache severity was characterized using a visual analog scale ranging from 0 to 100, with a higher rating corresponding with increasing severity. Acoustic neuroma laterality and any prior treatment were recorded. Data from the audiogram at study enrollment was collected including pure tone averages (PTA) and speech discrimination scores (SDS) on the side of the acoustic neuroma. In accordance with the previously described guidelines, hearing was classified as Class A (PTA ≤ 30 dB and SDS ≥ 70%), Class B (PTA > 30 dB, ≤ 50 dB and SDS ≥ 50%), Class C (PTA > 50 dB and SDS ≥ 50%), and Class D (Any level PTA and SDS < 50%).²⁰ MRI images were jointly examined by three co-authors to systematically measure tumor size, tumor volume, and to define tumor characteristics, such as the presence of cysts or a fundal CSF cap. As Tos and Thomsen (1992) previously described, tumor size was based on the largest extrameatal (EM) size and categorized as follows: intrameatal, small (1-10 mm EM size), medium (11-20 mm EM size), moderately large (21-30 mm EM size), large (31-40 mm EM size), and giant (greater than 40 mm EM size).²¹ In a standardized fashion, tumor volume was calculated by multiplying total tumor areas in all slices by slice interval accounting for varying slice thicknesses for each MRI.²² Both tumor size and volume were calculated based on high-resolution T1 axial post contrast sequences. Tumor growth status, as determined by neurotologists at the time of clinical examination and

discussed with patients, was noted as growing (increase in size compared to any previous MRI not attributable to variability in imaging modality or measuring technique) or stable (no growth) by comparing sequential MRIs with at least a 6-month interval. Growth status was noted as “unknown” for patients who presented with a single MRI who by definition had no radiographically confirmed growth. Facial nerve function on baseline photographs was assessed by co-authors using the House-Brackmann grading scale.²³

Patient psychometric data were collected using paper or web-based validated questionnaires including Rosenberg Self-Esteem Scale, Beck Depression Inventory, Voice-Related Quality of Life (VRQOL), and Dizziness Questionnaire.^{24–27} Patients reported overall quality of life using a visual analog scale of 0–100, with higher rating corresponding with a more positive response. As previously described, Beck Depression Inventory includes twenty-one questions with total scores ranging from 0–63, with higher scores corresponding to increasing depression, and scores 10 or less characterized as normal. Rosenberg Self-Esteem Scale includes ten questions with total scores ranging from 0–25, with lower scores corresponding to lower self-esteem, and scores above 15 characterized as normal. The VRQOL and Dizziness Questionnaires consist of 10 and 6 questions, respectively, with a 5-point Likert scale for each item.²⁸

Outcome Assessment

The primary clinical endpoints were variables associated with patients undergoing acoustic neuroma surgical resection. The choice to undergo surgery versus active surveillance was examined as the dependent variable. Demographic, clinical, and psychometric factors were examined as independent variables.

Statistical Analysis

Data were collected using Research Electronic Data Capture (REDCAP; <http://www.project-redcap.org>) and analyzed using Stata SE software (version 13; Stata Corp; College Station, TX). Differences between demographic, clinical, and psychometric variables were analyzed using Student’s *t* test or nonparametric Wilcoxon rank-sum tests for continuous variables and cross tabulations, and using generalized chi-square or Fisher Exact tests for categorical variables. A multiple logistic regression model was created with the presence or absence of acoustic neuroma surgical resection as the dependent variable, and patient age, hearing classification, tumor grade, tumor growth status, headache severity scores, quality of life, depression, and self-esteem scores as the independent variables. The significance level was set at 0.05. To account for the possible influence of missing data, multiple imputation strategy was utilized demonstrating no significant difference in results or relationships on repeat analysis with imputed data.²⁹ Thus, the original multiple logistic regression model was used as described.

Results

A total of 255 patients were prospectively enrolled from October 2013 to March 2016. Thirty-nine patients were excluded who did not meet the aforementioned inclusion criteria, resulting in 216 eligible subjects (Table 1). Of the 216 eligible patients, 180 (83.3%)

completed the provided questionnaires with a response rate of 83.3%. Audiometric data and imaging data were available for 202 (94%) patients and 208 (96%) patients, respectively. The majority of the total study group was Caucasian, married or engaged, and female (58%). The mean age was 55 (standard deviation (SD), 14). The majority of tumors were on the left side (53%), intrameatal (28%), and had an unknown growth status (41%). The mean acoustic tumor volume was 3639 mm³ (SD, 6734). The mean pure tone average was 42.6 dB (SD, 27.7) with a mean word recognition score of 64.4% (SD, 37.8). A plurality of patients had Class A hearing (44.5%) and the vast majority (94.9%) had House-Brackmann Grade I facial nerve function.

Overall, 98 patients (45.4%) pursued surgical resection and 118 patients (54.6%) decided on active surveillance. The decision to pursue microsurgical resection was associated with patient age <65 years, headache and vertigo as a presenting symptom, higher number of total symptoms, higher headache severity scores, lower word discrimination scores, Class D hearing, growing tumors, higher grade tumors, and larger mean volume tumors ($p < 0.05$). Figure 1 characterizes the significant differences in hearing classification between surgery and active surveillance groups ($p < 0.05$). Patients with hearing loss, tinnitus, imbalance, and facial weakness were not significantly associated with a decision for surgical treatment. Regarding patient psychometric characteristics, there was no significant association between treatment choice and quality of life, depression, self-esteem, voice related quality of life, and dizziness scores. However, patients presenting with vertigo, imbalance, incontinence, and headache had significantly worse overall quality of life and depression scores ($p < 0.05$). Patients with imbalance and incontinence had significantly worse self-esteem scores ($p < 0.05$). Voice related quality of life was significantly lower in patients with hearing loss, difficulty swallowing liquids or solids, change in voice, and headache ($p < 0.05$). Moreover, dizziness scores were worse in patients presenting with hearing loss, tinnitus, imbalance, vertigo, difficulty swallowing liquids or solids, change in voice, incontinence, and headache. Female patients were associated with higher depression scores ($p < 0.05$). There were no other significant association between patient demographics and psychometric characteristics.

Multiple logistic regression analysis of variables associated with pursuing acoustic neuroma surgical resection showed that patients undergoing surgery were significantly associated with age < 65 years old, medium, moderately large, and large tumor grades, tumor growth, Class D hearing, and worse headache severity (Table III). The odds of patients undergoing surgery significantly increased in patients with medium (OR 4.34; 1.36-13.81), moderately large (OR 33.47; 5.72-195.83), large grade tumors (OR 56.63 4-02-195.83), and all patients with giant tumors underwent surgical resection.

Discussion

In this study population, acoustic neuroma patients undergoing surgical resection were more likely to be younger with larger tumors, growing tumors, worse hearing classification, and worse headache scores. There was no significant association between psychological factors and patients pursuing surgery, including quality of life, depression, and self-esteem. These findings highlight several important factors considered by both physicians and patients when deciding on surgical intervention.

In treatment decision-making, patients and providers weigh risks and benefits of surgery against active surveillance. This process is especially complicated with benign tumors in functionally important and anatomically complex areas, such as with acoustic neuroma, where the risks of treatments can quickly outpace the risks posed by the natural history of the lesion. Decision-making involves a multidimensional process with patients influenced by physician recommendations, personal preferences (e.g. time-off work, costs), desire for cure, anticipated health outcome, and expected quality of life.³⁰ Moreover, patients presenting for surgical evaluation desire tumor removal, eliminating the posed threat, symptom improvement, and preservation of overall function. However, on deciding to undergo surgery, the patient incurs the immediate risks of surgery. The risks of acoustic neuroma resection include worsening of hearing, vestibular disturbance, stroke, facial paralysis, injury to other cranial nerves, cerebrospinal fluid leak, meningitis, stroke, and death.³¹ Efforts to better understand patient decision-making in acoustic neuroma management have been investigated by others and show a complex balance of these risks.^{32–36} Yet, to enhance patient-centered informed consent discussions, we must improve our understanding of patient factors that influence decision-making. Our investigation is the first large prospective analysis looking at patient decision-making in management of vestibular schwannoma that takes into consideration tumor characteristics (size, hearing loss, vestibular disturbance), demographics (age and gender) and psychosocial variables (quality of life, depression, and self-esteem).

To better understand prostate cancer patient decision-making, Penson (2012) proposed that patients use both systematic and heuristic processing when deciding on treatment, which may apply to our acoustic neuroma population. The systematic approach involves information gathering, data integration, and rational analysis resulting in a decision. Additionally, patients rely on heuristics emerging from personal experiences, general impressions of their disease, social influences, and willingness to accept risks when deciding on treatment. Muller et al. found that the majority of patients (66%) presenting for acoustic neuroma consultation reported provider counseling as a crucial component of decision-making. Other utilized resources included Internet sources (46%), scientific literature (18%), and medical textbooks (24%) to help guide decision-making. Moreover, 78% of these patients felt that their doctors did not adequately respond to their life situation and individual conveniences when discussing treatment options for acoustic neuroma.³⁵ Given these findings, treating physicians must consider patient quality of life and the patient's ability to cope with potential disabilities to better address patient concerns when engaging in shared decision-making.

Age has an important role in determining treatment decision. Prior studies have described increased surgical complication rates in elderly patients.^{7, 37, 38} Several authors have recommended a more conservative approach in treating patients older than age 65, especially in those with comorbidities, compared to younger patients.^{7, 39} Our results suggest that clinical decision reflects the notion that the benefit of surgery does not outweigh risks in older adults. From a patient perspective, younger patients are more likely to accept the risk of surgery given their longer life expectancy and the possibility of increasing risks associated with cumulative growth.⁴⁰ Older patients, with a shorter life expectancy, may choose to avoid the potential complications of surgery with hopes of maintaining quality of

life, which may never be affected by a slow growing tumor. Thus, these data may serve to help reassure and convey to patients what acoustic neuroma treatment decision is commonly selected by other patients of a similar age.

Hearing loss is the most common complaint among acoustic neuroma patients regardless of age.⁸ In a survey by the Acoustic Neuroma Association, hearing loss was reported as the most difficult aspects of having an acoustic neuroma.⁴¹ Furthermore, studies investigating preference-based measures of health-related quality of life, with 0 for death and 1 for perfect health, have reported a health utility index of 0.82 for unilateral hearing loss.^{42, 43} Our results demonstrate a significant increased likelihood of patients undergoing surgery in those presenting with Class D hearing. This suggests that patients who highly value their complete or partial “useful” hearing may have reservations regarding pursuing treatment given the risk of total hearing loss. However, patients without meaningful or serviceable hearing (i.e. Class D) have one less potential risk to consider when deciding on treatment.

Few studies have investigated the role of headache in acoustic neuroma patients.^{44, 45} Patients have reported headache as one of the most common presenting symptoms after unilateral hearing loss and balance disturbance and as one of the most difficult aspects of the acoustic neuroma experience.⁴¹ In our patient population, the presence of headache and higher headache severity was significantly associated with pursuing surgical intervention. Considering the impact of headache on our patients, this finding may indicate that patients believe that surgery not only removes the tumor, but may also address their headache. This is an important misconception that should be addressed during the informed consent process, as surgery increases the short-term risk of headache, and long-term headache outcomes do not seem to differ between different treatment modalities.^{18, 45}

Several studies have discussed the role of tumor size and growth status when deciding on treatment.^{6, 46, 47} While two-thirds of acoustic neuromas do not grow, experts have advocated treating tumors demonstrating significant growth ($> 2\text{mm/year}$).^{39, 48} Furthermore, investigations have shown that larger tumors have a significantly higher chance of growing relative to smaller tumors.^{6, 8, 49} Tumor size is an important predictive factor for hearing and facial nerve outcomes.^{50–53} Our study found that the likelihood of patients undergoing surgery increased as tumor size increased when controlling for other patient factors. More specifically, there is a significant increase in the likelihood of undergoing surgery if a patient has a moderately large or larger tumor. Additionally, patients with tumors exhibiting growth on sequential MRIs were more likely to undergo surgery. These findings reflect both patient and physician concerns regarding the risks of morbidity and mortality attendant with larger and growing tumors. Accordingly, providers may use these data to reaffirm a patient’s decision to surgically remove larger and growing tumors. While surgery still entails risk, intervention may be pursued hoping to limit increased risks associated with delayed treatment and further growth, or the negative impact of an untreated tumor on the patient’s health status while preserving physical function and quality of life.

As physicians and patients discuss treatment options, there is increasing emphasis on the impact of decisions on patients’ health-related quality of life. Several studies have described the use of various quality of life metrics to characterize the acoustic neuroma population and

critically analyze treatment outcomes.^{17, 42} In our study population, few patients had depression, low self-esteem, or poor quality of life. Moreover, overall quality of life, depression, self-esteem, voice-related quality of life, and dizziness scores had no significant association with treatment selected controlling for other patient factors. It is reassuring that psychological factors do not significantly impact the decision to pursue surgery.

There are several limitations when examining factors influencing treatment decision-making. While the population of interest consisted of patients presenting for surgical evaluation, patients pursuing radiation therapy were not followed in this study. For select patients with acoustic neuroma, radiation therapy is a viable alternative and remains important to the decision-making discussion. Unfortunately, it is difficult to capture and quantify elements of the treatment decision-making discussion regarding radiation therapy versus surgery. Additionally, the comprehensive patient evaluation and discussion of radiation therapy is performed by the radiation oncologist, an opportunity that is offered to most patients. Although we did not capture patients who sought treatment from a radiation oncologist, we anticipate that similar principles of shared-decision making would apply. When deciding between treatment modalities information should be provided to patients that inform their priorities, such as future risk of recurrence or growth relative to lifespan, or the likelihood of short term versus long term hearing preservation. A gold standard has not been identified for measuring psychological factors in acoustic neuroma patients. Importantly, we cannot fully capture the individual physician-patient discussion that significantly influences the decision to pursue surgery. Hence, surgeon bias may play a role in patient counseling affecting the ultimate decision.

Nonetheless, these data demonstrate that decision-making regarding acoustic neuroma treatment is significantly influenced by age, tumor size, tumor growth status, hearing status, and headache severity. These results may augment informed consent discussions by serving as a decision reference point regarding treatment decision-making incorporating patient specific factors. Moreover, these findings are timely as current medical jurisprudence favors a patient-centered informed consent resulting from shared decision-making.⁵⁴ To better understand this complex, multifactor decision-making process, validated instruments measuring specific patient preferences and heuristics need to be identified and implemented in future prospective studies. For example, it would be interesting to know if patient beliefs regarding the relative health risk posed by their tumor influences decision-making. In addition, further investigation is warranted to examine patient beliefs regarding the impact of microsurgery on headaches. With an emphasis on patient-centered care, there is further need to consider a multi-dimensional approach, incorporating psychosocial factors, to improve the counseling of patients regarding acoustic neuroma treatment.

Conclusion

Younger patients with larger acoustic neuromas, growing tumors, worse headaches, and without meaningful hearing are more likely to undergo surgery rather than active surveillance. Psychological factors such as quality of life, depression, and self-esteem do not significantly impact treatment decision-making. Further investigation regarding the impact

of patient-reported symptoms and psychosocial influences on patient decision-making may improve acoustic neuroma management discussions.

Acknowledgments

Supported in part by the David M. Rubenstein Fund for Hearing Research and the NIH 5T32DC000027-29, Research in Training in Otolaryngology.

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Figure 1.
Distribution of hearing classification between surgery and active surveillance groups.
($p < 0.001$)

Table 1

Demographic, Clinical, and Acoustic Neuroma Characteristics

Variable	All, n=216	Active Surveillance, n=118	Surgery, n=98	P value ^c
<u>Demographic Characteristics</u>				
Age, yr mean (SD)	55 (14)	59 (14)	50 (12)	<0.001
Elderly (>65 yr) ^d , %	25	35	13	0.001
Sex, %				
Male	42	57	40	0.772
Female	58	43	60	
Race, %				0.166
White	91	94	88	
African American	3	1	5	
Hispanic	2	0	4	
Asian or Pacific Islander	2	3	1	
Other	2	2	2	
Marital Status, %				0.844
Single	26	26	27	
Married or Engaged	74	74	73	
<u>Clinical Characteristics</u>				
Symptoms, % present				
Hearing loss	69	64	74	0.111
Tinnitus	58	57	60	0.611
Imbalance	37	34	40	0.370
Vertigo	24	19	31	0.041
Facial weakness	2	3	1	0.628
Headache	26	18	37	0.002
Total Symptoms, mean (SD)	2 (2)	2 (2)	3 (2)	0.021
Headache Severity ^c , mean (SD)	22.1 (26.4)	14.6 (20.6)	31.1 (29.7)	<0.001
<u>Audiometric Data, mean (SD)</u>				
Pure Tone Average, dB	42.6 (27.7)	39.2 (25.3)	46.5 (29.8)	0.119
Speech Discrimination, %	64.4 (37.8)	71.2 (33.8)	56.6 (40.7)	0.008
<u>Tumor Characteristics</u>				
Tumor Grade, %				<0.001
Intrameatal	28	43	8	
Small(Extrameatal length 1–10mm)	24	32	13	
Medium(Extrameatal length 11–20mm)	21	18	26	
Moderately Large(Extrameatal length 21–30mm)	17	5	32	
Large(Extrameatal length 31–40mm)	6	1	12	
Giant(Extrameatal length >41mm)	4	1	9	
Tumor Volume, mm3 mean (SD)	3639 (6734)	1273 (3962)	6314 (8123)	<0.001
Side of Tumor, %				0.625

Variable	All, n=216	Active Surveillance, n=118	Surgery, n=98	P value ^e
Left	53	49	54	
Right	47	51	46	
Tumor Growth Status, %				<0.001
No	39	62	9	
Yes	20	14	28	
Unknown ^d	41	24	63	

^aPatients categorized as elderly if age 65 years or older.

^bTotal symptoms were calculated from patient self-reporting on presence of 12 symptoms including hearing loss, tinnitus, vertigo, imbalance, facial weakness, facial numbness, difficulty swallowing liquids, difficulty swallowing solids, change in voice, double vision, incontinence, or headache.

^cHeadache severity was measured on a visual analog scale, 0–100, with higher rating corresponding with increasing severity

^dTumor growth status was marked unknown if only a single MRI available for initial surgical evaluation.

Table 2

Psychometric Patient Characteristics.

	All, n=179	Active Surveillance, n=98	Surgery, n=81	P value
Quality of Life (0–100), mean (SD)	78.4 (17.2)	77.3 (17.6)	79.7 (16.8)	0.285
Becks Depression Inventory (0–63), mean (SD)	6.8 (6.5)	6.3 (6.6)	7.5 (6.5)	0.084
Normal, %	75	80	68	
Mild Depression, %	18	13	25	
Moderate Depression, %	6	5	6	
Severe Depression, %	1	1	1	
Rosenberg Self Esteem (0–40), mean (SD)	24.4 (4.7)	24.2 (4.9)	24.6 (4.5)	0.618
Low Self Esteem, % positive	3	3	2	
Voice-Related Quality of Life (0–50), mean (SD)	12.2 (4.7)	12.2 (4)	12.3 (5.4)	0.634
Excellent, %	3	2	5	
Good, %	89	92	85	
Fair, %	7	5	9	
Poor, %	1	1	1	
Very Poor, %	0	0	0	
Worst, %	0	0	0	
Dizziness Scale (0–30), mean (SD)	12.3 (6.9)	11.8 (6.6)	13.1 (7.1)	0.1450

Table 3

Multiple logistic regression analysis of variables associated with acoustic neuroma surgical resection.

Variable Surgery	Odds Ratio	95% CI ^a	P value
Age > 65 years old	0.19	0.05 – 0.69	0.011
Small tumor grade	1.28	0.40 – 4.08	0.679
Medium tumor grade	4.34	1.36 – 13.81	0.013
Moderately large tumor grade	33.47	5.72 – 195.83	<0.001
Large tumor grade ^b	56.63	4.02 – 518.93	0.002
Tumor growth present	4.51	1.66 – 12.28	0.003
Class B hearing	1.11	0.32 – 3.84	0.874
Class C hearing	1.69	0.25 – 11.51	0.594
Class D hearing	3.96	1.29 – 12.16	0.016
Headache Severity	1.03	1.01 – 1.05	0.001
Quality of life	1.04	1.00 – 1.08	0.067
Depression	1.05	0.95 – 1.17	0.318
Self-esteem	1.03	0.91 – 1.16	0.646

^aCI = Confidence Interval

^bGiant tumor grade completely predicted surgery in this model.