Surgical Treatment of Giant Vestibular Schwannomas: Facial Nerve Outcome and Tumor Control

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■ BACKGROUND: **Surgical treatment of giant vestibular schwannomas (GVS) is challenging. The philosophy of incomplete tumor resection may balance the preservation of facial nerve function and long-term tumor control.**

■ OBJECTIVE: **We aimed to evaluate the outcome of facial nerve function and tumor control in treating GVS via our institutional surgical strategy.**

■ METHODS: **From September 2009 to August 2014, 218 patients who underwent surgical treatment of GVS were enrolled in our study. The clinical features, extent of resections, facial nerve outcome, and the tumor regrowth free rate of these patients were retrospectively analyzed. The treatment strategy of this disease was discussed.**

■ RESULTS: **All patients had anatomic preservation of the facial nerve. Gross total resection (GTR) was achieved in 58 patients (28.6%), near-total resection (NTR) in 103 (50.7%), and subtotal resection (STR) in 42 (20.7%). Two patients died because of postoperative complications. After a mean follow-up of 39.7 ± 18.3 months, a favorable facial nerve outcome was achieved in 58.6%, 79.6%, and 83.3% of patients who underwent GTR, NTR, and STR, respectively. During follow-up, 20 patients had tumor regrowth and were treated by stereotactic radiosurgery (SRS), and tumor regrowth free rates were 96.6%, 92.2%, and 76.2% in GTR, NTR, and STR, respectively. The extent of resection was the independent risk factor for poor facial nerve function ($P = 0.006$).**

■ CONCLUSIONS: **A surgical philosophy of prioritizing facial nerve preservation over total tumor resection was recommended in treatment of GVS. Favorable facial nerve outcome and tumor control were achieved after NTR of the tumors.**

INTRODUCTION

Vestibular schwannomas, also called acoustic neuromas, are benign tumors arising from the VIII cranial nerve sheath. They represent approximately 5%–6% of all intracranial tumors and 80% of cerebellopontine angle tumors.[1,2] As a result of the advances in neuroimaging facilities, early detection of vestibular schwannomas has achieved significant progress in Western countries; however, in developing countries such as China and India, giant vestibular schwannomas (GVS, maximal diameter ≥4 cm) are still not exceptional.[3,4] Large vestibular schwannomas and GVSs are commonly associated with significant compressive effect on the critical structures and obstruction of the cerebrospinal fluid pathways, which could result in high morbidity and mortality.[5,6]

Mortality is no longer the major concern in management of vestibular schwannomas, and a favorable facial nerve function has become the main objective. Therefore, stereotactic radiosurgery (SRS) has been increasingly adopted in treating vestibular schwannomas, even for large tumors with maximal diameter ≥3 cm.[7] However, for GVS, microsurgical resection remains the optimal treatment. Given the giant size of the tumor, stretching of facial nerve, poor surgical plane, and small space for surgical

Key words
- Giant vestibular schwannoma
- Gross total resection
- Incomplete resection
- Microsurgery
- Near-total resection
- Vestibular schwannoma

Abbreviations and Acronyms
GTR: Gross total resection
GVS: Giant vestibular schwannoma
HB: House-Brackmann
MRI: Magnetic resonance imaging
NTR: Near-total resection
STR: Subtotal resection
SRS: Stereotactic radiosurgery

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manipulation, microsurgical resection of GVS with a favorable functional outcome is challenging. As a result, strategies including incomplete resection with revised SRS for recurrent tumor and planned partial resection followed by SRS have been proposed.[8,9] Although incomplete resection could reduce surgery-related facial nerve injury and in turn achieve better functional outcome, because of the small sample size in previous studies, the natural history of residual tumors was uncertain.[10] In addition, Samii et al.[11] stated that total resection was the optimal treatment that could achieve favorable tumor control as well as good facial nerve outcome. Therefore, more investigations with a large sample size were necessary to identify an optimal treatment strategy that could successfully balance the preservation of facial nerve function and long-term tumor control in treating GVS.

Since September 2009, we have adopted a surgical philosophy of prioritizing facial nerve preservation over total tumor resection; 218 eligible patients with GVS underwent surgical treatment between September 2009 and August 2014. In the present study, we aimed to retrospectively analyze the clinical features, facial nerve outcome, and tumor regrowth free rate of these patients and summarize our experience of the treatment strategy of this disease. To our knowledge, this is the largest series concerning GVS.

METHODS

From September 2009 to August 2014, 490 consecutive patients with vestibular schwannoma received surgical treatment by a single group in our hospital. We excluded patients with tumors $\leq$4 cm in diameter and those who had facial nerve dysfunctions before surgery. Moreover, patients diagnosed as having neurofibromatosis II and those who had previous treatment of either microsurgery or SRS were excluded. Consequently, 218 eligible patients were enrolled in our study.

Clinical Chart and Radiologic Findings

All the patients underwent routine admission examination including clinical history and neurologic examination. Data including age, gender, symptoms, neurologic signs at admission, and the duration of hearing loss were obtained.

Preoperatively, thin-layer computed tomography and magnetic resonance imaging (MRI) including T1-weighted, T2-weighted, and gadolinium-enhanced T1-weighted sequences were performed as routine. The size of tumor was calculated as the maximal extrameatal diameter on axial, sagittal, or coronal MRI. The presence of cystic formation and hydrocephalus were noted.

Surgery

Retrosigmoid craniotomy was performed for all patients. The extent of resection was guided by intraoperative neurophysiologic monitoring as well as the surgeon's assessment (facial nerve integrity and vulnerability). A decline of the facial nerve function for more than 50% according to neurophysiologic monitoring (amplitude of the motor evoked potential with a standard stimulus) was regarded as the threshold at which further resection was avoided. The locations and anatomic preservation of the facial nerve were recorded. The displacements of the facial nerve along the tumor surface were identified by microscopic inspection with the aid of neurophysiologic monitoring. Identification of the integrity of facial nerves was based on the results of intraoperative observation and neurophysiologic monitoring.

Clinical Outcome and Follow-Up

Postoperative complications were noted and the facial nerve function was assessed according to House-Brackmann (HB) grading at 3 days after surgery. The follow-up was performed 3 months and 12 months postoperatively and once a year thereafter. During the follow-up period, all patients underwent neurologic assessments and cranial MRI. Changes in facial nerve functions were assessed by the senior authors in the outpatient center. Experts in neuroimaging processed the cross-analysis to identify the size of residuals and tumor regrowth. MRI at the 3-month follow-up was considered to be the baseline for evaluating the extent of resection and the size of residuals. Stripes of residual tumors thinner than 5 mm (thin layer along the facial nerves) were defined as near-total resection (NTR). Stripes of residual tumors with maximal thickness exceeding 5 mm and less than 10 mm along the facial nerve, or any enhanced nodule $\leq$1 cm^3 on baseline MRI were classified as subtotal resection (STR). Any enhanced nodular residuals >1 cm^3 were defined as partial resection. Linear enhancement pattern (thinner than 2 mm) on baseline MRI was considered to correspond to dural inflammation or postoperative scar tissue. The observation strategy was applied for patients with residual tumors. The tumor regrowth was confirmed when the residual tumor on follow-up MRI was 2 mm larger than that on baseline MRI. The SRS was reserved for patients with tumor regrowth. Patients with a follow-up of less than 12 months were excluded from outcome analysis.

Statistical Analysis

The following variables were documented: age, gender, size, cystic formation, presence of hydrocephalus, the locations of the facial nerve, and the extent of resection. Univariate and multivariate regression analysis were used to analyze the statistical significance between these variables and poor facial nerve functions (HB grades III–VI) as well as the tumor regrowth free rate. A Student t test was used to compare continuous variables and a Pearson χ^2 test was used to compare categorical variables. The results of multivariate regression were assessed in terms of odds ratio. The Kaplan-Meier graph was applied to show the tumor regrowth free rate. All statistical analysis were processed by SPSS software (version 19.0 [IBM Corp. Armonk, New York, USA]), and $P < 0.05$ was considered statistically significant.

RESULTS

There were 110 males and 108 females with a mean age of 41.8 $\pm$ 12.1 years (range, 15–69 years). The most common presentation was hearing loss and tinnitus ($n = 207$); other symptoms and neurologic signs included ataxia ($n = 103$), dizziness/vertigo ($n = 89$), facial numbness ($n = 73$), and gait disturbance ($n = 53$). Symptoms of lower cranial nerve deficits occurred in 27 patients (12.4%) and 46.8% of patients ($n = 102$) presented with symptoms caused by intracranial hypertension (86 patients had symptomatic hydrocephalus). The duration of symptom onset to surgery was 24.6 $\pm$ 33.1 months (range, 0.5–240 months).