





# Repeat Surgery for Vestibular Schwannomas: An Institutional Case Series

Khizar R. Nandoliya<sup>1</sup>  Emily J. Winterhalter<sup>1</sup> Constantine L. Karras<sup>1</sup> Rushmin Khazanchi<sup>1</sup>  
Mark W. Youngblood<sup>1</sup> Pavlos Texakalidis<sup>1</sup> James P. Chandler<sup>1</sup> Stephen T. Magill<sup>1</sup> 

<sup>1</sup> Department of Neurological Surgery, Malnati Brain Tumor Institute, Northwestern University Feinberg School of Medicine, Chicago, Illinois, United States

**Address for correspondence** Stephen T. Magill, MD, PhD, Department of Neurological Surgery, Northwestern University Feinberg School of Medicine, 676 N. St. Clair Street, Suite 2210, Chicago, IL 60611, United States (e-mail: stephen.magill@nm.org).

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## Abstract

**Introduction** Vestibular schwannomas (VSs) are treated with microsurgery and/or radiosurgery. Repeat resection is rare, and few studies have reported postoperative outcomes. The objective of this study was to describe clinical characteristics and outcomes in patients undergoing repeat surgery for VS.

**Methods** All adult ( $\geq 18$  years) patients undergoing VS resection between 2003 and 2022 at our institution were retrospectively reviewed to identify patients who underwent repeat surgery of an ipsilateral VS following prior gross-total (GTR) or subtotal resection. Patient, radiographic, and clinical characteristics were reviewed. Primary outcomes were postoperative tumor volume, extent of resection, postoperative cranial nerve deficits, and time to further tumor progression.

**Results** Of 102 patients undergoing VS resection, 6 (5.9%) had undergone repeat surgery. Median (range) follow-up was 20 (5–117) months. Three patients were female. Median age was 56 (36–60) years. Median pre- and postoperative tumor volumes were 8.2 (1.8–28.2) cm<sup>3</sup> and 0.4 (0–3.8) cm<sup>3</sup>. GTR was achieved in two patients. Four patients had higher House-Brackmann scores at last follow-up, but none had tumor progression.

**Conclusion** In this small cohort of patients, repeat resection of recurrent or progressive VS can effectively reduce tumor volume with acceptable perioperative outcomes.

## Keywords

- ▶ acoustic neuroma
- ▶ microsurgery
- ▶ repeat surgery
- ▶ vestibular schwannoma

## Introduction

Vestibular schwannomas (VSs) are benign intracranial tumors derived from myelinating Schwann cells of the vestibulocochlear nerve. Although benign, VS growth can cause significant morbidity due to compression of the brainstem and cerebellum or impairment of vestibulocochlear functionality. VS management has recently trended toward a more conservative approach consisting of surveillance.<sup>1</sup>

Treatment indications include initial large size or documented tumor growth, as well as neurological deficits. Outside of neurofibromatosis type 2 (NF2), where anti-vascular endothelial growth factor antibodies or tyrosine kinase inhibitors are being investigated,<sup>2</sup> current treatment options include microsurgical resection or stereotactic radiosurgery (SRS). SRS alone often results in excellent outcomes for the majority of smaller tumors.<sup>3</sup> However, surgical resection may be necessary for small tumors presenting with

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vestibular symptoms,<sup>4</sup> or for larger tumors presenting with mass effect, hydrocephalus, or associated neurological symptoms.

Tumor recurrence after gross-total resection (GTR) or progression after subtotal resection (STR) occurs in a significant proportion of patients, with some studies reporting 5-year post-GTR recurrence rates of 5%,<sup>5</sup> and post-STR progression rates of 15 to 20%.<sup>5,6</sup> As with primary tumors, progressive/recurrent tumors can be managed conservatively, or treated with repeat surgical resection or radiosurgery, which is most frequently offered in this scenario.<sup>6,7</sup> Repeat surgery has also been associated with a very low failure rate of 91.5%.<sup>8</sup> There are only around 200 reported cases of repeat surgery for VS in the literature due to the relative rarity of the situation where this is indicated, and thus the data remain heterogeneous, complicating efforts at meaningful meta-analysis.<sup>8</sup> The goal of this study was to contribute our institutional experience to the literature so that it may be compounded with future systematic reviews and meta-analyses to report outcomes of repeat surgery for VS.

## Methods

This is a retrospective study conducted at a single major academic medical center. All patients that underwent surgical resection for VSs at our institution from 2003 to 2022 were retrospectively reviewed. Adult patients ( $\geq 18$  years) undergoing repeat microsurgery for VS demonstrating recurrence or progression after prior surgeries were included. Two patients without preoperative imaging in the electronic medical record and one patient with NF2 were excluded. This study was approved by the institutional review board. The requirement for patient informed consent was waived for this retrospective study.

Chart review was conducted to collect the following variables: age, sex, follow-up time, time to repeat surgery, surgical approach for repeat surgery, preoperative recurrent tumor volumes, extent of resection, preoperative cranial nerve deficits, and history of prior SRS. The following patient outcomes were recorded: postoperative tumor volume, extent of resection, postoperative cranial nerve deficits, and time to further tumor progression. Pre- and postoperative tumor volumes were calculated from T1 post-contrast magnetic resonance images (MRIs) in Visage 7. Time to further progression was calculated based on the time from the repeat surgery and the first T1 post-contrast MRI that revealed tumor progression or recurrence. Facial nerve function was evaluated by comparing House-Brackmann (HB) scores at presentation and last follow-up.

## Results

Of 102 patients undergoing VS resection during the study period, 6 (5.9%) underwent prior surgical resection of ipsilateral VS and were included in this analysis after exclusion criteria were applied. Median (range) last follow-up was 20 (5–117) months. Three (50%) patients were female. Age ranged from 36 to 60 years, with a median of 55 years. All

**Table 1** Patient and tumor characteristics

Patient and tumor characteristics	
Patients, <i>n</i>	6
Median (range) age, y	55 (36–60)
Female, <i>n</i> (%)	4 (57.1)
Median (range) follow-up, mo	20 (5–117)
WHO grade 1, <i>n</i> (%)	6 (100)
Tumor volumes	
Preop median (range) tumor volume, cm <sup>3</sup>	8.2 (1.8–28.2)
Postop median (range) volume, cm <sup>3</sup>	0.4 (0–3.8)

Abbreviation: WHO, World Health Organization.

tumors were World Health Organization grade 1 following both initial and repeat surgeries. Median (range) time to repeat surgery was 60 (24–96) months. The median maximum recurrent tumor diameter was 3.1 (1.9–4.7) cm. Preoperative tumor volume ranged from 1.8 to 28.2 cm<sup>3</sup>, with a median of 8.2 cm<sup>3</sup>. GTR was achieved in  $n = 2/6$  (33%) repeat surgeries. Of the remaining patients that underwent STR ( $n = 4/6$ , 67%), median (range) postoperative residual tumor volume was 0.7 (0.3–1.6) cm<sup>3</sup>. The median percent reduction in tumor volume was 90% (range: 53–98%). Overall patient and tumor characteristics are reported in **Table 1**.

Characteristics of individual patients are reported in **Table 2**. Four patients had cranial nerve palsies besides hearing loss, prior to repeat surgery. All patients had some degree of preoperative hearing loss. Two patients had preoperative facial nerve palsy alone, one had facial nerve weakness and dysphagia, and another had difficulty chewing. Preoperative HB scores consisted of HB 1 ( $n = 3$ ), HB 2 ( $n = 1$ ), HB 5 ( $n = 1$ ), and HB 6 ( $n = 1$ ). Postrepeat surgery HB scores at last follow-up were HB 1 ( $n = 1$ ), HB 2 ( $n = 1$ ), HB 3 ( $n = 1$ ), and HB 6 ( $n = 3$ ). Three (50%) patients had received SRS between resections. The initial surgical approaches were retrosigmoid in four patients (67%), middle fossa in one patient, and translabyrinthine in one patient. Four (67%) patients underwent repeat surgery via a retrosigmoid approach, one patient underwent a translabyrinthine approach, and one underwent a combined retrosigmoid and translabyrinthine approach. One patient experienced local radiographic tumor progression 7 months after repeat surgery, but this did not require further treatment as tumor growth remained radiographically stable for the remainder of follow-up. The radiographic changes were attributed to postoperative tumor rearrangement. One (17%) patient returned to clinic with a cerebrospinal fluid leak that was successfully treated with lumbar drainage.

## Discussion

Here, we report six cases of repeat microsurgery for VSs. Most repeat surgeries resulted in STR, although GTR was

**Table 2** Characteristics of individual patients undergoing repeat surgery

Patient	Preop CN palsy	Preop HB score	Postop HB score	SRS between resections	Max tumor diameter, cm	Preop tumor volume, cm <sup>3</sup>	Postop tumor volume, cm <sup>3</sup>	Time to repeat surgery, mo	Initial surgical approach	Repeat surgical approach
1	FN weakness	2	3	No	4.7	28.2	0	72	Retrosigmoid	Retrosigmoid
2	FN weakness	5	6	No	3.6	20.2	0.4	48	Retrosigmoid	Combined retrosigmoid + translabyrinthine
3	Difficulty chewing	1	1	Yes	3.1	5.9	1.07	96	Retrosigmoid	Retrosigmoid
4	None	1	2	No	1.9	1.8	0	84	Middle fossa	Retrosigmoid
5	None	1	6	Yes	2.3	3.4	1.6	36	Translabyrinthine	Translabyrinthine
6	FN weakness, dysphagia	6	6	Yes	3	10.4	0.3	24	Retrosigmoid	Retrosigmoid

Abbreviations: CN, cranial nerve; FN, facial nerve; HB, House-Brackmann; SRS, stereotactic radiosurgery.

achieved in two patients. In all cases, repeat surgery was successful in significantly decreasing tumor volume. One patient experienced postoperative complications, which was managed successfully with the patient returning to baseline.

Although no formal guidelines exist on the management of recurrent or progressive VSs previously treated with microsurgical resection, SRS is often the preferred option.<sup>9–12</sup> In a series of 173 patients by Huang et al, the facial nerve preservation rate following SRS for recurrent VS after prior microsurgery was 94.5%,<sup>13</sup> similar to that for primary radiosurgery.<sup>14</sup> In comparison, a recent study of 29 patients undergoing repeat surgery for VS reported 76% of patients having long-lasting HB IV to VI facial nerve palsies.<sup>15</sup> A recent meta-analysis by Fabbris et al analyzing surgical treatment for VS recurrence and progression reported that 64% of the 205 patients had moderate or complete facial palsies following repeat surgery.<sup>8</sup> Our reported experience, with higher postrepeat surgery HB scores in  $n = 4/6$  (67%) patients at last follow-up, also suggests that repeat surgery may place the facial nerve at greater risk.

It should be noted that a selection bias is typically present when electing for SRS versus microsurgery for recurrent/progressive tumors—those treated with SRS tend to be smaller and less aggressive than those treated with repeat microsurgery.<sup>3</sup> In a study of 173 radiosurgery procedures for recurrent VS after previous resection, Huang et al reported a median tumor volume of 2.7 (0.2–21.6) cm<sup>3</sup>,<sup>13</sup> which is much smaller than the median tumor volume of 8.2 cm<sup>3</sup> reported here.

In this series, there was no clinically meaningful tumor progression following repeat surgery. This is consistent with prior studies by Perry et al and Przepiórka et al that reported no progression after mean follow-up times of 55 and 42 months, respectively.<sup>15,16</sup> Huang et al likewise reported a low progression rate of 6% at a median follow-up time of 74 months, highlighting the efficacy of repeat surgery but the importance of vigilant long-term follow-up in the management of VS.<sup>13</sup>

There were several important limitations to this study. This is a retrospective study with a small sample size that is limited by selection bias. Additionally, observer bias is present in the

data set because only information available in the electronic medical record could be obtained. Furthermore, given our limited median follow-up, tumor recurrence/progression rates should not be extrapolated to the larger population of patients receiving repeat surgery for VS.

## Conclusion

Repeat surgery for VS is efficacious for large-volume recurrent or progressive VS, but is associated with a high risk of facial nerve dysfunction and perioperative complications, highlighting the need for careful patient selection. This study demonstrates that repeat surgery can effectively reduce tumor volume with favorable oncologic outcomes in patients with large VS recurrences, albeit with functional outcomes that are inferior to those typically achieved with SRS. This study also demonstrates that repeat surgery can be carefully considered as an option for patients with large VS recurrences.

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## Conflict of Interest

None declared.

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