

Preservation of Hearing and Facial Nerve Function with the Microsurgical Excision of Large Vestibular Schwannomas: Experience with the Retrosigmoid Approach

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Disclosures can be found in Additional Information at the end of the article

Abstract

Introduction

Vestibular schwannomas (VS) are the most common benign neoplasms of a cerebellopontine angle (CPA), which arise from the Schwann cells of the vestibulocochlear nerve. Eighty percent of CPA tumors are VS followed by meningioma as the second common mass lesion in this critical potential space. Treatment options range from watchful waiting with serial imaging studies to radiosurgery or a microsurgical excision or a combination of surgery and radiation therapy. The primary objective of the study was to assess hearing and facial nerve status before and after the surgery via the retrosigmoid approach.

Methods

The database of Aga Khan University Hospital was searched for diagnoses of vestibular schwannomas between 2000 and 2007. A total of 35 patients were identified; among them, 27 were selected for the study who met the inclusion criteria. The variables of the study were age, gender, presenting symptoms, size of the tumor, surgical approach, hearing levels, and facial nerve function. Hearing loss was categorized according to the Gardner-Robertson hearing classification and the House-Brackmann Scale was used for facial nerve assessment.

Results

Out of the 27 patients, 18 were male and nine were female. The mean age was 43 years. The most common presenting complaint was hearing loss and tinnitus, seen in 21 patients. Headache was present in six patients, ataxia in five, and vertigo in three. Facial nerve weakness was noticed in six patients. Two patients had Grade-III paralysis, three had Grade-IV paralysis, and one had Grade-V paralysis. The audiogram confirmed the presence of sensorineural hearing loss (SNHL) in all patients. Twelve patients out of 27 had Class II hearing with the threshold between 31 and 50 decibels and a Speech Discrimination Score (SDS) of 50% to 69%. Ten patients had non-serviceable hearing and the remaining five had poor hearing. The audiogram was repeated after surgery for those 12 patients who had Class II hearing and showed that seven out of 12 patients maintained a hearing threshold within the range of Class

Received 10/18/2018

Review began 10/24/2018

Review ended 12/01/2018

Published 12/04/2018

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How to cite this article

Rajput M, Ahmad A, Arain A, et al. (December 04, 2018) Preservation of Hearing and Facial Nerve Function with the Microsurgical Excision of Large Vestibular Schwannomas: Experience with the Retrosigmoid Approach. Cureus 10(12): e3684. DOI 10.7759/cureus.3684

II at the one-year follow-up (hearing preservation 58%). The facial nerve preservation rate was 56% considering House-Brackmann Grade III or less as acceptable facial nerve function.

Conclusion

The optimal treatment for small vestibular schwannomas is a matter of controversy; however, the choice of treatment for large vestibular schwannomas in patients without significant comorbidity is generally microsurgical excision. The surgical excision of a large VS with the retrosigmoid approach is found to be safe consistently. The hearing and facial nerve preservation in our study were found comparable with the literature.

Categories: Otolaryngology, Neurosurgery

Keywords: vestibular schwannoma, acoustic neuroma, retrosigmoid craniotomy, retrosigmoid approach, hearing preservation, cerebellopontine angle, schwannoma

Introduction

Vestibular schwannomas (VS) are benign neoplasms that arise from the myelin sheath of the eighth cranial nerve. They account for 8% of all intracranial tumors and 80% of cerebellopontine angle tumors [1]. Treatment options include microsurgery, fractionated stereotactic radiotherapy, stereotactic radiosurgery, and a combination of surgery and radiotherapy or observation [2]. The goals of VS management have shifted from surgical excision to functional preservation, particularly when the removal of the tumor is not considered safe in terms of cranial nerve preservation [3-4]. Studies have shown that the function of the facial nerve is compromised in attempts of gross total removal of a large VS [5-6]. Depending on many factors, including patient age, tumor size, growth, and symptomatology, patients can choose surgery, radiation, or conservative management [7].

More than 90% of the cases are unilateral and present at a median age of 50 years. Patients usually present with unilateral hearing loss and tinnitus. Pure tone audiometry reveals asymmetric sensorineural hearing loss. Loss of speech discrimination score is out of proportion to the hearing impairment and this prompts further investigation with magnetic resonance imaging (MRI) of the internal auditory canal. Symptomatology is a function of cranial neuropathies that result due to direct pressure as the tumor grows. The average growth rate of vestibular schwannomas ranges from 2 mm to 4 mm per year in 50% of the cases, whereas less than 10% can regress [8]. The extramural tumors are more likely to grow than those located within the internal auditory canal [9]. Tumor expansion in the cerebellopontine angle causes a compression of the brainstem and leads to life-threatening neurological complications.

Generally, small to medium-sized tumors that are less than 3 cm can be managed differently from the large vestibular schwannomas. Surgery is the favored option over stereotactic radiation therapy for large vestibular schwannomas. Some of the authors reported the successful treatment of a large VS with stereotactic radiation therapy [10]. However, others believe that radiation therapy may risk ischemia of the seventh cranial nerve and brainstem compression with the consequent complications [11-12]. The optimal treatment, particularly for a small to medium-sized tumor, remains controversial and the choice of modality of treatment remains at the discretion of the treating physician and available resources. Therefore, the approach to the patient is variable from center to center. The symptomatic younger patients, particularly those with persistent dizziness, with anatomically favorable tumors and a good hearing level, are offered gross total resection and also those with larger tumors and a mass effect on the brain stem [12].

The preservation of hearing and facial nerve function has always been an important

consideration in the management of VS. The current study was conducted at the Aga Khan University Hospital, which is a tertiary care referral center in the city of Karachi, Pakistan. The primary objective of the study was to assess hearing and facial nerve status before and after the surgery via the retrosigmoid approach.

Materials And Methods

The database of Aga Khan University Hospital (AKUH) was searched for the diagnosis of vestibular schwannoma between 2000 and 2007. Total 35 patients were identified among them 27 were selected for the study and the remaining eight patients were excluded because they either had previous surgery outside AKUH or radiation therapy or the data required for the study was not adequately available.

Review of the medical records including physician's notes, imaging study and audiograms were carried out. The variables of the study were age, gender, presenting symptoms, size of the tumor, surgical approach, hearing levels, and facial nerve function. The hearing loss was categorized according to the Gardener-Robertson hearing classification, as shown in Table 1 [13].

Class	Description	Audiogram	Speech Discrimination Score
I	Good/excellent	0 – 30	70% – 100%
II	Serviceable	31 – 50	50% – 69%
III	Non-serviceable	51 – 90	5% – 49%
IV	Poor	91 max	1 – 4%
V	None	Not testable	0

TABLE 1: Gardener-Robertson classification of hearing

Preoperative and postoperative facial nerve status were assessed with the House-Brackmann grading system as shown in Table 2 [14].

SCALE	Description
Grade I	Normal
Grade II	Noticeable on close inspection
Grade III	Obvious but not disfiguring
Grade IV	Disfiguring
Grade V	Barely perceptible movement
Grade VI	Complete paralysis

TABLE 2: House-Brackmann scale

Results

Out of 27 patients, 18 were male and nine were female. The mean age was 43 years. The most common presenting complaint was hearing loss and tinnitus, seen in 21 patients. Headache was present in six patients, ataxia in five, and vertigo in three. Facial nerve weakness was noticed in six patients. Two patients had Grade-III paralysis, three had Grade-IV paralysis and one had Grade-V paralysis. Twenty-one patients had normal facial nerve function at presentation. Clinical presentation is shown in Table 3.

Clinical Feature	Number of Patients
Hearing Loss	21
Tinnitus	21
Headache	6
Ataxia	5
Vertigo	3
Facial Palsy	6

TABLE 3: Clinical presentation of the patients

The audiogram confirmed the presence of sensorineural hearing loss (SNHL) in all patients. SNHL was also seen on audiogram in those patients who did not report a hearing loss at the time of presentation. According to the Gardner-Robertson hearing classification, 12 patients out of 27 patients had serviceable hearing with a hearing threshold between 31 and 50 decibels and Speech Discrimination Score (SDC) 50% to 69%. Ten patients had a non-serviceable hearing and remaining five had poor hearing. All patients were investigated with contrast-enhanced MRI, which revealed large vestibular schwannoma in the cerebellopontine angle. The size of the tumor was reported between 3 cm to 4 cm in six patients and more than 4 cm in 21

patients.

All patients were treated surgically with the retrosigmoid craniotomy approach by neurosurgeons. The audiogram was repeated after surgery for those 12 patients who had preoperative serviceable hearing (Class II). The postoperative audiogram showed seven out of 12 patients maintained a hearing threshold within the range of Class II at the one-year follow-up (hearing preservation 58%). Study variables and results are shown in Table 4.

Variables	Results
Gender	Male = 18, Female = 9
Mean age	43 years
Preoperative serviceable hearing	12 patients
Postoperative serviceable hearing	7 patients
Tumor size 3 to 4 cm	6 patients
Tumor size >4 cm	21 patients

TABLE 4: Variables and results

The facial nerve function assessment at the one-year follow-up was noted as Grade I in five patients, Grade II in three patients, Grade III in five patients, Grade IV in 10 patients, and Grade V in four patients. Preoperative and postoperative facial nerve status is shown in Table 5.

	Grade I	Grade II	Grade III	Grade IV	Grade V
Preoperative	21	0	2	3	1
Postoperative	5	3	5	10	4

TABLE 5: Preoperative and postoperative facial nerve function according to the House-Brackmann grading scale

The facial nerve preservation rate was 56% considering House-Brackmann Grade III or less as acceptable facial nerve function.

Discussion

The management of vestibular schwannomas is a matter of debate, particularly for small tumors that are less than 2 cm in size. The larger and symptomatic tumors are generally considered for microsurgical excision except in cases with significant comorbidities complicating open surgery [15]. The utmost goal of surgery for vestibular schwannomas in patients with serviceable hearing is to achieve complete resection with the preservation of

hearing [16-18].

The retrosigmoid approach for vestibular schwannomas provides panoramic visualization of the cerebellopontine angle from the tentorium cerebelli to the foramen magnum. A retraction of the temporal lobe of the brain is not required in the retrosigmoid approach. The main disadvantage is the limited exposure of the internal auditory canal, hence, the lateral dissection of the tumor is difficult [19]. The likelihood of hearing preservation becomes less if the tumor infiltrates the cochlear nerve, preoperative hearing is poor, or the tumor size is large.

In recent years, some skull base surgeons started the use of endoscopes for the excision of the tumors in the cerebellopontine angle. These endoscopic-assisted procedures are now gaining popularity for the posterolateral skull base surgery [20].

The size of the tumor does not necessarily correlate with the presence of serviceable hearing at the time of initial presentation [21]. This is also seen in 12 of our patients who had serviceable hearing despite large grade 4 tumor size according to the Koos classification [22].

Injury to the facial nerve is one of the major complications with the surgical management of vestibular schwannomas [23]. Facial nerve function is considered satisfactory as long as the House-Brackmann Grade is 3 or less. The review of 89 articles on facial nerve function reported 78% of preservation with the retrosigmoid approach in tumor size of <20 mm and 67% in larger tumors [24]. The facial nerve preservation rate in our study, where all patients had large tumors, was 56% considering House-Brackmann Grade III or less as acceptable facial nerve function.

All patients were operated with the retrosigmoid approach in the standard position, as described in the literature [25-26]. Significant variations have been reported regarding hearing preservation after microsurgical resection of large vestibular schwannomas, ranging from 11% to 70% [27-28]. In a study of 54 patients, preservation of hearing was reported in 53.7% of patients with a size of more than 3 cm vestibular schwannomas [29]. In our study, we found 12 patients with serviceable hearing preoperatively and after surgery, seven out of those 12 patients had a serviceable hearing at the one-year follow-up. The hearing preservation rate in our study was 58%, which is comparable to the percentages reported in the literature for large vestibular schwannomas. The highest rate of a hearing preservation was reported in the middle cranial fossa approach - as high as 70% in small tumors, which decreases to 50% as the tumor size increases [30].

Conclusions

The optimal treatment for the small vestibular schwannoma is a matter of controversy; however, the choice for the treatment of a large vestibular schwannoma in patients without significant comorbidity is generally microsurgical excision. Surgical excision of a large VS with the retrosigmoid approach is consistently found safe. The hearing and facial nerve preservation in our study were found comparable with that in the literature.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three

years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Mahaley MS, Mettlin C, Natarajan N, Laws ER, Peace BB: Analysis of patterns of care of brain tumor patients in the United States: a study of the brain tumor section of the AANS and the CNS and the commission on cancer of the ACS. *Clin Neurosurg.* 1990, 36:347-352.
2. Wong R, Low H, Tan D: Local experience with radiosurgery for vestibular schwannomas and recommendations for management (IN PRESS). *Singapore Med J.* 2018. [10.11622/smedj.2018107](https://doi.org/10.11622/smedj.2018107)
3. Kemink JL, Langman AW, Niparko JK, Graham MD: Operative management of acoustic neuromas: the priority of neurologic function over complete resection. *Otolaryngol Head Neck Surg.* 1991, 104:96-99. [10.1177/019459989110400117](https://doi.org/10.1177/019459989110400117)
4. Sughrue ME, Kaur R, Rutkowski MJ, et al.: Extent of resection and the long-term durability of vestibular schwannoma surgery. *J Neurosurg.* 2011, 114:1218-1223. [10.3171/2010.11.JNS10257](https://doi.org/10.3171/2010.11.JNS10257)
5. Samii M, Gerganov VM, Samii A: Functional outcome after complete surgical removal of giant vestibular schwannomas. *J Neurosurg.* 2010, 112:860-867. [10.3171/2009.7.JNS0989](https://doi.org/10.3171/2009.7.JNS0989)
6. Bloch O, Sughrue ME, Kaur R, et al.: Factors associated with preservation of facial nerve function after surgical resection of vestibular schwannoma. *J Neurooncol.* 2011, 102:281-286. [10.1007/s11060-010-0315-5](https://doi.org/10.1007/s11060-010-0315-5)
7. Lin EP, Crane BT: The management and imaging of vestibular schwannomas. *AJNR Am J Neuroradiol.* 2017, 38:2034-2043. [10.3174/ajnr.A5213](https://doi.org/10.3174/ajnr.A5213)
8. Martin TP, Yoo M, Mohr K, Davis RP: Conservative management of acoustic neuroma: a meta-analysis and proposed treatment algorithm. *Laryngoscope.* 2005, 115:450-454.
9. Foley RW, Maweni RM, Jaafar H, McConn WR, Javadpour M, Rawluk D: The impact of primary treatment strategy on the quality of life in patients with vestibular schwannoma. *World Neurosurg.* 2017, 102:111-116. [10.1016/j.wneu.2017.02.087](https://doi.org/10.1016/j.wneu.2017.02.087)
10. Chung WY, Pan DHC, Lee CC, et al.: Large vestibular schwannomas treated by gamma knife surgery: long-term outcomes. *J Neurosurg.* 2010, 113:112-121.
11. Mandl ES, Meijer OWM, Slotman BJ, Vandertop WP, Peerdeman SM: Stereotactic radiation therapy for large vestibular schwannomas. *Radiother Oncol.* 2010, 95:94-98. [10.1016/j.radonc.2009.12.042](https://doi.org/10.1016/j.radonc.2009.12.042)
12. Carlson ML, Tombers NM, Kerezoudis P, Celda MP, Lohse CM, Link MJ: Quality of life within the first 6 months of vestibular schwannoma diagnosis with implications for patient counseling. *Otol Neurotol.* 2018, 39:e1129-e1136.
13. Gardner G, Robertson JH: Hearing preservation in unilateral acoustic neuroma surgery. *Ann Otol Rhinol Laryngol.* 1988, 97:55-66. [10.1177/000348948809700110](https://doi.org/10.1177/000348948809700110)
14. House JW, Brackmann DE: Facial nerve grading system. *Otolaryngol Head Neck Surg.* 1985, 93:146-147. [10.1177/019459988509300202](https://doi.org/10.1177/019459988509300202)
15. Daniel RT, Tuleasca C, George M, et al.: Preserving normal facial nerve function and improving hearing outcome in large vestibular schwannomas with a combined approach: planned subtotal resection followed by gamma knife radiosurgery. *Acta Neurochir.* 2017, 159:1197-1211. [10.1007/s00701-017-3194-0](https://doi.org/10.1007/s00701-017-3194-0)
16. Ansari SF, Terry C, Cohen GAA: Surgery for vestibular schwannomas: a systematic review of complications by approach. *Neurosurg Focus.* 2012, 33:E14. [10.3171/2012.6.FOCUS12163](https://doi.org/10.3171/2012.6.FOCUS12163)
17. Sameshima T, Fukushima T, McElveen JT, Friedman AH: Critical assessment of operative approaches for hearing preservation in small acoustic neuroma surgery. *Neurosurgery.* 2010, 67:640-645. [10.1227/01.NEU.0000374853.97891.FB](https://doi.org/10.1227/01.NEU.0000374853.97891.FB)
18. Wang AC, Chinn SB, Than KD, Arts HA, Telian SA, El-Kashlan HK, Thompson BG: Durability of hearing preservation after microsurgical treatment of vestibular schwannoma using the middle cranial fossa approach. *J Neurosurg.* 2013, 119:131-138. [10.3171/2013.1.JNS1297](https://doi.org/10.3171/2013.1.JNS1297)
19. Nelson RF, Hansen MR, Gantz BJ: Hearing preservation surgery for vestibular schwannomas. *Curr Otorhinolaryngol Rep.* 2014, 2:235-241. [10.1007/s40136-014-0062-9](https://doi.org/10.1007/s40136-014-0062-9)
20. Montaser AS, Todeschini AB, Harris MS, Adunka OF, Prevedello DM: The role of endoscopy in resection of intracanalicular vestibular schwannoma via middle fossa approach: technical

- nuances. *World Neurosurg.* 2018, 120:395-399.
21. van DLR, de BBJ, Nelemans PJ, Dohmen AJC, Baumert BG, Stokroos RJ: Predictors of volumetric growth and auditory deterioration in vestibular schwannomas followed in a wait and scan policy. *Otol Neurotol.* 2011, 32:338-344. [10.1097/MAO.0b013e3182040d9f](https://doi.org/10.1097/MAO.0b013e3182040d9f)
 22. Erickson NJ, Schmalz PGR, Agee BS, Walters BC, McGrew BM, Fisher WS 3rd: Koos classification of vestibular schwannomas: a reliability study [Epub]. *Neurosurgery.* 2018, [10.1093/neuros/nyy409](https://doi.org/10.1093/neuros/nyy409)
 23. Bacciu A, Falcioni M, Pasanisi E, Di Lella F, Lauda L, Flanagan S, Sanna M: Intracranial facial nerve grafting after removal of vestibular schwannoma. *Am J Otolaryngol.* 2009, 30:83-88. [10.1016/j.amjoto.2008.02.010](https://doi.org/10.1016/j.amjoto.2008.02.010)
 24. Sughrue ME, Yang I, Rutkowski MJ, Aranda D, Parsa AT: Preservation of facial nerve function after resection of vestibular schwannoma. *Br J Neurosurg.* 2010, 24:666-671. [10.3109/02688697.2010.520761](https://doi.org/10.3109/02688697.2010.520761)
 25. Dandy WE: Removal of cerebellopontile (acoustic) tumors through a unilateral approach. *Arch Surg.* 1934, 29:337-344. [10.1001/archsurg.1934.01180030002001](https://doi.org/10.1001/archsurg.1934.01180030002001)
 26. Elhammady MS, Telischi FF, Morcos JJ: Retrosigmoid approach: indications, techniques, and results. *Otolaryngol Clin North Am.* 2012, 45:375-397. [10.1016/j.otc.2012.02.001](https://doi.org/10.1016/j.otc.2012.02.001)
 27. Samii M, Gerganov VM, Samii A: Functional outcome after complete surgical removal of giant vestibular schwannomas. *J Neurosurg.* 2010, 112:860-867. [10.3171/2009.7.JNS0989](https://doi.org/10.3171/2009.7.JNS0989)
 28. Tanrikulu L, Lohse P, Fahlbusch R, Naraghi R: Hearing preservation in acoustic neuroma resection: analysis of petrous bone measurement and intraoperative application. *Surg Neurol Int.* 2016, 7:S980-S988. [10.4103/2152-7806.195572](https://doi.org/10.4103/2152-7806.195572)
 29. Wanibuchi M, Fukushima T, McElveen JT, Friedman AH: Hearing preservation in surgery for large vestibular schwannomas. *J Neurosurg.* 2009, 111:845-854. [10.3171/2008.12.JNS08620](https://doi.org/10.3171/2008.12.JNS08620)
 30. Meyer TA, Canty PA, Wilkinson EP, Hansen MR, Rubinstein JT, Gantz BJ: Small acoustic neuromas: surgical outcomes versus observation or radiation. *Otol Neurotol.* 2006, 27:380-392.