

Successful Salvage LINAC-Based Stereotactic Radiotherapy in Rapidly Recurrent Acoustic Schwannoma: A Case Report

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Citation: Raj L, Malik S, Singh R, Arya AK. Successful Salvage LINAC-Based Stereotactic Radiotherapy in Rapidly Recurrent Acoustic Schwannoma: A Case Report. *Medi Clin Case Rep J* 2026;4(2):1743-1747. DOI: doi.org/10.51219/MCCRJ/Shivani-Malik/474

Received: 28 May, 2026; **Accepted:** 01 June, 2026; **Published:** 03 June, 2026

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ABSTRACT

Vestibular schwannoma is a benign tumor arising from the vestibular division of the eighth cranial nerve. Although recurrence after surgical excision is uncommon, management of recurrent lesions near critical neurovascular structures remains challenging. We report a rare case of rapidly recurrent vestibular schwannoma successfully treated with LINAC-based stereotactic radiotherapy.

A 22-year-old male presented with progressive right-sided facial deviation, decreased hearing and headache. Clinical examination revealed involvement of the right seventh and eighth cranial nerves. Contrast-enhanced magnetic resonance imaging (CE-MRI) demonstrated a large right cerebellopontine angle lesion causing significant mass effect and mild obstructive hydrocephalus. The patient underwent right retromastoid suboccipital craniectomy with gross total excision and histopathology confirmed WHO Grade 1 schwannoma. Despite surgery, follow-up imaging within two months revealed radiologically progressive recurrent disease.

Considering the close proximity of the recurrent lesion to the brainstem and major vascular structures, salvage hypofractionated stereotactic radiotherapy was delivered using LINAC (25 Gy in 5 fractions). Treatment was well tolerated with successful preservation of facial nerve function and achievement of all organ-at-risk constraints. The patient demonstrated marked symptomatic improvement with complete clinical recovery during follow-up. Post-treatment CE-MRI showed complete radiological response without evidence of residual or recurrent disease.

This case highlights the safety and efficacy of LINAC-based stereotactic radiotherapy as a minimally invasive salvage treatment option for recurrent vestibular schwannoma with excellent clinical and radiological outcomes.

Keywords: Recurrent acoustic schwannoma; LINAC-based stereotactic radiotherapy; Cerebellopontine angle tumor; Salvage radiotherapy

Introduction

Vestibular schwannoma, also known as acoustic schwannoma, is a benign and slow-growing neoplasm arising from Schwann cells of the vestibular division of the eighth cranial nerve. These tumors account for approximately 6-8% of all intracranial tumors and nearly 80–90% of lesions located in the cerebellopontine angle (CPA) region^{1,2}. Patients commonly present with unilateral sensorineural hearing loss, tinnitus, imbalance, vertigo or cranial nerve dysfunction depending upon tumor size and extent of compression over adjacent neurovascular structures³.

Magnetic resonance imaging (MRI) with gadolinium enhancement remains the gold standard for diagnosis and treatment planning. Management strategies for vestibular schwannoma include observation, microsurgical excision, stereotactic radiosurgery (SRS) and fractionated stereotactic radiotherapy (FSRT), with treatment selection depending upon patient age, tumor size, symptomatology, hearing status and proximity to critical structures⁴. Surgical excision is generally preferred for large symptomatic lesions causing mass effect or hydrocephalus; however, surgery may be associated with significant morbidity including facial nerve dysfunction, hearing impairment, cerebrospinal fluid leak and residual or recurrent disease⁵.

Tumor recurrence following gross total excision is relatively uncommon but has been reported in the literature, particularly in cases with microscopic residual disease or aggressive biological behavior⁶. Management of recurrent vestibular schwannoma remains challenging because of postoperative adhesions, altered anatomy and close association with the brainstem and cranial nerves. In such situations, stereotactic radiotherapy has emerged as an effective and minimally invasive salvage treatment modality with excellent local control rates and favorable cranial nerve preservation outcomes⁷.

LINAC-based stereotactic radiotherapy allows highly conformal dose delivery while minimizing radiation exposure to surrounding critical structures, thereby improving treatment precision and reducing treatment-related toxicity⁸. Herein, we report a rare case of rapidly recurrent vestibular schwannoma following gross total surgical excision that was successfully managed with hypofractionated LINAC-based stereotactic radiotherapy, resulting in excellent clinical and radiological response.

Case Presentation

A 22-year-old male presented to the Department of Radiation Oncology with complaints of progressive deviation of the face towards the right side, decreased hearing in the right ear and persistent headache for the preceding four and a half months. The onset of symptoms was insidious and all complaints were gradual and progressive in nature. There was no history suggestive of seizures, loss of consciousness, limb weakness, visual disturbances or bladder and bowel dysfunction.

On clinical examination, the patient had a well-healed postoperative scar mark measuring approximately 4 cm over the lower occipital region posteriorly. Neurological examination revealed features consistent with right-sided lower motor neuron facial nerve palsy. There was absence of forehead wrinkling on the right side, inability to raise the right eyebrow, incomplete closure of the right eye, inability to

perform complete lip movements including pouting and facial puffiness on the right side. Audiological symptoms suggestive of right vestibulocochlear nerve involvement were also present. Examination of the remaining cranial nerves was unremarkable. Motor power in bilateral upper and lower limbs was normal with preserved deep tendon reflexes. Sensory examination, cerebellar signs, gait assessment and higher mental functions were within normal limits.

The patient had undergone surgery approximately three months prior at an outside government institute in view of a right cerebellopontine (CP) angle space-occupying lesion. He underwent right retromastoid suboccipital craniectomy with gross total excision of the lesion under general anesthesia. Intraoperative findings revealed a large solid-cystic mass lesion in the right CP angle region. The lesion was described as pinkish-grey in appearance, soft, pliable, moderately vascular and moderately suckable.

Preoperative contrast-enhanced magnetic resonance imaging (CE-MRI) of the brain had demonstrated a large, well-defined extra-axial solid-cystic mass lesion located in the right CP angle cistern with extension into the internal auditory canal. The lesion appeared heterogeneously hyperintense on T2-weighted and FLAIR sequences and hypointense on T1 weighted images, measuring approximately 40 × 30 × 35 mm as shown in figure 1. Intense heterogeneous contrast enhancement was noted along with areas of calcification and small hemorrhagic foci, radiologically suggestive of acoustic schwannoma. Significant mass effect was present over the right middle cerebellar peduncle, right lateral aspect of the pons and right cerebellar hemisphere, associated with contralateral midline shift. Mild herniation of bilateral cerebellar tonsils through the foramen magnum and compression of the fourth ventricle with evidence of mild obstructive hydrocephalus were also observed. All these findings have been summarised in (Figure 1).

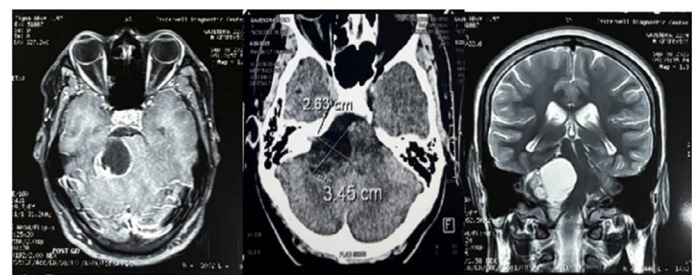


Figure 1: Preoperative radiological findings

Immediate postoperative non-contrast computed tomography (NCCT) brain demonstrated postoperative changes in the form of a resection cavity with foci of air and surrounding parenchymal hyperdensities involving the right midbrain region and cerebellar hemisphere, suggestive of postoperative intraparenchymal hemorrhagic changes. A postoperative drain was visualized in situ. Mild periventricular white matter hypodensities were noted in bilateral frontoparietal lobes. Benign calcifications were observed in the pineal gland and bilateral choroid plexus.

The patient remained symptomatically improved for approximately two months following surgery; however, he subsequently developed recurrent headache. Repeat CE-MRI brain revealed a recurrent lesion in the right CP angle region measuring approximately 31.4 × 24 × 27 mm, displaying imaging characteristics similar to the preoperative lesion.

Multiple prominent vascular structures, including the right vertebral artery, right anterior inferior cerebellar artery (AICA) and posterior inferior cerebellar artery (PICA), were seen interposed between the lesion and the brainstem, while the right superior cerebellar artery (SCA) was noted along the superior surface of the lesion. Radiological findings were suggestive of recurrent acoustic schwannoma as shown in (Figure 2).

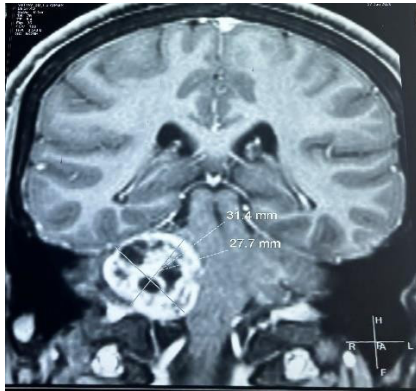


Figure 2: Radiological image suggestive of recurrence

Serial radiological evaluation over the subsequent month demonstrated progressive increase in lesion size. Follow-up CE-MRI revealed a well-defined heterogeneously enhancing mass lesion in the right CP angle cistern measuring 39 × 32 × 27 mm, causing significant medial compression of the pons and involving the right seventh and eighth cranial nerve complex laterally as depicted in (Figure 3). The internal auditory canal appeared unremarkable, with focal calcifications noted within the lesion.

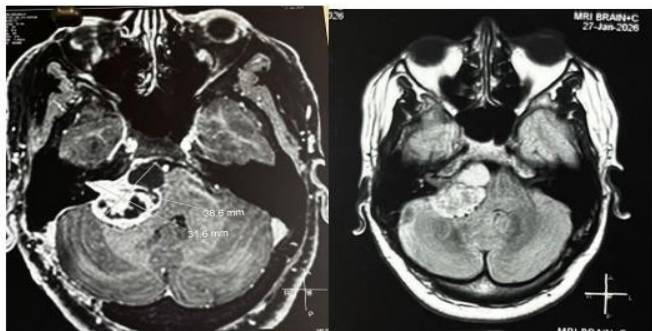


Figure 3: Pre stereotactic Radiotherapy image suggestive of progressive recurrence

Histopathological examination of the postoperative specimen was consistent with benign nerve sheath tumor (schwannoma), World Health Organization (WHO) Grade 1.

Considering the radiologically progressive recurrent disease in close proximity to critical neurovascular structures, the patient was planned for stereotactic radiotherapy (SRT). Treatment simulation was performed with complete immobilization using a double-shell thermoplastic cast as depicted in (Figure 4). SRT was delivered on a linear accelerator platform (Elekta Versa HD). A total dose of 25 Gy in 5 fractions was prescribed to the planning target volume over five consecutive days. Meticulous treatment planning was performed to ensure optimal target coverage while respecting dose constraints to all organs at risk. Particular emphasis was placed on preservation of the facial nerve and surrounding critical brainstem structures. The patient also received supportive care and medical management for symptomatic relief during treatment.



Figure 4: Double shelled immobilisation cast for SRT

The treatment was well tolerated without any acute significant radiation-related toxicity. At one month following completion of radiotherapy, the patient reported symptomatic improvement in hearing. During follow-up over the subsequent five months, the patient remained clinically asymptomatic with significant neurological recovery. Follow-up post-radiotherapy CE-MRI brain at 1 month demonstrated complete radiological response with no evidence of residual or recurrent disease as shown in Figure 5. Since 4 months, the patient continues to remain under regular surveillance till date with sustained excellent clinical (Asymptomatic with subjective response of 90% improvement in facial nerve involvement symptoms and 50% improvement in hearing) and radiological response following LINAC-based stereotactic radiotherapy.



Figure 5: complete radiological response with no evidence of tumor 1 month post SRT

Discussion

Vestibular schwannoma is a benign intracranial neoplasm arising from Schwann cells of the vestibular component of the eighth cranial nerve and represents the most common tumor of the cerebellopontine angle. Although these tumors are histologically benign and generally slow growing, larger lesions can produce significant neurological morbidity due to compression of adjacent cranial nerves, brainstem structures and cerebrospinal fluid pathways¹. The present case is clinically significant because of the unusually rapid postoperative recurrence despite gross total excision and the excellent response achieved with LINAC-based stereotactic radiotherapy.

The most common presenting symptom of vestibular schwannoma is unilateral sensorineural hearing loss, followed by tinnitus and imbalance. Facial nerve dysfunction is less common at presentation and usually indicates larger tumor size or significant compression of adjacent neural structures². In our patient, the lesion was large at initial presentation and produced both seventh and eighth cranial nerve deficits along with radiological evidence of brainstem compression and obstructive hydrocephalus, necessitating urgent surgical intervention.

Microsurgical resection remains an established treatment modality for large symptomatic vestibular schwannomas, particularly in younger patients and tumors associated with mass

effect³. However, complete surgical excision may not always be feasible because of adherence of the tumor capsule to the facial nerve, brainstem or surrounding vascular structures. Preservation of neurological function often takes priority over radical excision, which may result in residual microscopic disease and subsequent recurrence⁴. Reported recurrence rates following gross total excision vary in the literature and are generally low, ranging from approximately 0.3% to 9.2%, depending on duration of follow-up and extent of resection⁵. Early recurrence within a short postoperative interval, as observed in our case, is relatively uncommon and highlights the importance of close radiological surveillance even after apparently complete tumor removal.

Management of recurrent vestibular schwannoma remains challenging because repeat surgery carries increased operative risks due to fibrosis, distorted anatomy, postoperative adhesions and close proximity to critical neurovascular structures⁶. In the present case, repeat imaging demonstrated progressive recurrent disease closely related to the vertebral artery, anterior inferior cerebellar artery (AICA), posterior inferior cerebellar artery (PICA), superior cerebellar artery (SCA) and brainstem, making re-surgery potentially hazardous. Therefore, stereotactic radiotherapy was considered the most appropriate salvage treatment option.

Stereotactic radiosurgery and fractionated stereotactic radiotherapy have demonstrated excellent long-term tumor control rates exceeding 90% in multiple studies, with favorable preservation of hearing and facial nerve function⁷. Fractionated treatment is particularly advantageous for larger lesions or tumors located adjacent to sensitive critical structures because it allows better normal tissue repair while maintaining effective tumor control⁸. In our patient, hypofractionated stereotactic radiotherapy delivering 25 Gy in five fractions resulted in excellent clinical improvement, hearing recovery and complete radiological response without significant treatment-related toxicity.

LINAC-based stereotactic radiotherapy has emerged as a highly precise and effective treatment modality owing to advancements in image guidance, immobilization systems and conformal dose delivery techniques. Compared with conventional radiotherapy, it enables superior sparing of surrounding normal tissues including the brainstem, cochlea and facial nerve while delivering ablative doses to the target volume⁹. In the present case, all organ-at-risk dose constraints were successfully achieved with preservation of facial nerve function, highlighting the safety and feasibility of this approach.

Our case emphasizes the importance of individualized multidisciplinary management in recurrent vestibular schwannoma. Early recognition of recurrence, timely radiological evaluation and appropriate use of advanced stereotactic radiotherapy techniques can achieve excellent oncological and functional outcomes while avoiding the morbidity associated with repeat surgical intervention¹⁰⁻¹².

Conclusion

Rapid postoperative recurrence of vestibular schwannoma following gross total excision is uncommon and presents significant therapeutic challenges, particularly when the lesion is closely related to critical neurovascular structures. This

case highlights the effectiveness and safety of LINAC-based hypofractionated stereotactic radiotherapy as a salvage treatment modality in recurrent vestibular schwannoma. Precise conformal radiation delivery enabled excellent local tumor control with preservation of cranial nerve function and minimal treatment-related toxicity. The patient achieved complete clinical and radiological response with sustained symptomatic improvement during follow-up. Our experience supports the role of stereotactic radiotherapy as an important organ-preserving and minimally invasive treatment option for recurrent vestibular schwannoma, especially in patients where repeat surgical intervention may carry substantial morbidity.

Ethics Statement

Written informed consent for publication was obtained from the patient. Ethical approval was not required according to institutional policy because no experimental intervention was performed. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Author Contributions

- Lalit Raj: Manuscript writing
- Shivani Malik: Conceptualization and critical revision
- Renu Singh: Literature review
- Ashok Kumar Arya: Supervision and final approval

All authors reviewed and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

No external funding was received for this study.

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