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Case Report

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Gamma Knife Radiosurgery-Induced Acute Facial Palsy in Vestibular Schwannoma: A Case Report

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ABSTRACT

Stereotactic radiosurgery (SRS) is an established treatment for vestibular schwannoma, offering high tumor control rates and a favorable safety profile. SRS-induced facial palsy is typically a late-onset complication, with acute-onset cases being exceedingly rare. We report the case of a 42-year-old man with a left-sided Koos grade I vestibular schwannoma who underwent single-fraction Gamma Knife radiosurgery with a prescription dose of 11 Gy to the 50% isodose line. Baseline facial nerve function was intact. Seventy-two hours post-treatment, the patient developed House-Brackmann (HB) grade V peripheral facial palsy, accompanied by severe vestibular symptoms. Magnetic resonance imaging obtained on post-treatment day 6 demonstrated reduced contrast enhancement, partial capsular breakdown, and central hypointensity within the tumor, suggestive of acute necrotic change. Vestibular symptoms improved rapidly following corticosteroid therapy; however, facial palsy recovery was gradual, improving to HB grade II at 12 months, with persistence at final follow-up (20 months). The tumor remained radiologically stable. Acute-onset facial palsy following SRS for vestibular schwannoma is extremely rare, with only four previous cases reported in the literature. This is the first reported case to occur following a relatively low margin dose—11 Gy—in contrast to the 13-14 Gy doses prescribed in earlier reports.

KEYWORDS: Schwannoma, Gamma Knife radiosurgery, facial palsy

ABBREVIATIONS: SRS: Stereotactic radiosurgery, **GKRS:** Gamma Knife radiosurgery, **HB:** House-Brackmann

INTRODUCTION

Stereotactic radiosurgery (SRS) is a well-established and effective treatment modality for vestibular schwannomas, offering excellent long-term tumor control rates and a favorable safety profile (6,7,10). According to the European Association of Neuro-Oncology guidelines (5), SRS may be preferred over microsurgery for smaller vestibular schwannoma cases where preservation of facial nerve and hearing function is the primary therapeutic goal. However, despite its overall favorable safety profile, SRS can cause complications in a subset of patients, including hearing deterioration, vestibular symptoms, facial numbness, and facial nerve-related adverse effects, such as facial spasm and palsy (7,15).

Previous studies have reported facial nerve preservation rates ranging from 92.9% to 96.2% following Gamma Knife radiosurgery (GKRS) for vestibular schwannomas (8,15). Typically, SRS-induced facial palsy is a late-onset complication that may be either transient or permanent (7). In contrast, acute-onset facial palsy is extremely rare following SRS, with only a few cases reported in the literature (2,9,11,14). Herein, we present a patient with vestibular schwannoma who developed acute facial palsy shortly after receiving GKRS.

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CASE REPORT

A 42-year-old man presented with left-sided tinnitus, persisting for more than two years, and progressive hearing loss on the same side that had developed over the preceding months. He had no complaints suggestive of vestibular dysfunction. The patient had a medical history of hypertension and anxiety disorder, both of which were well controlled with regular medication. He was also an active smoker.

On physical examination, there was no response to conversational speech on the left side. Audiometric evaluation revealed severe sensorineural hearing loss on the left, with a pure tone average of 75 dB. Facial nerve function was intact bilaterally. In addition, there were no clinical signs of vestibular nerve dysfunction, such as gait instability, spontaneous nystagmus, or a positive Romberg sign.

Magnetic resonance imaging (MRI) revealed a Koos grade I vestibular schwannoma measuring 11 × 8 mm, located within the left internal auditory canal. Single-fraction, frame-based GKRS was delivered with a prescription dose of 11 Gy to the 50% isodose line (Figure 1). Radiosurgery parameters are summarized in Table I. The maximum dose to the left cochlea was 10.8 Gy, with a mean dose of 5.3 Gy. The facial nerve received a maximum dose of 10.4 Gy, measured along its visible cisternal segment, as the intracanalicular portion was obscured by tumor-related compression.

Approximately 72 hours after radiosurgery, the patient presented with left-sided facial weakness and severe vestibular symptoms—including nausea, vomiting, dizziness, imbalance, and vertigo—and required hospitalization. Physical examination revealed grade V peripheral left facial palsy, according to the House-Brackmann (HB) scale.

MRI obtained on post-treatment day 6 demonstrated a centrally hypointense area within the lesion. The peripheral enhancing rim appeared irregular, with multiple discontinuities suggestive of partial capsular breakdown. Quantitative assessment was performed using region of interest analysis on contrast-enhanced T1-weighted MRI. This revealed a decrease in the tumor-to-brainstem signal intensity ratio from 1.7 pre-GKRS to 1.1 at day 6, reduced to 0.8 in the central portion of the lesion, consistent with early necrotic change (Figure 2).

Vestibular symptoms markedly improved within days following corticosteroid therapy. However, the recovery from facial palsy was gradual, requiring several months. Three months after radiosurgery, vestibular symptoms had completely resolved, and facial palsy had improved to HB grade III. At 12 months, facial function had further improved to HB grade II, and the tumor remained radiologically stable. At the final follow-up, conducted 20 months after treatment, facial palsy persisted at HB grade II.

DISCUSSION

Several risk factors for facial palsy have been investigated extensively in patients undergoing SRS for vestibular schwannoma (8,15). A recent review comprising 15 studies and 3,155 patients treated with single-fraction GKRS reported a long-term facial nerve preservation rate of 92.9%, with a median follow-up of 59.4 months (8). Among all patients, those who received a margin dose of ≤13 Gy had a facial nerve preservation rate of 96.5%. Factors such as prior surgery, age over 60, and larger tumor volume have been associated with poorer facial nerve outcomes (8,15).

The facial palsies reported in these studies typically represent late-onset toxicity following SRS (8,15). Indeed, cranial nerve palsies are also well-recognized late-onset and progressive complications of conventional radiotherapy (3). In contrast, the patient described in this case report developed an acute and unexpected facial palsy shortly after treatment. Furthermore, although central tumor necrosis is a well-recognized long-term effect of SRS in vestibular schwannomas—typically appearing several months post-treatment as an asymptomatic radiological finding (1,12)—it was observed on MRI within days of GKRS in this instance.

The coexistence of facial palsy and MRI findings suggestive of acute tumor necrosis raises the possibility of a mechanistic association; however, the lack of histopathological or

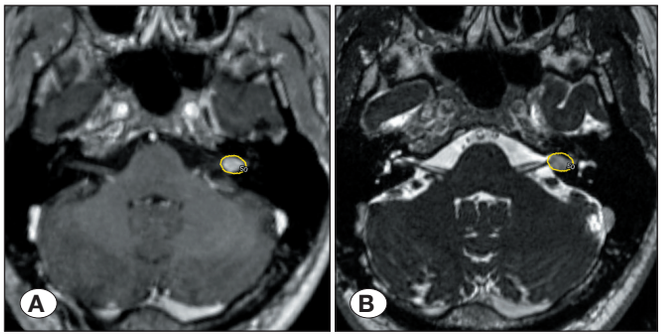

Figure 1: Axial post-contrast T1-weighted magnetic resonance imaging **(A)** and high-resolution T2-weighted constructive interference in steady state (CISS) image **(B)** obtained as part of the Gamma Knife radiosurgery planning protocol. The tumor is clearly visualized on both sequences, while the seventh and eighth cranial nerves are distinctly delineated on the CISS image. A margin dose of 11 Gy was prescribed to the 50% isodose line (yellow contours).

Table I: Radiosurgery Parameters

Parameter	Value
Margin Dose	11 Gy
Maximum Tumor Dose	22 Gy
Mean Tumor Dose	16.3 Gy
Isodose Line	50%
Coverage	100%
Gradient Index	3.04
Selectivity	0.83
Number of Shots	8

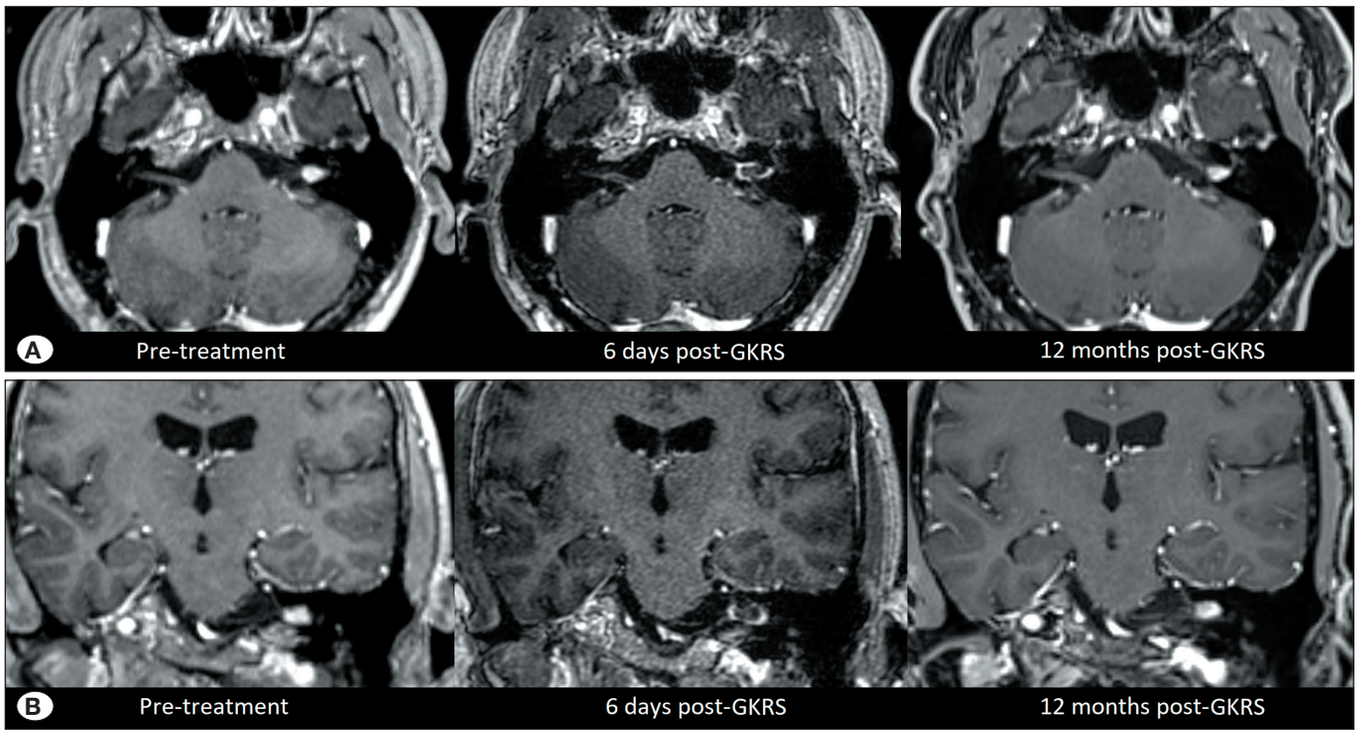

Figure 2: Axial **(A)** and coronal **(B)** post-contrast T1-weighted magnetic resonance images obtained pre-treatment, and at 6 days and 12 months post-Gamma Knife radiosurgery.

advanced imaging confirmation limits definitive conclusions. The incomplete recovery of facial function (HB grade II at 20 months) may be related to partial and irreversible facial nerve injury secondary to acute necrotic or inflammatory changes, or to acute or delayed radiosurgery-induced nerve damage.

A small number of similar cases have previously been described in the literature (2,9,11,14). To our knowledge, the first detailed case was reported by Tago et al. in 2000, and only four cases have been documented over the past quarter-century (14). In contrast to our case, in which a margin dose of 11 Gy was prescribed, previous reports involved higher margin doses, ranging from 13 to 14 Gy. Although our routine practice for single-fraction GKRS is a margin dose of 12 Gy to the 50% isodose line for vestibular schwannomas (5), a reduced margin dose of 11 Gy is prescribed for a subset of patients based on recent studies (4,13). This was applied in the present case to minimize the cochlear dose, as the tumor was located in close proximity to the cochlea.

In all previously reported cases (2,9,11,14), and the present instance, symptoms developed within 36 hours to 4 days after radiosurgery. None of the patients had a prior history of facial palsy, and the newly developed deficits ranged from HB grade III to V. A common feature among all cases was the presence of additional cranial nerve-related symptoms—such as hearing loss or vestibular dysfunction—in addition to facial palsy, as also observed in our patient. Moreover, all cases—including ours—demonstrated reduced contrast enhancement on early post-radiosurgery MRI, possibly reflecting acute tumor response.

CONCLUSION

The mechanism underlying SRS-induced acute facial palsy remains unclear, and only four cases have been previously reported in the literature. To the best of our knowledge, this is the fifth well-documented case of acute facial palsy following SRS. Notably, it is the first reported case occurring after a relatively low margin dose of 11 Gy, compared to higher doses in all previously reported cases.

Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

Ethics approval and consent to participate: This case report did not require formal Institutional Review Board approval; written informed consent was obtained from the patient.

AUTHORSHIP CONTRIBUTION

Study conception and design: OBC, MR
Data collection: OBC
Analysis and interpretation of results: OBC, MR
Draft manuscript preparation: OBC
Critical revision of the article: OBC, MR
Other (study supervision, fundings, materials, etc...): OBC, MR
All authors (OBC, MR) reviewed the results and approved the final version of the manuscript.

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