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Case Report

Dense Calcification Confirmed 12 Years after Initial Gamma Knife Radiosurgery for a Cerebellopontine Angle Meningioma

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Abstract

A 61-year-old male underwent Gamma Knife radiosurgery (GKRS) for a left cerebellopontine angle meningioma. Twelve years post-treatment, magnetic resonance imaging (MRI) and computed tomography (CT) scans demonstrated complete tumor calcification. This case represents the first documented instance of a cerebellopontine angle meningioma treated with GKRS exhibiting total calcification at long-term follow-up. The treated tumor volume was 7.446 cm^3, with a peripheral prescription dose of 12Gy at the 35% isodose line; 97% of the tumor received at least this dose. Serial MRI revealed progressive degeneration, necrosis, and reduced contrast enhancement. Final imaging at 12 years post-GKRS confirmed total calcification and stable tumor size. **Conclusion:** long-term follow-up after GKRS for skull base meningioma may result in complete tumor calcification, controlled tumor growth, and preserved clinical status.

Keywords : gamma knife radiosurgery ; radiosurgery ; cerebellopontine angle meningioma ; meningioma ; skull base meningioma

Introduction

Tumors at the cerebellopontine angle (CPA) account for 10-15% of all intracranial neoplasms. Among these tumors, vestibular schwannomas comprise 80-94%, meningiomas account for 3-10%, and epidermoid cysts represent 2-4%. (1,2,3)

Due to their proximity to critical neurovascular structures, cerebellopontine angle meningiomas present significant surgical challenges. The associated morbidity and mortality risks of surgically removing CPA meningiomas are noteworthy. (4,5)

The management approach for these tumors has gradually shifted from aggressive surgical resection to stereotactic radiosurgery (SRS) as a primary treatment, for tumors measuring 30 mm or less in maximum diameter. For larger tumors, initial surgical debulking followed by adjuvant radiosurgery for residual or recurrent disease. (4,5,6)

The rarity of CPA meningiomas (comprising only 1% of all intracranial meningiomas) has limited the statistical power of past studies, making it difficult to assess long-term outcomes thoroughly. (4,7) However, published data of CPA meningiomas treated with Gamma Knife radiosurgery indicated that the actuarial rates of progression-free survival (PFS) at 5 and 10 years were 92.5% and 77.0%, respectively. (4,8,9)

Case presentation

A 60-year-old male patient was referred to our Gamma Knife Radiosurgery center in September 2013 due to persistent headaches, episodes of dizziness, and decreased hearing in his left ear. His hearing was classified as Gardner-Robertson Scale Grade II, indicating that it was serviceable.

The patient had no facial nerve dysfunction, nor motor or sensory deficits and maintained a normal gait. His medical history included type II diabetes, which was managed with oral medication, as well as controlled hypertension. Other medical and surgical histories were irrelevant.

An MRI with contrast performed at the time of presentation revealed an extra-axial, dural-based mass located at the left cerebellopontine angle. The tumor showed homogeneous enhancement on T1-weighted images after contrast administration and appeared isointense to gray matter on T2- images. The lesion extended anteriorly to the tip of the Petro clival region and projected through the left internal acoustic canal and causing indentation of the brainstem; however, the MRI indicated no signs of hydrocephalus. Based on the MRI findings and clinical presentation, a diagnosis of a benign left cerebellopontine angle meningioma was established. The patient opted to undergo Gamma Knife Radiosurgery (GKRS) and was accepted for the procedure.

Radiosurgery and Tumor Parameters; The GKRS procedure was performed using the Leksell Gamma Knife 4-C version. A Leksell G

stereotactic frame was applied to the patient's head under local anesthesia. An MRI was conducted to obtain stereotactic axial T1-weighted images following gadolinium injection, along with T2- sequences. Treatment planning utilized the Leksell Gamma Plan software version 10 (Elekta, Stockholm, Sweden). A conformal treatment plan was achieved using multiple isocenters to encompass the tumor volume within the prescribed isodose. The treated left cerebellopontine angle tumor volume was 7.446 cm^3, with maximum diameters of 19.8 x 31.8 x 30.1 mm (XYZ). **Figure 1-A**

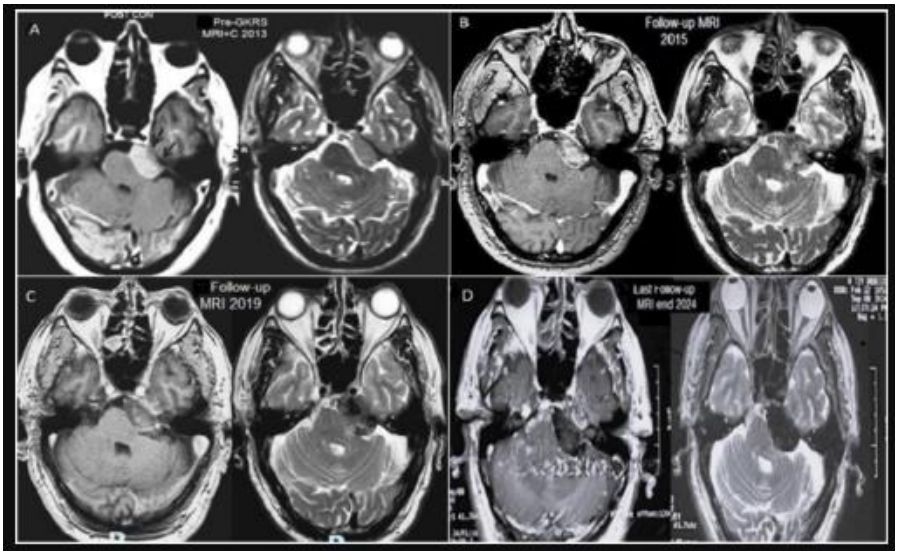

Figure 1: Serial MRI of GKRS treated left cerebellopontine angle meningioma;

A- pre-GKRS MRI in 2013 reveals a wide dural-based left cerebellopontine angle meningioma exhibits homogeneous contrast enhancement in T1 weighted image and isointense to gray matter in T2-weighted images. The lesion extends anteriorly to the tip of the Petro clival region, projecting obstructively through the pours of the left internal acoustic canal. The lesion slightly indented the brainstem. Tumor volume is 7.446 cm^3, with maximum diameters of 19.8 x 31.8 x 30.1 mm (XYZ), treated with GKRS with 12Gy peripheral prescription dose to the 35% isodose line.

B- Follow-up MRI T1 and T2 with contrast images in 2015 shows the GKRS treated left CPA meningioma in 2023 exhibits a stationary growth pattern, characterized by signs of heterogeneous degeneration and reduces contrast enhancement.

C- Follow-up MRI T1&T2+ contrast images in 2019 reveals a mild increase in the z-coordinate axis that was noted before in the 2017. Current MRI, demonstrates hypointense signal across all pulse sequences, characterized by heterogeneous faint enhancement and increasing areas of necrosis. The treated left CPA meningioma continued to compress the ipsilateral cistern accompany by mild perilesional edema on the anterior superior surface of the left cerebellar hemisphere.

D- The most recent follow-up MRI in September 2024 shows no significant changes in the size or extent of the treated left CPA meningioma in 2013 compared to earlier scans. Notably, the lesion is now wholly calcified. It exhibits very low signal intensity on T2-weighted images and mixed iso- and low signal on T1 images. There have been no changes in the previously noted mild perilesional edema or the mass effect.

The peripheral prescription dose was 12 Gy given to the 35% isodose line, the maximum radiation dose was 34.8 Gy and 97% of the target volume received the prescription dose. The Lomax Conformity Index (Lomax CI) was 0.96. Brain stem received less than 10 Gy, left semicircular apparatus received less than 3.8 Gy, and left cochlea received less than 4.4 Gy.

Outcome and Follow-up; At our center, follow-up evaluations typically include clinical and radiological assessments scheduled six months after gamma knife treatment, followed by annual evaluations for five years, and then every two to three years, or as clinically indicated. The follow-up MRI scans with contrast for this case were conducted in 2014, 2015, 2017, 2019, and September 2024. Additionally, CT scans of the brain and bone window were performed in early 2025.

The MRI results from 2014 and 2015 indicated that the treated left CPA (cerebellopontine angle) meningioma exhibited a stationary growth pattern, with signs of heterogeneous degeneration and decreased contrast enhancement. By 2017, the MRI showed a slight increase in the craniocaudal diameter (Z-coordinate), alongside more pronounced necrotic changes and a stable degree of displacement of the pons.

In 2019, MRI displayed a hypointense signal across all pulse sequences, characterized by heterogeneous faint enhancement due to increasing areas of necrosis, accompanied by mild perilesional edema on the anterior superior surface of the left cerebellar hemisphere.

The follow-up MRI in September 2024 demonstrated no significant changes in the size, extension, or imaging characteristics of the treated left CPA meningioma compared to earlier scans. The tumor displayed low signal intensity on T2-weighted images and T1, with faint inhomogeneous contrast enhancement. Notably, the tumor was now entirely calcified. Computed tomography brain scan (CT scan) and bone window in early 2025 revealed a well-defined, dense, calcified left CPA meningioma that was almost inseparable from the petrous bone. **Fig 1,2**

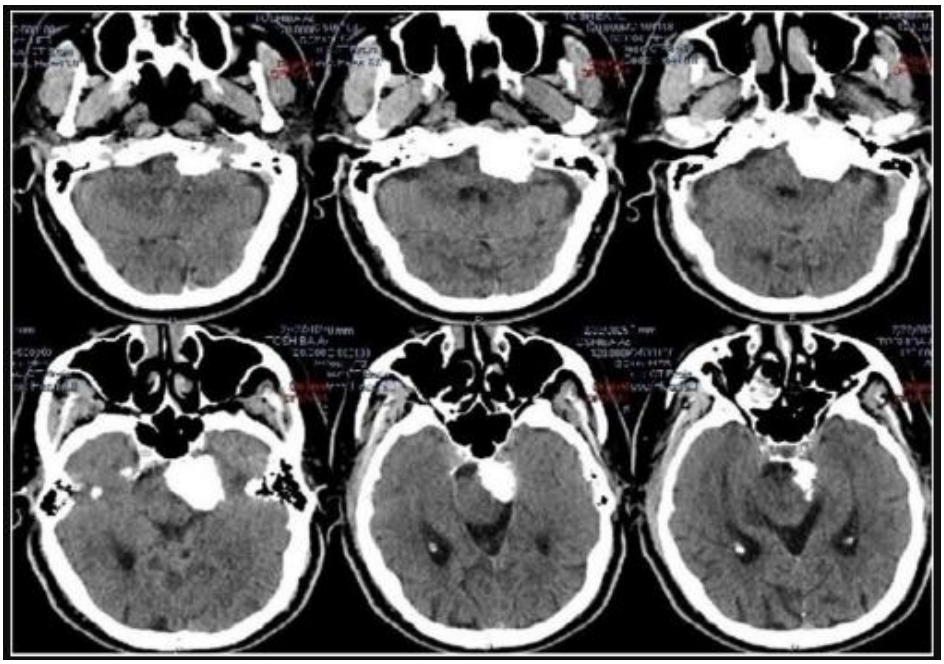

Figure 2: Computed tomography brain scan (CT brain scan) reveals Left CPA extra-axial well-defined dense calcified meningioma indenting the pons left aspect. There are mild global cerebral involutional changes in the term of prominent extra-axial CSF spaces.

Clinically, the patient remained stable until 2019, when he experienced a significant deterioration in hearing in his left ear. Headaches became less intense, primarily around the left eye. The patient developed new left trigeminal neuralgia, mainly triggered by jaw movement and chewing, with dysesthesia. He was prescribed a low dose of carbamazepine in conjunction with paracetamol.

At the most recent clinical follow-up in 2025, the patient discontinued carbamazepine as his pain became manageable with paracetamol, though he still experienced left facial dysesthesia in addition to complete hearing loss in his left ear.

Discussion

This case report represents the first documented instance in the literature of total calcification of a left cerebellopontine angle (CPA) meningioma after long-term of 12 years post- GKRS therapy.

In the literature regarding the treatment of cerebellopontine angle meningiomas with Gamma Knife radiosurgery, there is a noticeable lack of discussion regarding the serial radiological changes that occur within these tumors. Most publications primarily focus on tumor growth control rates. This oversight may be attributed to the rarity of meningiomas in this specific location compared to the more frequently encountered vestibular schwannomas**.** [4,7,13,14]

Raper, Daniel, et al. 2014 published a case report of a partially calcified right Petro clival presumed meningioma treated with Gamma Knife radiosurgery with a prescription dose of 14.0 Gy to the 50% isodose line. Subsequent imaging follow-up at 8 months post-GKRS demonstrated a marked decrease in the calcified component of the tumor with overall stability in tumor volume. [12]

Contrary to the short-term result case report presented by Raper, Daniel et al. (12) the current study presented a case report left cerebellopontine angle meningioma initially treated with GKRS and after 12 years of radiological follow-up of 12 years the last MRI and CT demonstrated complete tumor calcification that almost inseparable from the petrous bone with tumor growth control. These findings are supported by the hypothesis of acquired heterotopic calcification explanation, which is related to tissue trauma including radiation injury. These calcifications are assumed to be secondary to the tissue's ongoing degeneration and necrosis changes. [10-11 ,15]

Conclusion

Long-term follow-up of patients with skull base meningiomas treated with Gamma Knife radiosurgery may lead to necrosis and subsequently to complete tumor calcification, along with a high rate of growth control and maintaining an acceptable clinical status. Gamma Knife radiosurgery is a highly precise and effective treatment, especially for managing skull base meningiomas, provided that patient and tumor characteristics meet the appropriate criteria.

Learning points

1. This is first reported case of complete calcification of cerebellopontine meningioma treated with gamma knife radiosurgery after long-term 12 years follow-up.
2. Stereotactic radiosurgery represents a reasonable treatment option for certain skull base tumor including cerebellopontine angle meningioma.
3. In long-term GKRS for skull base meningioma results in tumor degeneration and necrosis that may initiates tumor calcification even with stable tumor volume.

Abbreviations

CPA=Cerebellopontine angle, GKRS=Gamma knife radiosurgery, Stereotactic radiosurgery=SRS.

Limitation

Being a case report and lack of pathology are limitations.

Contribution: Raef Farouk. Ahmed Hafez, conceived, designed the study, and critically revised the article. The author reviewed the manuscript and approved the final version of the manuscript.

Data availability statement: Available.

Competing interests: None.

Patient consent: Written informed consent was obtained from the patient for publication of this case review, including accompanying images.

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