CASE REPORT

Decreased calcification of a petroclival meningioma after Gamma Knife radiosurgery

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SUMMARY

Stereotactic radiosurgery (SRS) has been well reported in the treatment of certain calcified intracranial lesions such as meningiomas. However, reduction in the calcified portion of the tumour after SRS treatment has not been reported. We present the case of a 76-year-old man with a right petroclival lesion consistent on imaging with a calcified meningioma. The lesion progressed on serial neuroimaging studies, and the patient elected to undergo Gamma Knife radiosurgery. No complications were encountered during the radiosurgery. The patient underwent follow-up imaging at 4 and 8 months, during which the lesion was seen to remain stable in overall size, but with marked decrease in the calcified component. Stereotactic radiosurgery can lead to the reduction of all aspects of meningiomas including the calcified component. The radiobiological effects of high dose ionising radiation may result in bony changes and, thereby, decrease intratumoural calcification of an intracranial tumour.

BACKGROUND

Calcified intracranial lesions represent a subset of intracranial neoplasms; calcification of a lesion usually denotes a benign underlying pathology. The most common of these lesions is meningioma. Although microsurgical resection for meningiomas has traditionally been the first line of treatment, ionising radiation in such forms as intensity modulated radiotherapy (IMRT), fractionated stereotactic radiotherapy (FSRT) and stereotactic radiosurgery (SRS) have been used with increasing frequency to treat meningiomas.¹ SRS has been well reported in the treatment of certain calcified intracranial lesions, as an adjuvant treatment and as a primary treatment in some cases.^{1–8} The use of this modality has been associated with high tumour control rates, and low reported incidence of complications.¹ However, the reduction in the calcified portion of a tumour treated with SRS has not been reported in the literature.

CASE PRESENTATION

A 76-year-old man was incidentally diagnosed with a right petroclival lesion in 2003, measuring 17×11×16 mm (anteroposterior, lateral and craniocaudal) and with imaging characteristics of a calcified meningioma. The calcified component of the tumour measured 11×11×12 mm. A conservative treatment plan with close observation was followed and the patient underwent serial neuroimaging studies, which were stable. After a fall in June 2012, the patient underwent brain MR scan, which

demonstrated increase in size of the lesion to 21×16×23 mm (**figure 1**), in addition to small bilateral subdural haematomas. On examination, he had a mild positive Romberg sign and no pronator drift. Other clinical findings included, generalised lower extremity weakness at 4/5, with 5/5 power in the upper extremities. This examination remained stable over the period of clinical observation. Various treatment options were discussed with the patient, including observation, surgical resection and radiosurgery, and the patient elected for radiosurgery.

TREATMENT

The right petroclival lesion was treated with Gamma Knife radiosurgery with a prescription dose of 14.0 Gy to the 50% isodose line. The radiosurgery was performed without incident.

OUTCOME AND FOLLOW-UP

Initial follow-up imaging 4 months after radiosurgery demonstrated unchanged appearance of the lesion (**figure 2**). Subsequent imaging follow-up at 8 months post-SRS demonstrated a marked decrease in the calcified component of the tumour, with overall stability in tumour volume (**figure 3**). The calcified component now measured 4.6×2.6×4.7 mm. At last follow-up 9 months after

Figure 1 Pretreatment axial T1-weighted MRI brain with contrast demonstrating a 21×16×23 mm right petroclival lesion consistent with a meningioma.

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Figure 2 Four-month poststereotactic radiosurgery (SRS) CT head demonstrating stabilisation of growth of petroclival lesion. (A) Non-contrast axial slice, soft tissue window. (B) Contrast enhanced axial slice, soft tissue window. (C) Axial slice, bone window.

SRS, the patient was at his neurological baseline and had suffered no ongoing complications attributable to the meningioma or the radiosurgery.

DISCUSSION

This case represents the first report in the published literature of decrease in calcification of a presumed meningioma following radiosurgery. Meningiomas are common intracranial tumours that have diverse histological patterns, and many have associated intratumoural calcification and hyperostosis of overlying cranium.⁹ Although calcification is characteristic on CT and MRI, and often assists the radiologist and neurosurgeon in making a presumptive diagnosis, this feature is not a pathological contributor by current WHO grading criteria.¹⁰ Although calcification has been associated with slower tumour progression,¹¹ meningiomas with a calcified component can still demonstrate progressive growth and may still develop clinical symptoms from mass effect or raised intracranial pressure. Calcification is also a common feature of other extra-axial and intra-axial tumours, including low-grade gliomas, craniopharyngiomas, chordomas, oligodendrogliomas, ependymomas and gangliogliomas. However, meningiomas represent the most common calcified intracranial lesion.

SRS is a common adjuvant treatment for atypical and anaplastic meningiomas, even after total or near-total resection.²⁻⁴ SRS has also been used as a primary treatment for meningiomas and yields a high rate of tumour control (ie, tumour stability or regression).⁷⁻⁸ The most common target for SRS is skull base meningiomas. In large series of patients with skull base meningiomas treated with SRS, 5-year local control rates vary from 93% to 98.5%, and 10-year rates from 87% to 97%.¹⁻⁵ In general, SRS for primary and adjuvant treatment is well

tolerated with low rates of complications.⁸ Although the precise mechanism of the observed change in this case is not certain, the biology of radiosurgery is believed to yield generation of free radicals and resulting DNA breaks typical of traditional ionising radiation.¹ Radiosurgery is also known to yield a complex set of signals resulting in cellular damage to the targeted lesion and its vascular supply.¹² In particular, vascular changes, as well as cytotoxic effects, have been described after SRS, particularly in the case of arteriovenous malformations.¹³ Radiosurgery is less dependent on the cell cycle than traditional radiation therapy, but may partly exert its effect by creating 'hot spots' of cellular injury within a heterogeneous tumour mass.¹⁵ In some cases, high-dose ionising radiation can result in bony loss with the incidence of osteopaenia ranging from 8% to 23% and increasing with high single dose per fraction.¹⁶⁻¹⁷ Clinically, this phenomenon has been seen recently in a study by Saghal *et al*,¹⁸ which shows a high rate of bony changes resulting in vertebral compression fractures in spinal radiosurgery patients treated with >20 Gy/fraction. Therefore, it is possible that radiation delivered in high doses during radiosurgery to partially calcified tumours may result in tumour shrinkage and decreased intratumoural calcification. An inflammatory reaction such as this, induced by radiosurgical treatment, could be supported by imaging findings such as increased fluid attenuated inversion recovery or T2 signal on MRI, or peritumoural enhancement, although we do not have post-treatment MRI to support this theory in our case. This report represents the first published case of decreased calcification in a meningioma after treatment with SRS. A decrease in the calcification of a meningioma raises interesting radiobiological considerations and may represent a distinct effect from radiosurgery not previously seen within the intracranial tumour setting.

Figure 3 Eight-month post-SRS CT head demonstrating stabilisation of growth of petroclival lesion. (A) Non-contrast enhanced axial slice, soft tissue window. (B) Contrast enhanced axial slice, soft tissue window. (C) Axial slice, bone window.

Learning points

- We report the first case of progressive resolution of intratumoral calcification after stereotactic radiosurgery (SRS).
- Stereotactic radiosurgery represents a reasonable treatment option for certain calcified intracranial lesions, such as meningiomas.
- SRS may result in decreased volumes of the soft tissue component, and the calcified portion of the tumour.

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Competing interests None.

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