



## Case Report

# Successful management of an intraluminal superior sagittal sinus meningioma causing elevated intracranial pressure using gamma knife radiosurgery in subacute setting: A case report

Enyinna Nwachuku<sup>1</sup>, James Duehr<sup>2</sup>, Matthew W. Pease<sup>1</sup>, L. Dade Lunsford<sup>1</sup>, Edward A. Monaco<sup>1</sup>

<sup>1</sup>Department of Neurosurgery, University of Pittsburgh Medical Center, <sup>2</sup>Department of School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, United States.

E-mail: \*Enyinna Nwachuku - nwachukuel@upmc.edu; James Duehr - jed161@pitt.edu; Matthew W. Pease - peasemw@upmc.edu; L. Dade Lunsford - lunsfordld@upmc.edu; Edward A. Monaco - monacoa2@upmc.edu



### \*Corresponding author:

Enyinna Nwachuku,  
Department of Neurosurgery,  
University of Pittsburgh  
Medical Center, Pittsburgh,  
Pennsylvania, United States.

[nwachukuel@upmc.edu](mailto:nwachukuel@upmc.edu)

Received : 22 August 2020

Accepted : 07 October 2020

Published : 08 March 2021

### DOI

10.25259/SNI\_562\_2020

### Quick Response Code:



## ABSTRACT

**Background:** Gamma Knife stereotactic radiosurgery (GKRS) facilitates precisely focused radiation to an intracranial target while minimizing substantial off-target radiation in the surrounding normal tissue. Meningiomas attached to or invading the superior sagittal sinus may result in sinus occlusion and are often impossible to completely resect safely. The authors describe successful management of a patient with a meningioma located completely inside the posterior aspect of the superior sagittal sinus.

**Case Description:** A 46-year-old woman presented to the emergency department with progressive generalized headaches accompanied by worsening vision. The patient underwent a diagnostic brain magnetic resonance imaging which showed a solitary a 7 × 6 × 10 mm homogeneously contrast-enhancing lesion within the lumen of the posterior aspect of superior sagittal sinus without ventricular enlargement or peritumoral edema. The lesion was thought to be a meningioma radiographically. To evaluate the suspected increased intracranial pressure, a lumbar puncture was subsequently performed and demonstrated an opening pressure of 30 cm H<sub>2</sub>O. After drainage of 40 cc of CSF, the spinal closing pressure was 9 cm H<sub>2</sub>O. After failure of conservative management with acetazolamide, and determination of surgical inoperability due to the critical intraluminal location of the mass lesion, the patient underwent Gamma Knife radiosurgery. The 0.36 cc tumor was treated as an outpatient in the Perfexion® model Gamma Knife with a highly conformal and selective plan that enclosed the 3D geometry of the tumor with a minimal margin tumor dose of 14 Gy at the 50% isodose. Three months after GKRS, the patient reported continued reduction in the frequency and severity of both her headaches and her visual disturbance. Ophthalmological consultation noted progressive resolution of her optic disc edema confirmed by formal optical coherence tomography. The patient is now 3 years out from GKRS with complete resolution of headache symptoms along with persistent reduction in tumor size (3 × 1 × 4 mm) on serial period imaging and resolution of papilledema.

**Conclusion:** Tumors located in such critical anatomic regions, as in our patient, should be considered for primary GKRS when the risks of biopsy or removal are too high. GKRS was able to provide great radiographic and clinical result in an intricately located meningioma.

**Keywords:** Gamma Knife radiosurgery, Image-guided neurosurgery, Lesion, Radiosurgery, Stereotactic surgery

## INTRODUCTION

Gamma Knife stereotactic radiosurgery (GKRS) facilitates precisely focused radiation to an intracranial target while minimizing substantial off-target radiation in the surrounding normal tissue. GKRS is frequently used for meningiomas located in critical structures such as the cavernous sinus (of any Grades 1–3) to reduce risks associated with attempted resection.<sup>[1,15,17]</sup> Meningiomas attached to or invading the superior sagittal sinus may result in sinus occlusion and are often impossible to completely resect safely. In this case report, the authors describe successful management of a patient with intracranial hypertension caused by a meningioma located completely inside the posterior aspect of the superior sagittal sinus.

## CASE REPORT

A 46-year-old woman with a history of sleep apnea, obesity, and osteoarthritis presented to the emergency department with progressive generalized headaches accompanied by worsening vision. One month previously, she noted a gradual increase in frequency of headache which she interpreted as related to underlying migraine events. The headaches were accompanied by increasing visual changes, notably zigzagging lines and a string in the middle of her visual field. After admission, the patient underwent a diagnostic brain magnetic resonance imaging (MRI) followed by MR angiogram and MR venogram. The diagnostic MRI showed a solitary  $7 \times 6 \times 10$  mm homogeneously contrast-enhancing lesion within the lumen of the posterior aspect of superior sagittal sinus not accompanied by ventricular enlargement or peritumoral edema [Figure 1]. Long TR (repetition time) MR imaging showed a tumor isointense with brain signal. CT scans of the chest, abdomen, and pelvis failed to detect any other tumor.

After initial stabilization in the emergency room, she was discharged after gentle intravenous hydration for her headache. Neurological evaluation failed to disclose any clinical signs. To evaluate the suspected increased intracranial pressure, a lumbar puncture was subsequently performed and demonstrated an opening pressure of 30 cm H<sub>2</sub>O. After drainage of 40 cc of CSF, the spinal closing pressure was 9 cm H<sub>2</sub>O. Ophthalmological examination demonstrated normal visual acuity and fields including a slip lamp examination. The clinical suspicion of papilledema was confirmed by optical coherence tomography (OCT) which showed bilateral optic edema [Figure 2]. As a result, the patient was started on anti-angle glaucoma therapy (Diamox 500 mg twice a day), while surgical options were considered. Given the critical location of the tumor in the posterior one-third of the superior sagittal sinus, stereotactic radiosurgery using the Leksell Gamma Knife was proposed as an alternative to high-risk surgical

resection by craniotomy or shunting. The time from diagnosis to GKRS treatment was 2 weeks and the patient was on Diamox for the entire duration. She was then slowly weaned off Diamox over a 3-month time period post-GKRS.

## Treatment

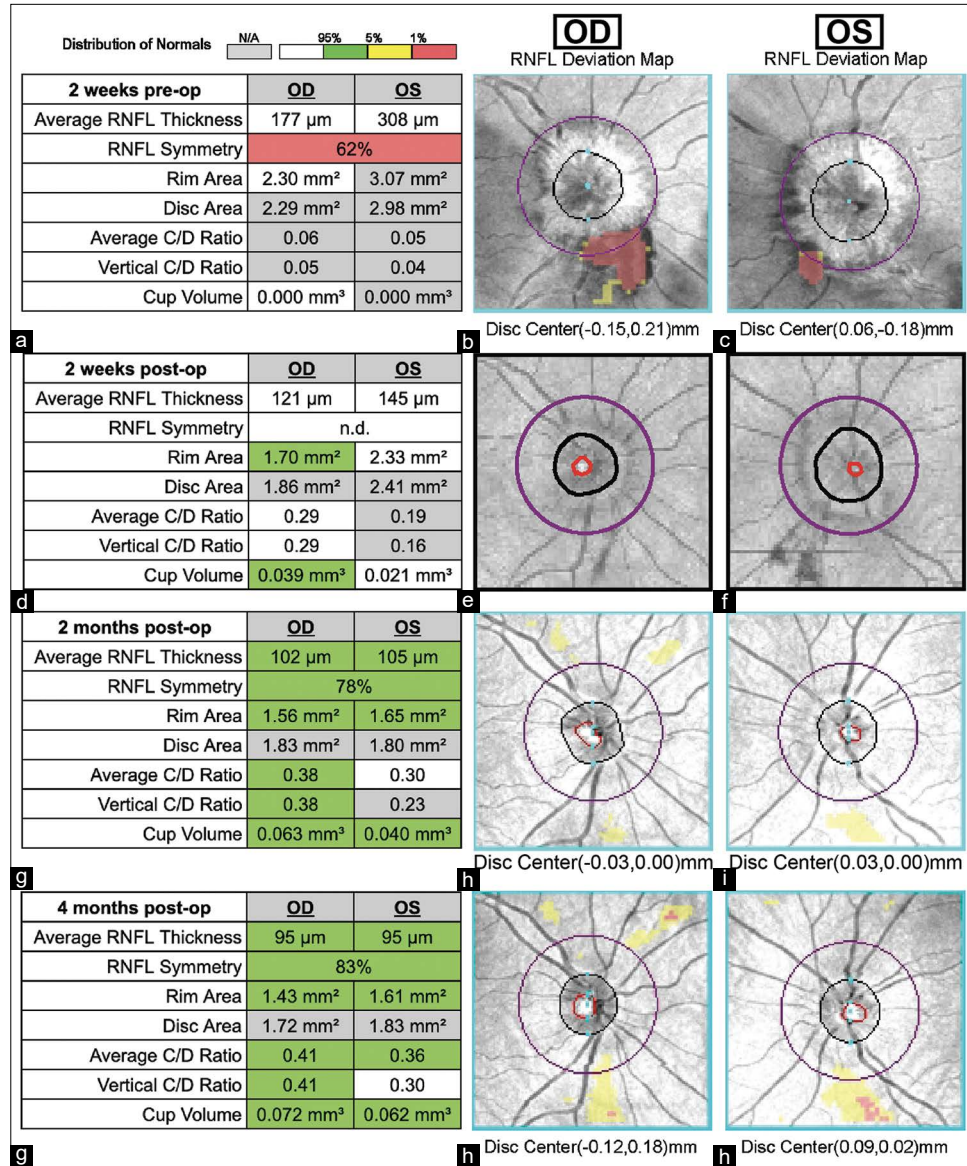
Using mild intravenous conscious sedation with midazolam and fentanyl supplemented by local anesthesia (0.5% bupivacaine and 0.5% lidocaine mixture, 40 cc total given with 10 cc at each pin site), a Leksell Model G (Elekta, Inc., Atlanta, GA) stereotactic head frame was attached to the cranial vault. Axial plane contrast enhanced 1.5 mm SPGR and 3 mm nonskipping T2-weighted whole-head MRI imaging were obtained. The 0.36 cc tumor was treated as an outpatient the Perfexion model Gamma Knife that used 3 isocenters of radiation employing the 4 and 8 mm diameter collimators to create a 14 Gy treatment volume at 50% isodose which enclosed 99% of the T1 contrast and T2 images with 3 mm cuts [Figure 3]. She received a single dose of 40 mg of intravenous methylprednisolone and was discharged the same day on a tapering dose of Diamox.

## RESULTS

Three months post-GKRS, the patient was reevaluated. She reported continued reduction in the frequency and severity of both her headaches and her visual disturbance over a 2-week time period following GKRS. Ophthalmological consultation noted progressive resolution of her optic disc edema confirmed by formal OCT tomography (OCT) 2 weeks after radiosurgery. The patient's OCT showed significant improvement in the ensuing 4 months accompanied by improved retinal nerve fiber layer thickness [Figure 1]. MR imaging 3 months post-GKRS [Figure 3] confirmed a significant reduction in the size of the intraluminal lesion in the superior sagittal sinus at 0.1 cc, as well reconstitution of sagittal sinus flow, absence of peritumoral edema, and a normal ventricular size subsequent follow-up out to 3 years after GKRS demonstrated excellent tumor control without regrowth ( $3 \times 1 \times 4$  mm) and the patient reported headache resolution requiring no further medical or surgical management.

## DISCUSSION

Many critical advancements in imaging techniques, surgical approaches, and medical technology have greatly improved outcomes after resection of convexity meningiomas tumors located in the posterior aspect of the superior sagittal sinus often prove to be problematic because of the obstruction of normal venous outflow and resultant increased intracranial pressure.<sup>[13]</sup> Microsurgical techniques can confirm histology but may be associated with risks of sinus thrombosis, venous infarction, and hydrocephalus.<sup>[2,16]</sup> For patients with tumors

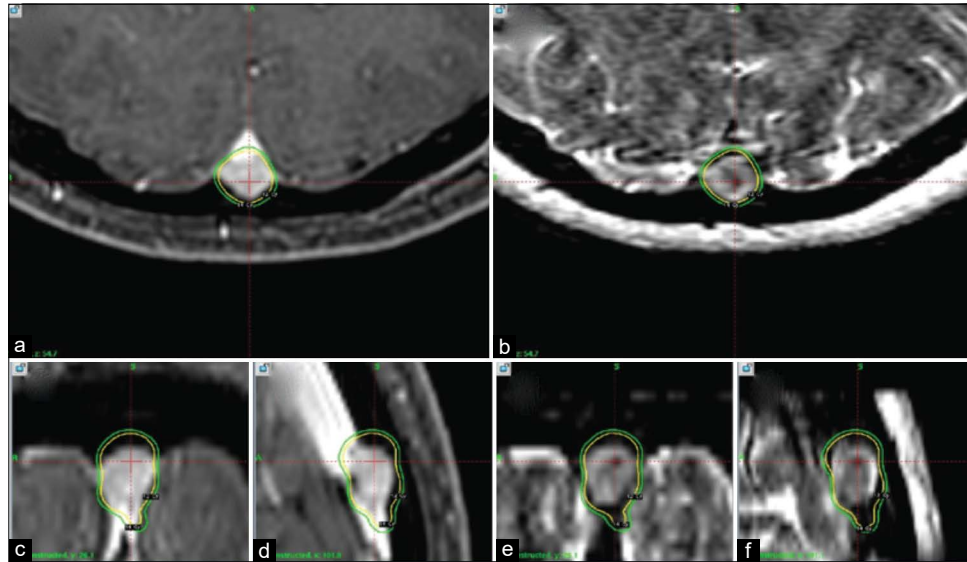


**Figure 1:** Optical coherence tomography (OCT) scans before and after GKRS treatment. OCT is a technique that permits noninvasive cross-sectional imaging of the retina. All images were obtained using a CIRRUS 5000 instrument with Zeiss OCT-HD software v9.0.0.281. (a-c) Two weeks before GKRS. (d-f) Two weeks post-GKRS. (g-i) Two months post-GKRS. (j-l) Four months post-GKRS. (a, d, g, and j) The summary data of the scan, including RNFL (Retinal Nerve Fiber Layer) thickness, RNFL symmetry (coefficient calculated by comparing OD and OS RNFL tomography), and C/D (cup to disc) ratios. (b, e, h, and k) The OD (right eye) RNFL deviation map, based on an en face fundus image with machine drawn boundaries of the cup (red), disc (black), and RNFL calculation circle (purple). (c, d, i, and l) The same for OS (left eye).

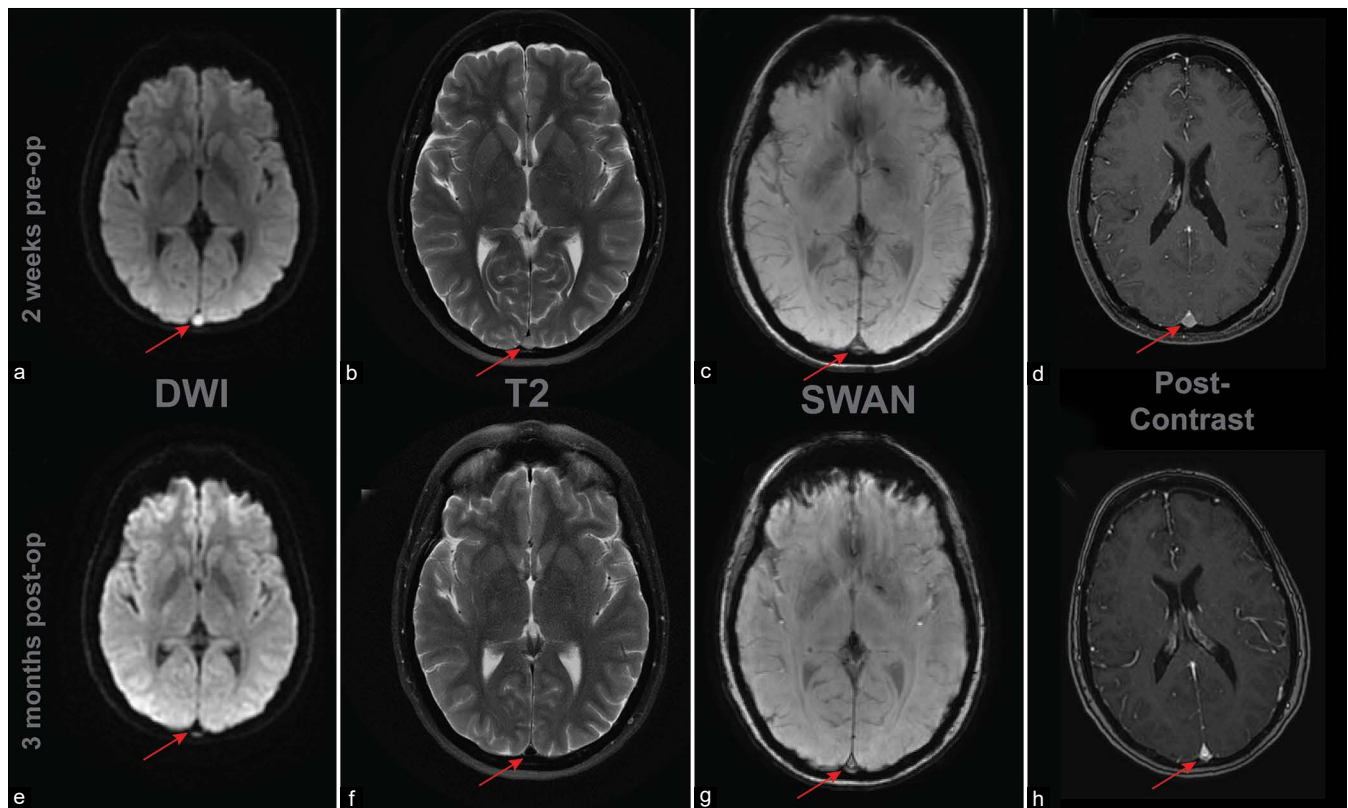
in such high-risk locations, stereotactic radiosurgery has proven to be an effective noninvasive treatment.<sup>[1,15,67]</sup>

At our center, where more than 16,500 patients have undergone cranial radiosurgery during a 33-year interval, more than 2000 patients have had meningiomas. Both our outcome studies and many other published reports indicate that between 85–95% of meningiomas have progression-free survivals extending now for more than 30 years.<sup>[4,8-12,18]</sup> This case report of a rare tumor within the lumen of the posterior superior sagittal sinus for

which GKRS was successfully applied in next to acute settings, resulted in early symptomatic improvement, relief of elevated intracranial pressure, tumor regression with long-term tumor control, and reconstitution of sinus blood flow. Based on current literature, the rate of postradiation complications, mainly edema, is approximately 16% for parasagittal lesions which holds the closest resemblance to the tumor in our patient. It was noted that that risk of these complications increased once marginal tumor dose was greater than 18 Gy.



**Figure 2:** Gamma Knife radiosurgery dosage and localization plan. Treatment plan for GKRS irradiation using a Leksell Gamma Knife<sup>®</sup> Perfexion<sup>™</sup> instrument. (a, c, and d) T1-weighted sequences with gadolinium contrast, while (b, e, and f) T2 weighted. Illustrated are the 12 gy (yellow) and 14 gy (green) isodose lines. Orientation as follows: (a and b) axial. (c and e) Coronal. (d and f) Sagittal.



**Figure 3:** Magnetic resonance imaging (MRI) sequences before and after Gamma Knife stereotactic radiosurgery treatment. (a-d) MRI with contrast obtained 2 weeks before treatment. (e-h) MRI with contrast obtained 3 months posttreatment. Specific sequences (DWI, T2 weighted, SWAN, and postcontrast) are as delineated in the figure. Red arrow shows progression at tumor regression with treatment with top figures showing pretreatment and figures at the bottom showing post-treatment.

The average accepted dosage around this location was 14 Gy, as was utilized in our patient.<sup>[3]</sup> The presented risk outweighed

that our surgical resection holds 2–5% risk of mortality and 29% risk of morbidity.<sup>[2,5]</sup>

Given the completely intraluminal location of this lesion, the histology of this solitary tumor is unconfirmed but suspected by imaging to be a meningioma. Given that symptoms resolved with 14 Gy, the grade was likely low (1 or atypical, but not beyond). The risk of tumor biopsy or resection of a tumor in the posterior sagittal sinus was an impediment to histological confirmation. Hemangiopericytomas may mimic meningiomas using MRI and often respond more quickly and with greater volumetric reduction than do meningiomas,<sup>[7]</sup> however, the dormant nature and persistent symptomatic relief after treatment with GKRS of this lesion suggest a more benign natural history usually seen in low-grade meningiomas.<sup>[14]</sup> Continual long-term follow-up of the patient's vision and neurological status supplemented by periodic imaging is important to verify tumor control, confirm the diagnosis of meningioma, and rule out the possibility of hemangiopericytoma.

## CONCLUSION

We believe that tumors located in such critical anatomic regions should be considered for primary GKRS when the risks of biopsy or removal are too high. The rapid improvement in patient symptoms and early tumor regression after radiosurgery were additionally gratifying outcomes in this patient. This case further illustrates that GKRS can be effectively implemented as a neurosurgical tool in the subacute management of symptomatic cavernous sinus meningiomas with partial intraluminal infiltration.

## Statement of ethics

Formal informed consent was obtained from the patient involved in addition to all her information being deidentified for the purpose of publication.

## Authors' contributions

- Enyinna L. Nwachuku, M.D.: Concept, data acquisition, manuscript preparation, and revision
- James E. Duehr, Ph.D.: Data acquisition and manuscript preparation
- Matthew W. Pease, M.D.: Manuscript preparation and revision
- L. Dade Lunsford, M.D.: Manuscript preparation and revision
- Edward A. Monaco, M.D., Ph.D.: Concept and manuscript preparation and revision.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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**How to cite this article:** Nwachuku E, Duehr J, Pease MW, Lunsford LD, Monaco EA. Successful management of an intraluminal superior sagittal sinus meningioma causing elevated intracranial pressure using gamma knife radiosurgery in subacute setting: A case report. *Surg Neurol Int* 2021;12:86.