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Case Report

Retractorless interhemispheric transtentorial approach for large lesions in the posterior incisural space

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ABSTRACT

Background: Surgical resection of lesions in the posterior incisural space presents a significant surgical challenge, which may result in postoperative visual complications and other neurological deficits. We, therefore, describe a retractorless interhemispheric transtentorial approach that avoids surrounding brain structures with positive outcomes and no complications or visual damage.

Case Description: We present four cases of lesions in the posterior incisural space that was treated with a retractorless interhemispheric transtentorial approach. Two patients were previously seen at another institution for a falcotentorial meningioma. We resected the meningiomas with a parietal-occipital interhemispheric transtentorial approach with no neurological deficits. A third patient presented with a large superior vermian hemangioblastoma with a steep angle of the tentorium. The fourth patient had a large upper vermian metastatic lesion with progressive enlargement, which was refractory to radiation treatments and chemotherapy, and we achieved partial resection. Postoperative visual function was completely preserved in all patients.

Conclusion: A carefully executed retractorless interhemispheric approach in select cases is an effective option to reduce morbidity and prevent visual complications when removing lesions in the posterior tentorial incisure.

Keywords: Falcotentorial, Hemangioblastoma, Interhemispheric, Meningioma, Retractorless

INTRODUCTION

The tentorial incisura is the anterior opening between the free edge of the tentorium cerebelli and the petroclival ridge for the passage of the brainstem where the supratentorial space communicates with the infratentorial space. Within it, the posterior incisural space is a complex region located posterior to the midbrain where the pineal gland and the tentorial notch are located. The posterior incisural space is home to significant neurovascular structures such as the Vein of Galen, basal vein of Rosenthal, internal occipital vein, posterior cerebral artery, splenium of corpus callosum, superior vermis, and trochlear nerve.[22] Within it, a number of neoplasms can arise which create a formidable surgical challenge. Among these are falcotentorial meningiomas

which involve the posterior incisural space. These lesions are extremely rare, comprising 1% of all meningiomas,[10,20] and are intrinsically difficult to resect as they lie in close proximity to the above-mentioned critical vascular and neural structures. The parietal-occipital craniotomy, which offers a standard parafalcine approach to access falcotentorial meningiomas, carries the risk of injury to the optical apparatus from occipital lobe retraction, which often results in visual deficits including permanent blindness.[4,8,23,25] With this manuscript, we describe a retractorless interhemispheric approach exemplified in the resection of four large posterior incisural space tumors that resulted in good patient outcomes with no procedure-related complications or visual deficits. These cases demonstrate that omitting retractors during surgical treatment in the posterior incisural space in select cases can prevent visual complications that are a frequent challenge in the treatment of these lesions.

CASE REPORTS

Patients were evaluated and managed at our institution from November 2016 to November 2018.

Patient 1

A 62-year-old female with a history of hypertension, hyperlipidemia, and cerebrovascular accident was followed at another institution for several years with a gradually enlarging falcotentorial lesion. The patient presented to our emergency room with intensifying occipital headaches that were throbbing and pressurized in nature along with worsening balance and gait difficulties. On physical exam, the patient had residual stroke deficits with left upper extremity weakness, right central face palsy, left dysmetria, and worsening gait imbalance. Preoperative imaging showed a 3.6 cm × 3.5 cm × 3 cm enhancing lesion in the posterior incisural space with severe brainstem compression [Figure 1a-c].

The patient underwent two stages of resection: an initial left parietal-occipital transtentorial retractorless interhemispheric approach under general anesthesia with electrophysiological monitoring followed 2 days later by a right sided approach for complete tumor resection [Figure 1d-f]. The steep angle of the tentorium was not permissive for the usual supracerebellar and infratentorial approach; the majority of the tumor was located toward the left of the midline and initially, complete resection was attempted through this approach.

For stage one, the patient was placed in a lateral position with their left side facing down and the sagittal plane parallel to the floor. Gravity served to retract the parietal-occipital lobe [Figure 2]. An L-shaped incision was made, with the short arm of the L across the midline and the long arm positioned

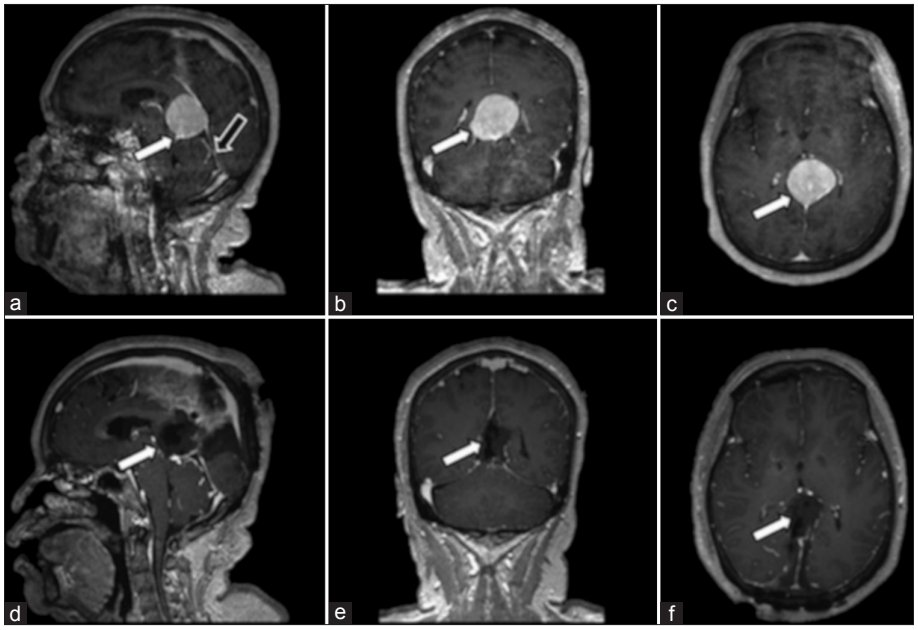

Figure 1: Magnetic resonance images for patient 1. (a) Preoperative postcontrast T1 sagittal, avidly enhancing mass measuring 3.6 cm anterior-posterior (white arrow) along the tentorium, compressing the aqueduct of Sylvius. Tentorial angle is excessively steep (black arrow), which prohibits an infratentorial approach. (b) Preoperative postcontrast T1 coronal, redemonstration of hyperintense mass measuring 3 cm transverse (white arrow). (c) Preoperative postcontrast T1 axial, hyperintense mass measuring 3.5 cm cranial-caudal (white arrow). (d) Postoperative postcontrast T1 sagittal, postsurgical changes demonstrating gross total resection of pineal region mass (white arrow). (e) Postoperative postcontrast T1 coronal, postsurgical changes demonstrating gross total resection of pineal region mass (white arrow). (f) Postoperative postcontrast T1 axial, postsurgical changes demonstrating gross total resection of pineal region mass (white arrow).

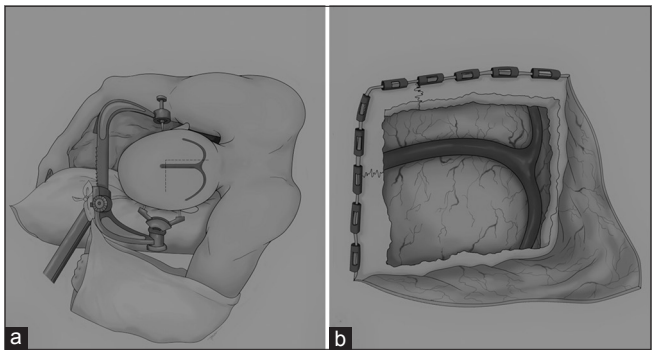

Figure 2: (a) Surgical position keeping sagittal plane parallel to the floor. (b) Craniotomy exposing bilateral dura as well as torcula.

inferiorly for 7 cm, reaching below the torcula and transverse sinus level to allow adequate blood supply to the flap. After scalp flap retraction, the bone flap was excised as guided by stereotactic navigation. To this end, we created six burr holes, three at each side of the sagittal sinus, with two superior holes 6.5 cm above the torcula level, two inferior holes just above the torcula level, and the last two at mid-distance. The epidural space was dissected toward the left (4.5 cm) and the right side (3 cm). The bone flap was executed 4.5 cm toward the left, and 2.5 cm toward the right of the superior sagittal sinus to allow mobilization of the sinus during deeper interhemispheric dissection. At this point, a left parietal-occipital ventriculostomy was placed, guided by stereotactic navigation, just within the edge of the craniotomy area (6 cm above torcula level and 3 cm left lateral to midline). The dura was opened on the left side in C-fashion with the base toward the superior sagittal sinus, and the ventriculostomy was opened to drain 25 cc of cerebrospinal fluid (CSF), allowing brain relaxation. Microsurgical dissection was performed at the interhemispheric fissure using the highest magnification without fixed retractors, covering the parietal-occipital cortex with Telfa patties and only gentle dynamic traction with surgical bipolar and suction. The tentorium was electro-coagulated and opened for approximately 2 cm, with 1 cm lateral and parallel to the straight sinus. The lesion was hypervascular and fibrous and attached to the falx and bilateral tentorium. The capsule of the tumor was localized, electro-coagulated, centrally debulked, and gradually dissected from the inferior sagittal sinus, Vein of Galen, straight sinus, and internal cerebral veins. Approximately 20% of the tumor located toward the right side was not visible. Postoperatively, the patient had baseline neurological conditions and was offered the option for observation, stereotactic radiation treatment, or reoperation for residual lesion. The patient and her family desired complete resection of the residual lesion, and we, therefore, proceeded 2 days later with a contralateral approach using the same technique but with right side facing down and opening the right-sided dura in the same fashion.

Complete resection of the tumor, including dural attachments, was achieved with no surgical complications. The ventriculostomy was removed on postoperative day 2. The patient continued to experience her baseline remote stroke sequelae symptoms, although her gait imbalance deficit improved in approximately 2 months. Postoperatively and at 6-month follow-up, radiographic imaging showed no residual lesion. Pathological examination confirmed a WHO Grade I fibrous meningioma.

Patient 2

A 38-year-old female with no significant medical history presented with severe headaches and nausea that was exacerbated by activities such as bending over and lifting. The patient was previously seen by other neurosurgeons outside of the United States and had undergone an attempted biopsy for a pineal region lesion through a frontal endoscopic approach. This patient developed Parinaud syndrome, diplopia, and gait imbalance which lasted approximately 1 month. Later, they had a second stereotactic biopsy that revealed a WHO Grade 1 meningothelial/fibroblastic meningioma. The patient was neurologically intact by the time of our initial evaluation. Imaging revealed a 3.5 cm × 3.1 cm × 3 cm large pineal region enhancing lesion with brainstem (midbrain in the tectal plate) and cerebellar compression [Figure 3a-c].

The lesion was resected through bilateral parietal-occipital stereotactic craniotomy (larger on the right side) utilizing a posterior right occipital interhemispheric and transtentorial approach as described in the previous case. Given the steep tentorial angle, prior surgical treatments this patient was subjected previously with subsequent morbidity, and goal to reach the most ventral aspect of the tumor without cerebellar retraction, the right occipital interhemispheric and transtentorial approach were selected over the supracerebellar-infratentorial option. The lesion was highly vascular, and we performed gradual central debulking with an ultrasonic aspirator with careful microdissection of the tumor capsule from vascular structures. A subtotal resection was performed, leaving the superior and left the aspect of the capsule, which was attached strongly to the Vein of Galen, bilateral veins of Rosenthal, and also toward the tectal plate of the midbrain. A right frontal ventriculostomy was placed preoperatively and removed 2 days after surgery.

On discharge, the patient's baseline symptoms resolved and she was neurologically intact. Pathology confirmed a WHO Grade I fibrous meningioma. Follow-up magnetic resonance imaging (MRI) 8 months after surgery revealed the minimal residual presence and no signs of progression [Figure 3d-f].

Patient 3

A 65-year-old male with a remote history of scalp melanoma had worsening headaches before admission. He

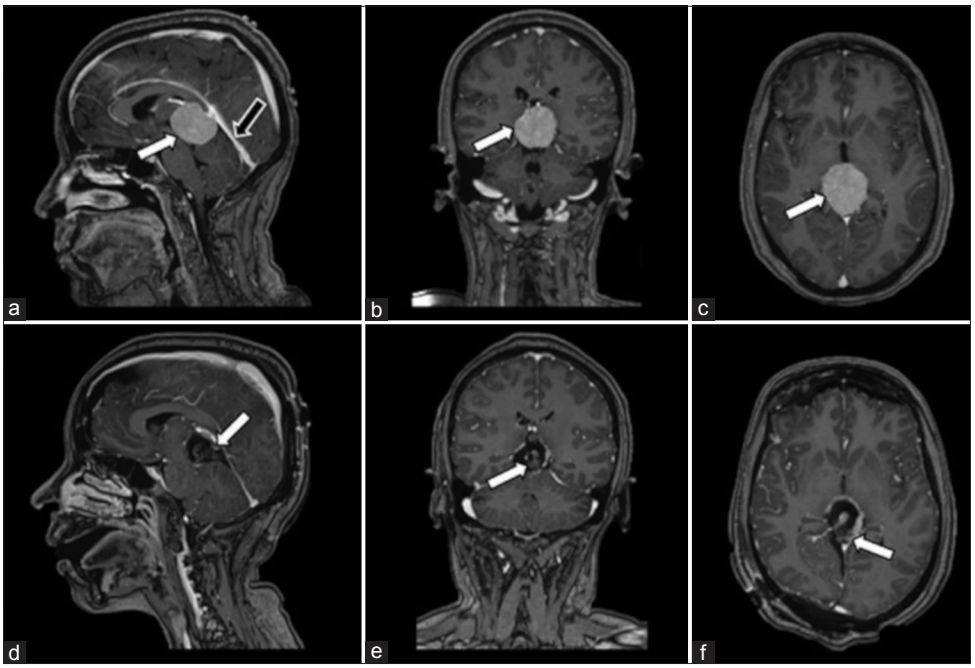

Figure 3: Magnetic resonance Images for patient 2. (a) Preoperative postcontrast T1 sagittal, homogeneously enhancing ovoid mass centered in the quadrigeminal cistern/pineal region which measures 3.5 cm anterior-posterior (white arrow), compressing the cerebral aqueduct. Tentorial angle is excessively steep (black arrow), which prohibits an infratentorial approach. (b) Preoperative postcontrast T1 coronal, homogeneously enhancing mass measuring 3.1 cm transverse (white arrow). (c) Preoperative postcontrast T1 axial, homogeneously enhancing mass measuring 3 cm cranial-caudal (white arrow). (d) Postoperative postcontrast T1 sagittal, postsurgical changes demonstrating residual tumor capsule (white arrow) attached to segments of the Vein of Galen and internal cerebral vein. (e) Postoperative postcontrast T1 coronal, postsurgical changes demonstrating gross total resection of pineal region mass (white arrow). (f) Postoperative postcontrast T1 axial, postsurgical changes demonstrating residual tumor capsule (white arrow) attached to segments of the Vein of Galen and internal cerebral vein.

was found to have a 3.2 cm × 2.9 cm × 3.2 cm posterior fossa lesion arising from the inferior surface of the left tentorial leaflet, associated with cerebellar edema, effacement of the fourth ventricle, and mild hydrocephalus [Figure 4a-c]. He was operated on initially by another neurosurgeon with a left-sided suboccipital approach, who discovered that the lesion was highly vascular and difficult to access. No neurological deficits were encountered after this operation. A recommendation was made for reoperation with an occipital interhemispheric transtentorial approach, and the patient agreed with the plan for the surgery.

The patient was kept in a lateral position using a beanbag, and the left side was kept down with cranial fixation, such that the sagittal plane was parallel to the floor. The lesion was resected through a bilateral parietal-occipital stereotactic craniotomy (larger on the left side), utilizing a posterior left occipital interhemispheric and transtentorial approach as described in the previous cases. A right frontal ventriculostomy was placed preoperatively, and we drained a total of 60 cc of CSF during the entire operation. After transtentorial exposure, we encountered a highly vascular and hemorrhagic tumor. We gradually debulked centrally with the ultrasonic aspirator and bipolar electrocoagulation. The largest arterial supply to the tumor, a branch of the superior cerebellar artery, was interrupted with a 7 mm titanium clip and the segment of the tentorium that was attached to the tumor was entirely resected, requiring hemoclips for hemostasis. The ventriculostomy was removed on postoperative day 2.

The patient was neurologically intact and discharged home on postoperative day 5. The pathology report confirmed a WHO Grade I hemangioblastoma, and an immediate postoperative MRI and another at 5 months postsurgery confirmed gross total resection [Figure 4d-f].

Patient 4

A 47-year-old female presented with dysmetria and gait imbalance, with a history of metastatic breast cancer that was already managed at another institution with chemotherapy and whole brain radiation treatments for a superior vermian metastasis 3.1 cm × 3.0 cm × 3 cm [Figure 5a-c]. Imaging studies showed progressive enlargement of the lesion and

were presented at our institutional tumor board conference, recommending surgical debulking.

A lumbar drain was placed, as no signs of obstructive hydrocephalus or increased pressure in the posterior fossa were encountered. The patient was kept in a lateral position using a beanbag and the right side was kept down with cranial fixation, with the sagittal plane parallel to the floor. The lesion was approached with a bilateral parietal-occipital stereotactic craniotomy (larger on the right side) utilizing a similar posterior right occipital interhemispheric and transtentorial approach. The lesion was centrally debulked using ultrasonic aspirator. The ventral part of the tumor was strongly attached to the superior cerebellar peduncles and midbrain and showed signs of calcification. We debulked as much as possible and eggshell the capsule of the tumor that was strongly attached to additional structures around the cerebellum, the vermis, and the brainstem, and proceeded to dissect centrally to the core. Overall, 25 cc of CSF was removed through the lumbar drain.

Postoperatively, the patient continued to experience dysmetria and gait imbalance. The lumbar drain was removed on postoperative day 2 and she was discharged to a rehabilitation center on postoperative day 13. Pathology reported metastatic adenocarcinoma with prominent necrosis and we are pending to start stereotactic radiation treatment for the residual lesion [Figure 5d-f].

DISCUSSION

This report presents four cases of large posterior incisural space complex tumors that were successfully resected using a retractorless interhemispheric approach with good outcomes. Importantly, visual function was completely preserved in all patients. These findings indicate that in select patients, a retractorless interhemispheric approach may be advantageous in avoiding the risk of visual deficits, to overcome a considerable surgical challenge for the current standard techniques.

Falcotentorial meningioma resection approaches

Due to their complex nature and proximity to vital structures, several surgical approaches have been implemented in the treatment of falcotentorial meningiomas, including occipital interhemispheric transtentorial, infratentorial supracerebellar, biparietooccipital craniotomies, and supra/infratentorial-trans-sinus approaches.[1,2,9,12,16,21,24] The choice of surgical approach depends primarily on the size and location of the tumor as well as angiographic characteristics.

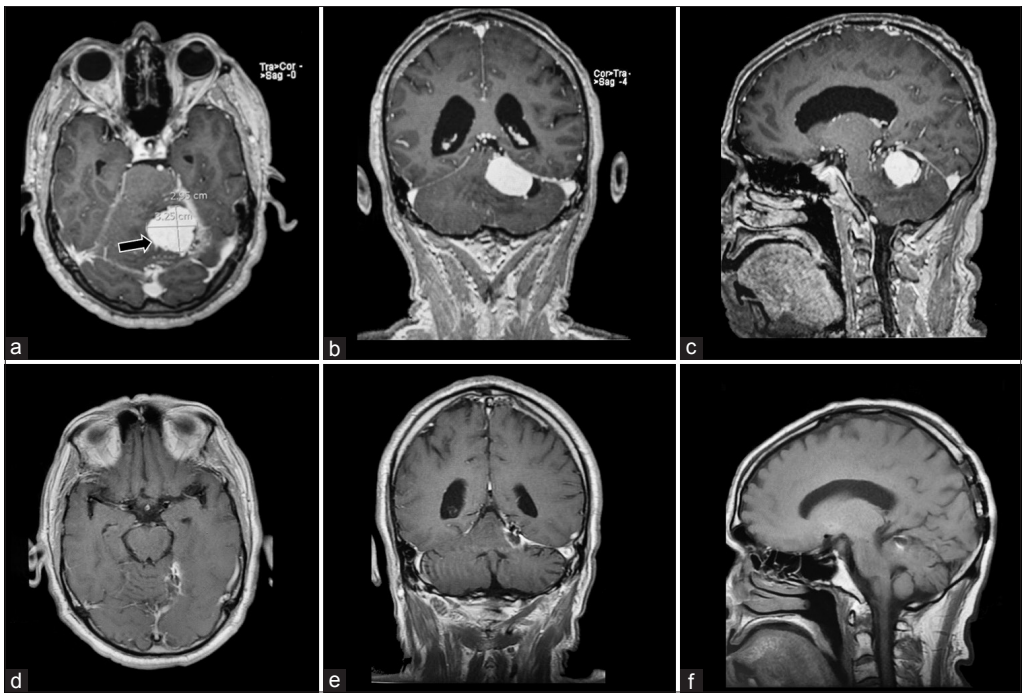

Figure 4: Magnetic resonance images for patient 3. (a) Preoperative postcontrast T1 axial, homogeneously enhancing infratentorial paramedian lesion with high perilesional vascularity (black arrow). (b) Preoperative postcontrast T1 coronal, showing tentorial attachments. (c) Preoperative postcontrast T1 sagittal, showing a homogeneously enhancing mass with perilesional vascularity, and steep tentorial angle. (d) Postoperative (5 months) postcontrast T1 axial, demonstrating minimal tentorial enhancement and vascular clips artifact. (e) Postoperative postcontrast T1 coronal, demonstrating gross total resection and vascular clips artifact. (f) Postoperative noncontrast T1 sagittal, showing postsurgical changes.

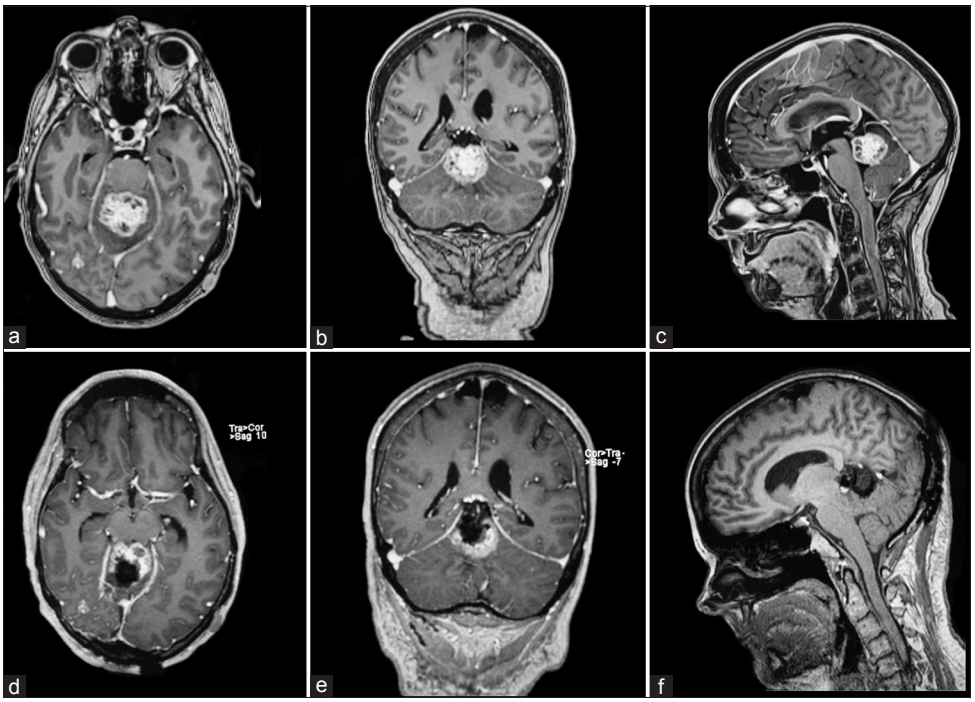

Figure 5: Magnetic resonance images for patient 4. (a) Preoperative postcontrast T1 axial, showing heterogeneously enhancing superior vermian lesion without hydrocephalus. (b) Preoperative postcontrast T1 coronal. (c) Preoperative postcontrast T1 sagittal, showing a heterogeneously enhancing mass with a displacement of tectal plate and steep tentorial angle. (d) Postoperative postcontrast T1 axial, demonstrating minimal surgical cavity and residual lesion. (e) Postoperative postcontrast T1 coronal, demonstrating partial resection. (f) Postoperative noncontrast T1 sagittal, demonstrating postsurgical changes.

For example, an occipital interhemispheric approach generally preserves the internal cerebral veins, Vein of Galen, and straight sinus.[7] A posterior interhemispheric retrocallosal transfalcine approach is useful for select superiorly positioned falcotentorial meningiomas, though the Vein of Galen and straight sinus at the falcotentorial junction must be carefully avoided.[14] The bi-occipital suboccipital transsinus transtentorial approach can be effective for large, deep-seated meningiomas and involves mild retraction of the occipital lobe and cerebellum, resulting in wide supratentorial and infratentorial exposure of extensive pineal region tumors.[13] Ultimately, the goal of each surgical approach is complete or near complete tumor resection without compromising vital structures.

Visual deficits

Visual deficits are a frequent complication of the various approaches utilizing retractors to resect falcotentorial meningiomas, due to damage to the optic apparatus.[3,8,19,23,25,5] A summary of visual outcomes after lesions resection is shown in Table 1. Together, these studies illustrate the commonality of postoperative visual deficits experienced by falcotentorial meningioma patients after various surgical approaches.

Advantages of a retractorless posterior interhemispheric approach

The posterior interhemispheric approach has been used to access lesions in the pineal region, posterior incisural space, posterior region of third ventricle, and adjacent structures.[11,15,17,26] Distinctively, this approach allows for gravity-assisted occipital lobe retraction,[18] which can enhance exposure during surgery and reduce morbidity such as visual deficits postoperatively.[6] Using gravity-assisted occipital lobe retraction, we avoided the use of retractors, which are often used to access the tumor site during current surgical approaches. Prolonged occipital lobe retraction may be a causative factor resulting in postoperative visual deficits,[6,15,18] as pressure on the medial occipital lobe from spatula retraction can compromise the vasculature in the calcarine area.[3] A retractorless approach has been reported to help avoid bilateral cortical blindness due to occipital lobe retraction.[4] Gravity-assisted retraction was used successfully in this study using strategic patient positioning, which resulted in the positive outcomes of tumor resection and complete preservation of visual function in all patients. It is important to note that partial resection in patient four was not a limitation caused by the retractorless approach, since partial debulking was decided on due to strong attachments of the metastatic lesion to the dorsal midbrain and cerebellar

Table 1: Visual outcomes.

Author and year	*n*	Approach	Transient visual deficit (%)	Permanent visual deficit (%)
Bassiouni *et al*. 2008[3]	13	Occipital transtentorial (9), occipital (2), supracerebellar infratentorial (2)	1/13 (7.7)	1/13 (7.7)
Goto *et al*. 2006[8]	14	Occipital transtentorial	8/14 (57)	3/14 (21)
Nazzaro *et al*. 1992[19]	12	Transtentorial (semisitting)	12/12 (100)	2/12 (16.6)
Quinones-Hinojosa *et al*. 2009[23]	9	Supratentorial/infratentorial torcular craniotomy	9/9 (100)	0
Raco *et al*. 2004[25]	13	Occipital craniotomy (3), bioccipital craniotomy (1), supracerebellar/infratentorial (2)	0	2/13 (15.4)
Present series	4	Parietal-occipital transtentorial retractorless interhemispheric	0	0

peduncles, and resulted in the stable postoperative neurological exam.

CONCLUSION

The retractorless interhemispheric transtentorial approach presented here was successful in the resection of four large tumors in the posterior incisural space without damage to the optic apparatus or development of postoperative visual deficits. Together, this report suggests that a carefully executed retractorless approach should be considered for falcotentorial tumors, as well as large upper vermian lesions, as a means of preserving visual function, which currently poses a considerable surgical challenge.

Authors' contributions

Conception and design: Lopez-Gonzalez, Patel. Acquisition of data: all authors analysis and interpretation of data: Lopez-Gonzalez, Patel. Drafting the manuscript: Lopez-Gonzalez, Patel. Critically revising the manuscript: all authors reviewed submitted version of the manuscript: all authors.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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