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Technical Notes

Refining pineal gland tumor resection with bilateral occipital transtentorial approach: Technical insights

Muhammad Fakhri Raiyan Pratama[1], Wisnu Baskoro[1], Gabriel Jason Ganadhi[2], Azriel Farrel Kresna Aditya[2]

[1]Department of Neurosurgery, Soeradji Tirtonegoro Hospital, Klaten, [2]Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia.

E-mail: *Muhammad Fakhri Raiyan Pratama - eff.nsurg@gmail.com; Wisnu Baskoro - snu.nssby@gmail.com; Gabriel Jason Ganadhi - gabrielganadhi@mail.ugm.ac.id; Azriel Farrel Kresna Aditya - azrielfarrel15@mail.ugm.ac.id

***Corresponding author:**
Muhammad Fakhri Raiyan Pratama,
Department of Neurosurgery, Soeradji Tirtonegoro Hospital, Klaten, Indonesia.

eff.nsurg@gmail.com

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ABSTRACT

Background: Pineal gland tumors are infrequent malignancies that predominantly manifest in children, comprising a mere 3–11% of all pediatric brain cancers and <1% of adult brain tumors. Pineal resection can be accessed through various approaches, most commonly the supracerebral infratentorial approach and the occipital transtentorial (OT) approach. Bilateral OT approach (BiOTA) on pineal gland complete resection allowed exposure and, therefore safer complete resection of the contralateral lesion, though the use is rarely reported before this case report.

Methods: The patient was positioned in a prone/Concorde position, with the operator alternating between the right and left sides. A lumbar cerebrospinal fluid drain was installed between the L3 and L4 vertebrae to induce brain relaxation. A linear midline incision was made, followed by occipital craniectomy using multiple burr holes to create a kite shape, and then, the bone flap was removed, and the dura mater was opened. The BiOTA was performed by first addressing the right side and then the left, completing the procedure by closing both sides of the tentorium.

Results: Using BiOTA, we successfully achieved total removal of the tumor without postoperative visual disturbance, a common issue frequently reported with the use of the OT approach.

Conclusion: The BiOTA is suitable for large pineal tumors with disturbed complete visualization of the tumors by cerebral falx that needed total resection.

Keywords: Adult, Bilateral occipital transtentorial approach, Complete resection, Pineal gland tumor

INTRODUCTION

The pineal gland, a small neuroendocrine structure located in the epithalamus, plays a vital role in regulating circadian rhythms by producing melatonin. Anatomically, the pineal gland is situated within the posterior incisural space, bounded by the posterior wall of the third ventricle, the splenium of the corpus callosum, and the surrounding thalamic structures.[1,2] This region is anatomically complex, with critical venous structures such as the internal cerebral veins, the great cerebral vein of Galen, and multiple deep cerebral veins converging around the gland.[2,3] In addition, the posterior cerebral and superior cerebellar arteries, along with their branches, pass through this area, further complicating surgical access to lesions.[1,3]

Pineal tumors, although rare, present significant challenges due to their deep-seated location and proximity to critical vascular and neural structures. Surgical resection, the mainstay of treatment for large pineal tumors, is technically demanding. The occipital transtentorial (OT) approach is one of the most widely used techniques for accessing this region.[3] However, in cases where the lesion extends contralaterally or is obscured by the cerebral falx, the OT approach may limit visibility and compromise complete tumor resection.[3]

To address these limitations, the bilateral OT approach (BiOTA) provides enhanced visualization and allows for safer, more complete resection of lesions on both sides of the cerebral falx. This report illustrates the technical nuances and clinical outcomes of using BiOTA in the case of a large pineal tumor, demonstrating its effectiveness in achieving total resection while minimizing postoperative complications.

ILLUSTRATIVE CASE

A 33-year-old male first presents to primary healthcare with complaints of visual disturbance and headaches. Visual disturbances persist for 2 weeks before the patient comes to primary healthcare. The patient was then referred to our ophthalmology outpatient clinic. The patient reports that the headaches are more frequent in the morning. Headaches persisted for 3 months until he noticed a gradual decline in his visual acuity, especially his peripheral vision. The patient has had a history of hypertension for 4 years prior, for which he takes medication irregularly. He denies any other significant medical conditions or recent changes in medication. Previous and family history of malignancy were denied. There is no significant family history of neurological disorders.

Physical examination reveals bilateral visual field defects, particularly affecting the peripheral vision. Cranial nerve examination shows bilateral papilledema. Coordination and motor strength are within normal limits. Sensation is intact. Magnetic resonance imaging (MRI) indicates a large mass 4.22 × 3.51 × 4.25 cm posterior to the midbrain [Figures 1a, 1b, 1c]. The primary focus of this patient's treatment is on surgical resection of the tumor. Endocrine evaluation was not performed in this case, as the patient's physical examination revealed no signs or symptoms of hormonal abnormalities.

METHODS

The patient was positioned in a prone/Concorde position involving the operator alternating right to left of the patient during the procedure [Figure 2]. The craniotomy site faced toward the roof, and therefore, the operator's neck looked down for the duration of the operation. A lumbar cerebrospinal fluid drain was installed in between the L3 and L4 vertebrae. This was aimed to induce brain relaxation during the procedure.

The employed incision methodology involves a linear midline incision [Figure 3a]. Scalp and underlying muscles were retracted to the sides to allow for craniotomy. The path of the posterior segment of the superior sagittal sinus, the torcular, and the transverse sinus is determined using standard anatomical landmarks. Occipital craniectomy was performed with two burr holes on the right and left side located above the level of external occipital protuberance approximately 5 cm from the midline, a single burr hole below the confluence sinus, and a single burr hole approximately located 7 cm superior to the external occipital protuberance. These burr holes aim to form a sinking kite shape [Figure 3b]. The procedure was followed by removing the bone flap and carefully opening the dura mater [Figure 3c].

The BiOTA was modified from the original OT approach, which is the first choice technique used in our center for addressing lesions in the posterior region of the brain. Practically, this technique involves performing the OT approach twice, operating the right side and left side separately. We completed it first from the right side. The right occipital lobe was retracted along the inferomedial surface, followed by the surgical resection of the tentorium cerebelli 15 mm anterior from the confluence toward the tentorial incisura and 1–1.5 cm lateral of

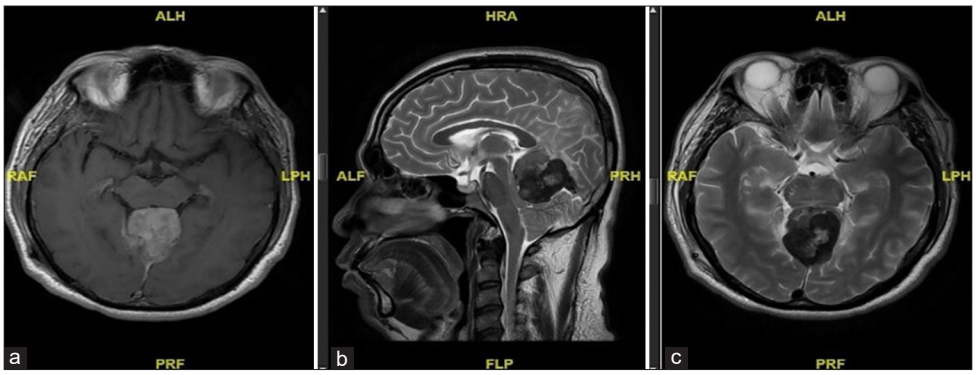

Figure 1: (a) Preoperative magnetic resonance imaging (MRI) T1-weighted axial view. (b) Preoperative MRI T2-weighted sagittal view. (c) Preoperative MRI T2-weighted axial view.

the cerebral falx. This is achieved through a 15° angle incision relative to the straight sinus [Figure 4]. Due to its arterial supply, it is normal during tentorial incision to experience some bleeding, but it is easily handled by cauterization. This maneuver unveils the quadrigeminal cistern area, with the cerebral falx remaining intact, dividing the view in the middle. Unfortunately, approximately one-third of the tumor is on the left side, which will be accessed later. The cerebral falx was not manipulated in any way, as we consider that it posed too much risk due to the potential for impacting the straight sinus.

The operator moved to the left side of the patient and the same steps were used to access the left posterior incisural space. Once extraction was completed, both sides of the tentorium were closed.

The duration of the extraction in the presented case spans 4 h. Subdural and subgaleal drains were installed and evaluated for several days until leakage was minimal. Vital signs postoperative were stable, and the patient was admitted to the ward. Pathology confirms the diagnosis as a benign fibrous tumor. A follow-up visit and evaluatory MRI were scheduled for 1 week after the patient was discharged ,with results explained in Figure 5. Subgaleal leakage was found during evaluation, and the patient was given acetazolamide for 1 month. The patient was advised to be evaluated every 2 weeks and scheduled for an MRI scan 6 months after discharge.

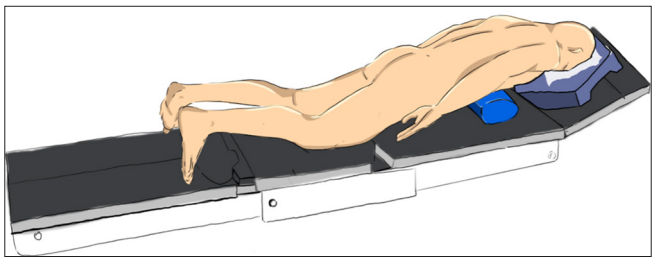

Figure 2: Concorde positioning for the patient.

DISCUSSION

Pineal parenchymal and germ cell tumors are this category's primary lesions. In approximately 90% of cases, elevated intracranial pressure (ICP) is the predominant manifestation of pineal space-occupying lesions.[1,2] This disorder frequently presents itself as a severe and sudden headache, which may be unilateral or chronic and ameliorates during periods of rest for the individual. Pineal disorders are also known to induce sleep cycle abnormalities since the pineal gland produces melatonin, the sleep-regulating hormone.[5]

A large mass, 4.22 × 3.51 × 4.25 cm in size, was found occupying the posterior incisural space, suggesting a mass with pineal gland origin. Pineal resection can be accessed through various approaches, with the OT approach being the most commonly practiced in our center. However, when dealing with a tumor this size, the typical unilateral OT approach was limited in accessing the contralateral lesion, posing a challenge to achieving complete removal of the tumor.

BiOTA on pineal gland complete resection allowed exposure and, therefore, safer complete resection of the contralateral lesion, though the use was rarely reported before this case report. To our knowledge, the BiOTA was first mentioned briefly by Kawashima, *et al*. (2002), which performed the approach in a cadaveric brain. It was stated that broader

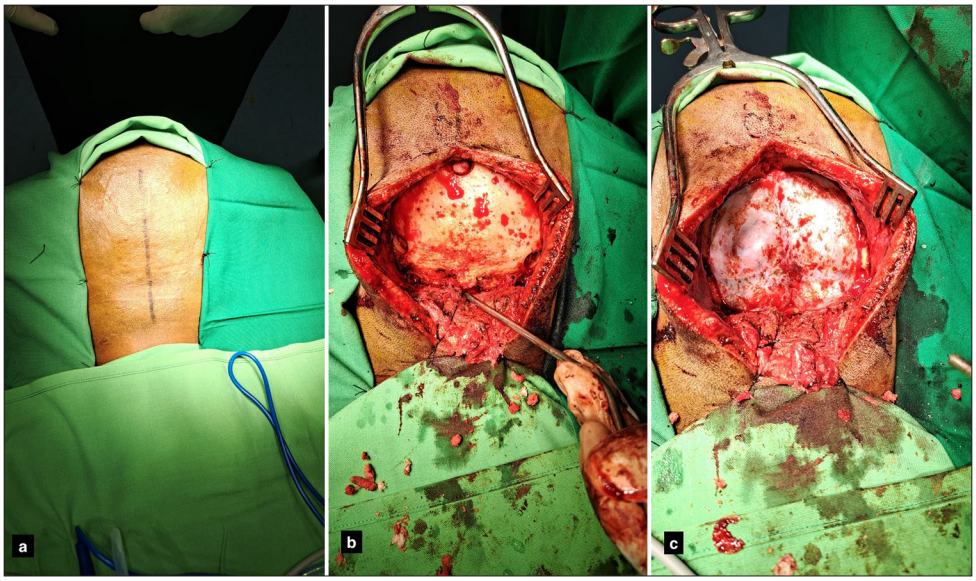

Figure 3: (a) Scalp incision line, (b) Location of burr holes, (c) Postcraniectomy view of the dura mater.

surgical perspectives within the supratentorial region and quadrigeminal floor could be achieved using BiOTA.[3,5] No other publications ever mention this technique, especially in actual cases. Using BiOTA, we successfully achieved total removal of the tumor without postoperative visual disturbance, a common issue frequently reported with the OT approach.

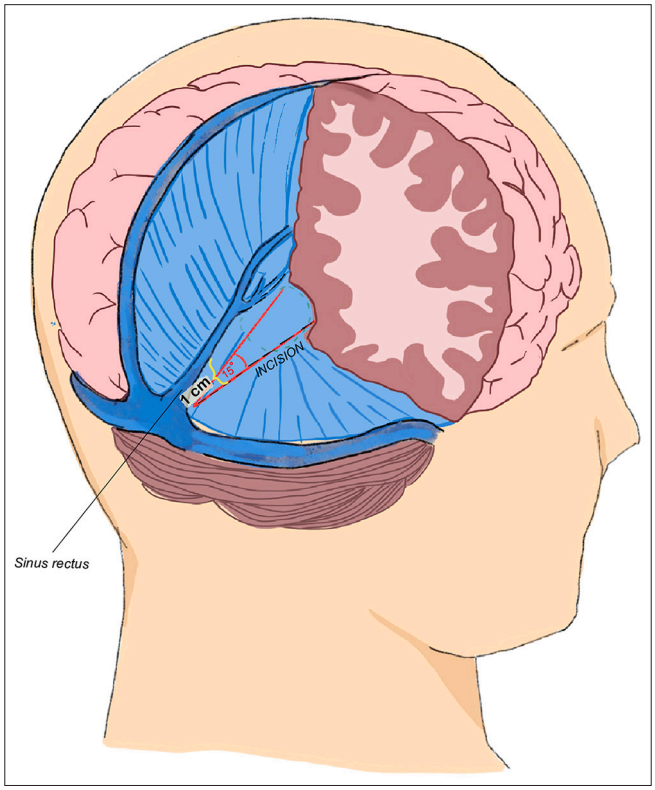

Figure 4: Precise tentorial incision performed 1 cm from the midline, angled at 15° from the sagittal plane, providing optimal access while minimizing structural disruption.

BiOTA offers a distinct advantage for the operator, notably the ability to discern contralateral lesions.[3] In Indonesia, many health centers have not been able to do brain surgery in the usual sitting position, which requires special knowledge and skill from the anesthetic team. With this technique, the patient is positioned in a prone/Concorde position, involving the operator alternating the patient's right-to-left position during the procedure. In this instance, the Concorde position, an adaptation of the prone position, is the positioning we use for the transtentorial approach.

Furthermore, this approach provides better vision and greater freedom for mobility to avoid critical structures such as the Galen vein, straight sinus, and inferior sagittal sinus throughout the surgical procedure. In our experience, it helps maintain concentration throughout the process, a human factor frequently overlooked in the surgical area. We were able to altogether remove the tumor in under 5.5 h. The retraction lasted around 4 h of the overall length. The difference between the approach that was used in this case and the approach that was introduced previously was based on our decision not to incise the cerebral falx. The bilateral incisions of the cerebellar tentorium were proficient in providing visualization of the tumor and providing adequate space to operate and resect the tumor.

The use of an occipital bi-transtentorial/falcine approach was proposed, which incised both sides of the tentorium and the falcine to access the contralateral side.[6] However, we did not find the necessity to incise the falcine as opening both sides of the tentorium provided the visual angle we

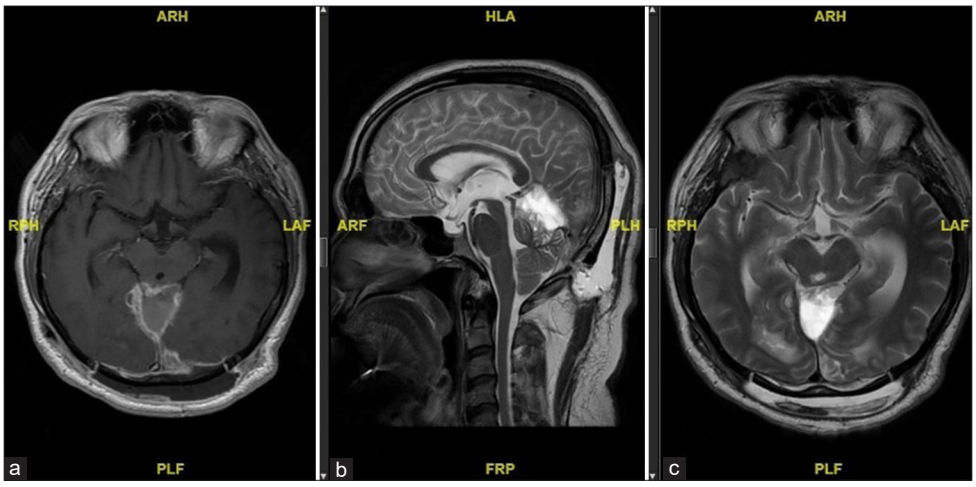

Figure 5: (a) Postoperative magnetic resonance imaging (MRI) T1-weighted axial view. (b) Postoperative MRI T2-weighted sagittal view. (c) Postoperative MRI T2-weighted axial view. Hyperintense posterior to the midbrain indicates the accumulation of cerebrospinal fluids.

needed. The risk of injuring adjacent sinuses does not exceed the benefits. The only drawbacks associated with BiOTA include the requisite prolonged bilateral retraction of the occipital lobes,[3] heightening the postoperative risk of visual disturbances.[4] In addition, a larger dura incision is necessitated. However, we did not find any remarkable postoperative event in this case report. CSF leakage to subgaleal space was notable but resolved within 4 days. The primary complaint of visual disturbance was resolved, as it was suspected to be related to ICP.

A case study revealed that visual disturbance was not solely due to the duration but also the retraction position. Inferior surface retraction of the occipital lobe proves no sign of postprocedure visual field defect.[5] We did not employ ventriculoperitoneal shunt preoperation, which studies also suggest may assist in preventing visual disturbance. However, we installed a lumbar drain to achieve the same effect. The Lumbar drain is deemed as safe and effective as the ventricular drain in aiding brain relaxation.[4,7] More research is still needed on the prevention of visual disturbances in procedures with occipital retraction.

CONCLUSION

Based on this discussion, the BiOTA is suitable for large pineal tumors with disturbed complete visualization of the tumors by cerebral falx that needed total resection. Further studies are needed on the outcome of this technique and the categorization of large tumors that are acceptable to be managed by BiOTA.

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