Lumina Indones J Neurol. Vol I No 3 (December 2025)
https://doi.org/10.19166/lijn.v1i3.10334

CASE REPORT

SUPRAORBITAL APPROACH FOR TUBERCULUM SELLAE MENINGIOMA

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Abstract

Introduction: Tuberculum sellae meningiomas pose significant surgical challenges due to their proximity to critical neurovascular structures. Pterional craniotomy has been the conventional method for approaching anterior skull base lesions, while the supraorbital eyebrow approach has emerged as an alternative in selected cases.

Case Presentation: We report the case of a 50-year-old woman with progressive left temporal hemianopia due to a tuberculum sellae meningioma. The tumor was resected via left supraorbital approach, achieving gross total resection. Estimated intraoperative blood loss 50 mL, and total operative time 185 minutes. Histopathological examination confirmed WHO Grade I meningioma. Postoperative recovery was uneventful. Contrast-enhanced brain MRI at 3-month follow-up showed no residual or recurrent tumor.

Discussion: Surgical management of tuberculum sellae meningiomas is particularly challenging because of their proximity to critical structures. Conventional approaches provide wide exposure but require extensive soft tissue and bone manipulation. The supraorbital eyebrow approach offers a minimally invasive keyhole route. In our case, it allowed safe gross total resection, preservation of neurovascular function, and rapid postoperative recovery.

Conclusion: This case highlights the feasibility, safety, and effectiveness of the supraorbital eyebrow approach for resecting anterior skull base meningiomas.

Keywords: Anterior skull base surgery; Eyebrow craniotomy; Keyhole approach; Minimally invasive; Supraorbital approach; Tuberculum sellae meningioma

Received: October 15th, 2025
Accepted: December 1st, 2025
Published: December 27th, 2025
How to cite this paper: Oktaviani DR, Wahjoepramono POP, Wahjoepramono EJ. Supraorbital approach for tuberculum sellae meningioma: a case report. Lumina Indones J Neurol. 2025; 1(3); 43-50

Introduction

Tuberculum sellae meningiomas are attached to the dura mater of the tuberculum sellae and chiasmatic sulcus, located in the posterior border of the anterior cranial base. Though histologically benign, these tumors often present a surgical challenge due to their close proximity to critical anatomical structures such as the optic nerves, optic chiasm, and the internal carotid arteries and their branches. Surgical resection remains the treatment of choice, especially in symptomatic patients or those with progressive tumor enlargement. However, selecting the optimal surgical corridor is a nuanced decision, balancing the goals of maximal tumor removal, preservation of neurological function, and minimization of morbidity.[1]

Historically, the pterional approach, first described by Yasargil, has been the most commonly employed route to tuberculum sellae meningiomas. It offers wide access to the parasellar region and anterior circle of Willis, allowing early identification of the optic nerve and internal carotid artery. However, this approach often requires significant brain retraction, extensive soft tissue dissection, and may result in temporalis muscle atrophy or cosmetic asymmetry over time. The subfrontal approach, on the other hand, provides a direct view of midline and parasellar structures by elevating the frontal lobe through a bifrontal or unilateral craniotomy. This approach is particularly effective for tumors extending medially or superiorly. However, it can lead to frontal lobe edema, anosmia, and postoperative cerebrospinal fluid leakage due to the need for large dural openings and potential involvement of the frontal sinus.[2,3,4]

Supraorbital approach, a minimally invasive "keyhole" route introduced in its modern form by Perneczky in the 1990s, has emerged as a promising alternative in selected cases. By utilizing a small craniotomy just above the orbital rim, often hidden within the eyebrow, this technique allows direct access to the anterior cranial fossa, optic nerve, and parasellar region with minimal soft tissue disruption. It avoids the need for large skin incisions, reduces brain retraction, and achieves superior cosmetic results. Several studies have shown that the supraorbital approach can achieve comparable rates of gross total resection for small to medium-sized anterior clinoidal or parasellar meningiomas, particularly when there is no significant lateral extension or encasement of vascular structures. Moreover, the reduced operative time, shorter hospital stay, and improved postoperative recovery make it an attractive option, especially for elderly patients or those with comorbidities.[5,6]

We present the case of a patient with a tuberculum sellae meningioma resected via the supraorbital eyebrow approach. Through this case, we explore the surgical anatomy, technical nuances, and comparative advantages of this approach, emphasizing its role within the broader context of skull-base tumor surgery.

Case

A 50-year-old woman presented to the outpatient department at Siloam Hospitals Lippo Village with a chief complaint of progressive visual disturbance in the left eye that had been ongoing for approximately 10 months prior to admission. Initially, the patient experienced peripheral darkening of vision in the left eye, which gradually progressed to involve nearly the entire visual field. She was unable to see objects on the lateral side of her visual field. There was no history of double vision, proptosis, hearing loss, headache, limb weakness, paresthesia, or numbness. On physical examination, the patient exhibited a left temporal hemianopia. Other neurological and general examinations were within normal limits. Magnetic Resonance Imaging (MRI) was performed and revealed a mass on the left paramedian suprasellar (**Figure 1)**.

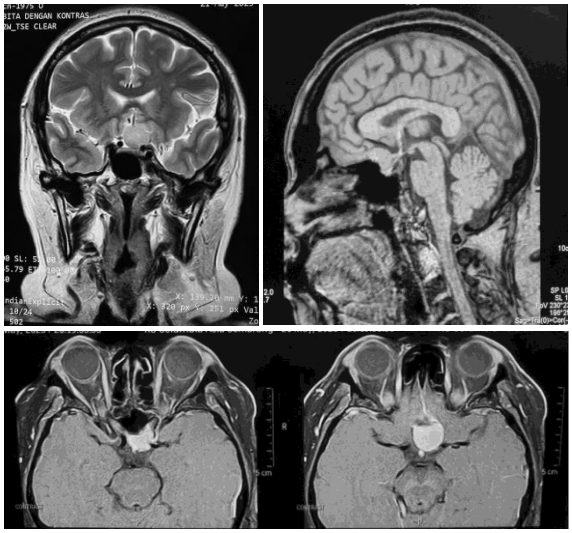

Figure 1. Magnetic Resonance Imaging (MRI) revealed a solid contrast-enhancing extra-axial mass in the left paramedian suprasellar region, with slight extension into the intrasellar area. The lesion measured approximately AP: 20.6 mm x LL: 21.48 mm x CC: 13.21 mm and was compressing the left side of the optic chiasm, with close contact to the superior border of the pituitary gland.

A Craniotomy tumor removal procedure were performed by the neurosurgery team through the left supraorbital approach, as illustrated in (**Figure 2)**. Gross total tumor resection was achieved. Intraoperative blood loss was approximately 50 mL, and total operative time was 185 minutes.

A non-contrast CT scan with 3D reconstruction was performed two days after surgery to evaluate the outcome of the craniotomy, it shows the bone flap neatly repositioned and secured using small plates and screws (**Figure 3)**. Histopathological examination of the tumor biopsy was diagnosed as meningothelial meningioma (WHO Grade 1).

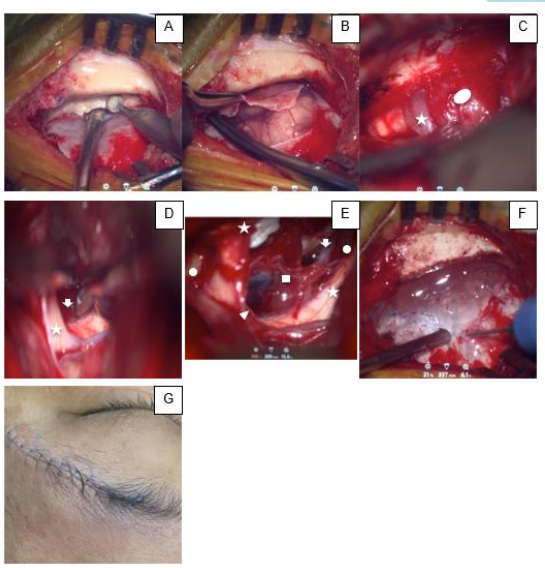

Figure 2 (A, B) After craniotomy, frontal base drilling, and durotomy were performed, cerebrospinal fluid was released. (C) Identification of the tumor, the tumor (ellipse) was dissected carefully from the optic nerve (star). (D) The tumor dissected from the nerve. (E) The neurovascular structures were clearly visualized, including the optic chiasm (arrowhead), bilateral optic nerves (star), pituitary stalk with lillequist membrane behind (square), bilateral internal carotid artery (circle), and posterior communicating artery (arrow). (F) The dura mater was coagulated and primarily closed using Beriplast. (G) The bone flap was fixed with plates and screws, and the surgical wound was closed in anatomical layers.

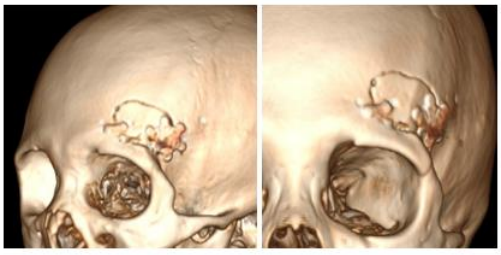

Figure 3. The postoperative CT scan 3D reconstruction reveals a well-aligned skull contour, with no signs of bone displacement or hardware issues.

Two weeks postoperative follow-up, the patient reported improvement in visual field disturbances, with no complaints of pain, double vision, hearing loss, headache or dizziness. There were also no signs of limb weakness, numbness, or tingling.

At 3 months follow-up, Postoperative contrast-enhanced brain MRI at 3-month follow-up showed no evidence of residual or recurrent tumor (**Figure 4)**.

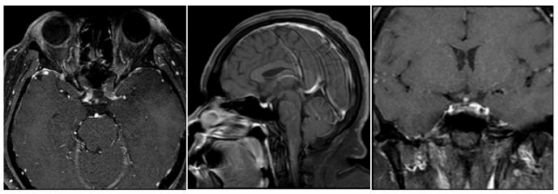

Figure 4. Postoperative contrast-enhanced Magnetic Resonance Imaging (MRI) at 3-month follow-up after left frontal craniotomy showed no evidence of residual meningioma in the planum sphenoidale–diaphragma sellae region. A mild dural thickening was observed along the planum sphenoidale. The remaining intracranial structures appeared within normal limits, with no evidence of acute infarction, hemorrhage, vascular malformation, or other space-occupying lesion.

Discussion

Tuberculum sellae meningiomas are challenging skull base tumors due to their proximity to vital neurovascular structures, including the optic nerve, internal carotid artery (ICA), pituitary stalk, and anterior cerebral circulation. Despite their histologically benign nature, their growth often results in significant clinical symptoms such as visual disturbances, as was the case in our 50-year-old female patient who presented with progressive left temporal hemianopia. Surgical resection remains the treatment of choice for these lesions, particularly when they cause neurological deficits. However, achieving gross total resection while minimizing complications requires not only precise technique but also the careful selection of the most appropriate surgical approach tailored to the tumor's location, size, and anatomical variances.[1,2]

In this case, the tumor was located at the left paramedian suprasellar region, extending slightly into the sellar regions, with compression of the medial aspect of the left optic nerve and close proximity to the superior aspect of the pituitary gland.

Because the optic nerve was compressed and stretched medially, it would block the view of the tumor's attachment site if we approach this tumor from a lateral direction, such as by using the pterional approach. The subfrontal approach provides a direct view of the midline and parasellar structures, however, this approach is highly invasive as its increase risks such as frontal lobe edema, anosmia, and postoperative cerebrospinal fluid leakage. [2,3,4]

The supraorbital approach provides a similar view but through a minimally invasive route. Given this predominantly anterior and paramedian location, the supraorbital eyebrow approach offered a uniquely favorable surgical corridor, with a clear corridor to the optic nerve and tuberculum sellae, where this tumor is attached. This approach provides a direct, anterior-inferior trajectory toward the suprasellar and parasellar regions, allowing early cerebrospinal fluid (CSF) release and brain relaxation, which reduces the need for significant retraction. The compact angle of approach permitted excellent exposure of the tumor while preserving surrounding brain parenchyma. Upon tumor debulking, critical landmarks such as the optic chiasm, pituitary stalk, internal carotid artery, and posterior communicating artery were clearly visualized, which enabled safe and complete resection.[6,7] The strength of the

supraorbital approach lies not only in its trajectory but also in its ability to maximize exposure while minimizing invasiveness. Traditional skull base approaches such as the pterional or orbitozygomatic craniotomies offer wide exposure but require larger skin incisions, temporalis muscle dissection, and greater soft tissue manipulation, which can result in longer recovery times, postoperative pain, and cosmetic issues. By contrast, the eyebrow incision used in the supraorbital approach is discreet and hidden within the natural brow line, preserving cosmetic appearance. The bone flap in this approach is small but adequately sized for access to anterior skull base lesions, making it an ideal keyhole surgery. As demonstrated in our patient, the bone flap was repositioned and secured using plates and screws without evidence of displacement or hardware complication on postoperative CT imaging. This minimized trauma led to a quicker recovery and superior aesthetic outcome.[8]

The supraorbital approach in this case is supported by numerous studies. Reisch and Perneczky (2005), pioneers of this technique, reported over a decade of experience and demonstrated that it provides adequate access to lesions of the anterior cranial fossa, with low morbidity and excellent cosmetic result. In their series, gross total resection was achieved in the majority of patients with small to medium-sized anterior clinoidal and parasellar meningiomas. This aligns with the findings from our case, where gross total tumor resection was achieved without postoperative complications.[5] Other studies by Yu YH et al, emphasized the approach's effectiveness for both intra and extra axial tumors, noting that it allowed surgeons to access the tumor with minimal retraction, shorter operative times, and fewer complications compared to traditional craniotomies. This is particularly important in anterior clinoidal meningiomas, where excessive manipulation of the optic nerve or ICA can have devastating consequences.[9] In a study by Lee JY et al., the supraorbital eyebrow approach was shown to provide sufficient surgical exposure for anterior cranial base tumors, including those located near the optic chiasm and anterior clinoid, especially when the tumor does not extend far laterally or deeply into the middle cranial fossa. Our case fits precisely within these criteria, enabling complete tumor removal through a narrow but strategic window.[10] A systematic review by Karatag Z et al. found that the supraorbital route achieves resection rates comparable to more extensive approaches, but with significantly better cosmetic satisfaction and lower complication rates, including reduced risk of frontal lobe edema and CSF leak.[11] Studies by De Almeida AN et al. further emphasized the value of meticulous preoperative imaging to define surgical windows and reduce intraoperative complications. Their study highlights that in well-selected cases, the supraorbital eyebrow approach allows tumor resection without the need for bone removal beyond the orbital rim or significant temporal dissection, reinforcing its minimally invasive nature.[8] Last, studies by Dinc et al. noted that this approach is particularly effective in patients with visual symptoms due to its capacity for early optic

nerve decompression and exposure of the opticocarotid region. In our patient, the use of this approach directly enabled safe and complete tumor resection while preserving neurological function and visual pathway integrity.[12]

Additionally, the supraorbital eyebrow approach has shown measurable advantages in terms of intraoperative blood loss and operative duration. In our case, intraoperative blood loss was approximately 50 mL, considerably lower than the average reported for pterional craniotomies, which ranges between 250–500 mL.[7,13] In a comparative study by Park et al., the average blood loss for the supraorbital group was 356 mL versus 537 mL in the pterional group ($p = 0.014$), highlighting the significant hemostatic advantage of the keyhole approach.[14] Our case of only 50 mL of blood loss further reinforces this benefit.

Operative time in our case was also shorter than in traditional approaches, with a total duration of approximately 180 minutes. According to Park et al., pterional surgeries typically take around 313 minutes, whereas supraorbital approaches average 220 minutes ($p < 0.001$), demonstrating the time-saving benefit of this approach. Shorter operative time not only reduces anesthetic risk but may also lead to fewer perioperative complications.[14]

Pain control is another important postoperative consideration. Our patient reported minimal postoperative discomfort, with a visual analog scale (VAS) score of 2–3. This is consistent with findings from the literature that patients undergoing supraorbital craniotomy generally experience less postoperative pain compared to those who undergo pterional craniotomy, due to the limited muscle dissection and smaller skin incision. Studies have reported that supraorbital patients mobilize earlier and require less analgesic use postoperatively.[13]

In this case report, we demonstrate that the supraorbital approach, despite being relatively uncommon in Indonesia, it can be a safe and effective option. We achieved gross total resection with minimal morbidity, excellent cosmetic outcome, reduced intraoperative blood loss, shorter operative time, and low postoperative pain. What makes this case particularly valuable is that it provides real-world evidence that such minimally invasive skull base techniques are not only feasible but also reproducible within the Indonesian neurosurgical setting. Given that most centers in Indonesia still rely on traditional, more invasive craniotomies for anterior skull base tumors, this case highlights that with proper planning and training, supraorbital approaches can be safely and successfully adopted. As such, this case does not just contribute to the broader global literature—it also serves as an important reference for Indonesian neurosurgeons, encouraging innovation and refinement in local surgical practice.hardware issues.

Conclusion

The supraorbital eyebrow approach represents a balance between surgical effectiveness and minimal invasiveness. In this case of a tuberculum sellae meningioma, it provided excellent access to the tumor, enabled gross total resection,

surgical visibility, minimally invasive access, and cosmetic and functional outcomes. For tumors located in the anterior cranial fossa, as in our case, this technique should be strongly considered as a first-line surgical strategy.

Conflict of Interest

The authors declared no conflict of interest.

Acknowledgment

The authors declared no acknowledgment.

Funding

This research received no grants from public, commercial, or non-profit funding agencies.

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