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Original Article

The extended supracerebellar transtentorial approach for resection of medial tentorial meningiomas

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Abstract

Background: The supracerebellar transtentorial (SCTT) approach has been established as a safe corridor to access the posteriomedial basal temporal region. Previous reports have demonstrated the efficacy of this route in the resection of intrinsic tumors and small arteriovenous malformations. Only one report in the English literature has described its use to resect a medial tentorial meningioma.

Methods: The authors discuss the relevant surgical anatomy of this approach and its advantages compared with more traditional routes, and illustrate its application to remove medial tentorial meningiomas through two operative cases with accompanying videos.

Results: In illustrative case one, the patient recovered from surgery with no deficits. All his preoperative symptoms had resolved at 3-month follow-up. At the 4-year follow-up, MRI did not demonstrate any growth of the residual tumor. In case two, gross total resection was achieved and the patient did not suffer any postoperative language or visual deficit. At 2-year follow-up, no tumor recurrence was present.

Conclusion: The SCTT approach has a potential to safely access extra-axial lesions located around the medial tentorial incisura. As demonstrated in these two cases, the approach merits consideration in patients with tentorial meningiomas as an alternative to more widely utilized skull base approaches and subtemporal routes.

Key Words: Meningioma, supracerebellar approach, tentorium

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INTRODUCTION

The supracerebellar transtentorial (SCTT) approach to the mediobasal temporal region (MTR) has been previously described in the literature.[2,7-9,13,14,19-21] In 1976, Voigt and Yasargil reported its use to remove a cavernous angioma in the posterior hippocampus.[19] Since this seminal case, numerous anatomical investigations and case series have further refined this approach.[2,9,11,14,15,20,21] Most of these studies, however, focus on intrinsic tumors (namely gliomas), hippocampal sclerosis, arteriovenous malformations (AVMs), and aneurysms.

Only one report[17] has explored the use of this technique for resection of a large extra-axial lesion (meningioma), since a wide operative corridor is often necessary for these lesions and is not easily afforded through the SCTT approach. Exposure of meningiomas in the medial tentorial region through conventional supratentorial routes is associated with significant morbidity.[1,4,12-14]

We will therefore describe our experience with two patient cases utilizing the SCTT approach to explore an alternative route to resect medial tentorial meningiomas associated with the dominant hemisphere.

SURGICAL ANATOMY OF THE MEDIOBASAL TEMPORAL REGION AND TENTORIUM

The MTR is the portion of the temporal lobe contained within the following limits: Medially, the cavernous sinus and basal cisterns; anteriorly, the lesser wing of the sphenoid bone; laterally, the rhinal and collerat al sulci of the temporal lobe; and posteriorly the isthmus of the cingulate gyrus.[5,16] de Oliveira *et al*.[5] partitioned the MTR into three zones from anterior to posterior [Figure 1]. The anterior portion extends from the anterior end of the rhinal sulcus to the inferior choroidal point (where the anterior choroidal artery enters the temporal horn and the inferior ventricular vein exits to join the basal vein[2]). The medial extent of this portion is the cerebral peduncle. The middle portion extends from the inferior choroidal point to the level of the quadrigeminal plate. The posterior portion contains the inferior surface of the lingual gyrus; the medial and anterior surfaces contain the isthmus of the cingulate gyrus and are separated from the tectum and pulvinar by the posterior portion of the ambient and quadrigeminal cisterns. The posterior third of the MTR contains the terminal branches of posterior cerebral artery (PCA), i.e., the calcarine and parieto-occipital arteries.[2,5]

Numerous important neurovascular structures exist in the MTR and tentorial incisura. The cerebral peduncles and midbrain tegmentum form the medial border of this space and the parahippocampal gyrus forms a curving lateral wall. The trochlear nerve (CN IV) passes through this region and is closely related to the tentorial free edge as it makes its way to the cavernous sinus. It usually reaches the free edge around the posterior portion of the cerebral peduncle. Preservation of CN IV is a key aspect of the transtentorial approach, and the early exposure and dissection afforded by this approach increases the chances for its preservation. Major arteries in the MTR include the anterior choroidal artery, PCA, and superior cerebellar artery (posterior portion), as well as M1 branches (in the anterior portion).[2,5,11] PCA branches, including lateral posterior choroidal arteries and thalamogeniculate arteries, course just medial to the free edge of the tentorium [Figure 1]. The venous structures in this region are perhaps the most significant, and the SCTT approach is notable for providing early exposure to these—a trait that is seen as an advantage by some and a drawback by others.[5,9] In this region, the internal cerebral veins and the basal vein of Rosenthal converge to form the vein of Galen, which subsequently joins the inferior sagittal sinus to form the straight sinus, thus the venous drainage of critical diencephalic structures passes through this region.[2,5,11]

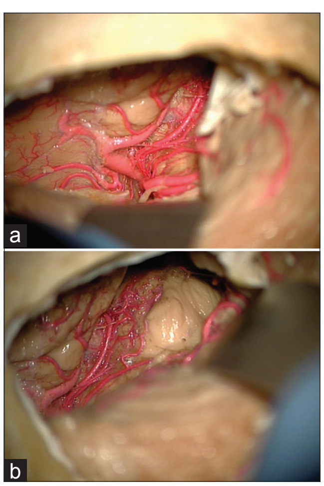

Figure 1: Cadaveric dissection images demonstrate the extent of exposure (anterior a and posterior b) along the medial temporal occipital regions by excising the tentorium

SURGICAL TECHNIQUE

The SCTT approach can be performed with the patient in the fully prone or park bench positions. Some describe the use of the sitting or semi-sitting position for optimal gravity-aided cerebellar retraction.[5,9,19-21] We have employed the park bench position to avoid the risks associated with the sitting position. This position places the patient in a lateral recumbent position with the torso elevated 10-15 degrees. The patient's head is then immobilized in a Mayfield head holder with the vertex tilted slightly toward the floor. The ipsilateral shoulder is allowed to fall forward. An important consideration is the length of the patient's neck and relative position of the shoulder—in a larger patient with a shorter neck, the ipsilateral shoulder may interfere with the surgeon's working zone.

A hockey-stick incision can be made in the midline or a linear incision in the paramedian positions, though the midline incision is likely to be associated with less postoperative pain.[9] A craniotomy is created with bony removal extending to the midline and just above the transverse sinus. The bone over the foramen magnum is left intact, although more inferior bony removal allows the release of cerebrospinal fluid (CSF) from the cisterna magna upon dural opening to aid with cerebellar retraction.[16,20] We use a lumbar drain placed at the beginning of the procedure to gradually drain CSF and achieve cerebellar relaxation. A key factor in the SCTT approach is to maximize the degree of cerebellar relaxation and decrease infratentorial tension in order to avoid aggressive cerebellar retraction and increase the working angles of instruments.

A dural incision is made with its base along the transverse sinus. Tentorial bridging veins draining the posterior cerebellar hemisphere are coagulated and cut to allow the cerebellum to fall away from the tentorium. Sacrifice of the posterior hemispheric bridging veins is safe, but compromise of the anterior vermian bridging veins may potentially lead to cerebellar venous infarction.[18,21] Two retraction sutures are placed along the tentorium just anterior to the transverse sinus; their tension will lead to superior mobilization/rotation of the transverse sinus and expansion of the working zone along the supracerebellar space. This maneuver expands the inferior to superior viewing angle for the surgeon.

Gradual release of the CSF will allow mobilization of the cerebellar hemisphere inferiorly and generous exposure of the tentorium. Medial tentorial meningiomas protrude along the tentorial incisura into the posterior fossa and compress the posterior brainstem and surrounding neurovascular structures [Figure 2a]. The early exposure of these structures provided by the SCTT approach allows for their protection by microdissection away from the tumor before significant tumor debulking is performed and the surgical field is obscured by bleeding [Figure 2b]. A generous portion of the tentorium is then incised from the petrous ridge to the midline while identifying and preserving the trochlear nerve along the entire anterior edge of the tentorium [Figure 2c]. Occasional bridging veins draining the occipital lobe and entering the superior aspect of the tentorium may be sacrificed. Bleeding from the edges of

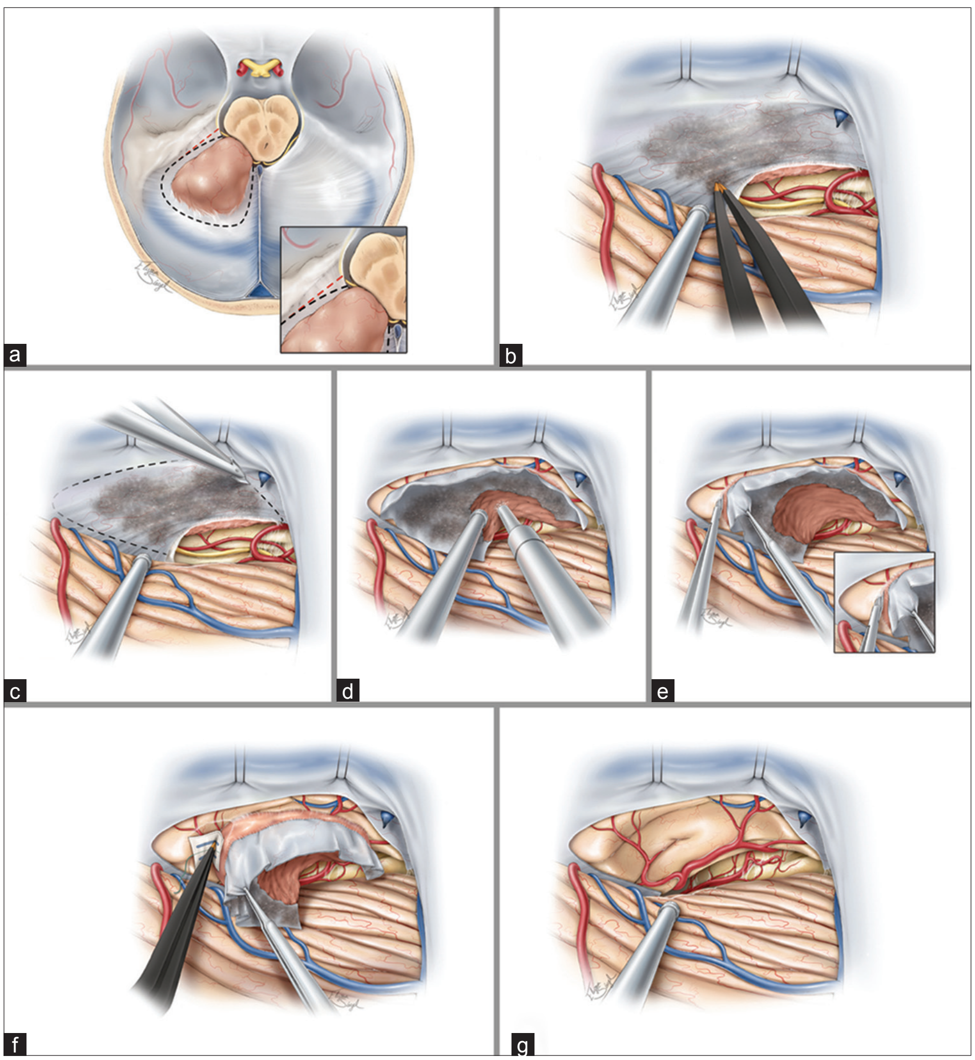

Figure 2: Medial tentorial meningiomas protrude along the tentorial incisura into the posterior fossa and compress the posterior brainstem and surrounding neurovascular structures. A tentorial incision along the red line will place the trochlear nerve at risk of injury and should be avoided. The black line defines the route of correct tentorial incision (a). The early exposure of these structures provided by the SCTT approach allows for their protection by microdissection away from the tumor before significant tumor debulking is performed and the surgical field is obscured by bleeding. Two retraction sutures are placed in the tentorium just anterior to the transverse sinus to mobilize this venous sinus superiorly and expand the operative corridor. These retraction sutures may be attached to the skin to maintain their tension (b). A generous portion of the tentorium is then incised from the petrous ridge to the midline while identifying and preserving the trochlear nerve along the entire anterior edge of the tentorium (c). The tumor can then be debulked and removed (d-g)

the tentorium may be controlled by bipolar coagulation and/or plugged by a layer of thrombin-soaked gelfoam. This tentorial resection creates a wide corridor to the basal occipital and posterior/medial temporal regions.

The above described sectioning of the tentorium will further devascularize the tumor and allow a relatively bloodless field to debulk the tumor and microsurgically mobilize it from the surrounding cortex and distal branches of the PCA and medial veins [Figure 2d-g].

ILLUSTRATIVE CASES

Case one

A 43-year-old male presented with several months of progressive dysarthria and gait imbalance. Imaging work-up including magnetic resonance imaging (MRI) demonstrated a large left medial tentorial meningioma extending along the posteromedial aspect of the temporal lobe and medial aspect of the brainstem, causing significant mass effect on these structures with early signs of hydrocephalus [Figure 3]. Large flow-voids within the tumor emphasized its rich vascularity [Figure 3e].

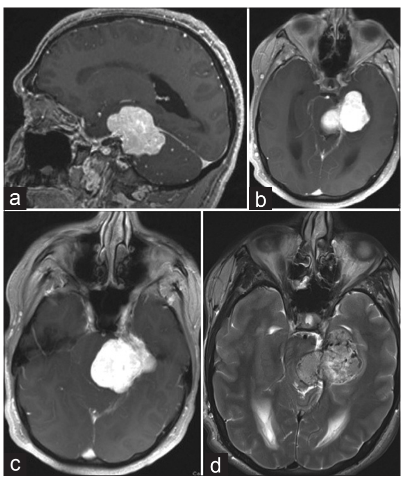

Figure 3: MRI demonstrated a large left medial tentorial meningioma extending along the posteromedial aspect of the temporal lobe and medial aspect of the brainstem, causing significant mass effect on these structures with early signs of hydrocephalus [(a) sagittal; (b and c) axial; (d) coronal T1 enhanced MRIs]. Large flow-voids within the tumor emphasized its rich vascularity [(e) axial T2 MRI]

Following modest embolization of the tumor's large feeding meningeal vessels, resection was attempted. A staged procedure for the infratentorial and supratentorial components of this tumor was considered. We decided that a SCTT route would avoid a staged operation and minimize the risk to the dominant temporal lobe. Using a paramedian incision [Figure 4], we attempted a SCTT approach with skeletonization of the transverse and sigmoid sinuses. After devascularization of the tumor's base along the tentorium, the tumor's infratentorial component was removed while preserving the trochlear nerve and surrounding vasculature [Video 1].

Using the technique mentioned above, we incised a section

Figure 4: A paramedian suboccipital incision was used. Please note that a subtemporal extension of the incision was planned but never used

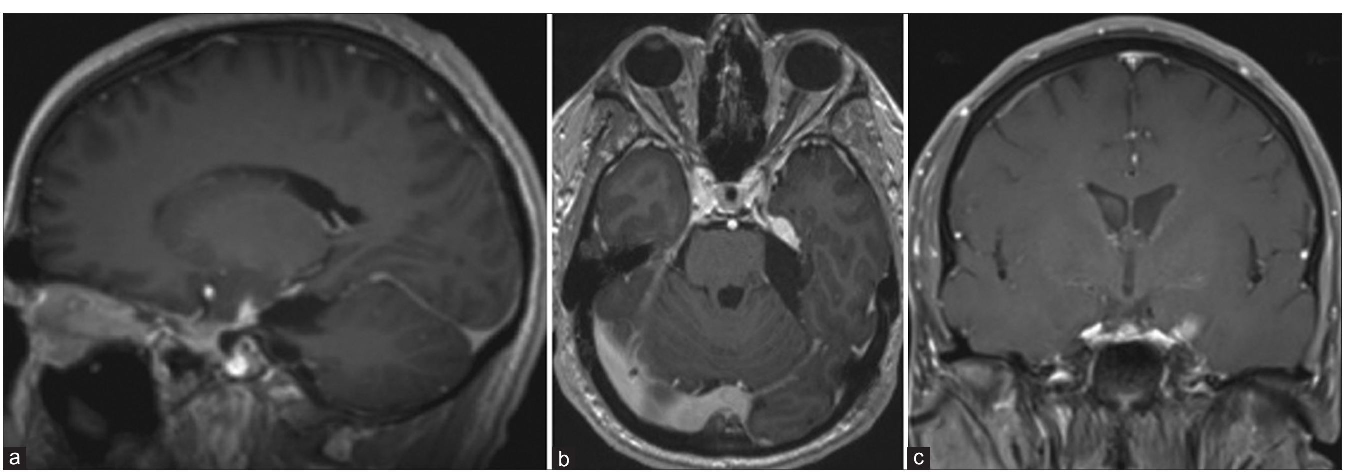

Figure 5: Postoperative sagittal (a), axial (b), and coronal contrast (c) enhanced T1 images confirm adequate tumor resection and small tumor residual along the lateral aspect of the petrous ridge (c)

of the tentorium affected by the tumor and removed the supratentorial extension of the tumor as well as the piece attached to the petrous apex. This operative corridor allowed microsurgical dissection of the tumor wall away from the cortex and adjacent distal PCA branches. A small portion of the tumor lateral and superior to the petrous apex was left behind due to its inaccessibility [Figure 5]. This case underlines the supratentorial limits of this approach, unless petrous apex bony drilling is attempted through the posterior fossa. Pathological examination found a World Health Organization (WHO) grade I meningioma. The patient recovered from surgery with no deficits. All his preoperative symptoms had resolved at 3-month follow-up. At the 4-year follow-up, MRI did not demonstrate any growth of the residual tumor.

Case two

A 33-year-old female presented with severe headaches and an episode of receptive aphasia. MRI evaluation revealed a left medial tentorial meningioma associated with cerebral edema [Figure 6]. The tumor was situated completely in the supratentorial space. Angiography disclosed a relatively vascular tumor, not amenable to embolization [Figure 7]. Traditional subtemporal or transtemporal approaches were considered, as the vein of Labbe was posteriorly situated, but the risk of injury to the language cortex was likely due to the required brain retraction [Video 2].

Through a left hockey-stick incision, the SCTT route was used to remove the tumor [Figure 8]. The tentorium was coagulated early in the procedure and the tumor was devascularized. The anterior edge of the tentorium and the portion of the tumor protruding through the tentorial incisura were exposed during the initial portion of the operation. The early exposure of critical brainstem structures afforded by this approach allowed for early decompression of the brainstem and dissection and protection of the trochlear nerve [Video 2]. The tumor was then debulked through the tentorium using an ultrasonic aspirator and microsurgically

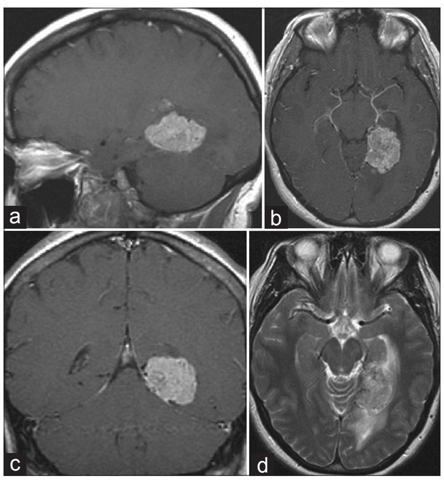

Figure 6: MRI evaluation [(a) sagittal; (b) axial; (c) coronal T1 enhanced images] revealed a left medial tentorial meningioma associated with cerebral edema [(d) T2 MR sequence]. The tumor was situated completely in the supratentorial space

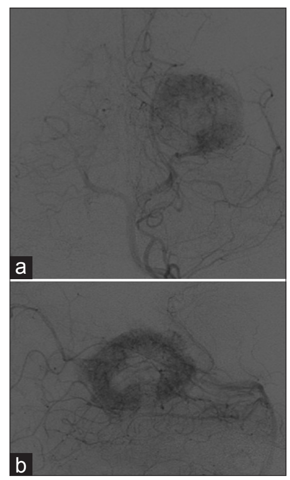

Figure 7: Angiography disclosed a relatively vascular tumor, not amenable to embolization due to its mainly pial arterial feeders [(a) anteroposterior; (b) lateral arterial phases]

Figure 8: The patient underwent a left SCTT craniotomy in the lateral position through a left-sided hockey-stick incision.

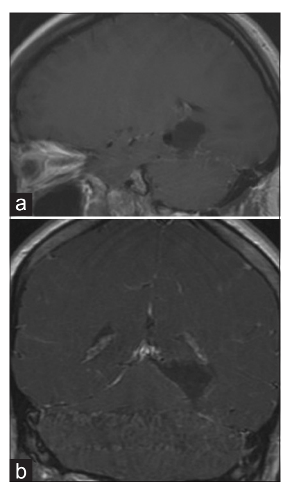

Figure 9: Postoperative MRIs [(a) sagittal; (b) coronal] confirm gross total resection of the tumor without complicating features.

dissected from the surrounding vessels. Gross total resection was achieved and the patient did not suffer from any postoperative language or visual deficit. A 3-month MRI confirmed the intraoperative findings [Figure 9]. At 2-year follow-up, no tumor recurrence was present [Video 2].

DISCUSSION

Although the SCTT approach has been described in the neurosurgical literature, there is only one report of its use to remove a meningioma.[17] Previous publications have described the approach for the treatment of glial neoplasms,[2,16] epilepsy,[2,5] aneurysms,[5,16,21] and other vascular malformations[19] [Table 1].

A number of techniques can be used to access the medial posterior temporal region through lateral and posterior approaches.[2,8] The transsylvian-transinsular approach provides good exposure of the anterior medial temporal lobe, but the posterior extension of the exposure is limited in allowing removal of extra-axial lesions along the medial tentorium.[2] The lateral temporal transsulcal/transgyral approach is less technically demanding than the transsylvian approach and provides an operative window for resection of the hippocampus. However, the temporal corticotomy places language function at risk in the dominant hemisphere. Furthermore, there is risk of damage to the optic radiations coursing over the roof of the temporal horn.[2,5,16,21]

Subtemporal approaches to the medial tentorium place the functional language cortex and optic radiations at less risk from direct damage, but these approaches are associated with language dysfunction as a result of excessive and/or prolonged temporal lobe retraction. Furthermore, any injury to the anastomotic vein of Labbé can be problematic.[2,16,17] Posterior approaches include the occipital interhemispheric and the SCTT routes. These approaches do not require retraction of the temporal lobe and preserve the optic radiations and language centers. The posterior interhemispheric approach may be limited due to the restricted operative corridor afforded by the presence of deep venous drainage (specifically, the internal occipital vein as it traverses from the medial aspect of the occipital lobe to the vein of Galen[11]) and significant brain retraction required to expose the lateral extension of the tumor. The supratentorial approaches also limit the ability to obtain proximal control of the feeding arteries to the tumor.

Table 1: Series with clinical application of the SCTT approach and pathologies treated

Author	Number of patients	Pathologies treated in the medial temporal region
De Oliveira, *et al.* 2012[5]	12	3 PCA aneurysms, 3 AVMs, 3 cavernous malformations, 3 gangliogliomas
Moftakhar, *et al.* 2007[9]	1	Ganglioglioma
Ture, *et al.* 2012[16]	15	7 tumors (gliomas), 2 cavernous malformations, 6 hippocampal sclerosis
Uchiyama, *et al.* 2001[17]	1	1 medial tentorial meningioma
Voigt and Yasargil 1976[19]	1	Cavernous malformation
Yonekawa, *et al.* 2001[21]	16	3 PCA aneurysms, 1 moyamoya, 1 medically intractable epilepsy, 10 gliomas, 1 metastasis

PCA: Posterior cerebral artery, AVM: Arteriovenous malformation, SCTT: Supracerebellar transtentorial

With our patients, the SCTT approach allowed adequate access to the tumor while minimizing morbidity associated with the above-mentioned more traditional approaches. In case one, the SCTT route avoided a staged operation and a more extensive skull base approach (i.e., petrosectomy). In this case, opening of the dura superior and inferior to the tentorium could have assisted with more tumor exposure and control of bleeding. In case two, the position of the tumor precluded access through more conventional approaches, such as subtemporal or transtemporal corridors, without facing a significant risk of postoperative deficit. In addition, early access to the base of the tumor allowed early tumor devascularization while minimizing blood loss and providing a clear field for microsurgical dissection of the important cerebrovascular structures (posterior brainstem and trochlear nerve) along the tentorial incisura. Through this approach, the instruments' working angles are enhanced, although their working distance is increased.

Tentorial meningiomas are rare tumors, accounting for 2-3% of all intracranial meningiomas,[1,3,6,12-14] but they are challenging to resect, due in part to their deep location. Conventional approaches also represent variations of the transpetrosal routes.[12-15] These approaches, although highly useful, carry surgical morbidity (reported as high as 41%, including infarction, hematoma, and new permanent neurologic deficit[12]) and higher risk of postoperative CSF leakage in up to 16% in some case series.[15] Indeed, one study cited a new-onset deficit in every patient who underwent a nonposterior approach surgery.[10] In contrast, case series published on the SCTT approach have cited considerably lower complication rates ranging from 15% to 28%,[10,13,21] with perioperative mortality rates as low as 2.5%.[12]

Limitations

The SCTT approach provides a longer working distance for the surgeon and is more technically demanding. In addition, incisions within the tentorium can be challenging due to the high vascularity of the region, especially increased by the presence of the tumor. The dome of the tumor is accessed at the end of the operation and is the "blind spot" for the operator. This fact may lead to an injury to vessels adherent to the dome of the tumor. Cerebellar retraction should be minimized to avoid retraction injury. The anterolateral extent of exposure is marked by the petrous bone and petrous bone drilling may lead to additional exposure.

CONCLUSION

The SCTT approach has a potential to safely access extra-axial lesions located around the medial tentorial incisura. As demonstrated in these two cases, the approach merits consideration in patients with tentorial meningiomas as an alternative to more widely used skull base approaches and subtemporal routes. As cited earlier, early exposure to the venous structures is seen by some as a blessing and by others as a shortcoming—careful review of the patient's preoperative venous imaging is critical to determine if this approach will be safe. In particular, the surgeon must assess whether the tumor is displacing the vasculature in such a way that dissection of the SCTT is beneficial or potentially more risky. Decisions regarding operative approach should be individualized based on a given patient's lesion, overall medical condition, and the skill and preference of the surgeon.

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