Falcotentorial Meningioma

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Only about 50 cases of falcotentorial meningiomas have been reported in the literature. These masses arise from the junction of the tentorium and falx cerebri, either anteriorly at the junction of the vein of Galen with the straight sinus or anywhere along the length of this junction toward the torcula.

The torcula may be predominantly affected; peritorcular meningiomas require a different set of considerations because of the intimate involvement of the major dural sinuses, and they are therefore discussed in their own chapter titled Peritorcular Meningioma.

Meningiomas associated with the tentorial incisura present a considerable number of surgical challenges because of their relationship to the structures involved in the principal deep venous drainage systems of the diencephalon. When the torcula and the occipital lobes are involved, the risk of cortical blindness is significant and should not be underestimated.

With careful patient selection and detailed preoperative assessment, surgical risks can be minimized. Preservation of the patent straight sinus is an important goal during the surgery.

Meticulous surgical technique is mandatory when the surgeon is working in the vicinity of the dural venous sinuses and central venous structures, given the requirement for patency of venous outflow and the risk of life-threatening intraoperative bleeding. The surgeon, of course, wants to achieve complete resection, but that goal may be impractical because of the risk of neurologic devastation from disruption of the diencephalic venous drainage systems. In these cases, the surgeon must remember that adequate tumor control can be achieved after surgery with modern radiosurgical intervention for small residual tumor.

Diagnosis

Due to their unique location in close proximity to the cerebral aqueduct, falcotentorial menigiomas can impair cerebrospinal fluid circulation and present with symptoms of elevated intracranial pressure. Headaches, ataxia, and incontinence are the most common presenting symptoms.

The vascular supply for these lesions is variable and may include the meningohypophyseal trunk, meningeal branches of the external carotid artery, meningeal branches of the ascending pharyngeal artery, branches of the medial and lateral posterior choroidal artery, the posterior cerebral artery, and the meningeal branches of the vertebral artery.

Falcotentorial meningiomas with predominant subtentorial extension are also supplied by small pial branches from the superior cerebellar artery.

Evaluation

The patient's functional status, age, comorbidities, and life expectancy are important considerations in the determination of time of intervention. Because the natural history of meningiomas is variable, it is important to establish the lesion's growth rate in asymptomatic or minimally symptomatic cases to determine the appropriateness of intervention.

Preoperative MR imaging is used during intraoperative frameless stereotaxy. T2-weighted sequences can provide anatomic relationships to the pineal gland, internal cerebral veins, thalamus, splenium of the corpus callosum, and parietooccipital lobes.

Assessment of the venous anatomy in relation to the tumor is further supplemented with a MR venogram or, more preferably, CT venogram. Cerebral angiography provides more details of the deep venous anatomy, but is not routinely necessary. The vein of Galen and straight sinus are often occluded by the tumor.

Tumors superior to the vein of Galen appear to arise within the pericallosal cistern and acquire a thick arachnoid covering as they invaginate into the quadrigeminal cistern, which permits complete removal of these tumors safely away from the vein of Galen.

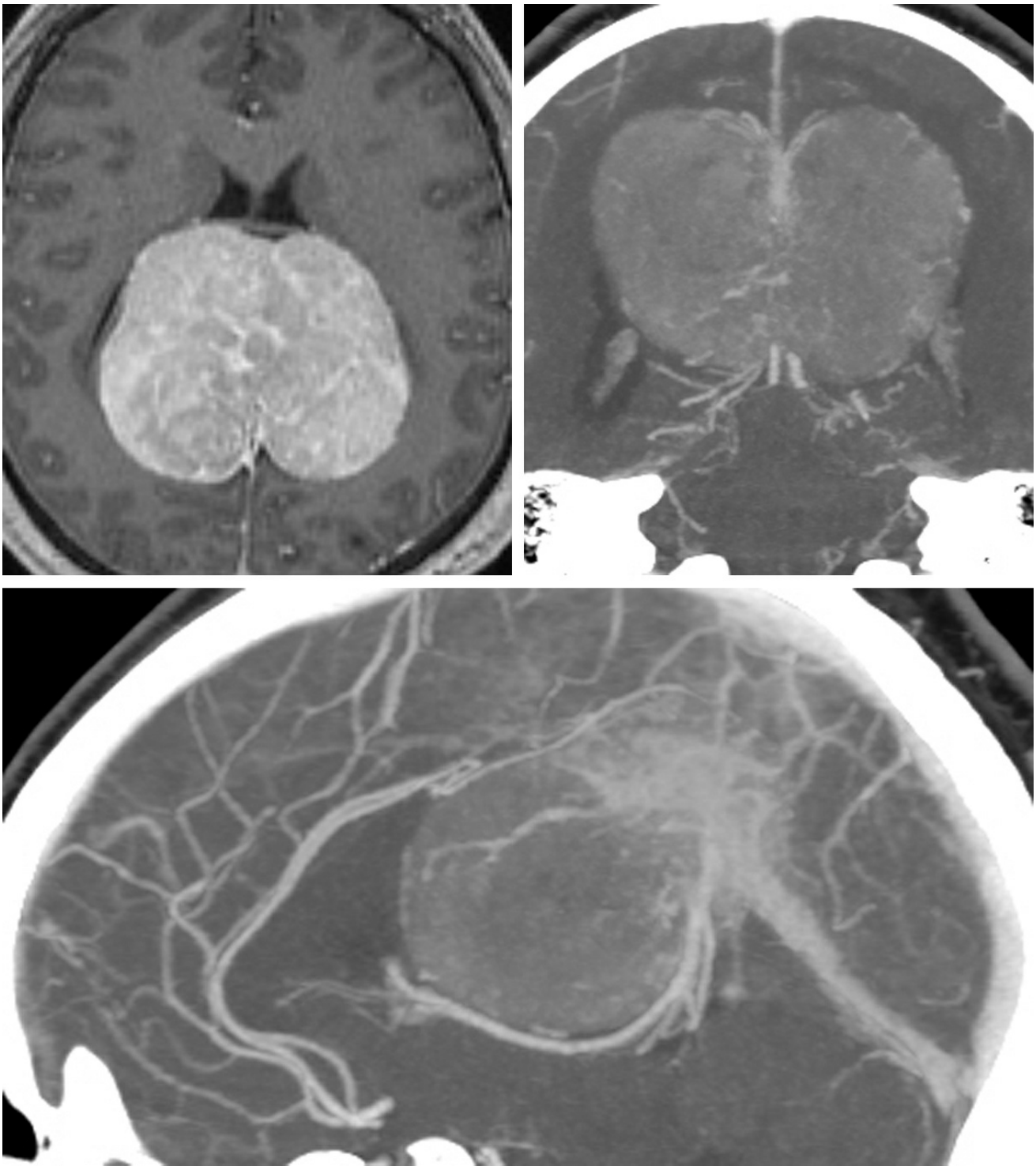

Figure 1: A giant anterior falcotentorial meningioma is shown (top row of images). Note the location of the deep veins at the lower pole of the tumor (bottom image). The major dural sinuses were unaffected by this tumor.

Indications for Procedure

Surgical resection is indicated for patients who have enlarging tumors causing progressive neurologic deficit and who are

medically fit for surgery.

On the other hand, calcified tumors that are not growing in patients over age 65 should be observed with serial imaging because these are less likely to grow and cause symptoms of mass effect.

Preoperative Considerations

In rare cases when the venous structures are encased by the tumor, preoperative cerebral angiography is beneficial to reliably define the collateral venous drainage. Angiography allows assessment of the degree of occlusion of the straight sinus and, in giant tumors, the torcula and transverse sinus.

Since the interhemispheric parieto-occipital approach is the most frequently preferred route to these tumors, the side of the craniotomy and its location must be chosen based on the position of the indispensable posterior parasagittal veins.

Moreover, preoperative cerebral angiography for falcotentorial meningiomas may reveal a hypertrophied arterial feeder from the tentorial artery of Bernasconi and Cassinari that, if embolized, may significantly reduce tumor bleeding, improving the safety of resection.

The relationship of the internal cerebral veins, basal veins, and vein of Galen to the tumor should be thoroughly understood preoperatively.

Operative Anatomy

The torcula represents the junction of the superior sagittal sinus with the transverse sinuses and straight sinus. Typically, the dominant transverse sinus is on the right. Variations in sinus anatomy occur in which the superior sagittal sinus may be duplicated or split into one separate supply vessel into each of the transverse sinuses. The location of the torcula is directly deep to the external occipital protuberance.

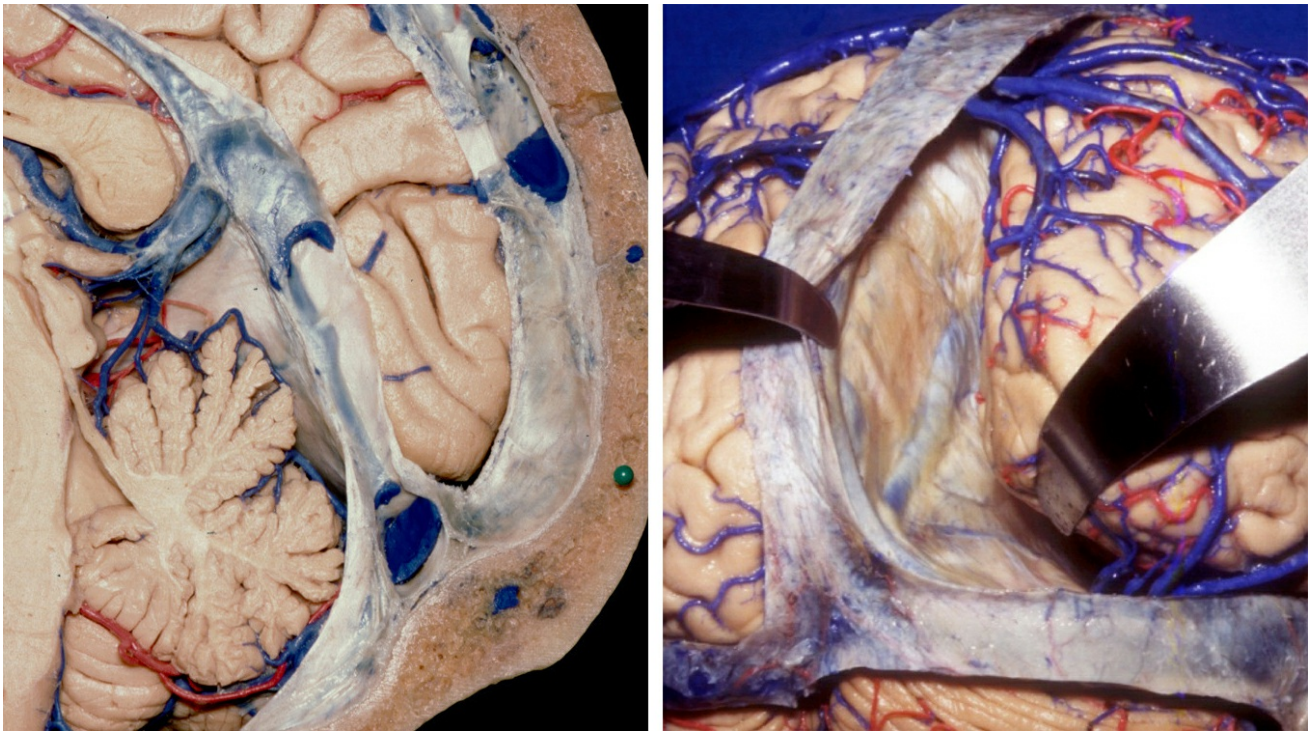

Figure 2: The relationship of the torcula to the occipital protuberance is shown (left image). To expose the torcula, I drill perpendicular to the oblique surface of the skull at this location. The junction of the dural sinuses (superior sagittal, transverse, and straight sinuses) via an interhemispheric vantage point is also demonstrated (right image). The straight sinus often carries numerous venous lakes at its periphery within the leaflets of the tentorium; these lakes can be a serious source of bleeding during tumor manipulation and should be packed with thrombin-soaked gelfoam and not coagulated. (Images courtesy of AL Rhoton, Jr.)

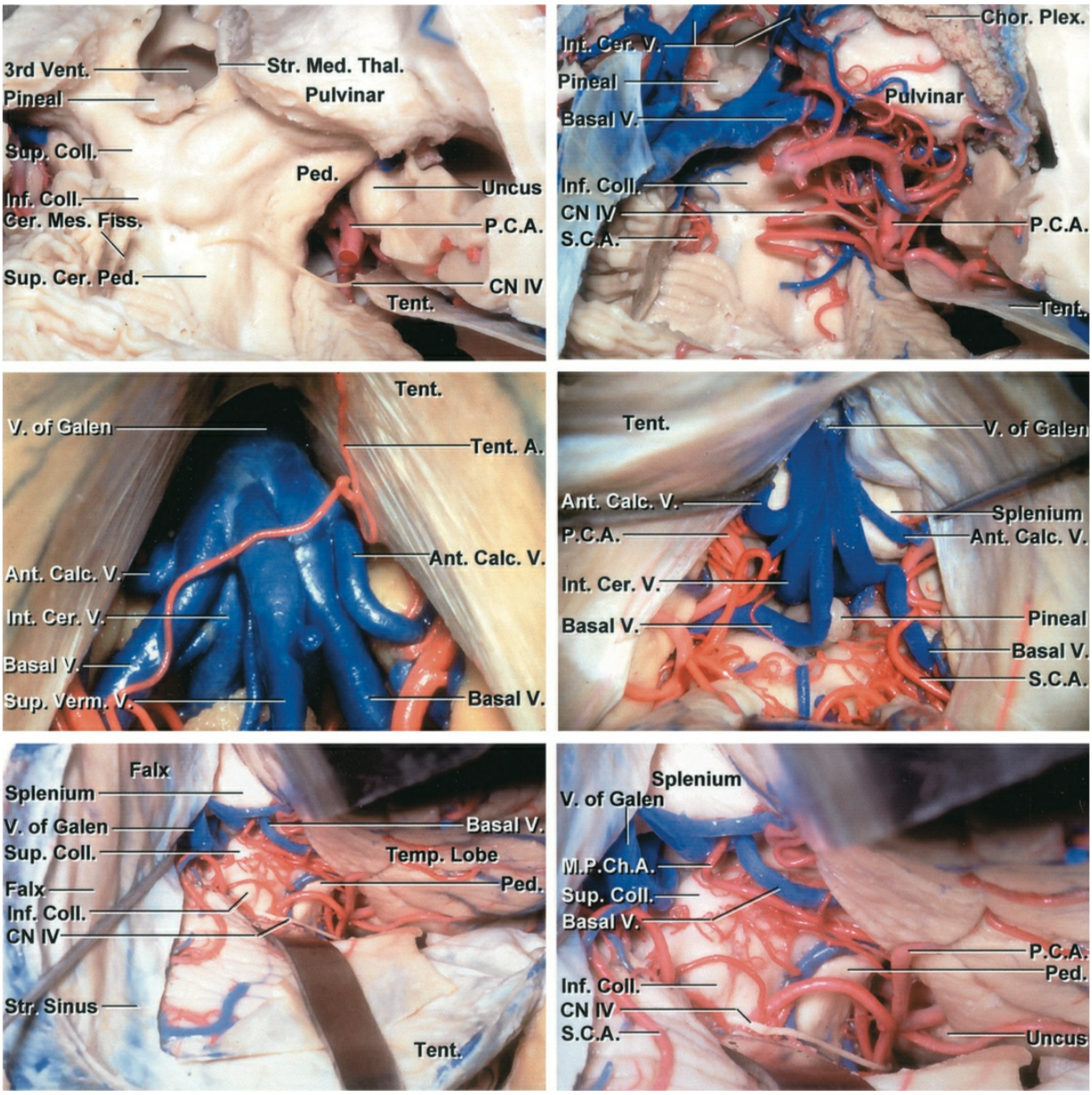

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Figure 3: The relevant neurovascular anatomy of the incisura is noted. The relationship of the tumor to the deep venous system is critical for preservation of the veins. The arachnoid planes are life saving in protecting function. (Images courtesy of AL Rhoton, Jr.)

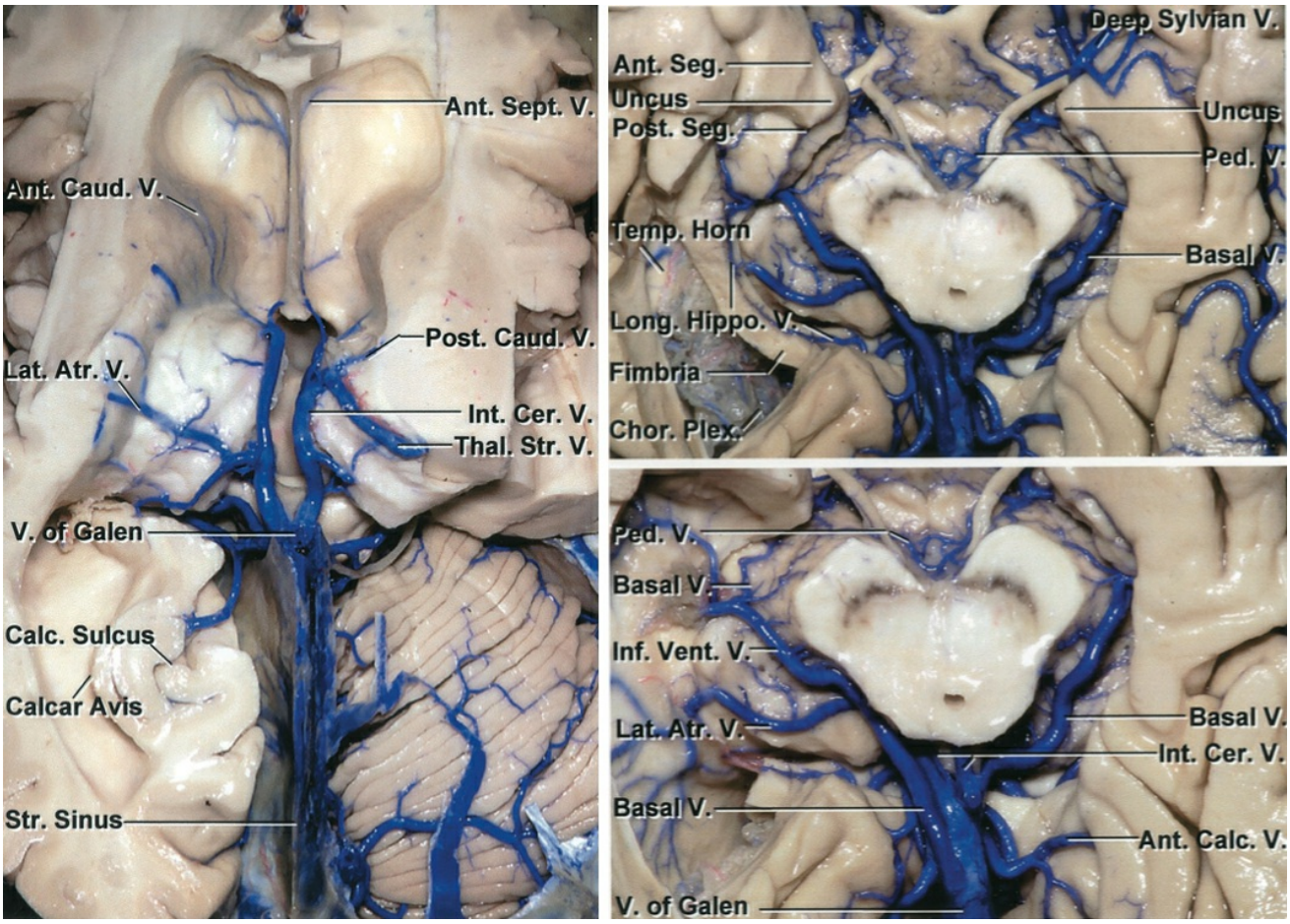

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Figure 4: The deep venous system from a superior view (left image) and inferior view (right image) is shown in detail. Venous injury is one of the primary sources of morbidity during meningioma resection in the region. (Images courtesy of AL Rhoton, Jr.)

RESECTION OF FALCOTENTORIAL MENINGIOMA

Selection of the suitable and anatomically favorable operative approach is key for safe and effective removal of falcotentorial meningiomas. Careful inspection of the preoperative images should identify the relationship of the tumor to the tentorium, splenium, internal cerebral veins, vein

of Galen, and basal vein of Rosenthal. The least disruptive route that preserves these neurovascular structures is necessary.

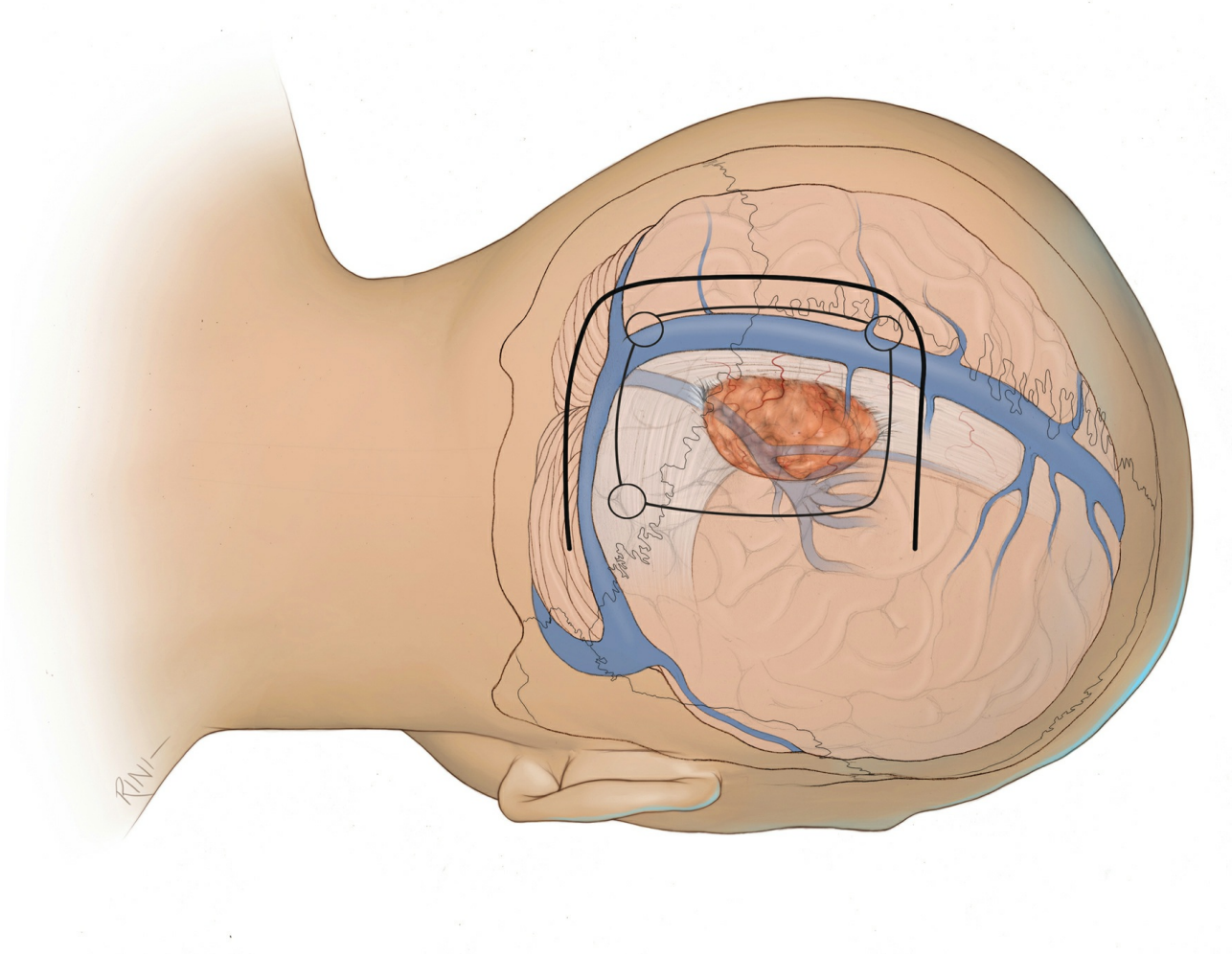


Figure 5: The patient is usually placed in the three-quarter prone or park-bench position to avoid raised venous pressure from the chest and abdominal compression related to the prone position and to reduce the risk of air embolism. The patient's head is slightly elevated at 15 degrees in relation to the floor and turned approximately 60 degrees toward the floor. The neck is flexed until there is two-fingers-breadth distance between the chin and chest. The side of the tumor is placed "down" so that gravity-retraction can be exploited and fixed retraction on the occipital lobe is

avoided. The incision and craniotomy for a large tumor are demonstrated.

I have a low threshold to use precordial Doppler ultrasonography and transesophageal echocardiography. The surgeon should keep a low level of suspicion for venous air embolism and I place a central line to deal with it.

I use a lumbar drain to decompress the dual sac early in surgery and facilitate elevation of the bone flap over the dural venous sinuses. (The craniotomy often encompasses the posterior superior sagittal and potentially the transverse sinuses, as well as the torcula).

I do not recommend the use of visual evoked potentials because these potentials are unreliable, altered depending on the anesthetic used, and difficult to record.

Frameless stereotaxy may be used to identify the extent of the tumor along the transverse and superior sagittal sinuses in order to plan the skin incision and craniotomy. A U-shaped or linear incision is usually used based on the location of the tumor along the falcotentorial junction.

Tumors that primarily extend above the tentorial incisura and displace the vein of Galen inferiorly are best approached via a posterior unilateral parieto-occipital interhemispheric transtentorial/transfalcine (torcular) approach. The bilateral approach places both occipital lobes at risk and is rarely required.

The side of approach usually depends on the side of greatest tumor extension; the cross-court trajectory can be effective for reaching the lateral pole of the deep tumor without significant brain retraction or transgression. I do not believe the combined supratentorial/infratentorial transsinus approach is necessary even for large tumors. Only occasionally the combined midline occipital and suboccipital approaches may be needed for giant multicompartmental masses.

Tumors below the tentorial incisura that displace the vein of Galen and other deep diencephalic veins superiorly are approached via a supracerebellar infratentorial approach.

The tumors with primarily a supratentorial component and a smaller infratentorial extension are reached via an occipital interhemispheric approach, and the transfalcine/transtentorial route is used for removal of the contralateral supratentorial/infratentorial component. The occipital lobe bearing the largest component of the tumor is also placed in the gravity-dependent position.

Unilateral tumors extending along the tentorium may require a “hockey-stick” incision that crosses the midline. The extent of peritorcular exposure depends on the peritorcular quadrants containing the tumor and on the tumor's geometry.

Exposure of the torcula can be accomplished by making multiple burr holes on the transverse sinus and two burr holes, one on each side of the superior sagittal sinus beyond

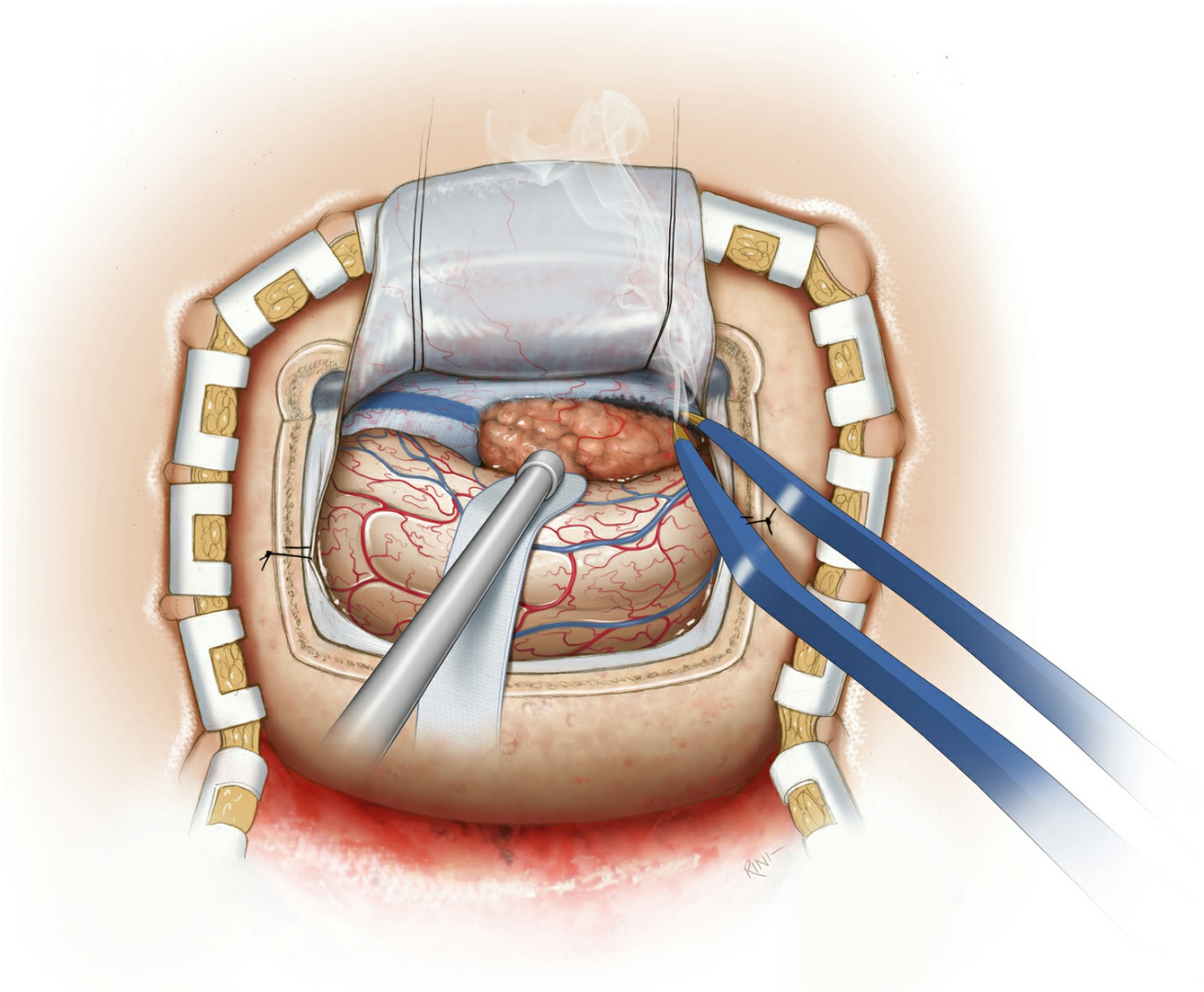
the superior extent of the tumor. The dural sinuses are carefully reflected off the bone flap before elevating the flap.

Bone wax and ample gelfoam powder soaked in thrombin solution should be readily available during the placement of burr holes and elevation of the bone flap; meticulous hemostasis must be maintained. If the tumor invades into the bone so that safe elevation of the bone flap in a single piece might be impossible or unsafe, thinning of the adjacent bone with a round burr drill and removing it in a stepwise fashion using Kerrison rongeurs is advised to safely access the tumor.

For more information regarding exposure and dural opening, please refer to the chapter on Peritorcular Meningioma.

INTRADURAL PROCEDURE

The dural opening is tailored according to the extent of the tumor, its geometry, and the predominance of its supra- and infratentorial components. The dural flaps are based on the dural venous sinuses. As mentioned before, the transfalcine and transtentorial corridors allow expansion of the operative reach via exposure of a single torcular quadrant.



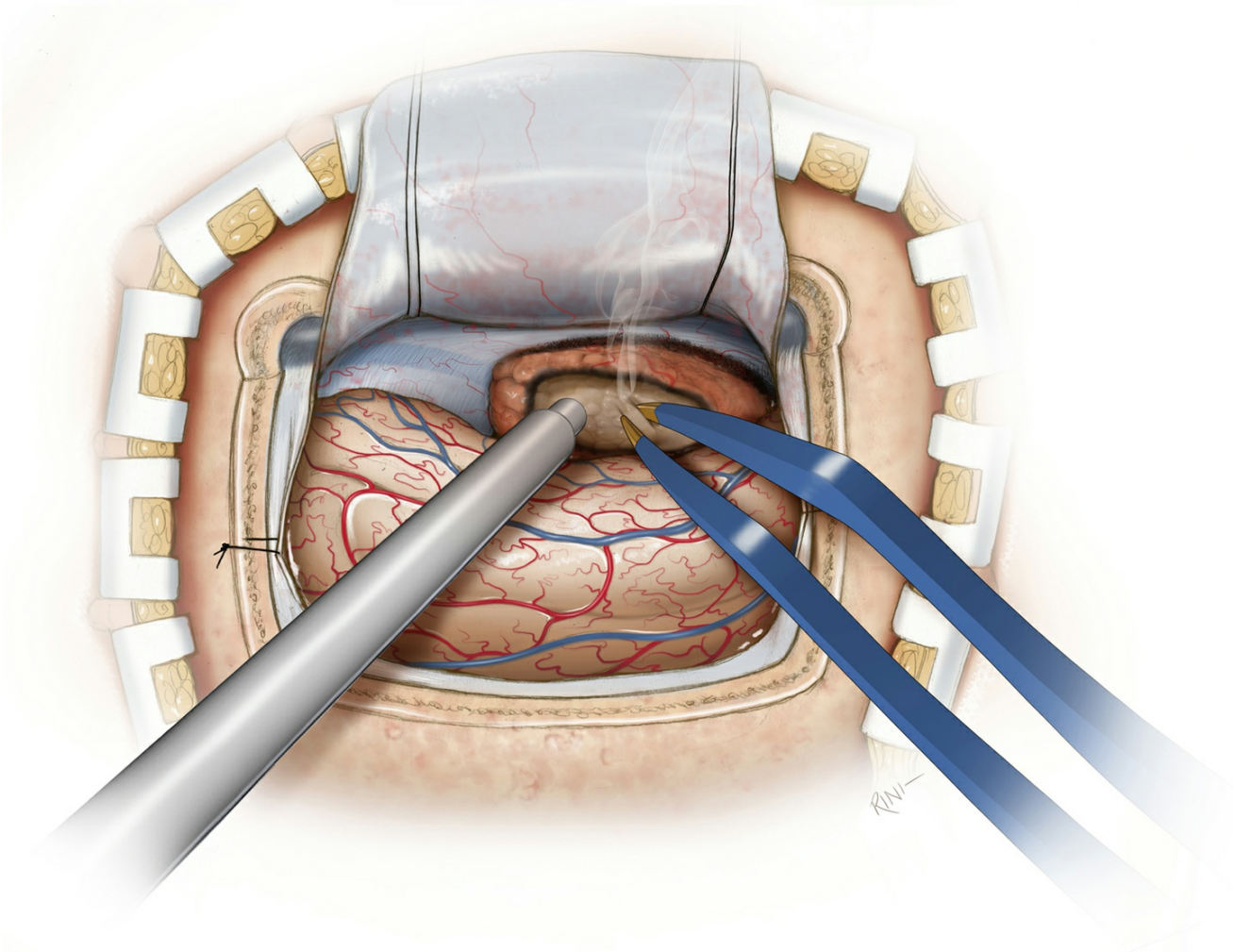


Figure 6: The tumor is devascularized from the tentorium/falx, and then debulked and finally dissected. The vascular tentorium and falx can be a significant source of bleeding, and timely attention to hemostasis via thrombin-soaked gelfoam packing of the dural leaflets is important.

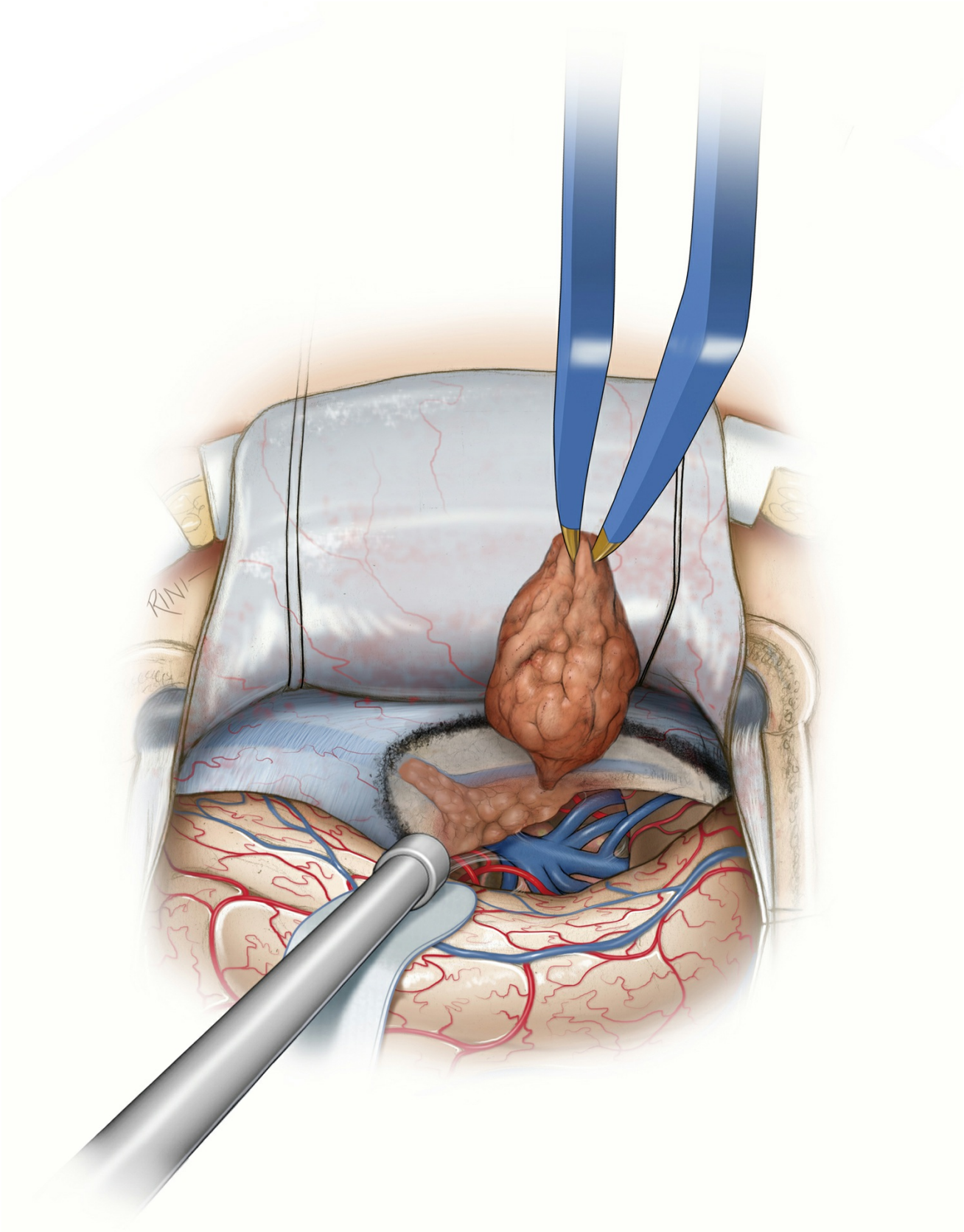


Figure 7: The affected falx and tentorium are resected, but all of the patent dural venous sinuses are preserved. Any large venous channels in the tentorium that may act as venous collaterals are also worth saving. This is especially important if any of the major dural sinuses including the straight sinus are compromised by the tumor.

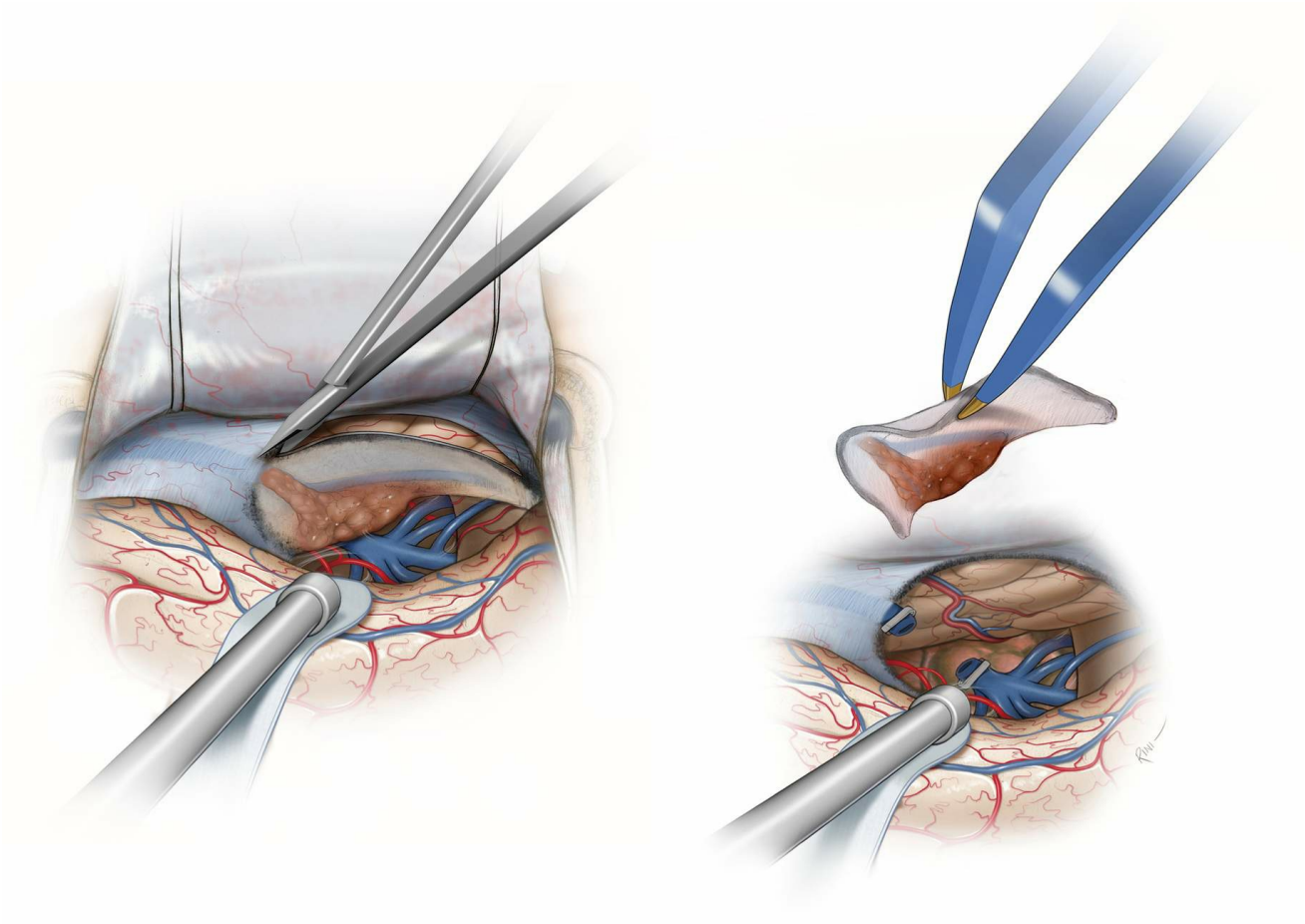


Figure 8: If the torcula and one or both of the transverse sinuses are functional or patent, the tentorium is incised from lateral to medial in front of the torcula, further devascularizing the tumor. However, if these dural sinuses are occluded, the sinuses are suture ligated at the lateral margin of the tumor. The sinuses are isolated by means of opening the posterior fossa dura. Any bridging vein(s) entering the relatively normal part of any sinus are

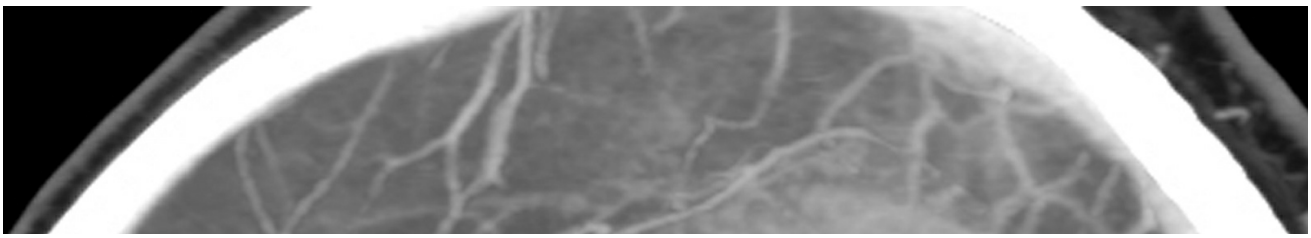
preserved. In these illustrations, the affected falx and tentorium as well as the occluded segment of the straight sinus are removed.

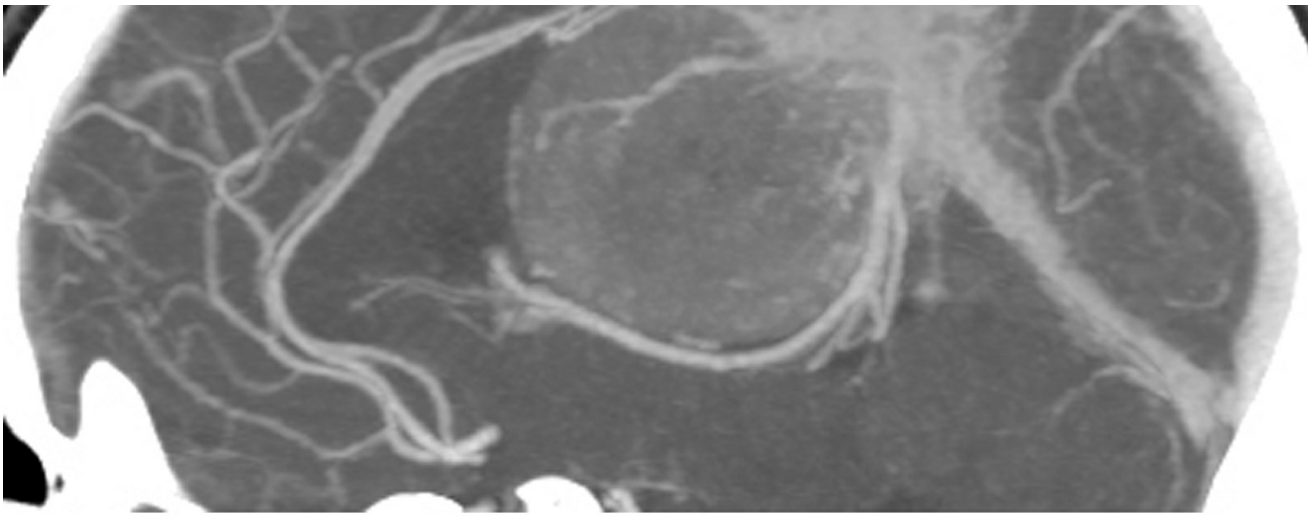
I prefer to use 2-0 or 3-0 nonabsorbable sutures with a tapered needle for ligating the sinuses. The needle passes through the convexity dura, subdural space, tentorium, and again through the convexity dura. The occluded vein of Galen is transected after ligation using an aneurysm clip. Of course, these maneuvers are only possible after the tumor is effectively debulked, and only the affected dural leaflets of the falx and tentorium are being excised. The straight sinus is also handled similarly. These steps complete circumferential disconnection of the affected falx and tentorium.

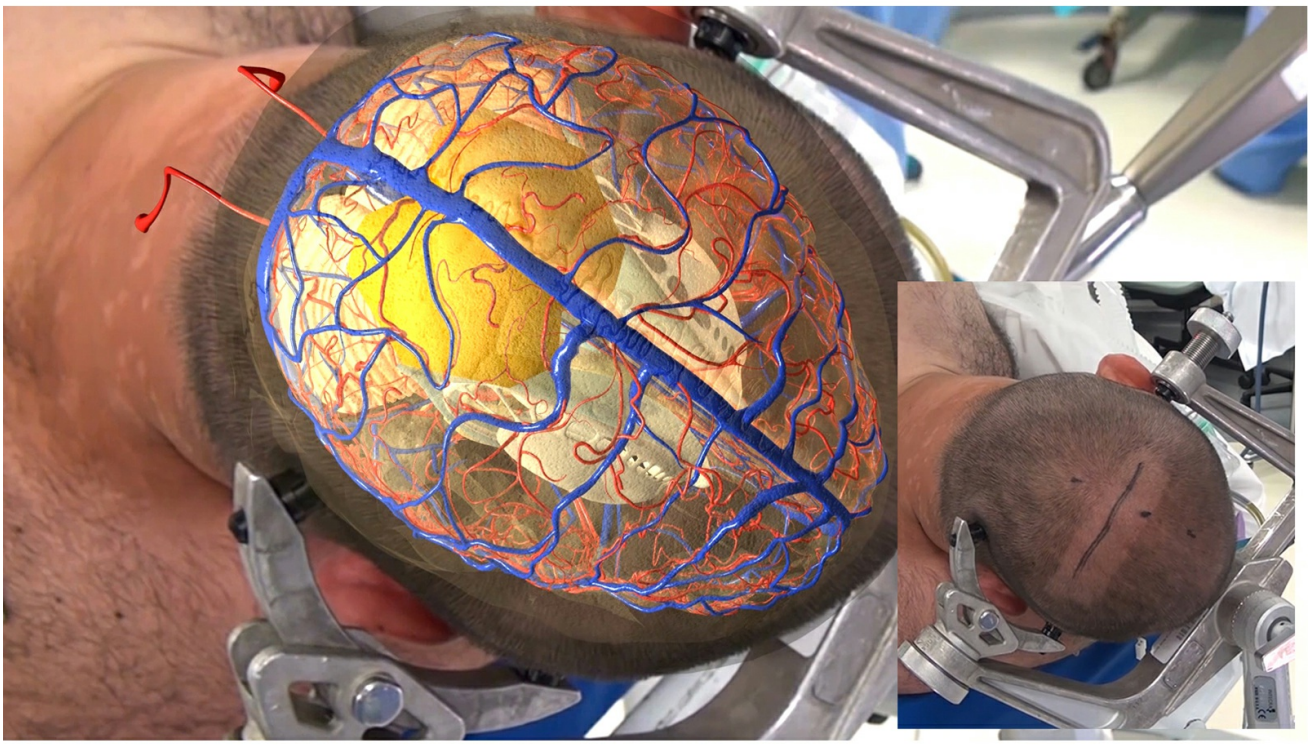
Preoperative angiography determines the plan for ligation of deep veins, including the vein of Galen and its tributaries. Identification of these veins is mandatory before the deeper parts of the tumor are manipulated. Blind traction on the deep portions of the tumor can lead to avulsion injury to the veins and perforating arteries.

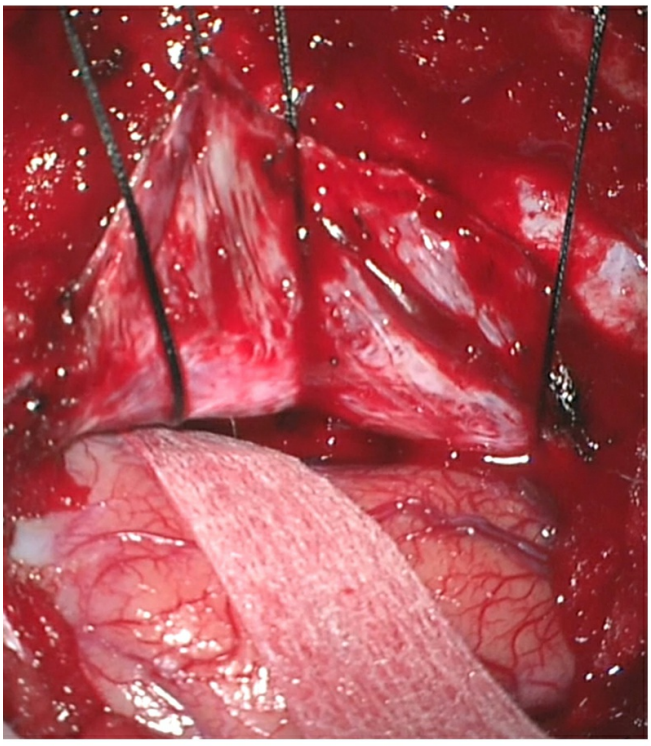
Case Example 1

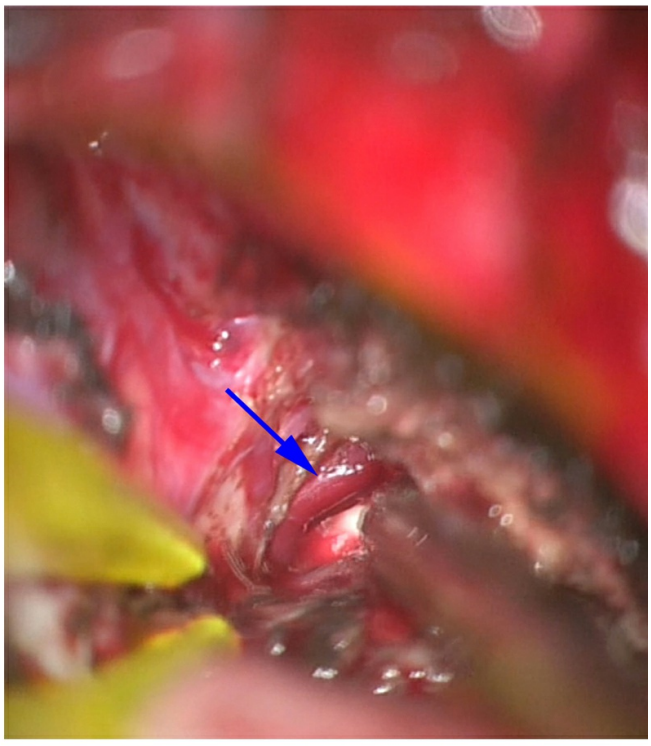
This 28-year-old man presented with memory difficulty. The preoperative images are presented in Figure 1 of this chapter but additional images are included here.

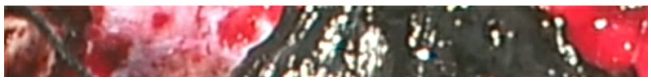












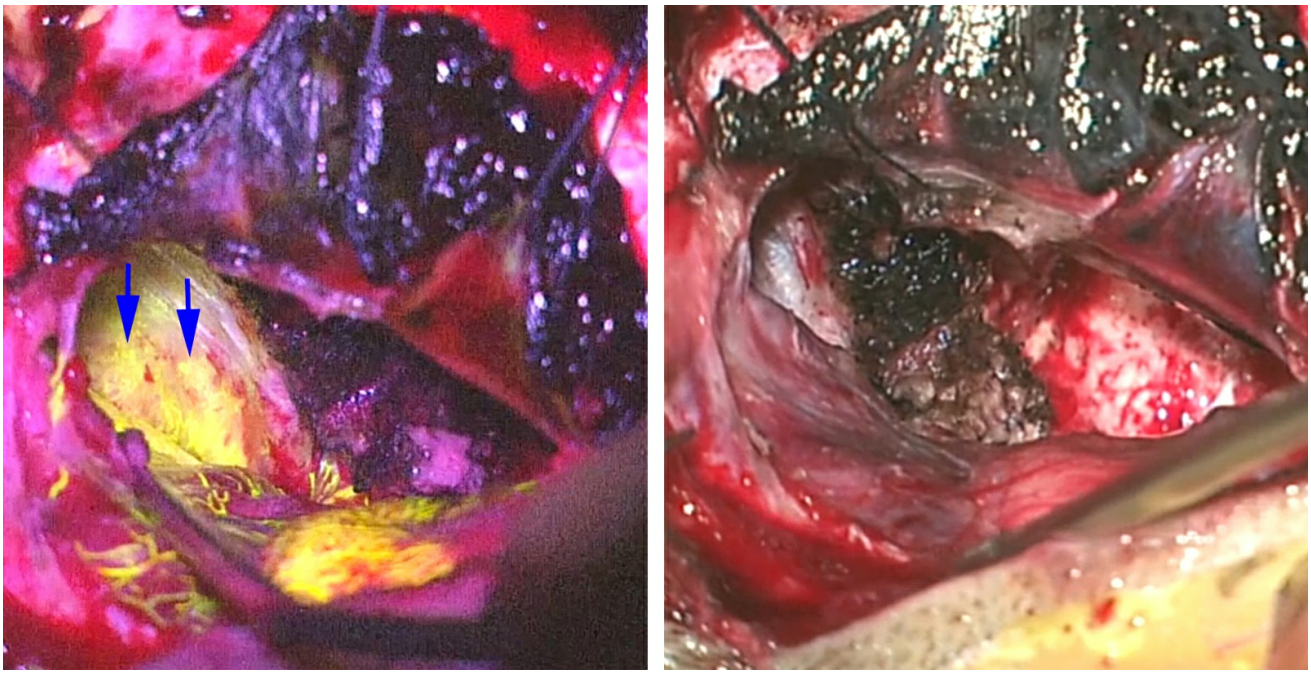
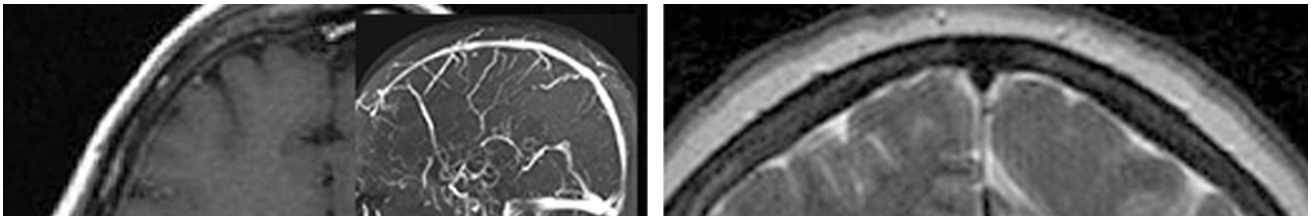
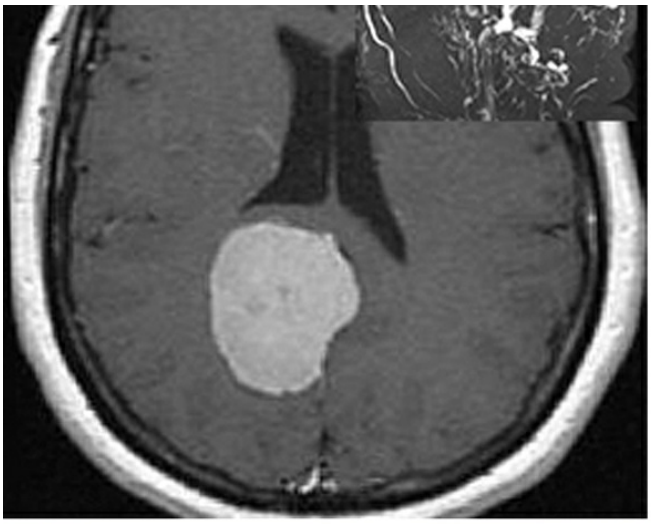


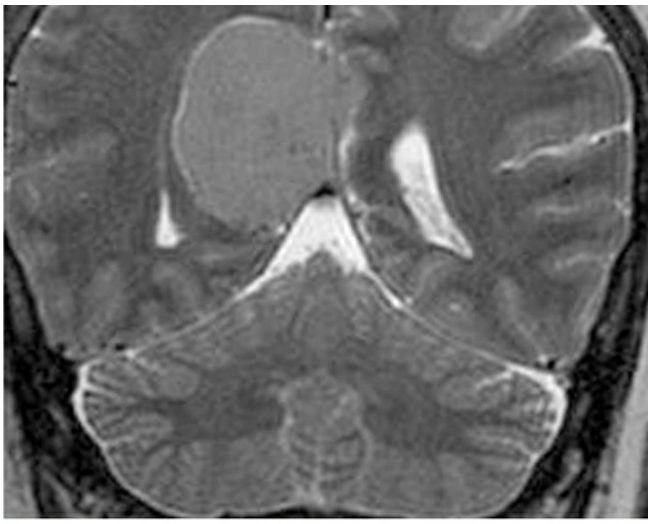
Figure 9: A giant anterior falcotentorial meningioma and the location of the veins in comparison to the tumor are noted on the CT angiogram (top row of images). The head position and tumor overlay illustrate the use of the unilateral right-sided parieto-occipital interhemispheric craniotomy and transfalcine tumor removal (middle row of images). The images in the third row show the small craniotomy and early identification of the vein of Galen along the posterior capsule of the tumor (arrow). After significant tumor removal, fluorescein angiography marks the exact location of the straight sinus. A small amount of tumor was left over the junction of the vein of Galen and straight sinus (bottom row of images).

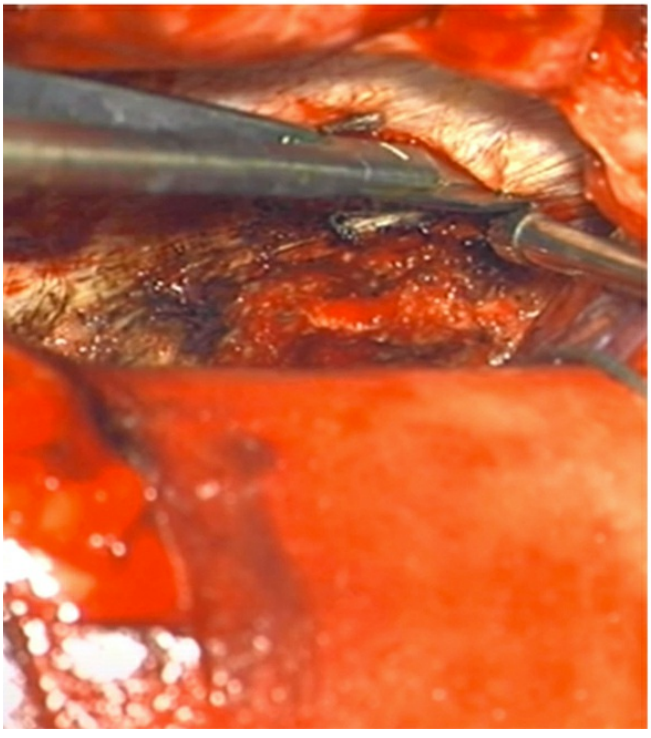
Case Example 2

52 year-old female presented with intractable headaches.









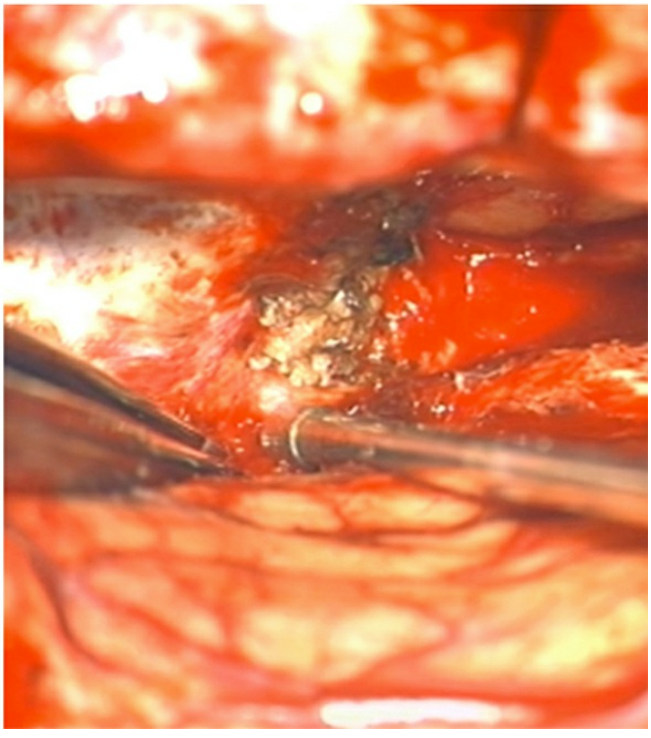


Figure 10: A more straightforward posterior parafalcine/anterior falcotentorial meningioma is shown. MR venogram demonstrated patency of all the deep veins and straight sinus (top row of images). The patient underwent an interhemispheric parieto-occipital craniotomy and transfalcine removal in the park bench position. A lumbar drain was utilized early in surgery for smooth entry into the interhemispheric space. The tumor side was placed in the dependent position to facilitate the use of gravity retraction (middle row of image). The images in the bottom row show the transfalcine incision and the final result of tumor removal away from the straight sinus.

Closure and Postoperative Care

Dural closure may be completed by means of artificial dural substitutes or pericranium. The lumbar drain is removed at the end of the procedure.

Pearls and Pitfalls

- Complete resection that places function at risk is not indicated to achieve adequate long-term control in the era of stereotactic radiosurgery.
- Preservation of functional dural sinuses and veins is an important goal of the surgery.

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