17

Surgical Management of Convexity Meningiomas

Michael P. Steinmetz, Ajit Krishnaney, and Joung H. Lee

◆ Patient Selection

Convexity meningiomas (CMs) are meningiomas arising from the meninges overlying the frontal, temporal, parietal, and occipital cortex, and not involving any of the major dural venous sinuses, the tentorium, or the falx cerebri. Clinical presentation may vary depending on the tumor's particular location. Seizures, headaches, and focal neurological deficit(s) are common presentations. With wide use of computed tomography (CT) and magnetic resonance imaging (MRI) done today as part of routine evaluations for headaches, minor head trauma, and various neurological complaints such as dizziness and visual changes, incidental meningiomas are being detected with an increasing frequency. Surgical removal of CMs is one of the most rewarding procedures performed by neurosurgeons because the surgery is often straightforward and the outcome excellent, with complete resection providing a cure for most patients.

MRI provides accurate diagnosis. On T1-weighted MRI, the majority of meningiomas are isointense, whereas the remainder are slightly hyperintense to the gray matter. Gadolinium-enhanced T1-weighted images reveal dramatic and usually homogeneous enhancement in meningiomas and, often, their associated "dural-tail." **(Fig. 17–1A,B)**. On T2-weighted sequences, nearly 50% of all meningiomas are hyperintense, whereas the other half are isointense to the gray matter. T2-weighted sequence is also highly sensitive in delineating the extent of peritumoral edema. However, dural-based metastasis, lymphoma, sarcoid, hemangiopericytoma, sarcoma, and pleomorphic xanthoastrocytoma have been found in patients who were thought to have a CM based on their preoperative MRI scans. These lesions, therefore, should be included in the differential diagnosis for patients presenting with an extra-axial lesion overlying the cerebral convexity. Cerebral angiography is rarely needed for most patients with CMs. In our practice, a preoperative embolization is considered only for patients with large CMs (>6 to 7 cm) **(Fig. 17–1C-F)**.

Surgery is the treatment of choice for most patients with CMs. Primary goals of surgery include (1) total resection of the tumor and the involved surrounding bone and dura when possible, and (2) reversal or improvement in neurological deficits/symptoms caused by the tumor. Given the benign nature of meningiomas and the established efficacy of adjuvant radiation, the goal of total removal must be balanced by the physician's basic credo to "do no harm." When total removal carries a significant risk of morbidity, a small piece of tumor may be left, with further plans of observation followed by reoperation or radiation when the tumor is noted to be growing or causing new symptoms. However, observation alone, with periodic (usually yearly) follow-up neurological and MR evaluations, is reasonable for elderly patients, especially if they have minimal or no symptoms caused by the tumor. Because people are living healthier and longer lives today, the age at which a person is considered "elderly" is debatable. The patient's absolute age is no longer important in the decision-making process in the management of convexity meningiomas; however, it may be reasonable to consider those with less than 10 to 15 years remaining in their life expectancy as elderly. In addition, observation may be an appropriate option for the following people regardless of their age: (1) patients with incidental small tumors with no surrounding edema, and (2) patients who insist on nonintervention after a thorough discussion of all treatment options. However, these patients must be compliant with the necessary radiographic and neurological follow-up evaluations.

◆ Preoperative Management

Symptomatic patients with a significant amount of peritumoral edema seen on T2-weighted MRI may be started on dexamethasone as an outpatient with surgery planned within 1 to 2 weeks. Anticonvulsants are started preoperatively only for patients who present with seizures. Otherwise, a loading dose of phenytoin is given at induction of anesthesia and then therapeutic levels are maintained postoperatively for up to several weeks, depending on the tumor size, brain manipulation required during surgery, and extent of perioperative swelling. For tumors large enough to cause visual symptoms/deficits or located in the occipital region, a detailed preoperative ophthalmologic evaluation, including a formal visual field testing, is obtained. Preoperative embolization is reserved for patients with large CMs (>6 to 7 cm).

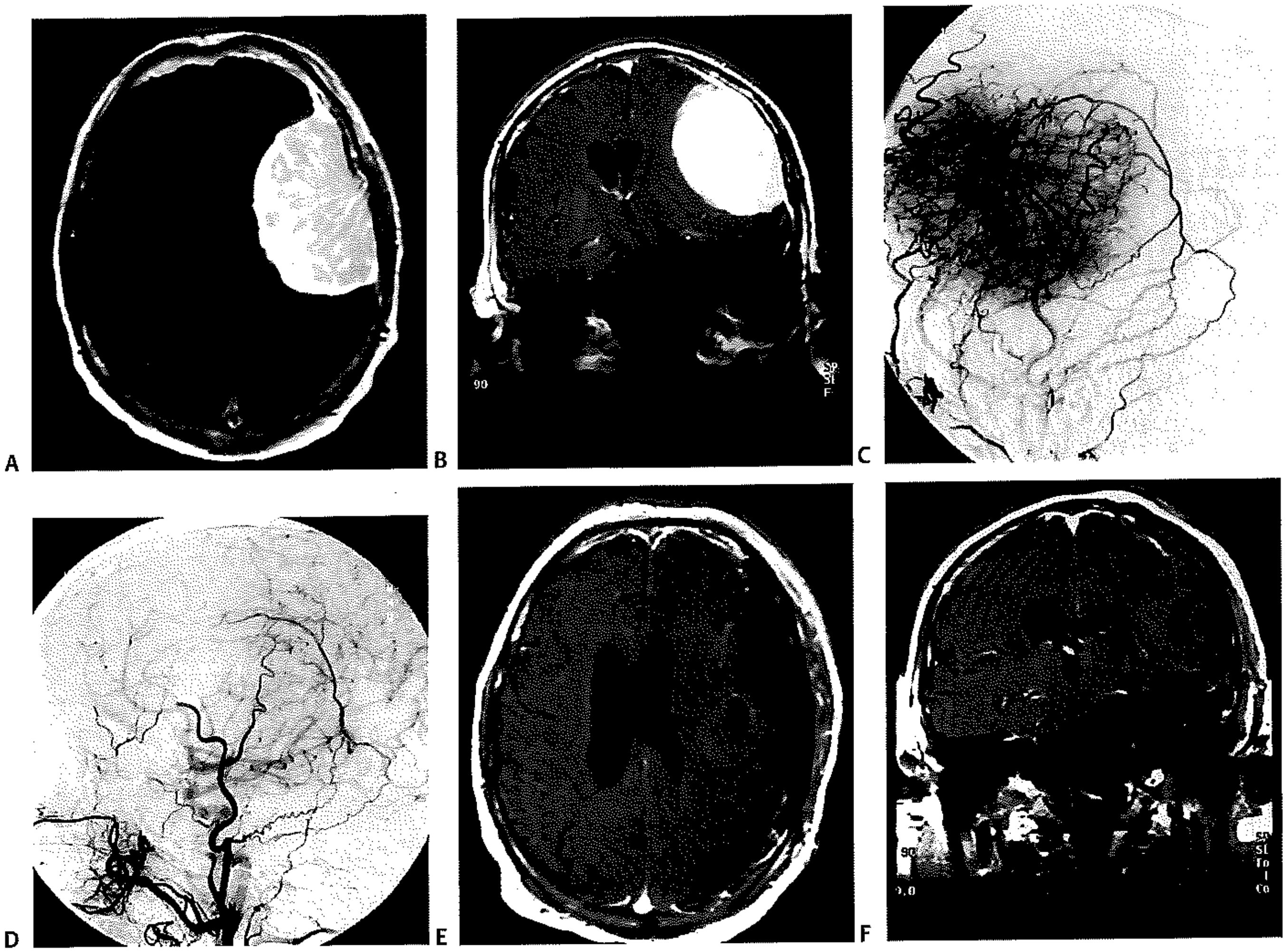


Figure 17–1 **(A,B)** A large left frontal convexity meningioma is demonstrated. There is mass effect involving the frontal and temporal lobes. **(C)** Angiography demonstrates a significant tumor blush, **(D)** which has resolved following embolization. **(E,F)** Using the techniques outlined in the chapter, the tumor was removed successfully and there is significant resolution of the mass effect.

◆ Operative Procedure

Convexity meningiomas require surgical approaches that are primarily dictated by their locations. The following, which are general principles for meningiomas of most locations, hold true for CMs as well:

1. Optimal patient positioning, incision, craniotomy, and tumor exposure
2. Early tumor devascularization
3. Internal decompression/extracapsular dissection
4. Preservation of adherent or adjacent neurovasculature
5. Removal of involved dura and bone
6. Closure

Patient Positioning, Skin Incision, Craniotomy

The patient positioning, appropriate incision placement, and selection of the optimal approach for tumor exposure are the critical elements of successful meningioma surgery. The patient is positioned in such a way that safety is maximized. Moreover, the ideal position must allow for an approach that provides complete exposure of the tumor and the involved surrounding bone and dura. At the same time, maximal brain relaxation must be achieved by use of gravity and uncompromised venous drainage. The head should be no lower than the level of the heart, regardless of the position selected, and undue severe neck rotation or flexion must be avoided. In addition, the surgeon's comfort for the duration of surgery must be maintained.

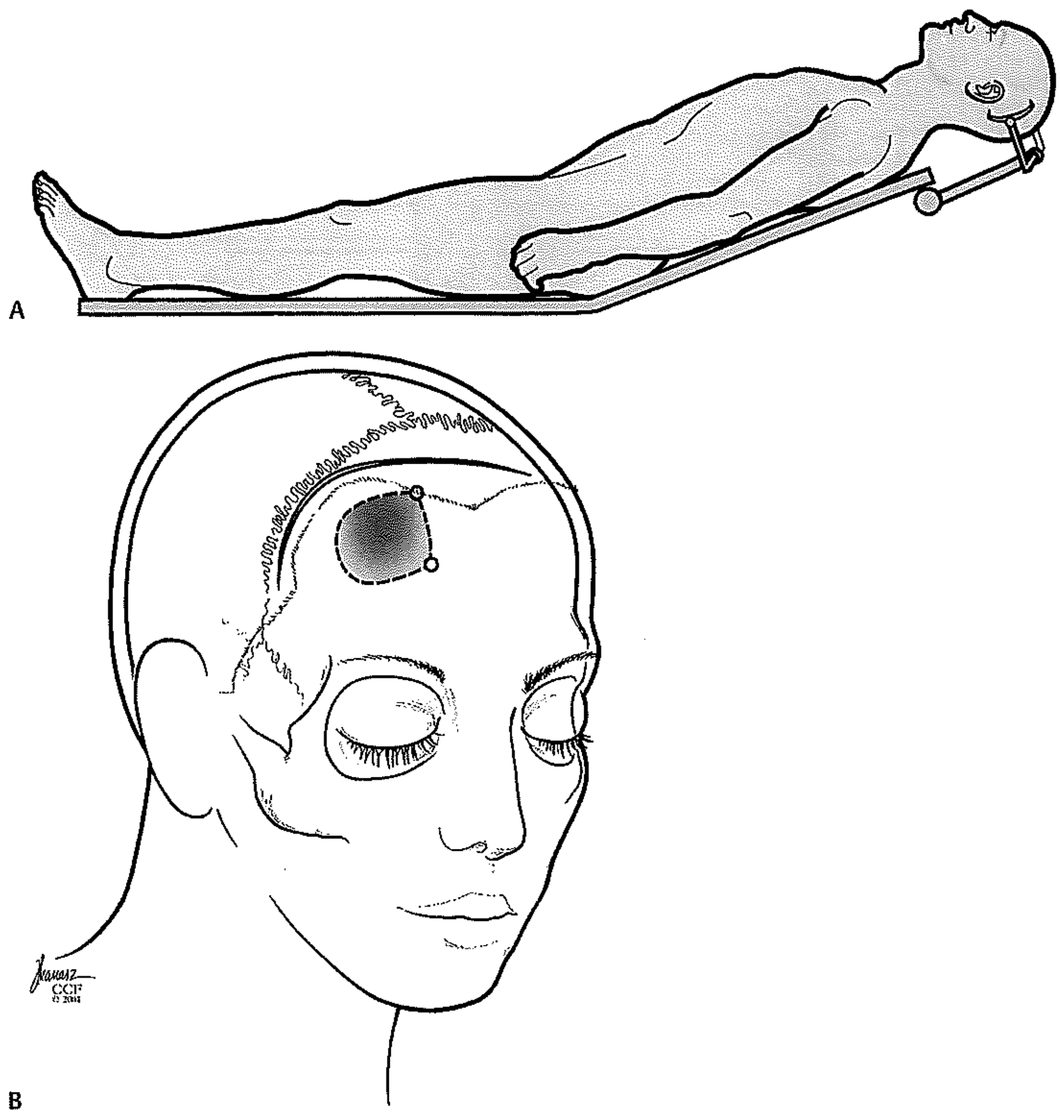


Figure 17–2 (A) For anterior frontal tumors, the patient is positioned supine with the nose straight up. (B) The incision extends from the side of the tumor above the zygoma and across the midline immediately behind the hairline. The length of the incision depends on the size of the planned craniotomy. The authors prefer to place two bur holes in the midline or immediately off the midline. The lower bur hole is placed immediately above the frontal sinus.

Depending on the tumor location, the patient may be positioned supine or prone. The planned scalp flap should contain the tumor in the center. Of important note, the incision must be planned to avoid any visible cosmetic defect or significant compromise to the scalp vascular supply. If a horseshoe-shaped incision is planned, the depth must not exceed the width of the flap. The size of the scalp and bone flaps must be large enough to allow for maximal exposure of the tumor, the involved bone and dura, as well as the limits of the dural tail, as noted on preoperative MRI scans. With the availability of frameless computer-assisted navigation systems, the exact extent of the tumor and the dural tail may be fully delineated during surgery. Computer-assisted navigation may also aid in accurate and optimal placement of the incision and craniotomy, especially in patients with a small CM.

For anterior frontal tumors, the patient is positioned supine with the nose straight. A bicoronal incision placed within the hairline is utilized **(Fig. 17–2)**. For frontotemporal or anterolateral tumors, the patient is positioned supine with the head turned to the side contralateral to the tumor by 30 to 45 degrees. A standard curvilinear

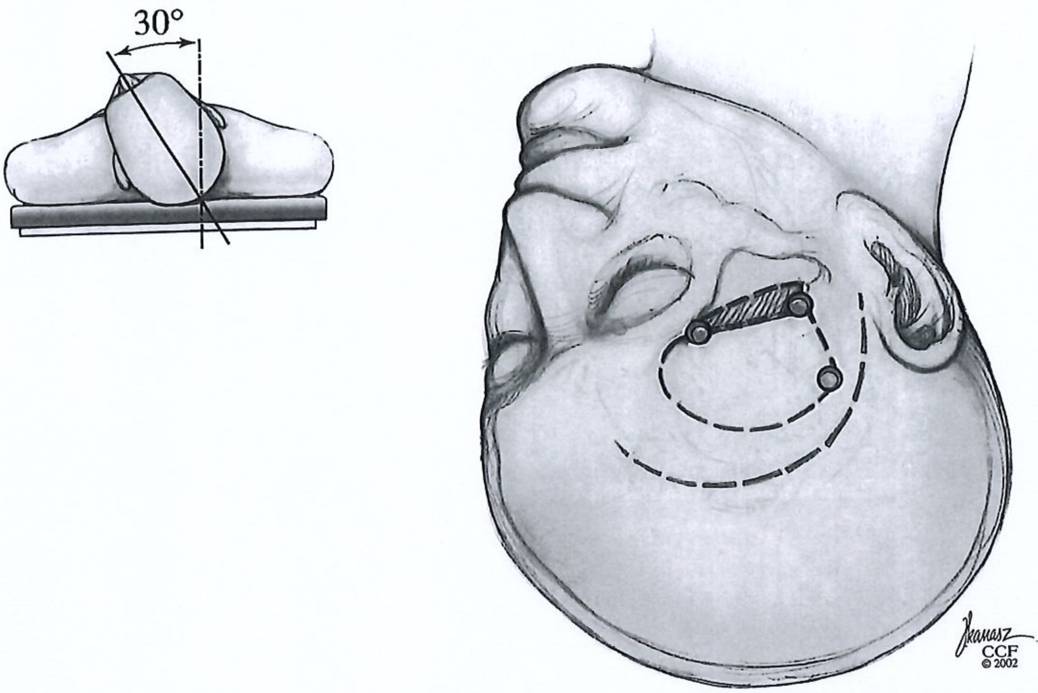


Figure 17–3 For frontotemporal or anterolateral tumors, the patient is positioned supine with the head rotated 30 to 45 degrees contralateral to the side of the tumor. A standard pterional incision is used. Three bur holes are utilized for the craniotomy, one at the keyhole, one in the temporal squamosa above the zygoma, and the third in the temporal parietal region. The sphenoid bone is drilled (shaded area).

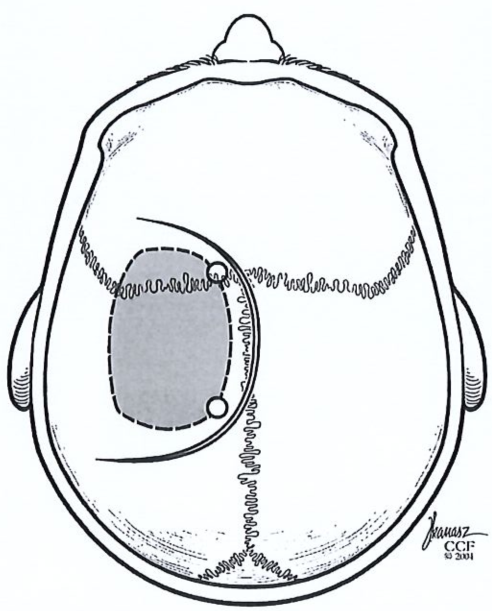
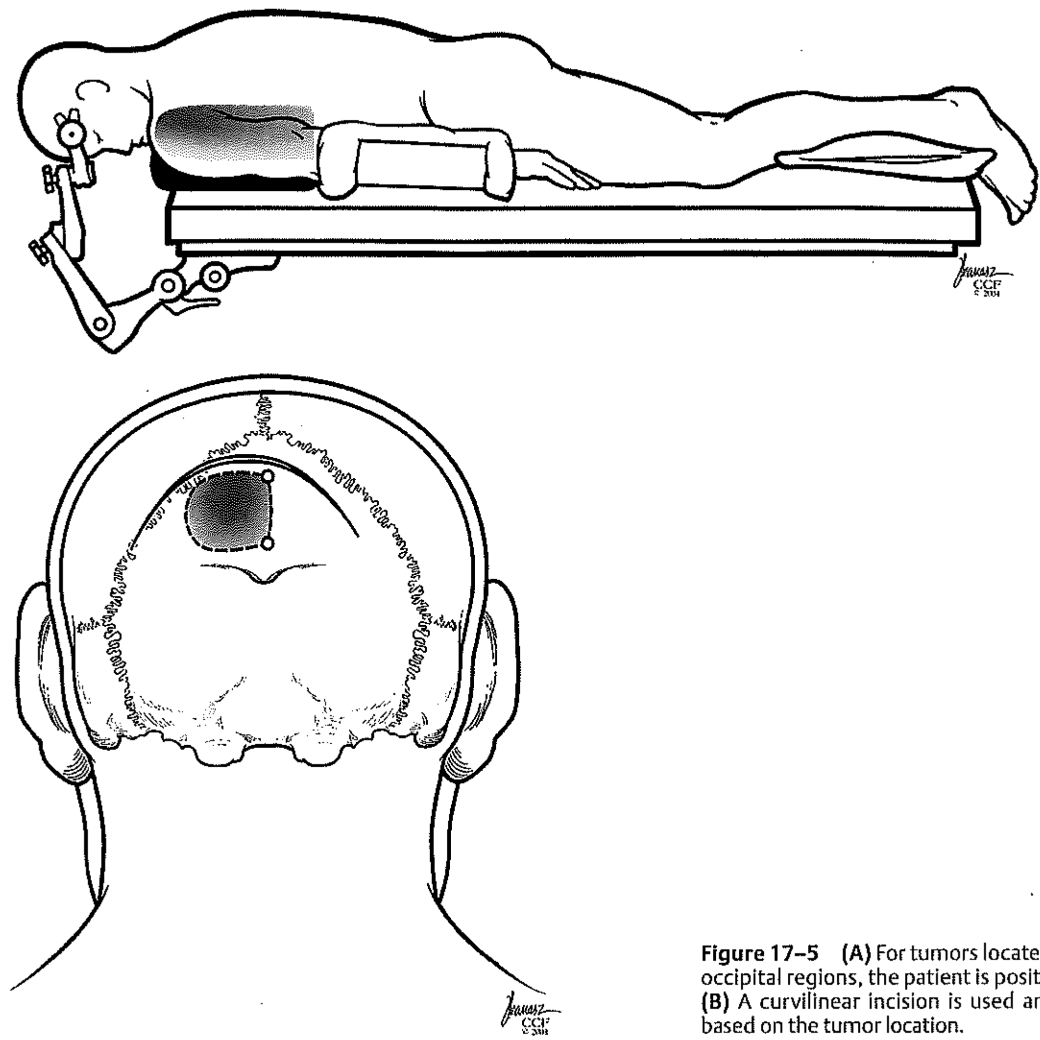


Figure 17–4 For posterior frontal and parietal tumors, the patient is positioned supine. The head is rotated until the side of the head is parallel to the floor. A horseshoe incision is utilized. Two bur holes are used based on the midline or immediately off the midline.

pterional incision may then be utilized. **(Fig. 17–3)** For posterolateral frontal, posterior temporal, and lateral parietal tumors, the patient may be positioned supine, with an ipsilateral shoulder roll, and the head rotated to the contralateral side to maintain the side of the head parallel to the floor. A horseshoe incision may then be used **(Fig. 17–4).** Lastly, for tumors located in the medial parietal or occipital regions, the authors prefer the prone position **(Fig. 17–5).**

A craniotomy is planned large enough to completely expose the tumor and the surrounding involved dura, as delineated by gadolinium-enhanced T1 MRI, with a 1- to 2-cm circumferential margin. After making one or two bur holes, craniotomy is performed. The free bone flap is dissected off of the underlying dura with the aid of Penfield dissectors. In patients with severe calvarial involvement by the tumor, performing a craniotomy around the tumor, followed by lifting off of the free bone flap as previously described, may be difficult or harmful to the underlying brain. Instead, the tumor eroding through the calvarium is removed with a rongeur, and the margin of skull defect through which the tumor eroded is removed either with a rongeur or with a high-speed 6-mm cutting bur until normal dura is exposed circumferentially around the tumor.



A

B

Figure 17–5 **(A)** For tumors located in the posterior parietal or occipital regions, the patient is positioned in the prone position. **(B)** A curvilinear incision is used and a craniotomy is planned based on the tumor location.

In most situations, several options exist in selecting the patient's position, incision, surgical approach, and exposure. The final selection must be based on what is best for the patient and the surgeon, based on the surgeon's knowledge, past experience, and preference.

Tumor Devascularization

Meningiomas may be quite vascular, and therefore, early tumor devascularization is paramount. Preoperative embolization may be utilized for large CMs. In CMs not embolized, upon dural exposure prior to opening the dura, extra time should be expended to coagulate all of the tumor-feeding vessels—most commonly the branches or the main trunk of the middle meningeal artery.

Internal Decompression and Extracapsular Dissection

The dura is next opened sharply with a 1-cm border beyond the tumor or the dura involved by tumor **(Fig. 17–6)**.

Although small meningiomas may be removed en bloc, internal decompression is a key initial step in actual tumor removal for most sizeable meningiomas, including those of the convexity locations, following adequate exposure and initial devascularization. Internal debulking is performed until a thin rim of exposed portion of the tumor is remaining. This internal debulking minimizes brain retraction and facilitates extracapsular dissection. Following initial internal decompression, extracapsular dissection is initiated by identifying a layer of arachnoid (maintained in most meningiomas) at

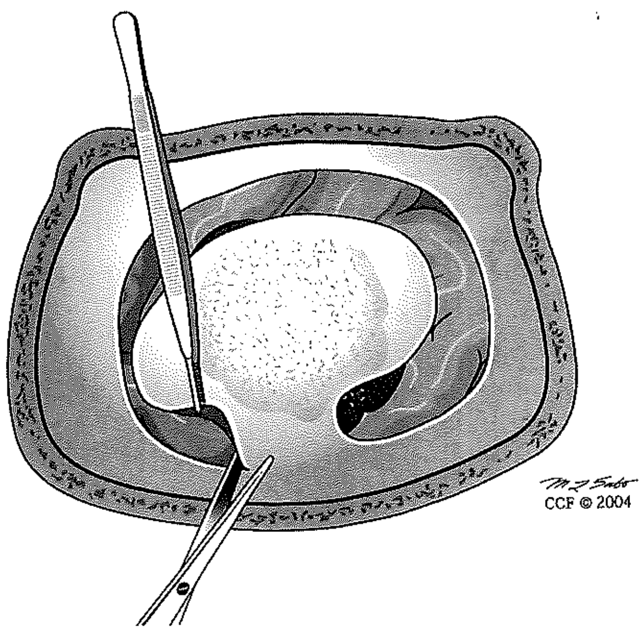


Figure 17–6 The dura is incised surrounding the tumor, ideally with a 1-cm margin.

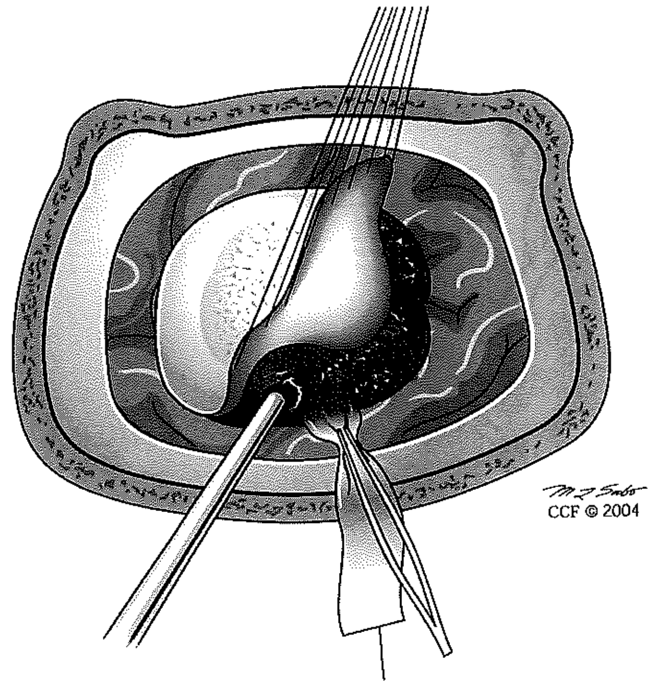


Figure 17–7 The capsule of the tumor is pulled toward the center of the tumor exposing a layer of arachnoid at the brain–tumor interface. This arachnoid is opened sharply and cottonoid patties are placed at this interface between the brain and tumor. As patties are being placed sequentially around the tumor, they are used to gently strip the arachnoid from the tumor capsule, covering the brain and arachnoid together, thereby protecting the brain from surgical trauma.

the brain–tumor interface. As surgery progresses, rather than increasing brain retraction to expose more of the tumor hidden under the brain, the thinned capsule is pulled toward the center of the tumor. Cottonoid patties are placed in the brain–tumor interface as the capsule is being pulled away from the brain, while maintaining the arachnoidal layer intact between the brain and the tumor (**Fig. 17–7**). As patties are being placed sequentially around the tumor, they are used to gently strip the arachnoid from the tumor capsule, covering the brain and arachnoid together, thereby protecting the brain from surgical trauma. Patties are sequentially placed until the tumor is completely dissected free from the brain (**Fig. 17–8**). After complete dissection, the tumor is completely removed from the brain, thus exposing the tumor bed and the patties (**Fig. 17–9**).

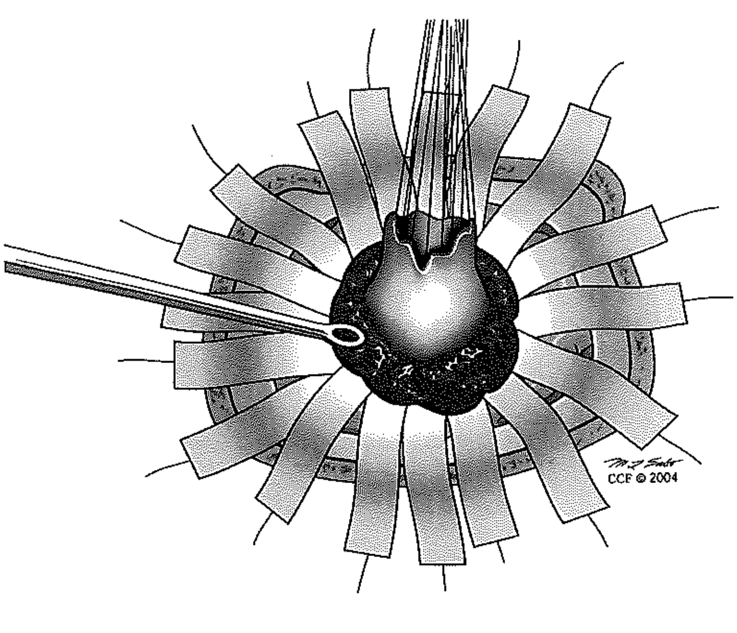


Figure 17–8 Patties are sequentially placed between the brain and tumor until it is completely dissected free from the brain.

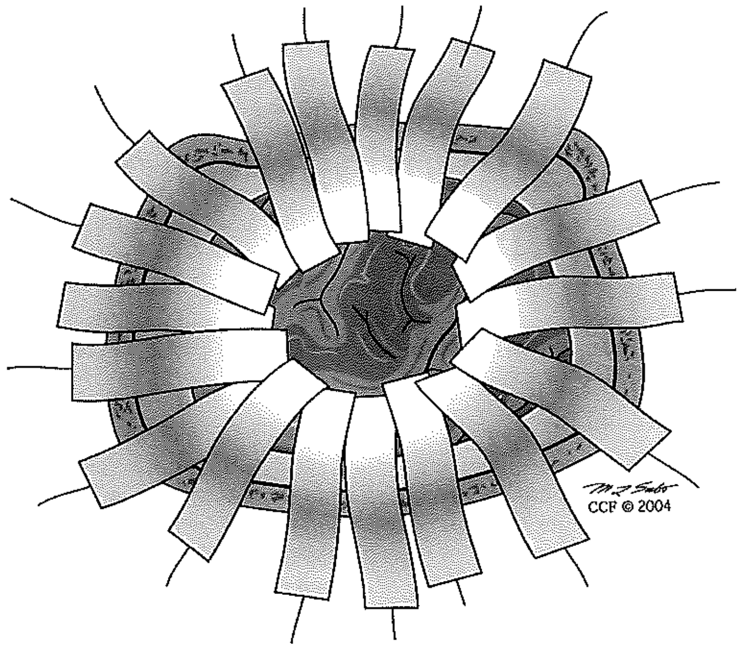


Figure 17–9 After the tumor is completely dissected free, it is removed from the brain thus exposing the tumor bed and the patties that have been placed.

Preservation of the Adherent or Adjacent Neurovasculature

During extracapsular dissection, any adherent sizeable cortical veins are carefully dissected and preserved to prevent any risk of postoperative venous infarction. Small arteries attached to the tumor surface are thoroughly inspected. As a rule, no artery or arterial branch is sacrificed except when the vessel is definitely confirmed to be a tumor feeder. Commonly, loops of vessels may be encased by the tumor or may course onto the capsule surface and become adherent. In these situations, the surgeon may initially misinterpret these vessels as tumor feeders. Before concluding that a vessel is a tumor feeder and therefore amenable to coagulation, the afferent and efferent course of the vessel must be fully appreciated. It is very rare for meningiomas to have feeders directly from major intracranial arterial trunks or their main branches. Therefore, no vessels coming directly off the MCA or its main branches in a large CM overlying the sylvian fissure should be coagulated. If any appreciable vasospasm occurs while dissecting tumor off arteries, small pieces of Gelfoam soaked in papaverine applied directly onto the vessel readily reverse the spasm.

Portions of tumor capsule are sequentially devascularized and completely dissected from the surrounding cortical surface, and blood vessels are further removed in segments until the entire tumor is removed.

Removal of the Involved Dura and Bone and Closure

After tumor removal, the undersurface of the remaining dural margin is carefully inspected circumferentially. The bone flap is also carefully examined, and any bone involvement is removed. This may easily be performed with a high-speed cutting bur.

The dural defect may be repaired with a commercially available dural substitute. Currently, the authors prefer to use synthetic collagen-based dural substitutes. A synthetic graft may simply be laid over the dural defect without the need for suture. The bone flap is then replaced and secured with titanium miniplates. When there is a cranial defect following removal of the involved calvarium, cranioplasty is performed using methylmethacrylate.

◆ Postoperative Management

Follow-up evaluations consist of careful neurological examination and MRI scans with and without gadolinium. Steroids, started preoperatively on patients with CMs causing neurological symptoms or those with radiographic peritumoral edema, are gradually weaned over several days. An antiepileptic, usually phenytoin, is administered for 1 to 6 weeks, depending on the tumor size, brain manipulation required during surgery, and extent of perioperative swelling. For patients with preoperative visual field defect due to occipital CMs, detailed neuro-ophthalmologic evaluations are an important part of follow-up management. Following resection of all meningiomas, a postoperative baseline MRI scan is obtained on day 1 or 2 after surgery. For benign tumors, following confirmation of total removal on postoperative MRI, further follow-up evaluation with imaging studies is performed every 1 to 5 years, depending on whether a Simpson grade I or II removal was achieved. Following a rare instance of subtotal CM removal, subsequent follow-up with MRI is done every year, with plans of either repeat surgery or adjuvant radiation if and when there is clinical or radiographic progression of the residual tumor. If the tumor is noted to be clinically and radiographically stable for a few years after initial surgery, the frequency of follow-up may be decreased to every 2 to 3 years.

For atypical meningiomas, after initial postoperative MRI following either subtotal or total removal, subsequent evaluations with MRI are performed every 6 months for the first 2 years. As with benign tumors, radiation or a repeat surgery is considered in the presence of documented clinical or radiographic progression of the residual tumor. With malignant meningiomas, adjuvant radiation is administered shortly after surgery regardless of the extent of resection. Depending on the extent of resection, follow-up MRI scans are performed every 3 to 6 months.