



Pterional Craniotomy

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General Considerations

The pterional or frontotemporal craniotomy is the workhorse of the supratentorial approaches. Because of its simplicity, flexibility, efficiency, and familiarity to neurosurgeons, this corridor is the most commonly used surgical route to lesions along the anterior and middle skull base.

*I use the **extended pterional approach**, defined as a standard pterional craniotomy supplemented and expanded by*

- 1. **Osteotomy along the lateral sphenoid wing to the level of the superior orbital fissure***
- 2. **Drilling along the roof of the orbit to flatten its surface.***
- 3. **If necessary, roungering temporal squama towards the floor of the middle fossa.***

These modifications provide unobstructed operative working angles toward the parasellar and subfrontal targets.

I consider this extended modification a *skull base approach*. The additional bone removal at the sphenoid wing and orbital roof expands the subfrontal operative trajectories toward the midline skull base while reducing retraction on the frontal lobe. The osteotomy along the roof of the orbit provides some of the advantages of an orbitozygomatic craniotomy, but it is more efficient and associated with less cosmetic deformity.

The extended pterional craniotomy must be tailored to the specific underlying pathology. The following steps describe the general principles

of this approach, whereas the other relevant chapters review tailored exposures and intradural dissection via this route.

Recently, a [supraorbital craniotomy through the eyebrow incision](#) has been used as part of the minimally invasive keyhole concept to parasellar and midline anterior skull base pathologies. Using the same concept, a minipterional approach has also been described, which is predominantly centered on the main axis of the sylvian fissure and results in a similar exposure to the one afforded via the standard pterional approach. The ultimate choice of exposure must be **minimally disruptive** and allow flexible operative working angles to handle the lesion safely and efficiently.

Most importantly, the exposure should provide appropriate working space to handle potentially catastrophic situations such as massive intraoperative hemorrhage from aneurysms and vascular tumors.

Therefore, routine indiscriminate use of one approach should be avoided. The operator should be intimately familiar with all modifications of the exposures to the subfrontal corridor and their advantages and limitations.

Indications for the Approach

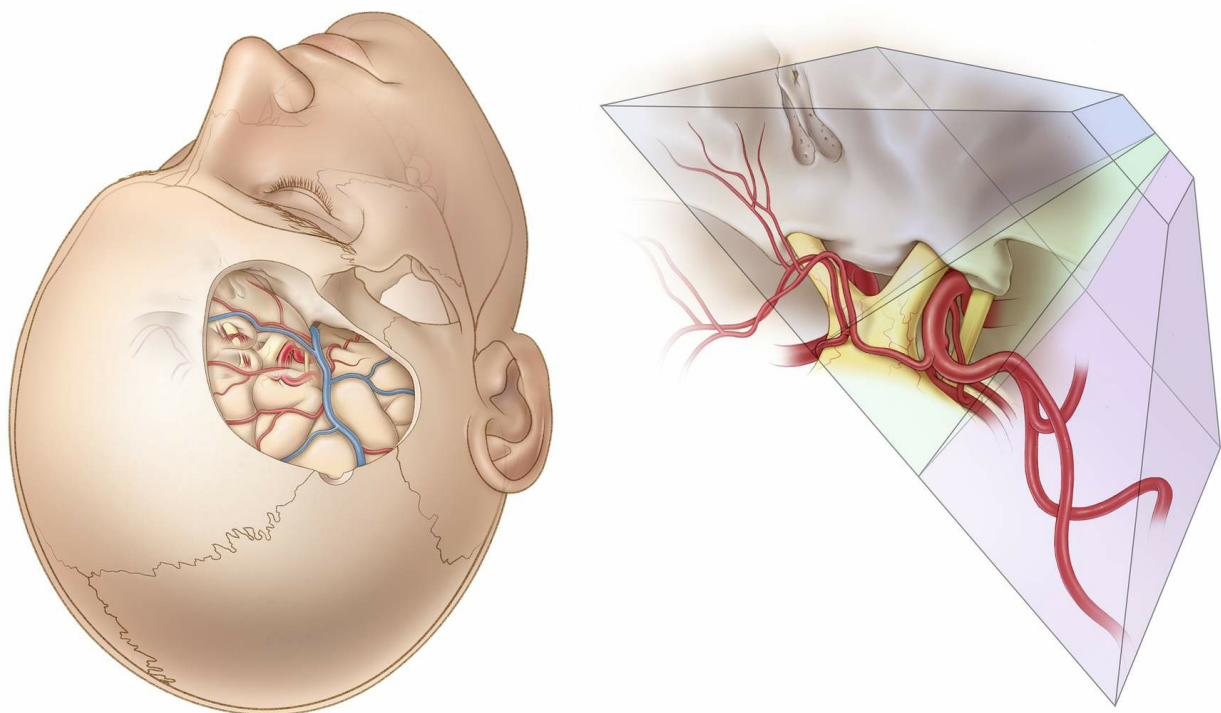


Figure 1: The extended pterional corridor can be used to expose

parasellar lesions around the circle of Willis and optic apparatus, anterior skull base tumors (including orbital lesions), and interpeduncular and intrasylvian pathologies.

The extended pterional approach has replaced the bifrontal craniotomy for giant midline anterior cranial fossa intradural lesions (ie olfactory and cribriform plate meningiomas) in my practice. With the exception of extradural skull base tumors extending into the intradural space (i.e. esthesioneuroblastomas, chondrosarcomas and other sinus malignancies), the unilateral lateral supraorbital or pterional exposure offers numerous advantages and no compromise in the necessary operative working angles.

I occasionally use the pterional route to reach contralateral lesions in very select cases such as contralateral ophthalmic, MCA and P1 artery aneurysms.

I do not use this route for purely third ventricular tumors, especially [craniopharyngiomas](#). The endoscopic endonasal route provides excellent working angles along the long axis of the ventricle and most parasellar tumors and facilitates dissection without excessive brain manipulation. For the past decade, through the use of endoscopic endonasal techniques, I have not approached any pituitary tumor (regardless of its size or texture) through the transcranial route.

Preoperative Considerations

I use antiepileptic medications for patients who are not suffering from preoperative seizures, and I terminate these medications 7 days after surgery in the absence of any seizure during the immediate postoperative period. A lumbar drain is placed for cerebrospinal fluid (CSF) drainage and facilitation of brain relaxation in select patients who harbor large skull base lesions filling the basal cisterns. Such lesions block CSF pathways along these cisterns and prevent adequate cerebral relaxation during opening of the corresponding arachnoid membranes.

Depending on the degree of mass effect caused by the tumor, mannitol

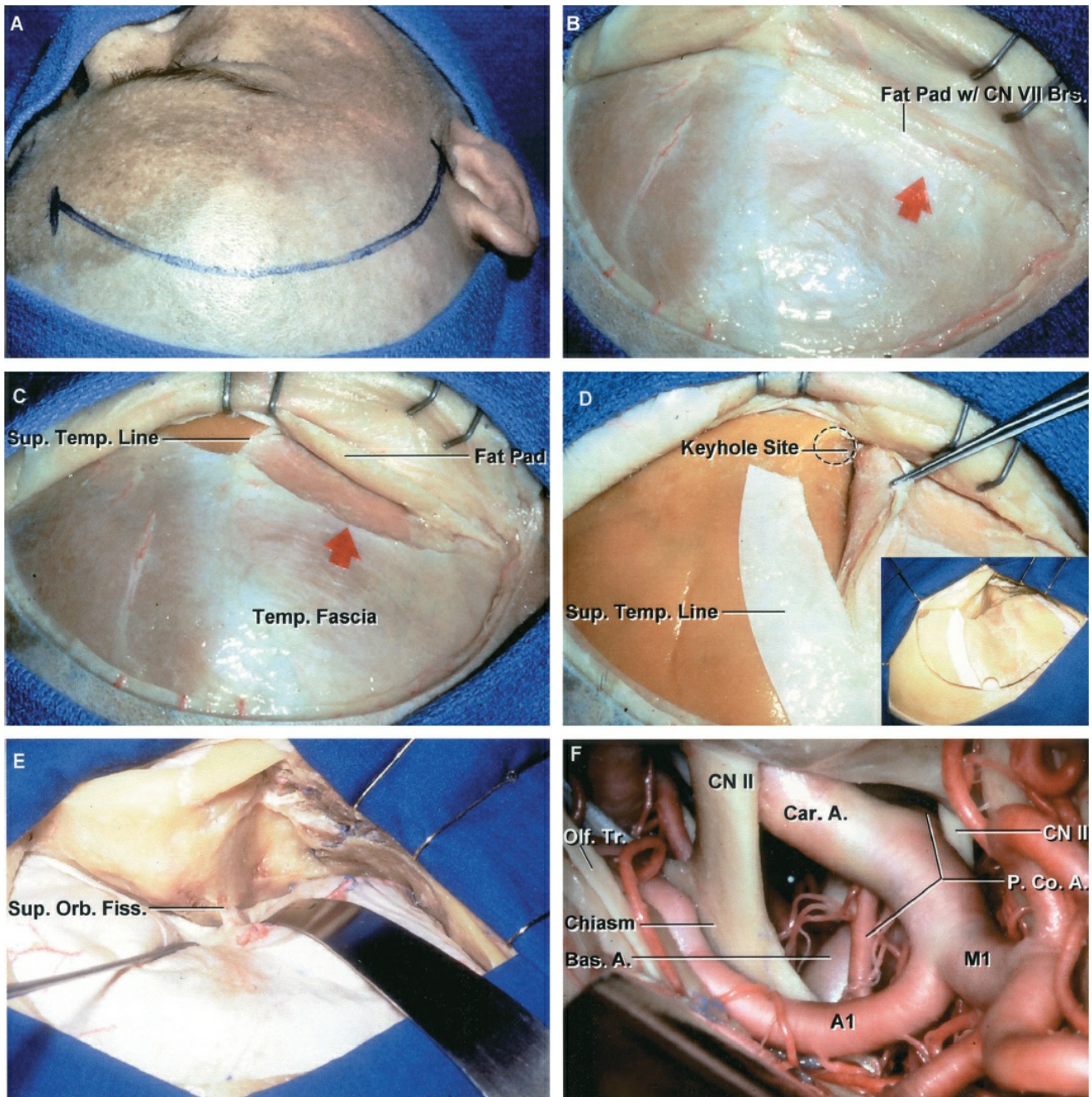
may be administered prior to the craniotomy. Dexamethasone is used in patients with significant vasogenic edema.

I use embolization sparingly in patients with an AVMs or meningiomas. Neuronavigation is usually used. Electroencephalography may be used for confirmation of burst suppression during clip ligation of aneurysms that are expected to require temporary parent vessel occlusion. I keep the patient normotensive throughout surgery, except patients with AVMs, for whom the systolic blood pressure is kept ~20-30% below their corresponding preoperative blood pressure.

Operative Anatomy

Relevant anatomy for performing an adequate pterional craniotomy involves knowledge of the scalp and temporal connective tissue layers and the keyhole site. Over the scalp, five concentric layers are easily recognized, namely the skin, the subcutaneous tissue, the galea aponeurotica, the loose connective tissue and the pericranium.

The temporal region has a much more complex anatomical relationship. Beneath the skin and subcutaneous tissue, the temporoparietal fascia comprises an extension of the galea over the temporal area. It is commonly included within the skin flap during surgical procedures. The next layer is the loose connective areolar tissue, which is commonly used to develop the dissection plane towards the zygomatic arch. This plane is followed to the inferior temporal septum where three fascial layers get fused (temporoparietal fascia, loose areolar tissue and temporal fascia). At that level, the temporal fascia splits into two layers, the deep and superficial laminae that involve the superficial temporal fat pad before adhering to the superior margin of the zygomatic arch. The temporal fascia is the last layer over the temporal muscle and is in continuity with pericranium above superior temporal line. The frontotemporal branches of the facial nerve are found in the fatty-fibrous tissue in front of the septum. At this stage, preservation of such branches involves performing interfascial or subfascial dissection.



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Figure 2: Pterional craniotomy: steps in exposure and operative anatomy. Incision (A). Subgaleal dissection of the myocutaneous layer in two separate layers (B). Subfascial dissection to protect the frontalis branch of the facial nerve (C). Inferior mobilization of the temporalis muscle (D). Osteotomy along the roof of the orbit to expand the subfrontal operative trajectory (E). Intradural exposure afforded by extended pterional craniotomy (F)(Images courtesy of AL Rhoton, Jr).

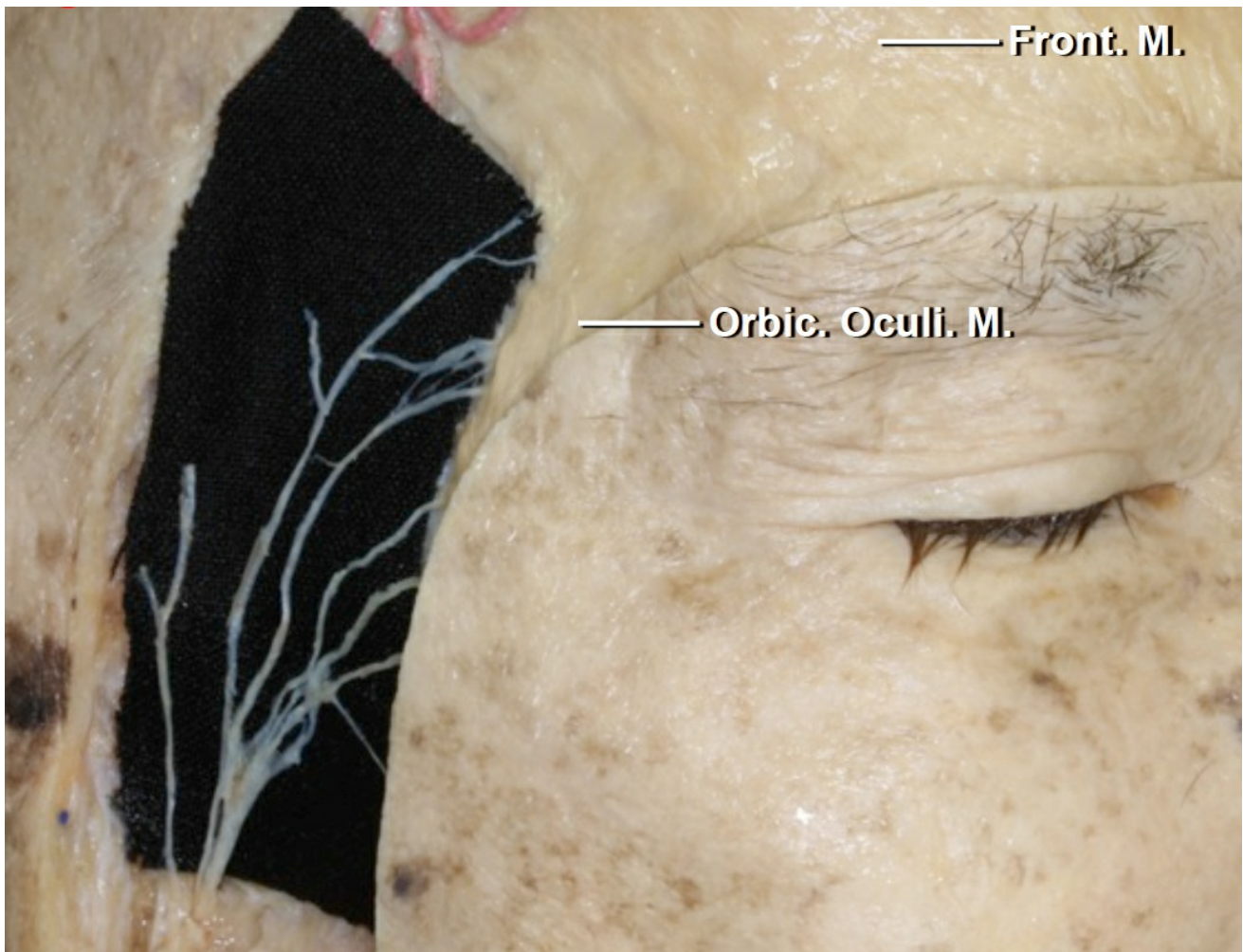
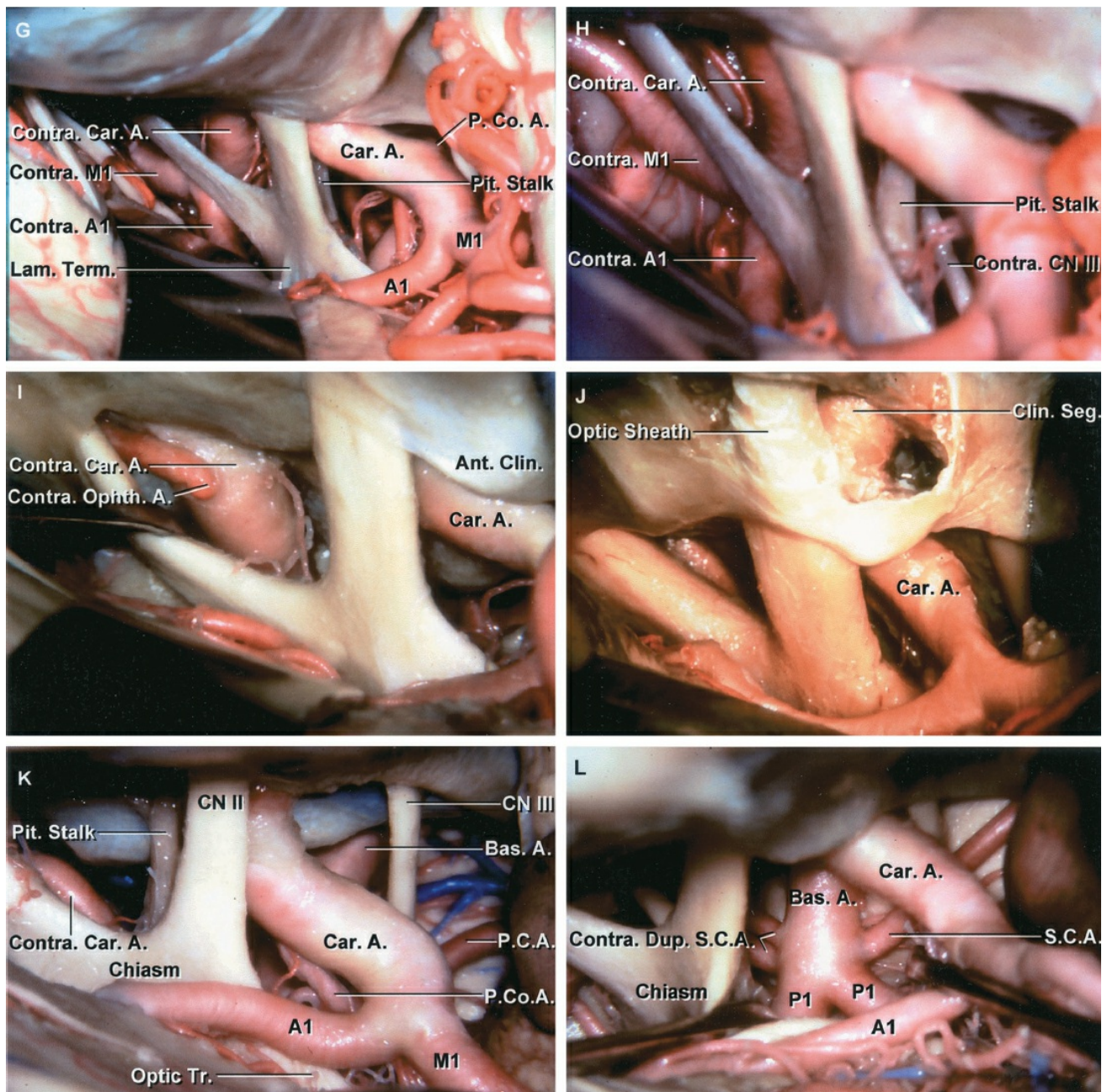


Figure 3: The locations of the frontalis branches of the facial nerve through the fat pad are demonstrated. These branches should be protected through the use of single layer myocutaneous flaps as well as interfascial and subfascial dissection through the fat pad. These maneuvers avoid postoperative frontalis palsy.

Please see more information below in the [additional considerations](#) section regarding the interfascial and subfascial techniques for preservation of the frontalis branch.

For more anatomical information related to the keyhole, please refer to the [Orbitozygomatic Craniotomy](#) chapter.



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Figure 4: Exposure provided through an extended pterional craniotomy. The ipsilateral vasculature and the contralateral vessels across the optic chiasm can be seen (G). Note the pituitary stalk seen inferior to the optic chiasm (H). The origin of the contralateral ophthalmic artery beneath the retracted optic nerve (I). The anterior clinoid process has been removed (J). The carotid oculomotor triangle and the basilar artery are visible (K). The basilar apex is more widely visible through the opticocarotid triangle (L)(Images courtesy of AL Rhoton, Jr).

PTERIONAL CRANIOTOMY

The patient is placed in the supine position with knees flexed and the head of the table elevated approximately 15-20 degrees. The head is immobilized in a skull clamp, turned (20-45 degrees) away from the side of the approach, and moderately hyperextended to allow the frontal lobes to fall away from the floor of the anterior cranial fossa. The latter maneuver requires the malar eminence to be the highest point on the head. *The closer the pathology to the midline and the further anteriorly the lesion is located, the less I turn the head. For example, I turn the head ~30 and ~45 degrees for an anterior communicating artery and middle cerebral artery aneurysm, respectively.*

Other colleagues use other parameters to position the head. More basal pathologies such as ophthalmic and posterior communicating artery aneurysms as well as cavernous sinus masses require little head deflection and greater head rotation so that the orbital ridge is left in the superior plane. On the other hand, middle cerebral and carotid bifurcation artery aneurysms as well as suprasellar tumors with more superior extension benefit from a greater head deflection and minimal head rotation, allowing the malar prominence to stay in the superior plane.

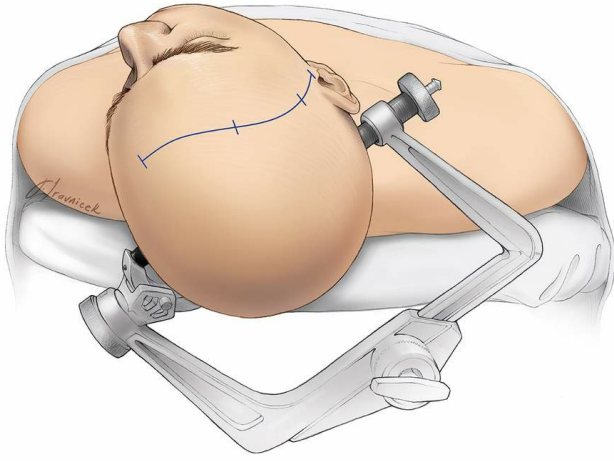


Figure 6: The patient is positioned supine and a shoulder roll is used for patients who have limited neck mobility. The pins are placed well behind the planned incision. **I prefer to place the dual pins along the contralateral superior temporal line and the single pin on the ipsilateral mastoid bone.** The head is slightly turned and extended to allow the frontal lobes to fall away with gravity.

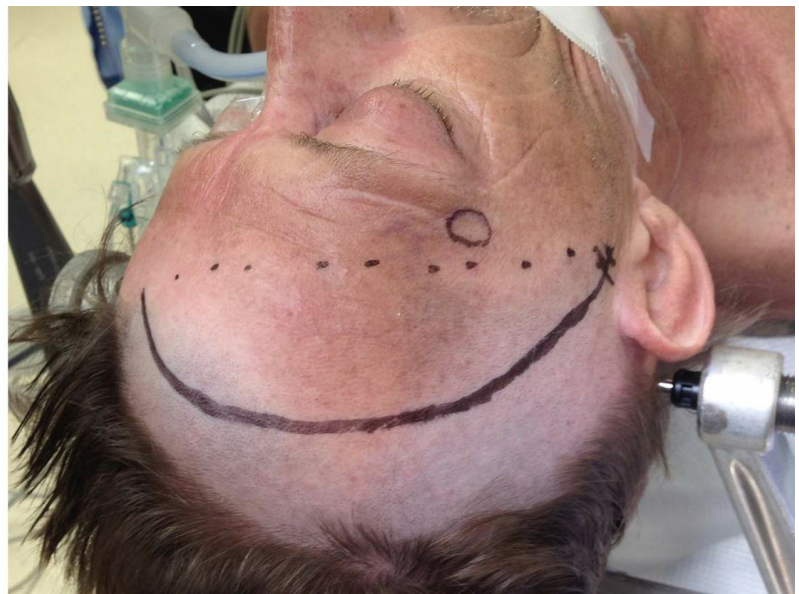
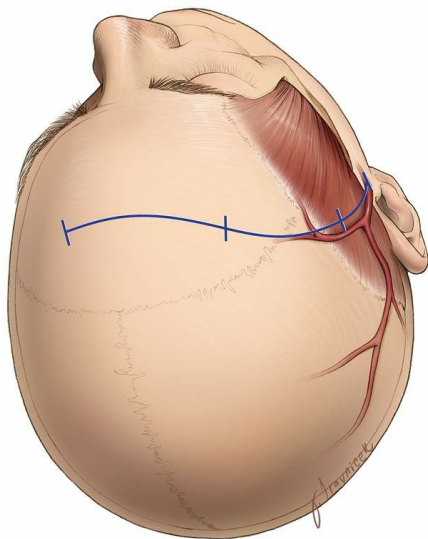


Figure 7: The incision begins 1 cm anterior to the tragus at the level of the zygoma. The initial portion of the incision includes a straight line marked perpendicular to the superior temporal line, after which the incision proceeds behind the hairline and extends to the midline or contralateral mid-pupillary line. The superficial temporal artery is posterior and the frontal branch of the facial nerve anterior to the incision. Further extension of the incision behind the hairline is not necessary for a subfrontal approach (right image).

For reflection of the scalp flap to allow adequate exposure of the keyhole

area, a straight line (hashed line) connecting the two ends of the incision should remain within 1cm distance of the keyhole (marked as a circle) (right image).

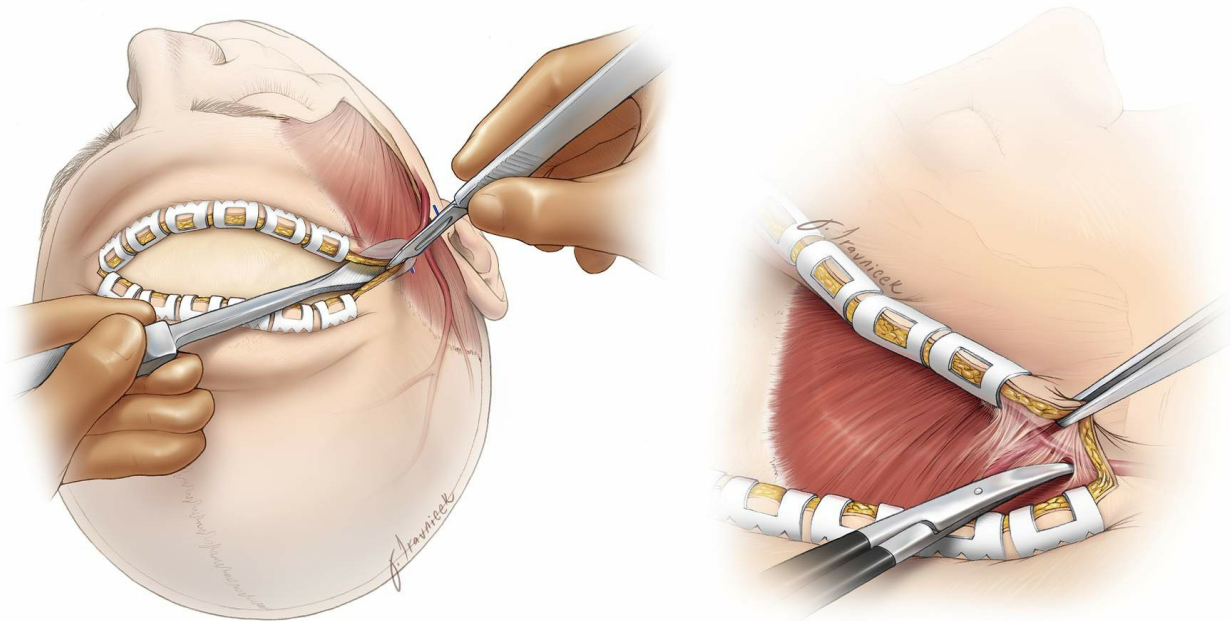


Figure 8: The skin is incised through the galea to the level of the pericranium. Hemostasis is maintained using Raney clips or bipolar electrocautery. When the incision reaches the superior temporal line, a periosteal elevator is introduced under the subcutaneous tissue to protect the superficial temporal artery and the temporalis muscle. The skin is cut with the cutting blade over the periosteal elevator (left image).

Once the superficial temporal artery is identified, blunt dissection with scissors is performed until the bifurcation of the frontal and parietal branches is seen. The frontal branch needs be coagulated and divided, preserving the parietal branch. Preservation of the frontal or parietal branches is especially important if a bypass is contemplated (right image).

In cases of larger scalp flaps with a more posterior extension of the incision, the frontal branch is preserved to allow optimal vascularization of the flap and enhanced healing. To avoid placing the facial nerve at risk, the incision should not extend below the zygoma.

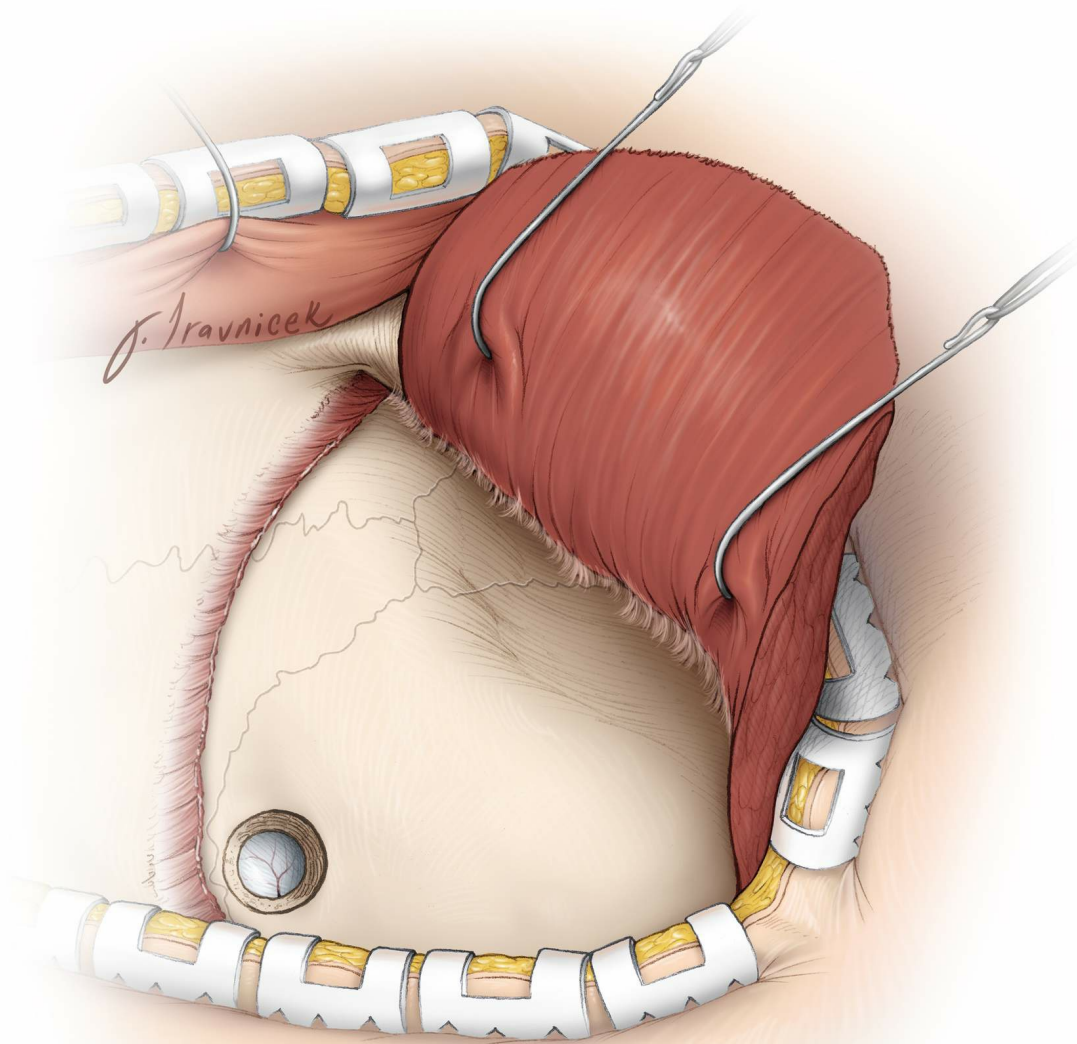


Figure 9: I prefer to reflect the scalp flap along with the temporalis muscle in a single myocutaneous layer. Alternatively, the muscle may be dissected in a separate layer. The temporalis muscle is incised using monopolar electrocautery in two directions, along the superior temporal line and the inferior aspect of the incision. The muscle is then reflected anteroinferiorly. It is important to preserve the deep temporalis fascia during this process by avoiding monopolar electrocautery. This fascia contains the neurovascular supply to the muscle. This maneuver may minimize postoperative temporalis muscle atrophy.

The temporalis muscle is then reflected inferiorly over the zygoma and secured with fishhooks. The frontal process of the zygoma just anterior to the keyhole is exposed to allow extension of the craniotomy to the level of the orbital roof.

I reflect the myocutaneous flap in one layer and do not leave a cuff of muscle behind along the superior temporal line. The muscle should be mobilized as anteroinferiorly as possible to reveal the pterion. When securing the flap with fish-hook retractors, I place a rolled-up gauze underneath the flap to prevent the kinking of the scalp and its subsequent ischemic damage.

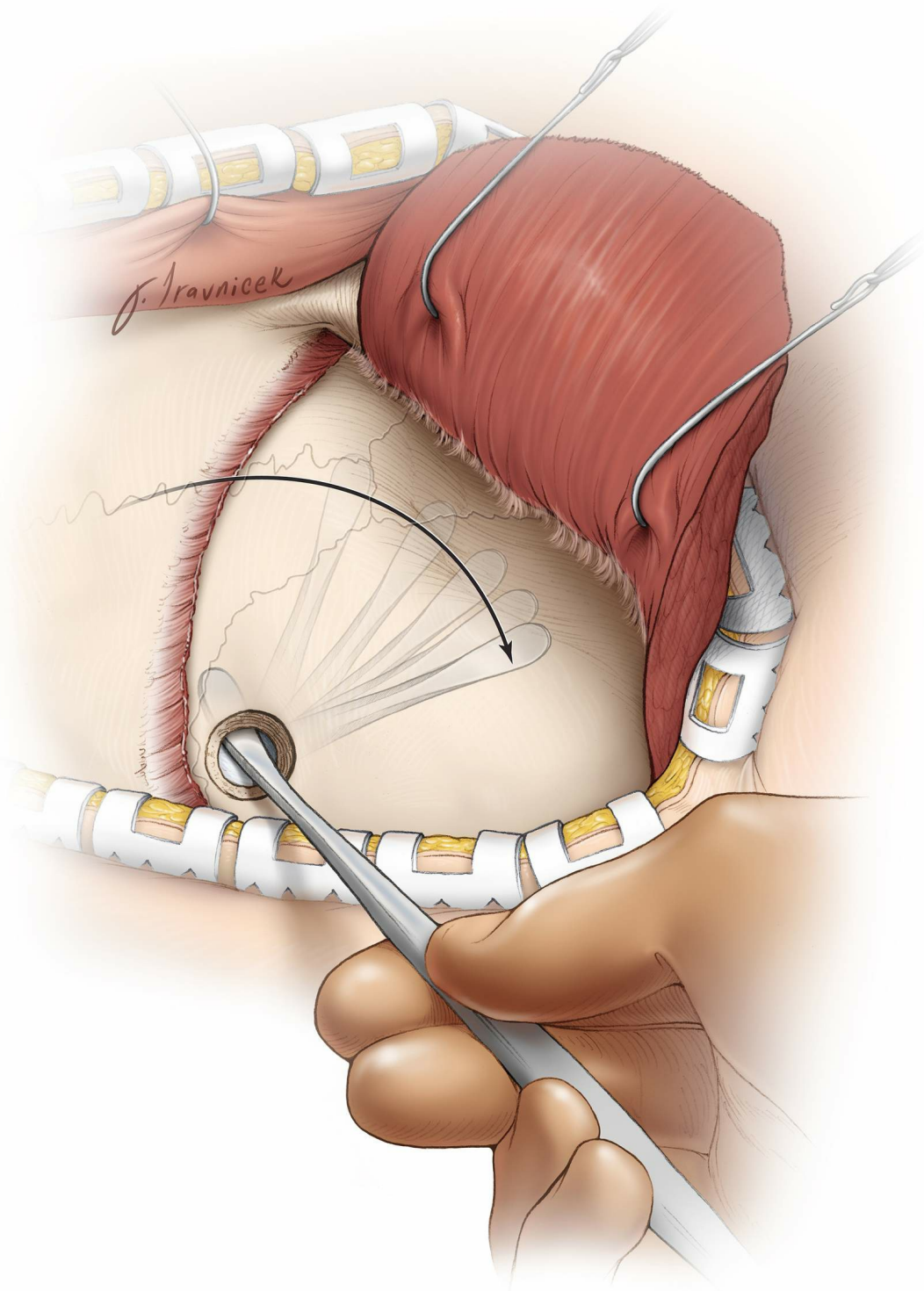


Figure 10: I place a burr hole just inferior to the most exposed posterior

aspect of the superior temporal line and dissect the dura away from the inner aspect of the skull bone. This single burr hole provides me with enough working space to navigate or “sweep” the dural dissector (#3 Penfield dissector) to mobilize the dura along the entire extent of planned bone flap towards the pterion.

An alternative option is placement of two burr holes, one along the keyhole and the other above the root of the zygoma. The latter technique leads to additional bone loss at the temple, potentially causing more postoperative cosmetic deformity. The single burr hole as illustrated above, will minimize this deformity as the bony defect lies under the muscle behind the hairline.

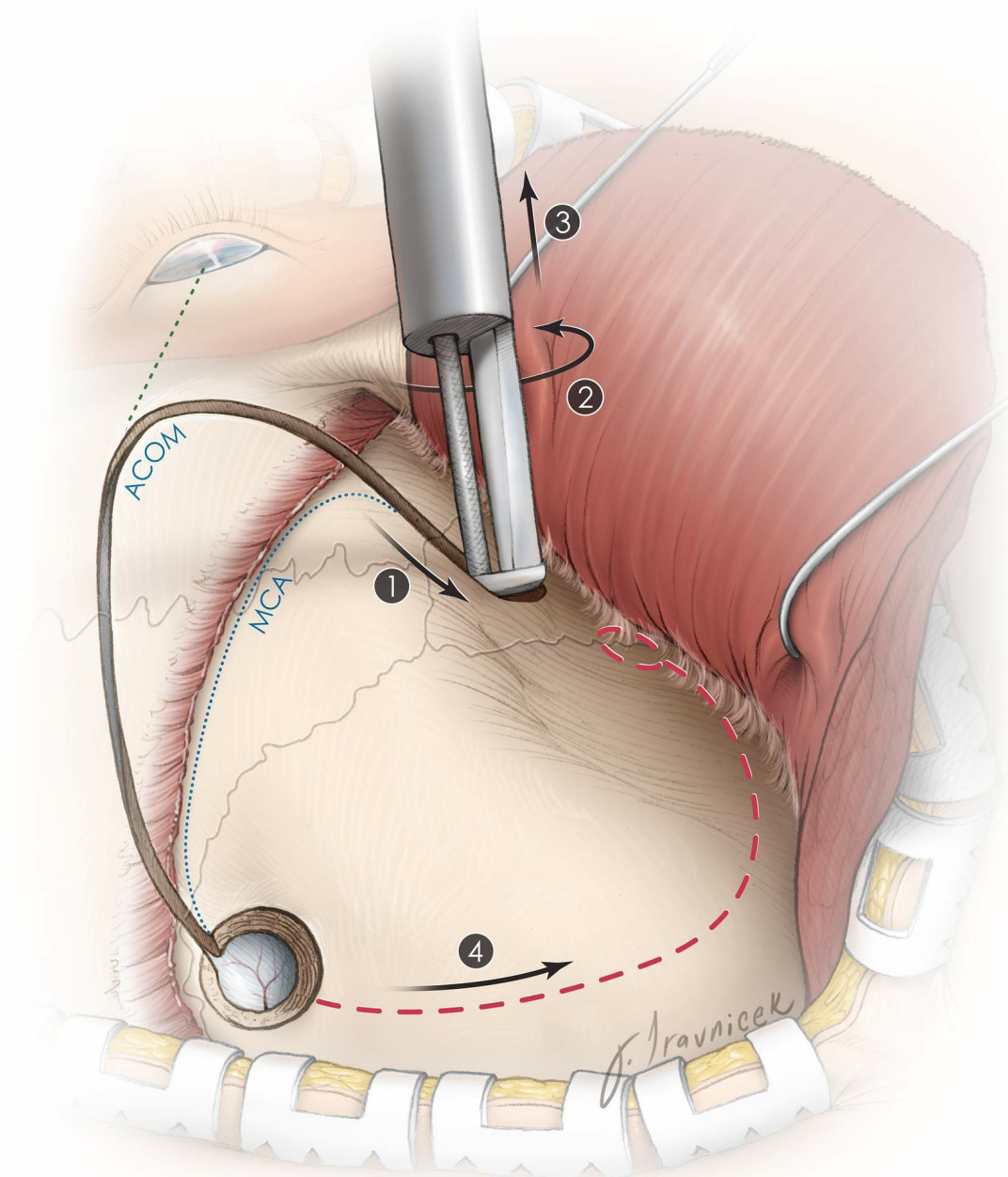


Figure 11: The craniotome or B1 bit with a footplate is then used to create the bone flap. The footplate of the drill may tear the dura, and is likely to do so as it makes turns, and especially at the turn along the frontal region. There are two osteotomies (marked as steps #1 and #4).

After completion of the first bony cut (#1), I turn the drill 180 degrees (step #2) at the pterion where the drill cannot make further progress by reaching the lateral sphenoid wing. This turn creates enough space within the bone for the heel of the drill to be removed (#3) to initiate the second osteotomy following the same technique (#4). The extent of craniotomies for middle cerebral artery and anterior communicating artery aneurysms are outlined. For most anterior skull base tumors requiring a subfrontal

approach, the extent of the craniotomy follows those for the anterior communicating artery aneurysm.

The anteromedial aspect of the craniotomy may violate the frontal sinus, so this bony area should be carefully inspected. Although the supraorbital notch has been cited as a landmark for defining the lateral aspect of the frontal sinus, this landmark is variable. Preoperative imaging and intraoperative navigation can help identify the lateral extent of the frontal sinus. If the frontal sinus is exposed, it should be exenterated, its mucosa removed and packed with muscle or bone wax.

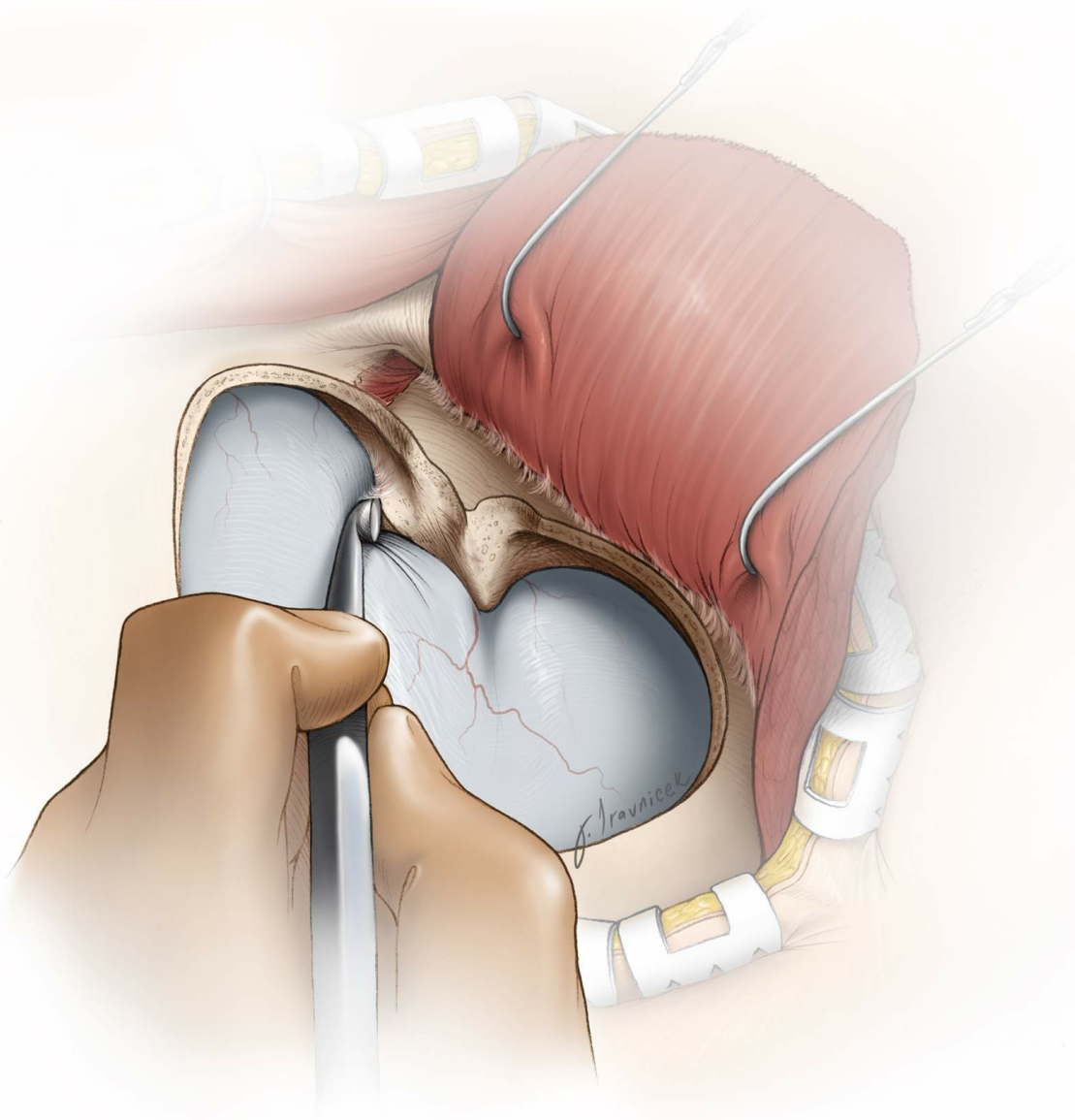


Figure 12: The bone over the lateral sphenoid wing is also drilled with a B1 bit to disconnect the bone flap from the wing. After I elevate the bone

flap, I strip the dura away from the roof of the orbit using a Penfield #1 dissector. I also mobilize the dura further away from both the frontal and temporal surfaces of the lateral sphenoid ridge.

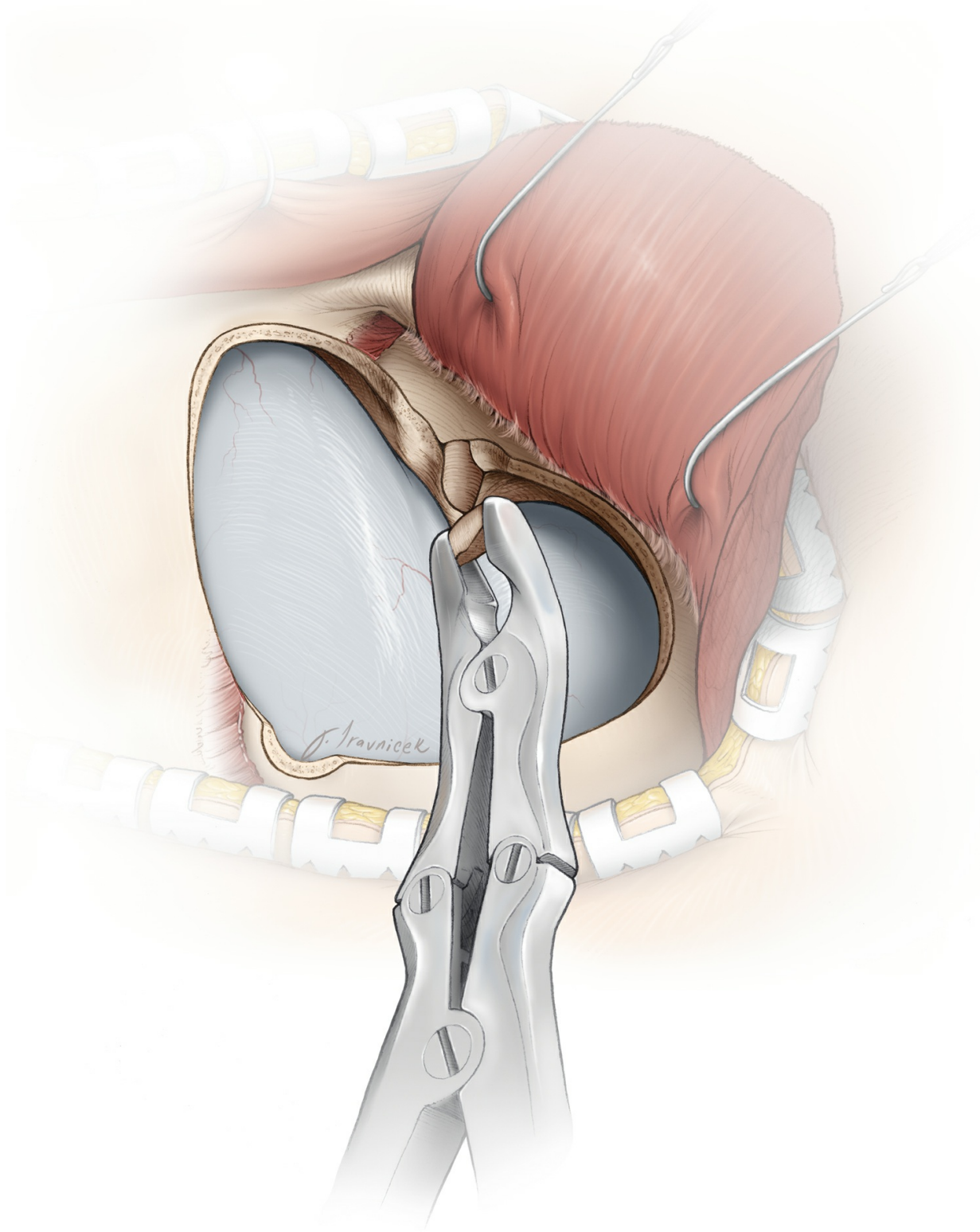


Figure 13: The lateral and mid sphenoid ridge is aggressively removed, initially using a rongeur to enhance efficiency, then an air drill with a side-cutting burr.

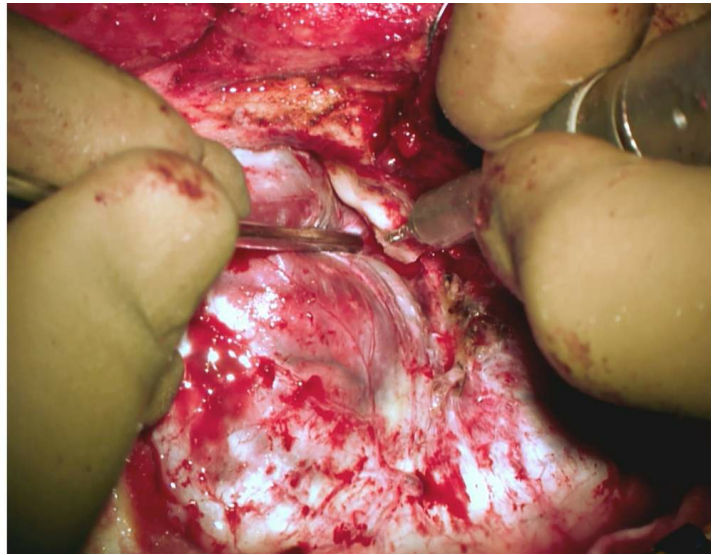
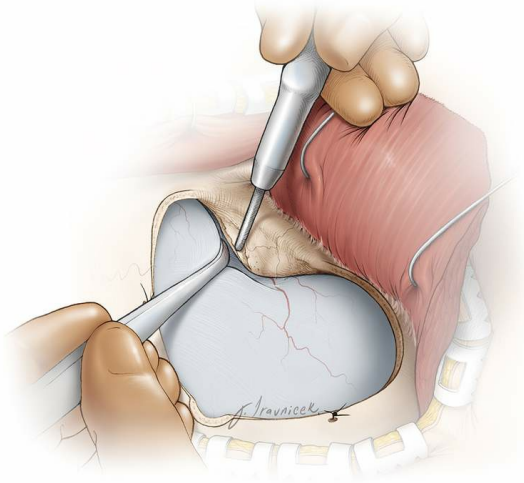


Figure 14: After the sphenoid ridge is drilled flat, additional bone removal along the ridge will expose the superior orbital fissure. I also use the drill to flatten the surface of the orbital roof and the supraorbital edge of the craniotomy. **These maneuvers are critical for facilitating an unobstructed subfrontal operative view toward the midline anterior skull base, and define the “extended” pterional craniotomy.**

Three dural tack-up sutures are placed around the edges of the craniotomy.

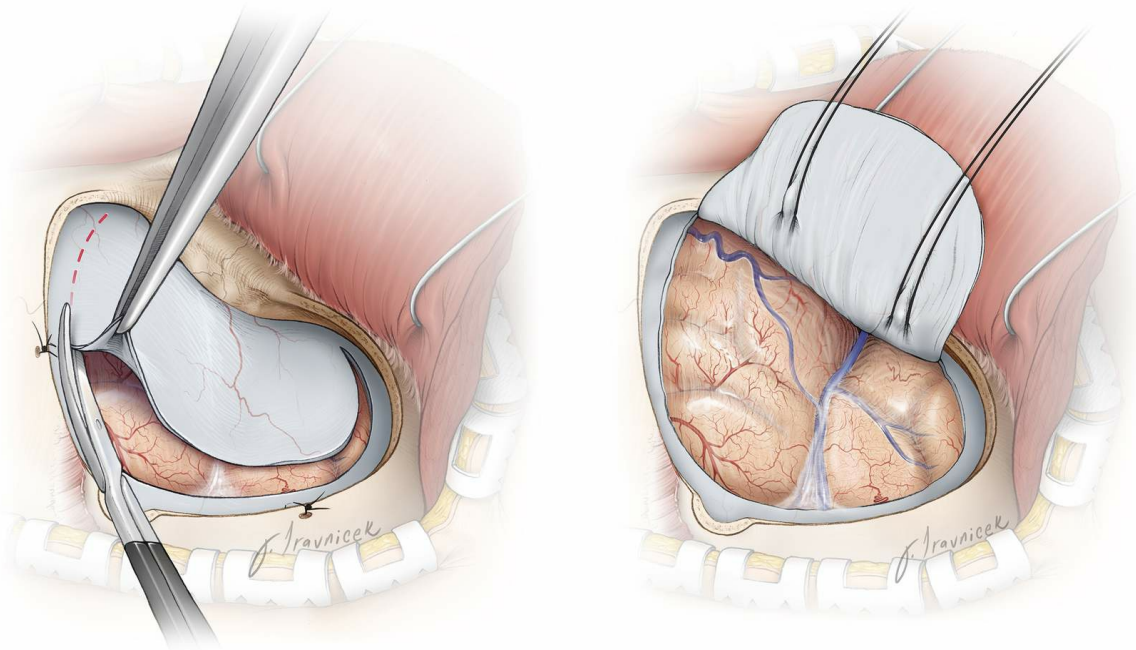


Figure 15: The dura is incised in a curvilinear fashion, reflected anteriorly, and may be secured to the myocutaneous flap with sutures. Please note that the dural retraction sutures are placed as close to the brain as possible to mobilize the dura and muscle away from the working zone of

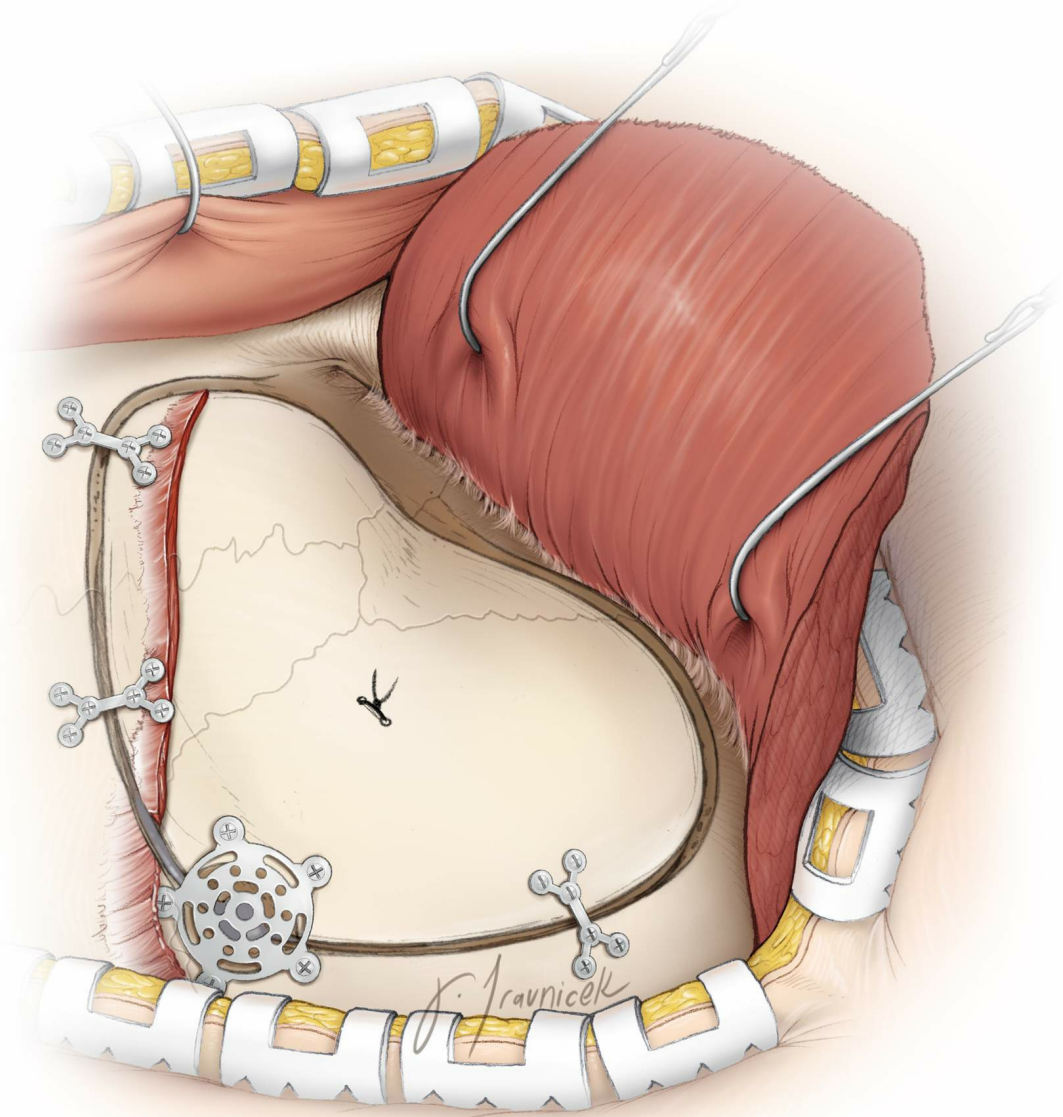


Figure 17: The bone flap is reattached using at least three fixation mini plates. Placement of the initial burr hole behind the hairline preserves bone around the key hole and minimizes the risk of cosmetic deformity. A central tack up stitch is optional.

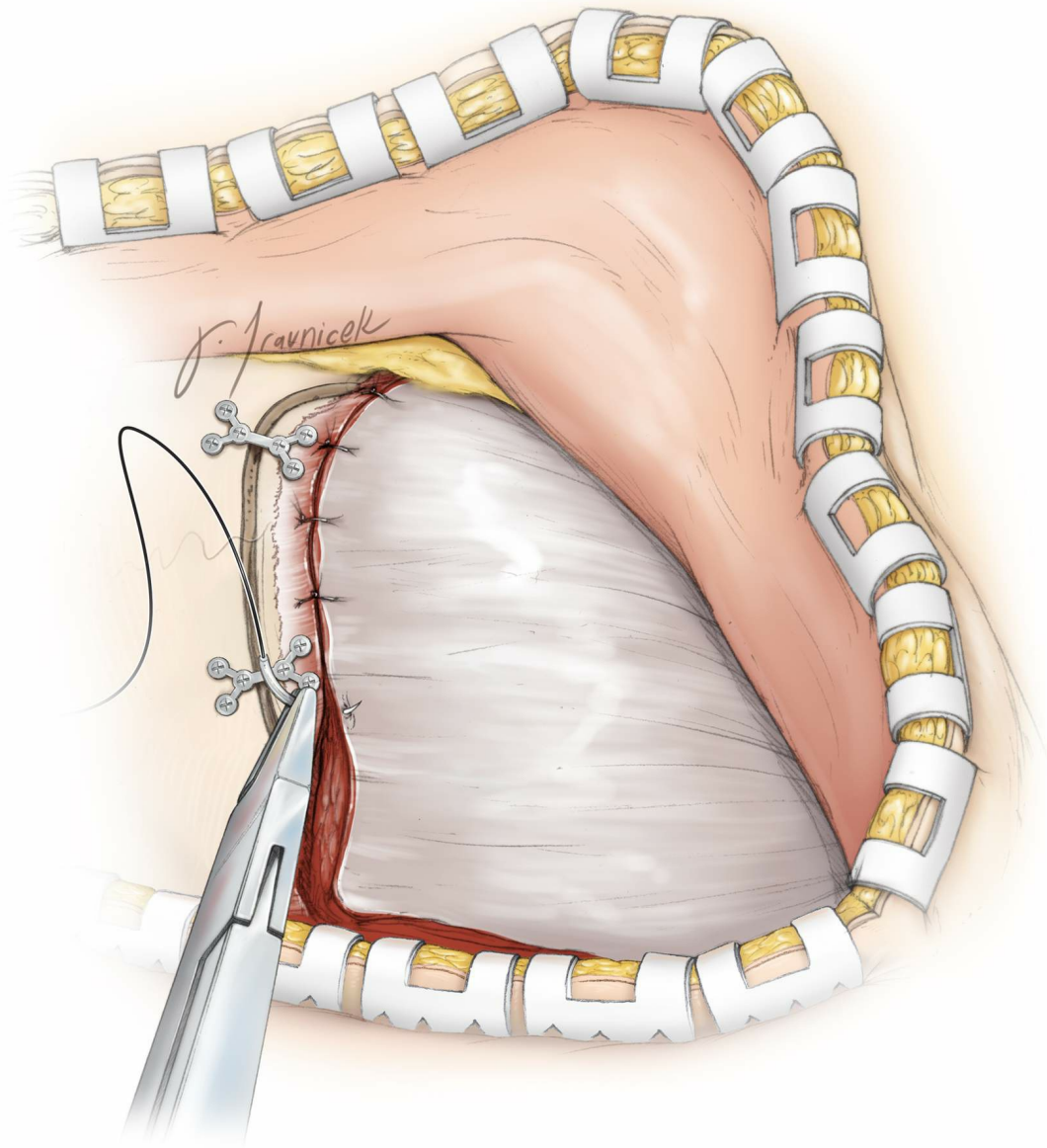


Figure 18: The temporalis fascia is reattached to its fascial cuff at the superior temporal line. In the case of a single layer myocutaneous flap, the fascia is reattached posteriorly only. The muscle is not included in this closure and only the fascia is gently approximated in order to minimize postoperative discomfort during jaw movements. I do not routinely use a subgaleal drain unless scalp hemostasis is problematic.

Dissection of the Fat Pad via the Interfascial and Subfascial Techniques

The following two images demonstrate the techniques of interfascial and subfascial dissection of the fat pad to minimize the risk of frontalis palsy.

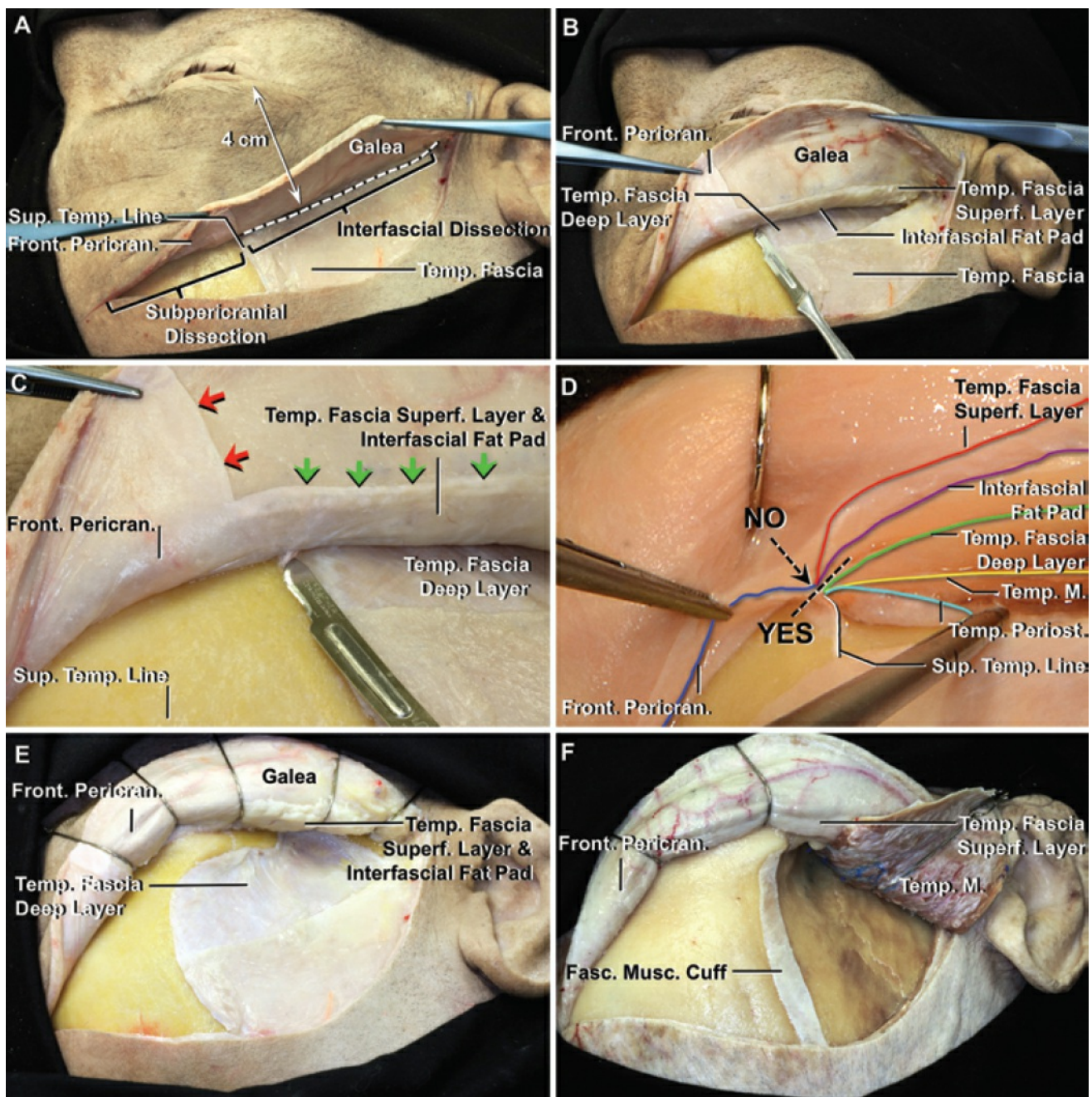


Figure 19: For the interfascial technique, approximately 4 cm above the lateral orbital rim (interrupted line), I incise through the superficial layer of the temporal fascia at the upper edge of the interfacial fat pad. This maneuver mobilizes the superficial layer of temporal fascia with the facial nerve branches on its outer surface and the adjacent frontal pericranium with the scalp flap (right upper image). Note the safe incision to avoid transecting the branches of the frontalis nerve (right middle image). The facial nerve branches are on the outer surface of the superficial layer of the temporalis fascia (images courtesy of AL Rhoton, Jr).

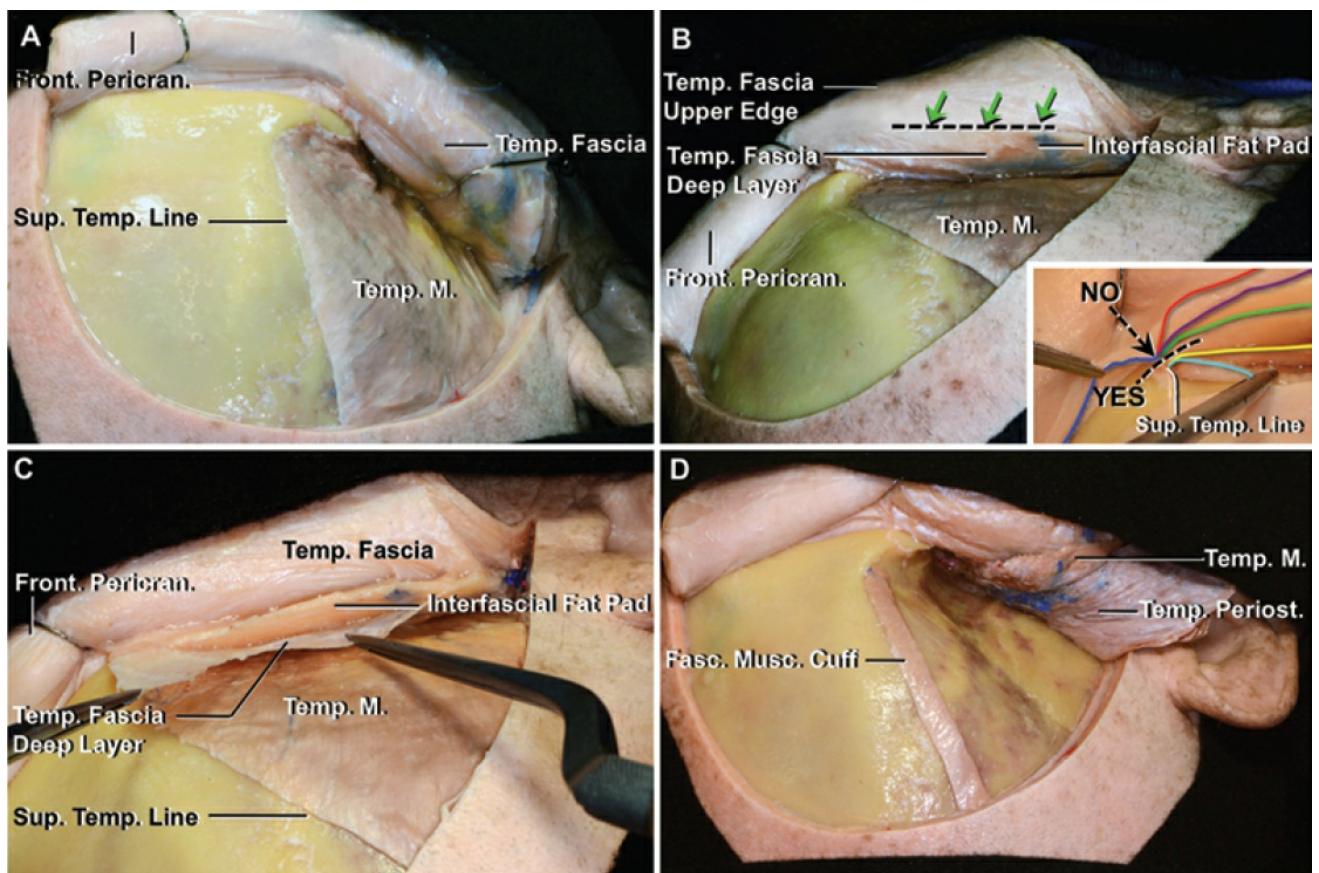


Figure 20: The subfascial technique elevates the deep surface of the temporal fascia from the outer surface of the temporalis muscle in continuity with the frontal pericranium. The superficial temporalis fascia, fat pad and deep temporalis fascia are all mobilized along with the scalp flap (right upper and left lower images) (images courtesy of AL Rhoton, Jr).

Pearls and Pitfalls

- I use the *extended pterional* approach, defined as a standard pterional craniotomy supplemented and expanded by aggressive osteotomy along the lateral sphenoid wing and roof of the orbit, to provide unobstructed operative working angles toward the parasellar area.
- The osteotomy along the roof of the orbit provides some of the advantages of orbitozygomatic craniotomy while being more efficient and associated with less cosmetic deformity.
- Orbital and sphenoid wing meningiomas lead to orbital roof and sphenoid wing hyperostosis. Any intentional fracture over the lateral sphenoid wing during bone flap elevation can unintentionally extend

to the optic canal and lead to blindness.

- The use of a pterional craniotomy for fibrous superior petroclival meningiomas and other large clival tumors is not advised. Petrosal osteotomies provide more expanded and safer approaches to these tumors.

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