



Bifrontal Craniotomy

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General Considerations

Pathologies that are positioned on one or both side(s) of the falx along the anterior fossa can be reached surgically through either the unilateral anterior parasagittal route or a combination of the supraorbital, pterional, and orbitozygomatic approaches. However, this type of unilateral approach may not provide adequate exposure of large midline lesions, especially tumors with extradural extension into the ethmoid and sphenoid sinuses.

Although more expanded variations of the bifrontal approach involving mobilization of bilateral orbital rims have been described, I do not believe such osteotomies are necessary; they do not significantly broaden tumor exposure since tumor enucleation often affords additional operative working space. Moreover, these osteotomies may be associated with increased risks of cosmetic deformity and cerebrospinal fluid (CSF) leakage.

Indications for the Approach

I use a bifrontal craniotomy only for large tumors that have anterior skull base invasion. This chapter therefore discusses techniques for using a bifrontal craniotomy for removal of midline extradural anterior cranial base lesions. It does not address the nuances related to excision of purely parafalcine intradural tumors. Regardless of their size, almost all intradurally confined tumors (that is, giant olfactory groove meningiomas) can be readily approached through a unilateral extended pterional or a lateral supraorbital corridor with transection of the anterior falx to provide contralateral access.

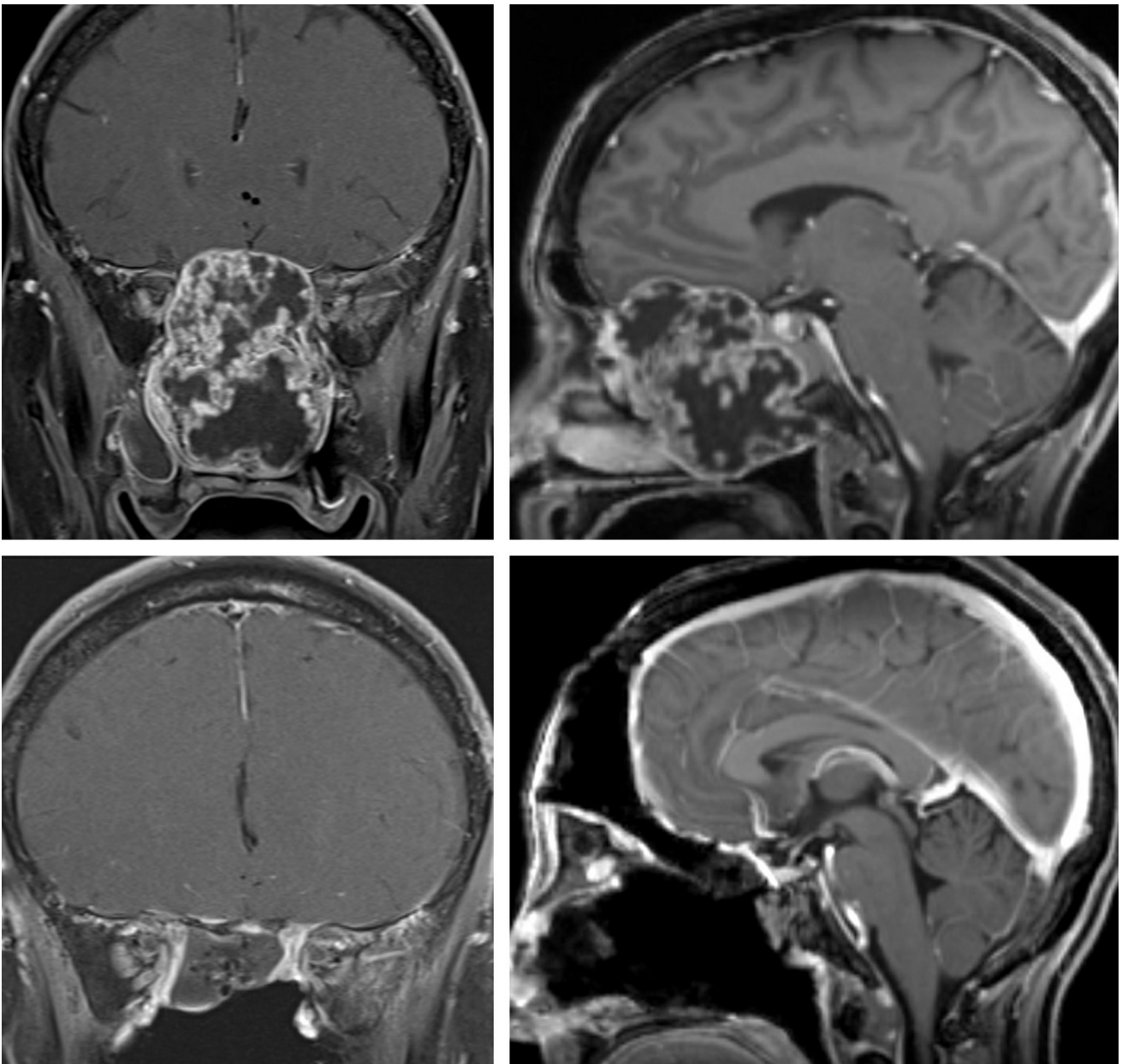


Figure 1: Anterior skull base chondrosarcoma with extensive invasion of the nasal cavities (upper images). This case illustrates appropriate indications for a bifrontal craniotomy. A transnasal approach was deemed inappropriate because the midline septal invasion of the tumor rendered the nasoseptal flap unavailable for skull base reconstruction. The bottom postoperative images demonstrate gross total resection of the mass.

When compared with a bifrontal craniotomy, the pterional or lateral supraorbital craniotomy avoids the frontal sinuses, obviates the need for sacrifice of the anterior superior sagittal sinus, and does not require manipulation of both frontal lobes. The unilateral approach also allows early identification of the optic nerve and carotid artery through the lateral trans-Sylvian trajectory and therefore facilitates their protection

during the later stages of tumor dissection.

Some of my colleagues prefer to use a bifrontal craniotomy for most midline anterior cranial fossa lesions because of the flexible operative working angles and more generous exposure of the tumor. I prefer to use this approach for extradural tumors such as esthesioblastomas and other tumors of the frontal and ethmoid sinuses.

The bifrontal craniectomy or craniotomy can also provide cerebral decompression for patients who have traumatic injuries such as bifrontal contusions associated with symptomatic cerebral edema. Similarly, this approach may be used for repair of frontal sinuses and other anterior skull base fractures that have caused CSF fistulas or cosmetic deformities.

Preoperative Considerations

Since most tumors approached through the bifrontal route are large and CSF cisterns are not accessed early during intradural dissection, a lumbar drain is highly useful for providing brain relaxation and mobilization to reach the cranial base.

A meningioma in this region can infrequently involve the superior sagittal sinus, necessitating a review of preoperative magnetic resonance (MR) or computer tomography (CT) venogram. The morphology of the frontal sinuses should be assessed because large sinuses may increase the risk of postoperative CSF leakage. Routine use of a vascularized pericranial graft to cover the exenterated frontal and ethmoid sinuses is recommended.

Spacious frontal sinuses and their wide exposure, as well as removal of the anterior fossa floor due to tumor invasion, often create large cranial base defects. These wide defects require additional measures such as skull base bone and flap reconstruction and prophylactic postoperative lumbar CSF drainage.

Operative Anatomy

Knowledge of the anatomy of the anterior skull base is necessary for execution of a bifrontal craniotomy.

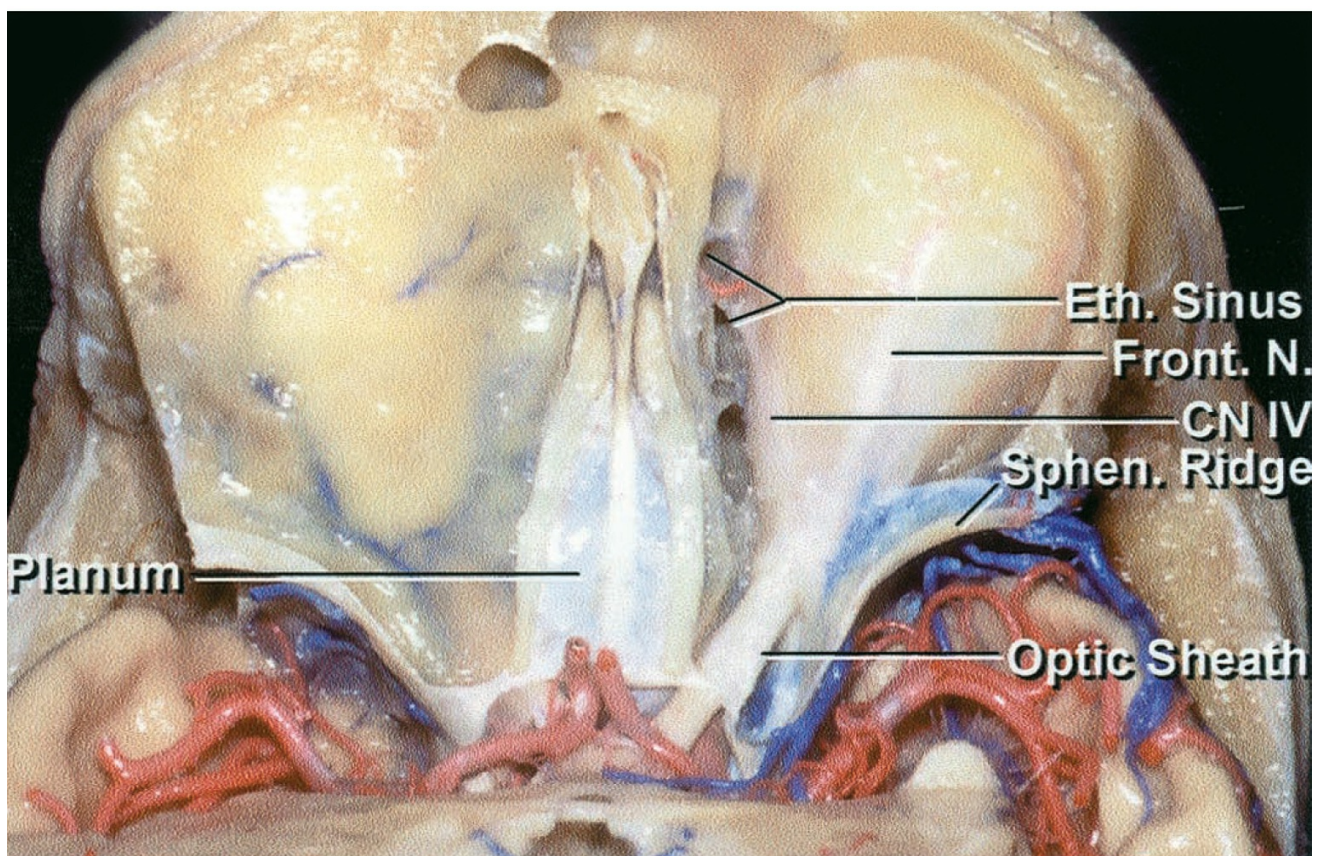
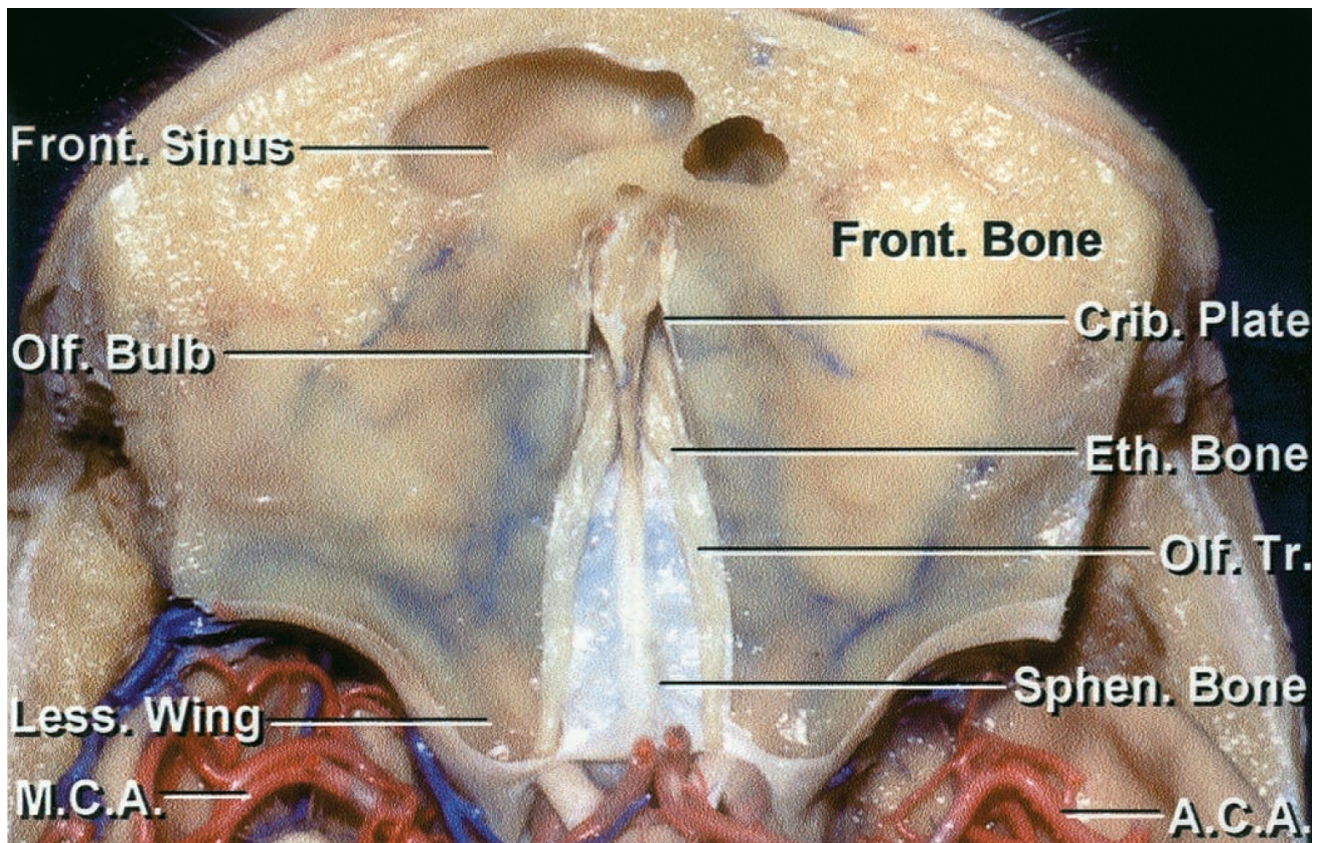


Figure 2: The anatomy of the anterior cranial fossa with the dura removed. Notice the asymmetry of the frontal sinuses (upper image), emphasizing the need to review preoperative imaging. The lower edge of the craniotomy must be at the level of the orbital roof. Note the proximity of the Crista Galli to the olfactory bulbs and cribriform plate

that resides in a “valley” as compared with orbital roofs. Extradural dissection of the dura at the level of the crista Galli and cribriform plate leads to exposure of the intradural space (Images courtesy of AL Rhoton, Jr).

BIFRONTAL CRANIOTOMY

The details of this operative technique are reviewed.

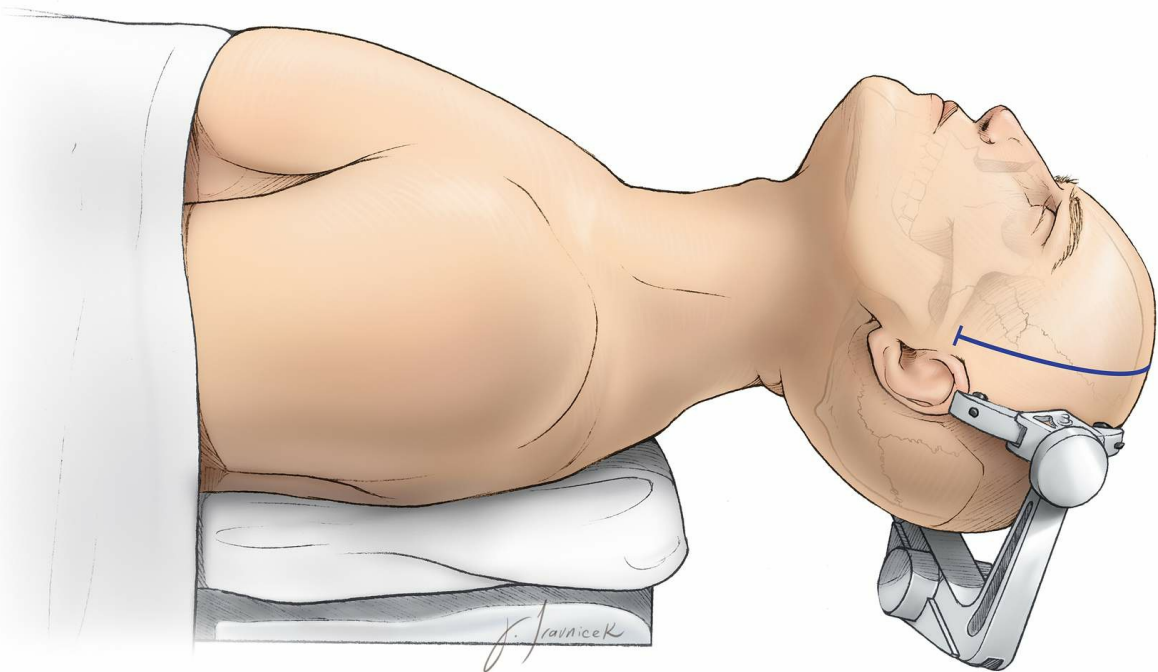


Figure 3: The patient is placed in the supine position with the head slightly extended or flexed based on the vertical extent of the tumor. This head position mobilizes the frontal lobes away from the cranial base using gravity-induced retraction. The head typically does not require rotation for the midline pathologies accessed through this route. The single pin of the skull clamp is just above and behind the pinna, while the contralateral and bisecting two pins are located above the pinna as illustrated. The positions of the pins should be appropriately planned to avoid their interference with the bicoronal skin incision.



Figure 4: A bicornal incision is designed (dark solid line). This incision should be as anterior as possible while staying behind the hairline. The incision does not always need to reach the tragus, but it at least should reach to the level of the superior edge of the pinna. The extent of the patient's neck flexion is tailored based on the cranial extension and inferior reach of the tumor into the nasal sinuses.

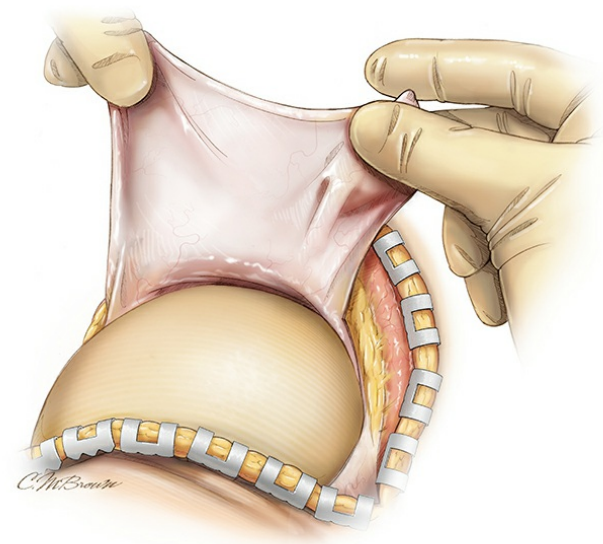
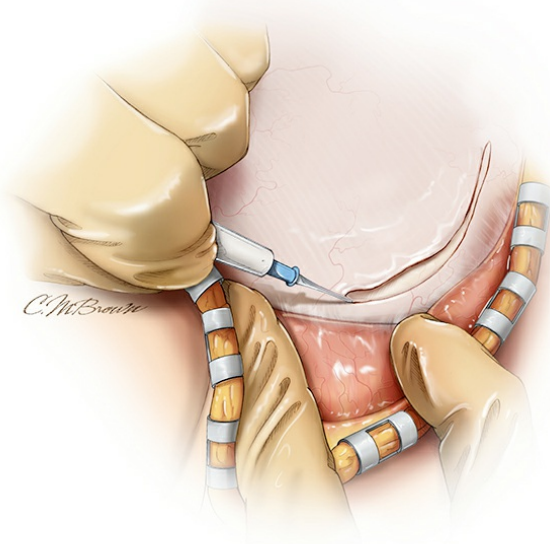


Figure 5: The scalp incision should leave the pericranium, temporalis muscle, and fascia intact. I routinely elevate a vascularized pericranial graft as a separate layer. The plane between the galea and pericranium is dissected/undermined more posteriorly beyond the incision to allow for elevation of a larger pericranial graft (left image). Monopolar electrocautery disconnects the posterior and lateral attachments of the pericranium (to the superior temporal line). This vascularized graft will be reflected and based anteriorly along the orbital rims.

A generous piece of pericranial flap is elevated, stretched, and kept moist during the operation by covering it with a wet piece of sponge (right image).

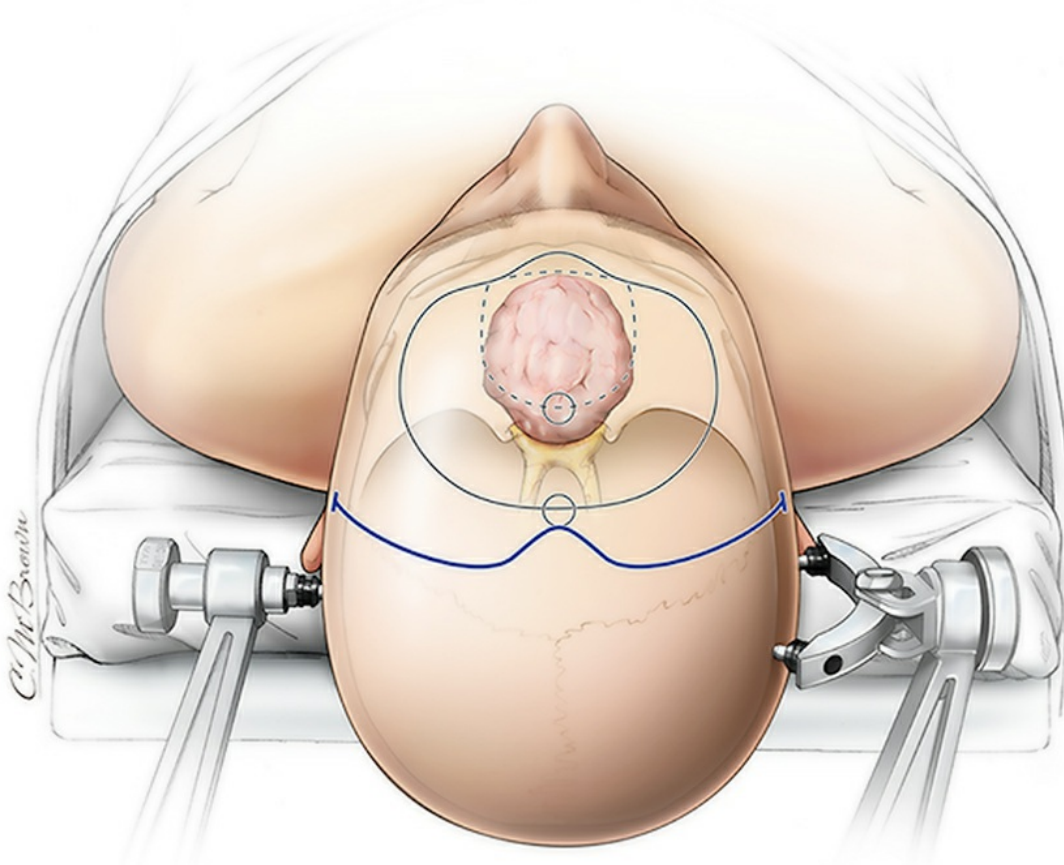


Figure 6: Design of the bone flap: A single burr hole is placed over the anterior superior sagittal sinus. The vertical height of the craniotomy is under 10 cm, and the width does not need to spread across the entire width of the orbital rims. Most lesions, regardless of their size, can be reached and removed through a limited “low” bifrontal craniotomy

(hashed line).

Some operators prefer a larger craniotomy (gray solid line). If larger bone flaps are infected postoperatively, their removal will leave the patient with a large frontal skull defect. Note the location of the skull clamp pins. More posterior placement of the pins risks fixation failure.

Upon completion of the burr hole and CSF drainage through the lumbar drain, the dura is then dissected off of the calvarium using a #3 Penfield. Burr holes in the region of the forehead are avoided for cosmetic reasons.

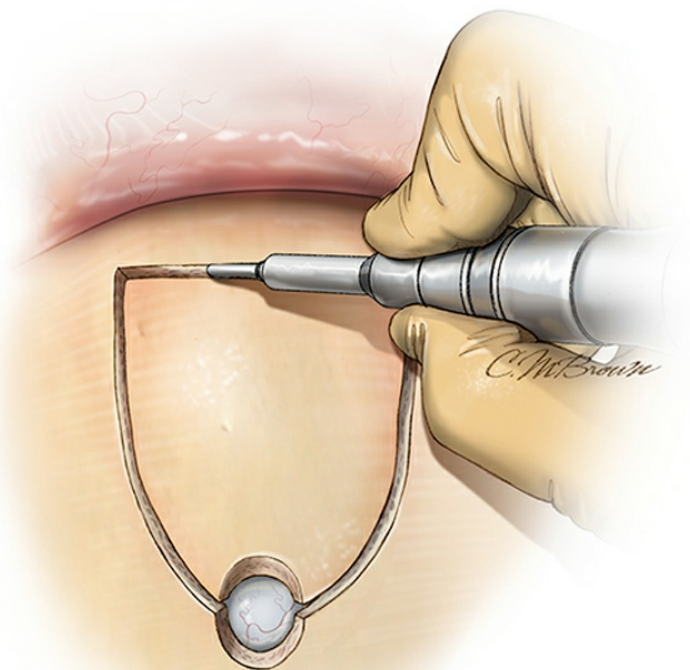


Figure 7: The craniotome with its footplate is used to complete the vertical bony cuts (top image). The final horizontal osteotomy over the frontal sinuses is performed using a straight side-cutting burr to first disconnect the anterior and then the posterior walls of the frontal sinus (bottom image).

Upon elevation of the bone flap, the frontal sinus mucosae are thoroughly removed using pituitary rongeurs and coagulated with monopolar electrocautery. I use muscle, betadine, or bacitracin-soaked bone wax to fill the sinuses. Alternatively, the sinuses are filled with betadine-soaked gelfoam and exenteration and cranialization will be completed at the end of the procedure when the dura is closed.

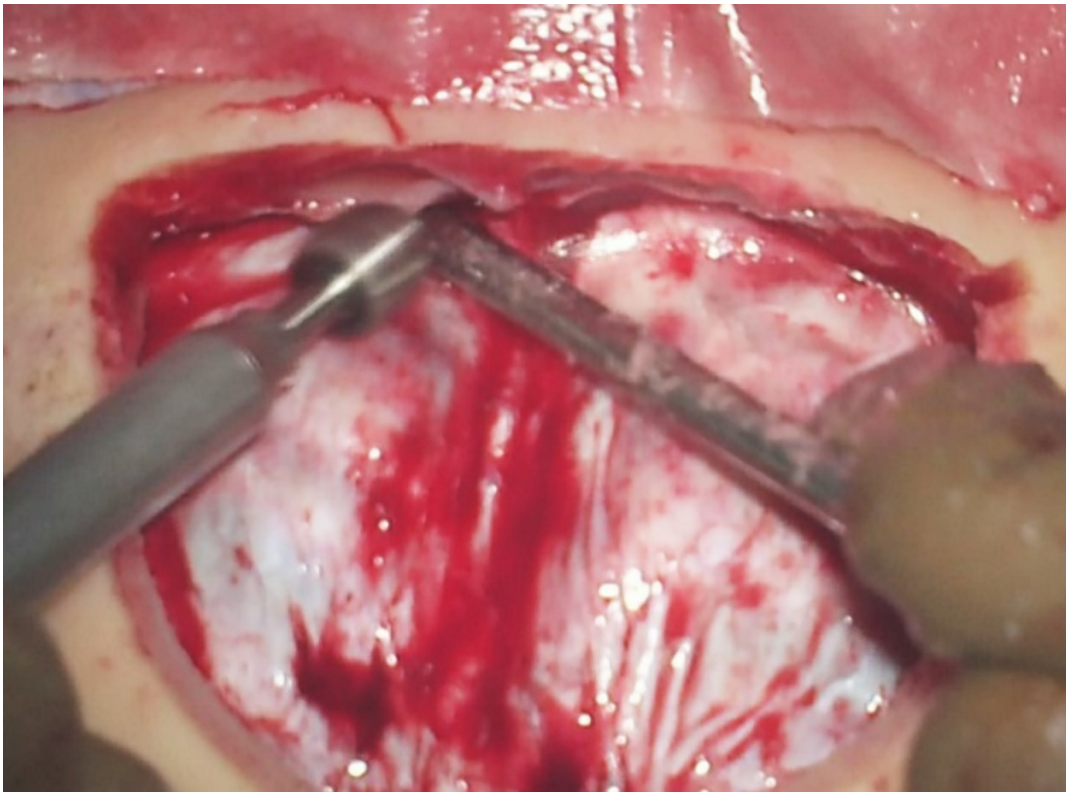


Figure 8: The inferior overhanging edges of the craniotomy and posterior walls of the frontal sinuses are removed to prevent them from obstructing the operator's view toward the basal frontal lobe.

The following details refer to extradural resection of skull base tumors invading the bone and nasal sinuses.

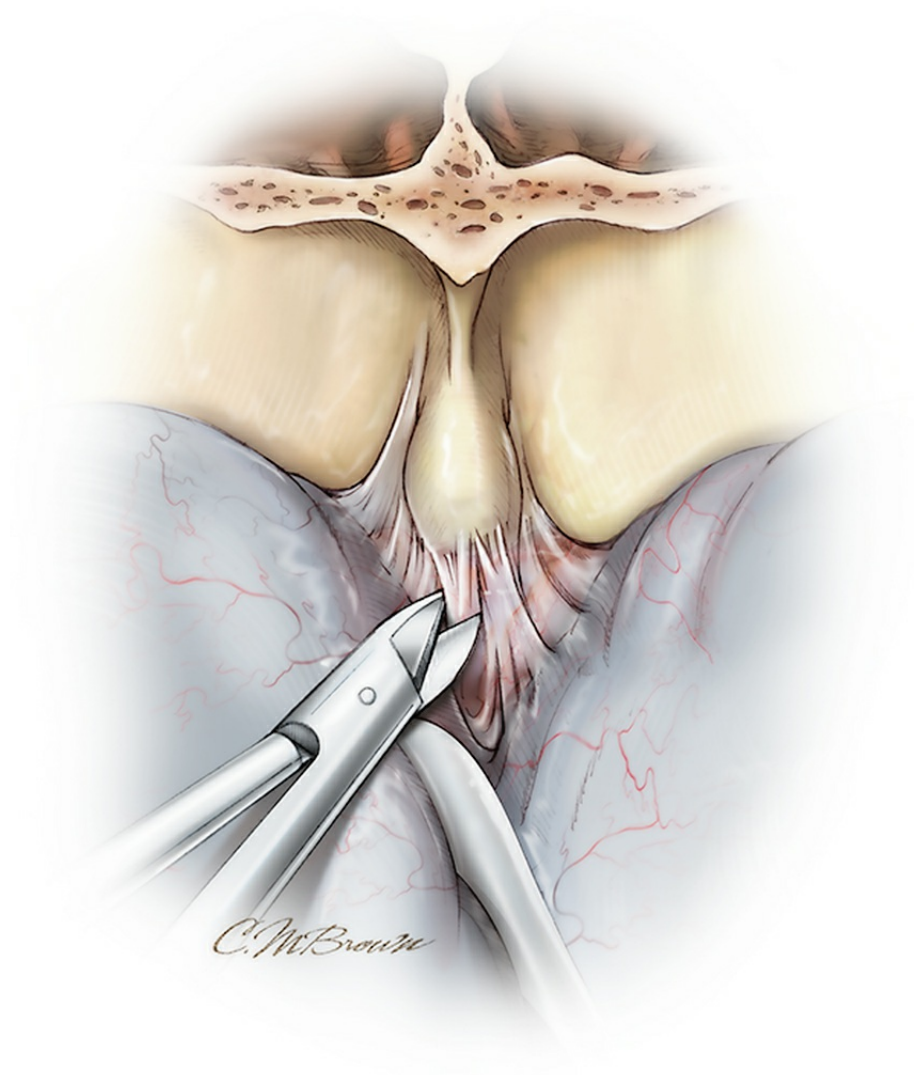


Figure 9: Pieces of temporalis muscle may also be used to fill the frontal sinuses. Further CSF drainage allows extradural dissection and lobar elevation away from the Crista Galli and exposure of the cribriform plate. The dura is mobilized from the orbital roof and Crista Galli using a #1 Penfield dissector.

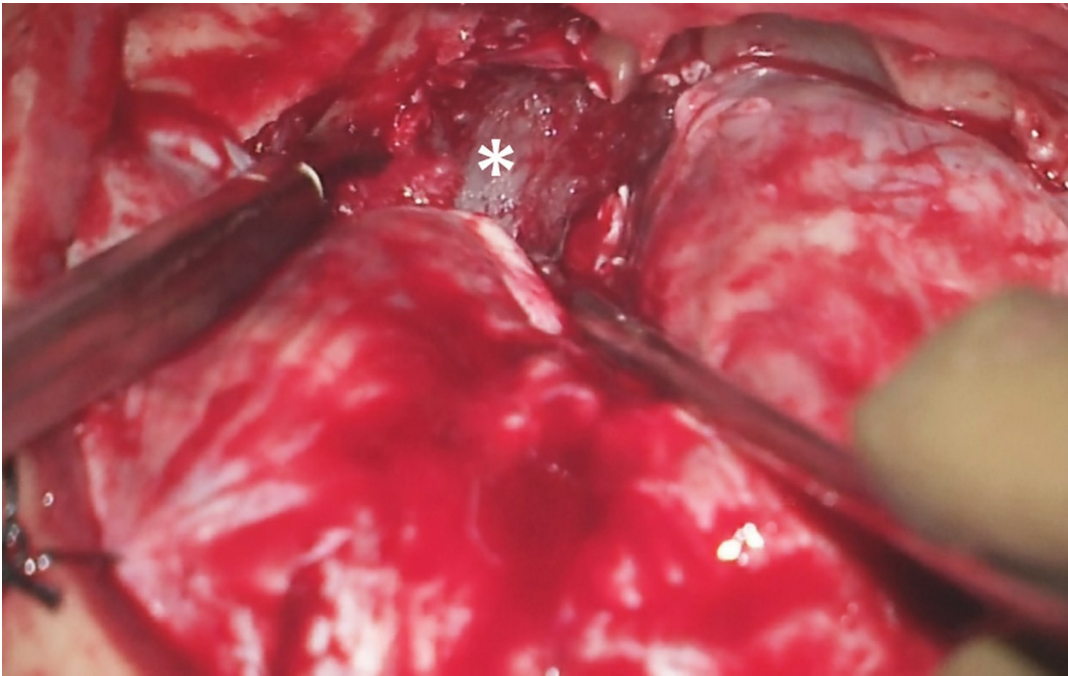


Figure 10: I dynamically retract the frontal lobes using the suction apparatus. Sharp dissection is used over the olfactory bulb to disconnect the bulb and expose the anterior extradural extension of the tumor (star). This intraoperative image refers to resection of an anterior skull base chondrosarcoma invading the nasal cavities (See Figure 1 above). Disconnection of the bulb also leads to dural opening and disclosure of the intradural portions of the tumor.

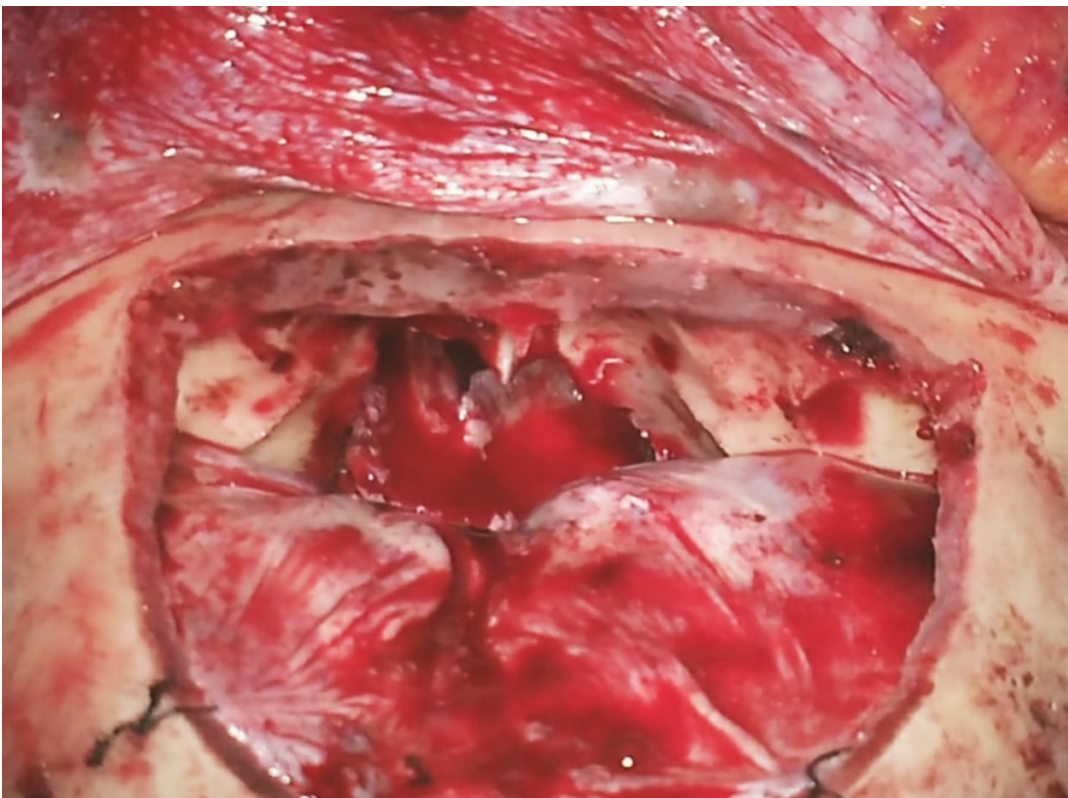


Figure 11: After gross total resection of the tumor and watertight closure of the dural defect using a piece of temporalis fascia graft, a large skull

base defect is apparent. The pericranial graft is seen at the top of the image.

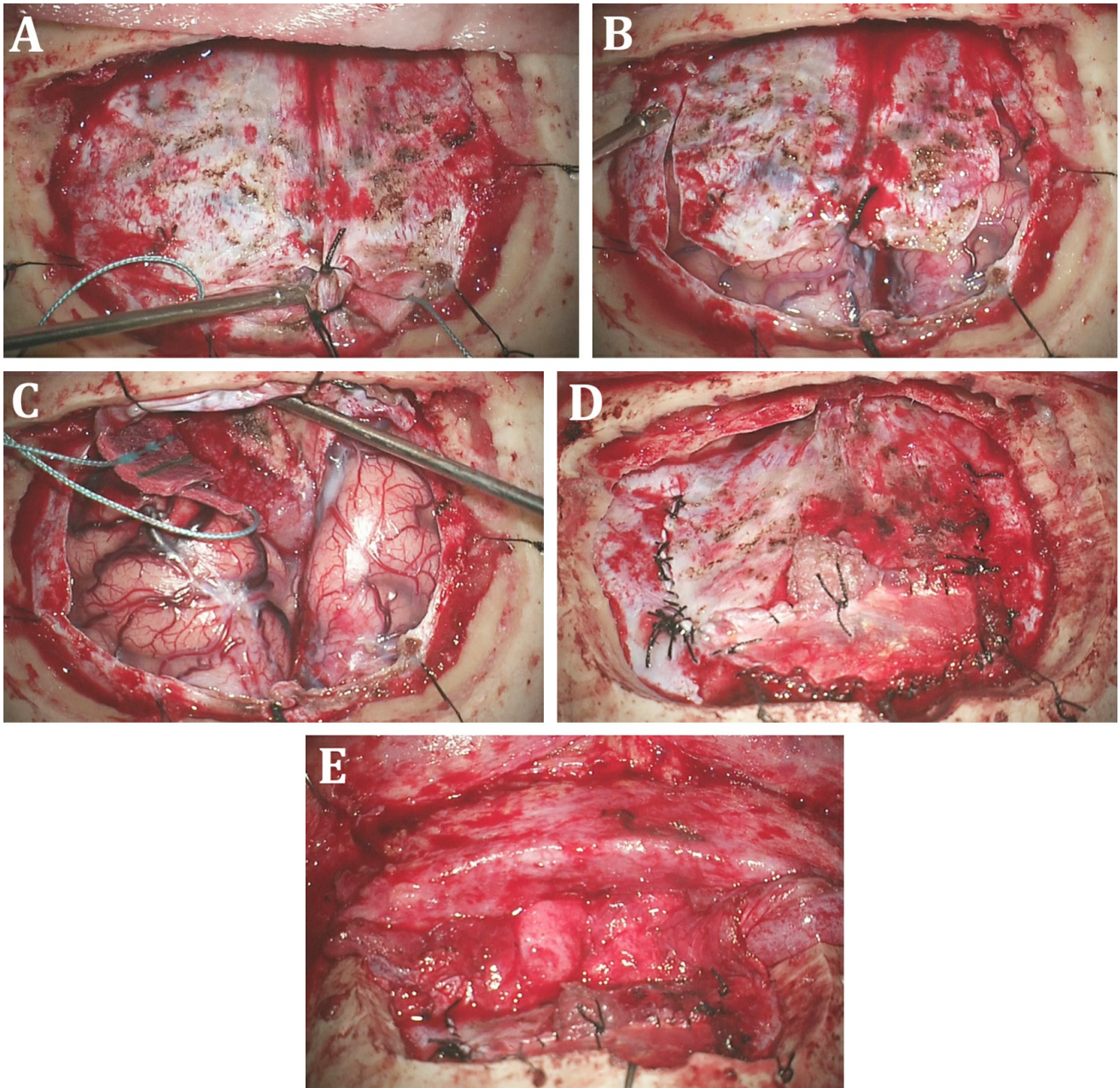


Figure 12: If the operator desires to approach purely intradural tumors such as meningiomas through a bifrontal approach, the dura may be opened through two horizontal incisions parallel to upper edge of craniotomy (A and B). The anterior superior sagittal sinus is then ligated with 0-silk sutures in two spots and divided. Although anterior parasagittal bridging veins are considered dispensable, the operator must exercise caution during their sacrifice. The tumor is evident at the tip of suction apparatus (C). The dura is then closed using a piece of temporalis fascia and the pericranium is used to cover the frontal sinuses (D and E).

The falx can then be sectioned where the superior sagittal sinus was

divided and the inferior flap of dura is reflected anteriorly. If additional intradural access is required, the lateral ends of the dural incision are extended posteriorly until adequate exposure is secured. With the neck extended, the frontal lobes should fall away from the floor, allowing wide access to the tumor. The lesion is microsurgically handled as appropriate.

Closure

After tumor resection is complete, watertight closure of the dura is necessary; a piece of temporalis fascia may be used for dural autografting. The frontal sinus requires further exenteration. Antibiotic-soaked gauze is placed over the dura and the previously used packing of betadine-soaked gelfoam is removed. Any residual mucosa is coagulated away using monopolar electrocautery. The frontal sinus is packed with muscle, fat or bone wax and the pericranial graft is reflected posteriorly to cover the frontal sinuses and the anterior skull base defect.

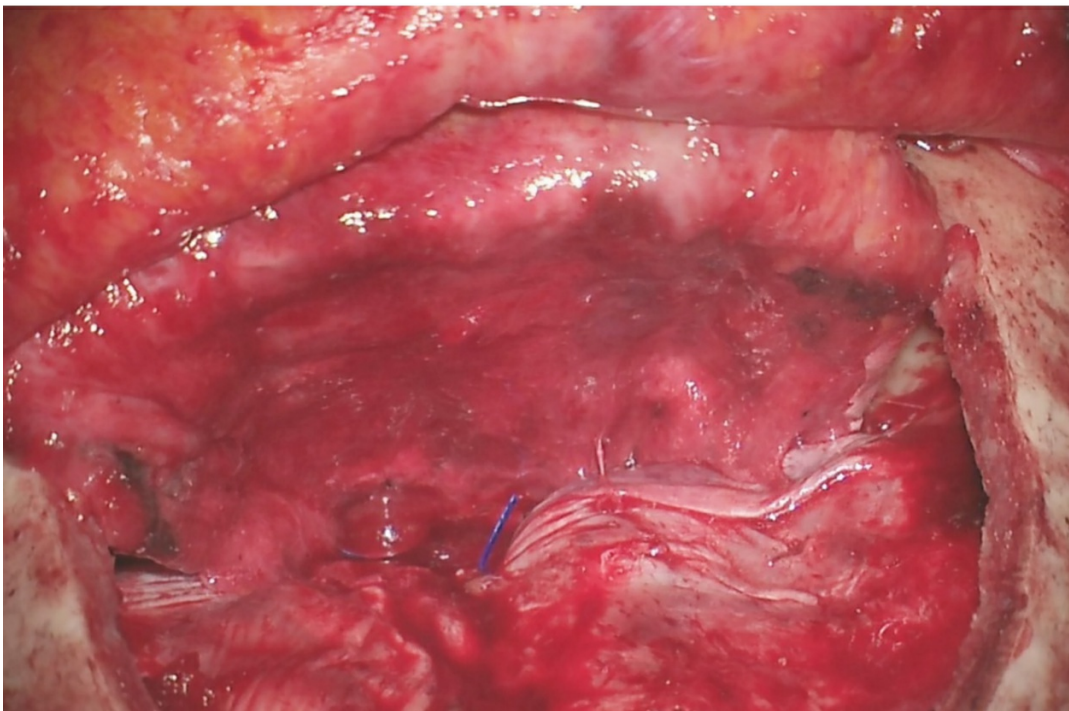
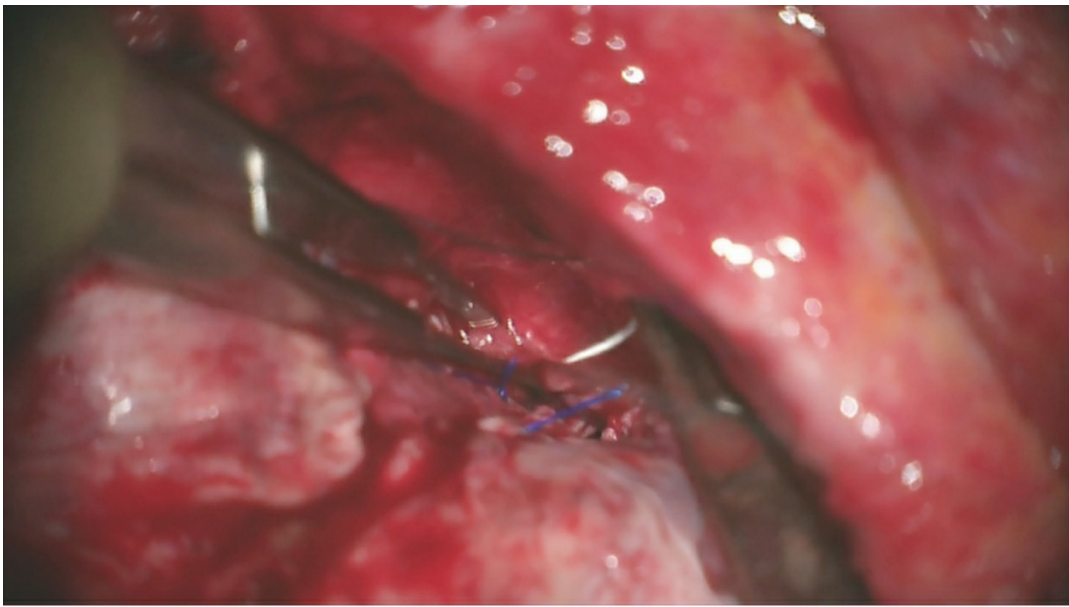


Figure 13: Excess pericranium is amputated and its edge is sutured to the dura along the floor of the anterior fossa as posteriorly as possible in a running fashion (top image). The pericranial graft provides a sheet of vascularized tissue to separate the intracranial space from the nasal cavity (bottom image).

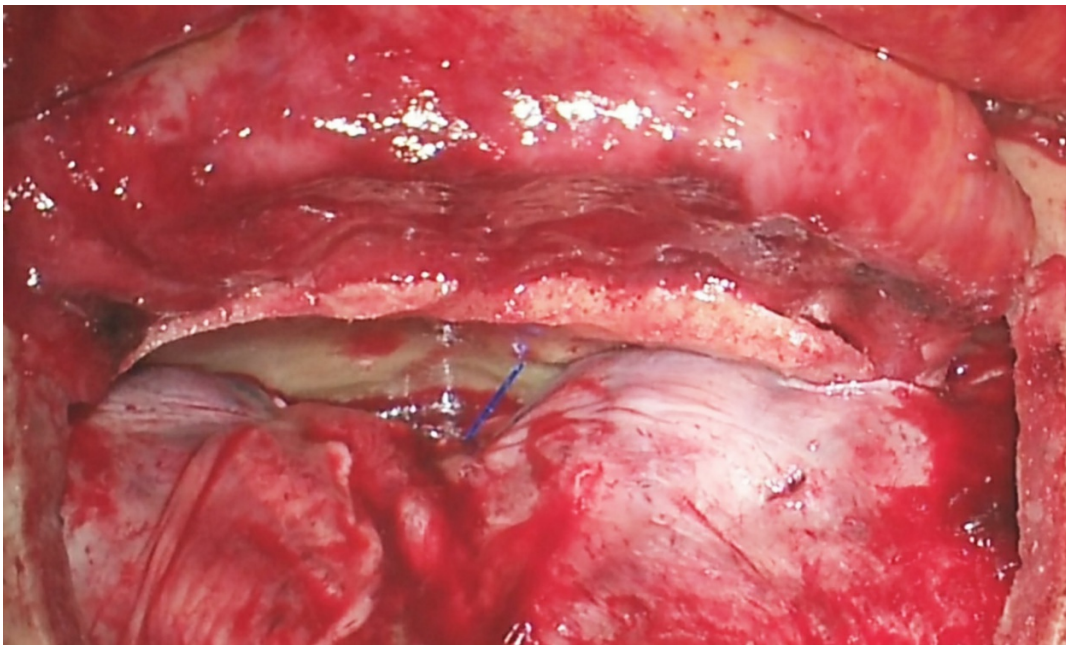


Figure 14: If a large area of ethmoid sinuses is exposed and a wide bony defect is present at the end of tumor resection, I prepare a split calvarial bone graft from the craniotomy bone flap and place the bone graft over (not under) the pericranial flap that is in place over the skull base defect. This piece of bone may be fixed to the orbital roof using small titanium screws. This bony reconstruction reinforces the skull base construct and avoids displacement of the pericranial graft by the patient's forceful coughing or sneezing.

Postoperative Considerations

I use a lumbar drain to divert CSF for 48 hours after surgery. This maneuver ensures that adequate borders are maintained between the 'outside' and 'inside' worlds. The patient is observed in the intensive care unit for a day or two and then transferred to the ward.

There are rare patients who have no evidence of a leak immediately postoperatively, but demonstrate a significant amount of pneumocephalus on their postoperative CT scan. In this situation, a large leak must be suspected and corrected through a repeat operation. **Otherwise, continuation of lumbar drainage will lead to reverse suctioning of air through the nose and dramatic worsening of the pneumocephalus. These cascades may cause acute neurologic deterioration and infection.** A repeat operation with careful dural closure and skull base reconstruction using vascularized regional and free tissue-transfer flaps are often necessary.

Pearls and Pitfalls

- A lumbar drain can be useful when immediate intraoperative brain relaxation is required. It can also be used postoperatively when short-term CSF diversion is necessary.
- A relatively small craniotomy is very effective in this approach. Large craniotomies place the patient at risk of a large bony defect if postoperative infection occurs.
- A bifrontal craniotomy has relatively limited indications. Most intradural tumors may be removed through the expanded pterional route.

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