Open vs Endoscopic: When To Use Which

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The authors discuss their surgical approaches of choice and rationale for their decisions in several cases of patients with skull base tumors. The cases were chosen to represent tumors in which reasonable cases could be made for either a transfacial or a transcranial approach.

CASE 1

A 40-year-old woman with headaches: The first patient was a 40-year-old woman who presented with headaches. Her initial imaging is shown in Figure 1.

Drs Sekhar, Mantovani, and Mortazavi: This is a medium-sized olfactory groove meningioma. Olfactory groove meningiomas of this size are well removed by a frontotemporal craniotomy (usually right-sided), combined with the removal of the roof of the orbit. After the basal cisterns are opened to drain cerebrospinal fluid (CSF) and the brain is relaxed, the ipsilateral frontal lobe is gently retracted. The tumor is debulked with the CO_2 laser or the ultrasonic aspirator. The falx cerebri is divided, and the crista galli is removed by using the ultrasonic bone curette or a high-speed drill, which is also used to remove any hyperostotic bone and the involved basal dura mater. At a minimum, the contralateral olfactory bulb and tract can be preserved. The rest of the tumor is dissected away from the brain into the central cavity, along the arachnoid plane, and removed totally. Reconstruction is performed at the end of the operation by placing a piece of pericranium or dural substitute on the basal bone and affixing it with fibrin glue.

When an olfactory groove meningioma is large (2.5 to 3-4 cm) or giant (>4-5 cm), we use a combination of a frontotemporal craniotomy crossing the midline with a full ipsilateral orbital osteotomy. This approach allows the tumor to be visualized from multiple angles (posterior, anterior, lateral) and removed. Tumors of this size often encase the frontopolar branches of the anterior cerebral artery, which can be carefully dissected and preserved. The tumor may also invade the frontal lobe, in which case dissection will have to be performed in the subpial plane. One olfactory bulb and tract can still be preserved if they are intact before the operation.

The microsurgical tumor resection can be supplemented by endoscope-assisted surgery through the cranial approach. CSF leakage is not a problem after the type of operation described above.

Endoscopic endonasal approaches (EEAs) have been used to remove olfactory groove meningiomas. Although medium-sized tumors can be removed well, it is difficult to remove large or giant tumors totally. In addition, the olfactory tract is always destroyed by this approach.

Dr Schwartz: This first case shows a small- to medium-sized meningioma that straddles the border between the planum sphenoidale and the cribriform plate. There is a bit of edema in the surrounding brain. The first criterion one should consider is the goal of surgery, which in this case is a gross total resection (GTR); however, subtotal resection followed by radiation, although not ideal, might lead to an acceptable outcome, which is reduction of mass effect and lack of subsequent growth of the tumor over the lifetime of the patient. Given the young age of the patient and the fact that GTR is achievable, the risk of radiation-induced malignancy and radiation necrosis should be avoided. The second criterion is functional preservation, which in this case is primarily olfaction and secondarily minimizing brain retraction to avoid encephalomalacia and seizures, as well as frontal sinus preservation to reduce the incidence of mucocele and infection.

The tumor lies medial to the vertical extension of the lamina papyracea. With these anatomic borders, the EEA can be used to obtain complete removal of this tumor. The advantages of the EEA are minimizing brain retraction and reducing the risk of postoperative seizures. The risk of wound infection is also lower with the EEA. The ability to remove all involved bone of the cribriform plate is an advantage of the EEA that will reduce

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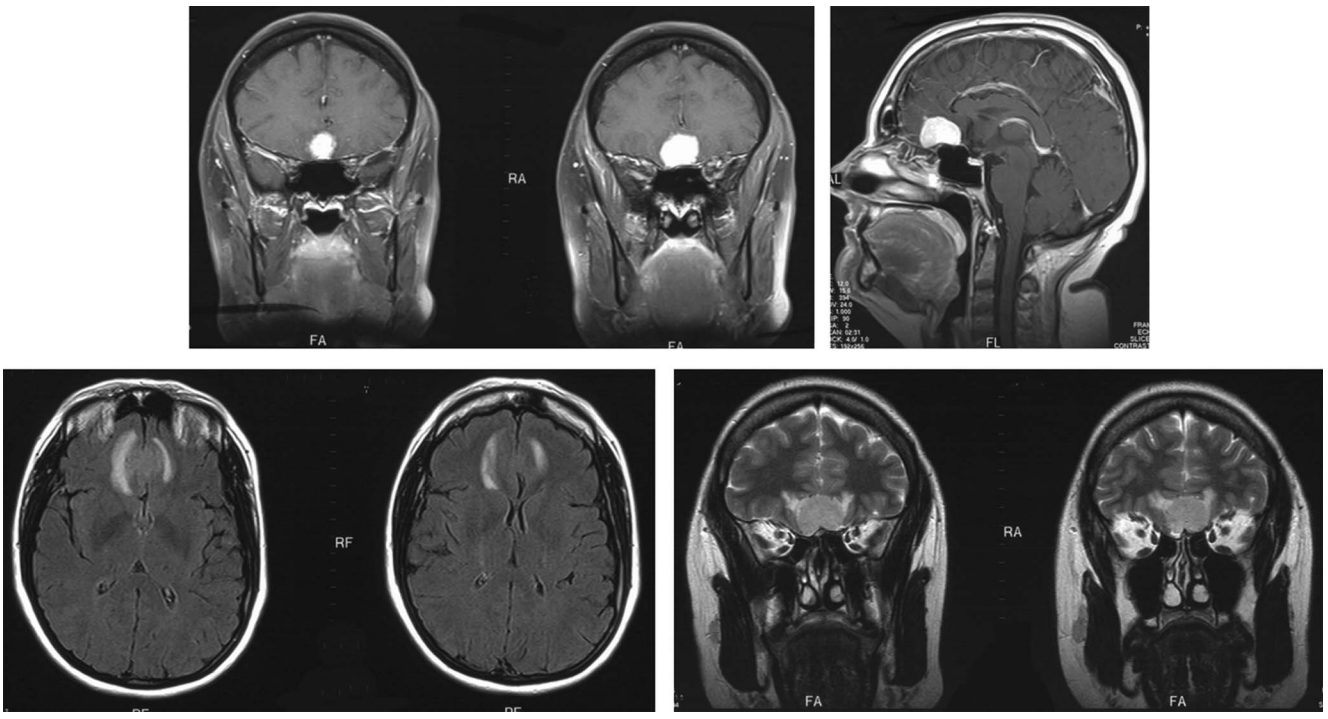

FIGURE 1. *A 40-year-old woman with headaches.*

the risk of recurrence. Although the bone removal can be done through a craniotomy, which would require a bifrontal approach and a pericranial flap, it often would not be done if the bone appeared grossly uninvolved with tumor. Cosmetically, the EEA would be better because it would avoid a skin incision. There are 2 major downsides to EEA. The first is the loss of olfaction, which is inevitable. The second is the risk of CSF leak. The risk of CSF leak should be $< 5\%$ for this case and possibly lower, but CSF leak would lead to likely reoperation and possible meningitis. The tumor is not so anterior that the nasoseptal flap would not reach its anterior margin, and the surgeon could use a gasket seal or other technique to make the leak rate essentially zero, but still the risk is higher with EEA. Nevertheless, one should remember that the risk of CSF leak with a transcranial approach is not zero if one is aggressive with the removal off the cribriform plate.

There are 2 reasons to prefer a transcranial approach here. The first is that olfaction can be preserved because the tumor is relatively small. Hence, I would carefully examine the patient's sense of smell preoperatively and openly discuss the inevitable loss of olfaction with EEA vs the possible loss of olfaction with a transcranial approach. If the tumor were larger and if there were little chance of preserving olfaction regardless of approach, the EEA would be favored. The other issue is the location of the tumor with respect to the cribriform plate and planum. Tumors mostly over the planum and behind the cribriform plate are easier to reach and the defect easier to close with EEA. Tumors that are more anterior and mostly over the cribriform plate are harder to reach with EEA and the defects harder to close. In this particular case, the tumor is in the gray zone. If the tumor were truly an olfactory groove meningioma, and more anterior, I would favor a supraorbital approach through an eyebrow incision with endoscopic assistance to see down into the cribriform plate. However, if the patient had thin eyebrows or was very concerned about appearance or formed keloids, I would not use this approach. I also use the criterion of whether the tumor is adjacent to the back wall of the frontal sinus. If the most anterior extent of the tumor is that close to the frontal sinus, then a transcranial approach is a fairly short route to the tumor, and little brain retraction would be required. With this criterion, this specific tumor is far enough back that EEA is reasonable. Finally, there is minimal edema in the brain; the amount of possible brain invasion is also minimal; and the tumor should be easy to remove through EEA.

Dr Couldwell: We chose to use an EEA for the removal of this tumor. The patient's olfaction had already been eliminated by the tumor, and this tumor is well within the size and location at which the entire attachment is accessible by an endonasal approach. The approach enables complete removal of bone attachment and involved dura, which aids in devascularization of the tumor with the approach and facilitates an optimal Simpson grade tumor removal. I prefer to be able to remove a generous cuff of normal dura surrounding the attachment, and this was achievable in this

particular case because the area of attachment was limited. This may be limited by the orbits when removing a larger tumor, however, and I will choose the best approach (open or endonasal) to achieve the optimal Simpson grade removal.

There is 1 important sign evident on the T2 and fluid-attenuated inversion-recovery images, that being some surrounding edema. This indicates pial violation by the tumor and should always be perceived as a warning to the surgeon. In this particular case, the orbitofrontal arteries needed to be dissected from the superior aspect of the tumor. With the endonasal approach, this is performed near the end of the tumor resection after much of the mass has been removed, and some manipulation of the arteries can occur before their visualization.

As noted above by Dr Schwartz, the risk of CSF leak is much higher with this approach. We used a multilayer closure using autologous fascia in this case with a good result. Certainly, a nasoseptal flap could also be used for this defect.

CASE 2

A 56-year-old woman with renal failure and visual loss: This patient was a 56-year-old woman who presented with visual loss and renal failure. Figure 2 demonstrates the imaging obtained for her evaluation.

Drs Sekhar, Mantovani, and Mortazavi: Meningiomas in this location are in the interface between the transcranial approach and EEA. When a planum/tuberculum sellae meningioma is < 4 cm in size, does not encase the internal cerebral artery and anterior cerebral artery, and does not completely invade the optic canals, then an EEA can be safely performed. Tumors larger than this size with brain invasion (World Health Organization grade II meningiomas) that are encasing the internal cerebral artery or anterior cerebral artery and occluding the optic canals are best removed by an intracranial approach.

Case 2 appears to be a good candidate for a transsphenoidal endoscopic resection.

Dr Schwartz: This patient has a mass that is most consistent with a tuberculum sella meningioma. No contrast agent was used in imaging because of the patient's renal failure. For this reason, we cannot rule out a craniopharyngioma or other pathology of the stalk, but meningioma is favored. The tumor is small, is between the carotid bifurcations, and lies just above the pituitary gland. The goal of surgery is GTR. The functional preservation issues are decompression of the optic chiasm and improvement of vision and maintaining pituitary function, which I assume is normal.

This case is more clear-cut in my mind, and I favor the EEA. The location of the tumor is a straight shot for EEA because it lies so posterior along the planum. There is no brain retraction, no scar, and better visualization of the pathology, which lies under the chiasm and extends down into the sella. In fact, the tumor extends far enough down into the sella that it likely involves the diaphragma, which will be seen more easily through an EEA. The stalk and superior hypophyseal arteries will also be seen more clearly through the EEA. I truly believe that visual preservation is higher with the EEA because the tumor lies below the chiasm and left nerve. These structures would be manipulated through a transcranial approach and would not be as manipulated through EEA. In addition, the undersurface of the chiasm is better visualized through the EEA. Finally, the closure is fairly easy with EEA; the bone opening will not be so large; and the nasoseptal flap

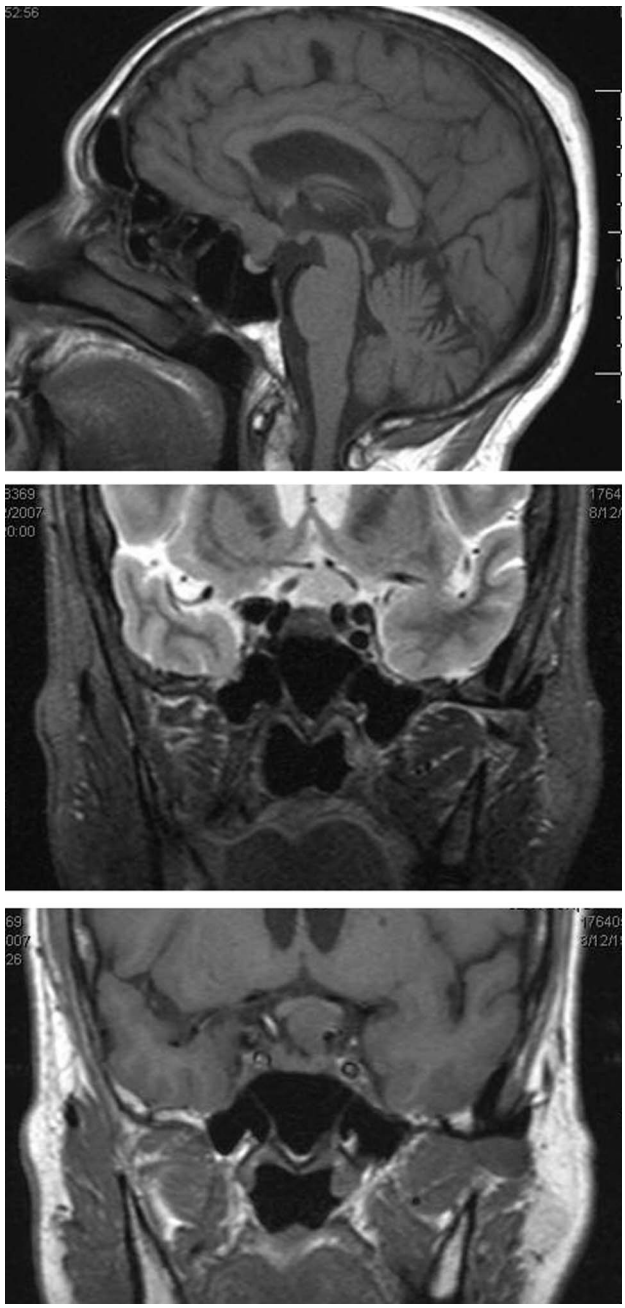

FIGURE 2. *A 56-year-old woman with renal failure and visual loss.*

will reach the defect easily. I would use a gasket seal here with fascia lata and leave a lumbar drain in for 24 hours to allow the tissue sealant a chance to harden. Our leak rate with such a case is essentially zero.

The downside of the EEA would be a reduction in nasal function for a period of 3 to 6 weeks, but this is transient.

Dr Couldwell: I performed an EEA to this tumor for the reasons mentioned by both authors above. This approach has the advantages of obviating need for brain retraction, removal of tumor attachment with the approach, and avoidance of a cranial incision. The approach is straightforward, and visualization of the tumor below the chiasm is superior.

We achieved a good removal of the tumor by this approach, but with careful review of the preoperative magnetic resonance imaging, one can see that the tumor extends superior and lateral to the carotid artery. There was involvement of tumor along the anterior clinoid dura, and we struggled to cauterize this area properly. Nevertheless, the postoperative magnetic resonance imaging with adequate renal precautions and with contrast demonstrated complete resection of the tumor.

Three years later, however, the patient had recurrence of the lesion along the clinoid that produced visual loss and required an additional transcranial (frontotemporal) approach for removal. This case emphasizes the major drawbacks of the endonasal approach, whether with visualization with an endoscope or microscope: The surgeon is limited in the approach angle (limited degrees of freedom with the approach). The approach to this area is limited laterally by the optic nerves and carotid arteries. If the tumor or its attachment extends laterally to these to any degree, it cannot be adequately accessed. With the endoscope, we can see laterally, but we can see much better than we can reach and operate. Lateral reach is a problem, especially with the attachment of meningiomas.

CASE 3

A 49-year-old woman with visual loss: In case 3, a 49-year-old woman presented with visual loss (Figure 3).

Drs Sekhar, Mantovani, and Mortazavi: This case demonstrates a classic tuberculum meningioma involving both optic canals. We would choose a transcranial approach for the reasons mentioned above. The technique of tumor resection is a unilateral (on the side of the arterial encasement in such cases) frontotemporal craniotomy followed by a full orbitotomy or a posterolateral orbitotomy (when the brain is very slack). The ipsilateral superior orbital fissure and the optic canal are unroofed with a diamond drill. If possible, some of the planum sphenoidale is removed with the drill extradurally. When the dura mater is opened, the medial sylvian fissure is opened, and the ipsilateral optic nerve is decompressed completely by opening the dural sheath. The tumor is debulked between the 2 optic nerves and through the opticocarotid space. The hyperostotic planum is frequently removed, and the contralateral optic nerve canal is also decompressed intradurally. The tumor is gradually removed piecemeal by pulling it into the decompressed cavity and dissecting in the arachnoid plane. The superior hypophyseal arteries must be preserved, and any encased arteries must be dissected. Brain retraction is minimal or none during the operation. Tumor can be completely removed along with its dural attachments, including from inside the sella.

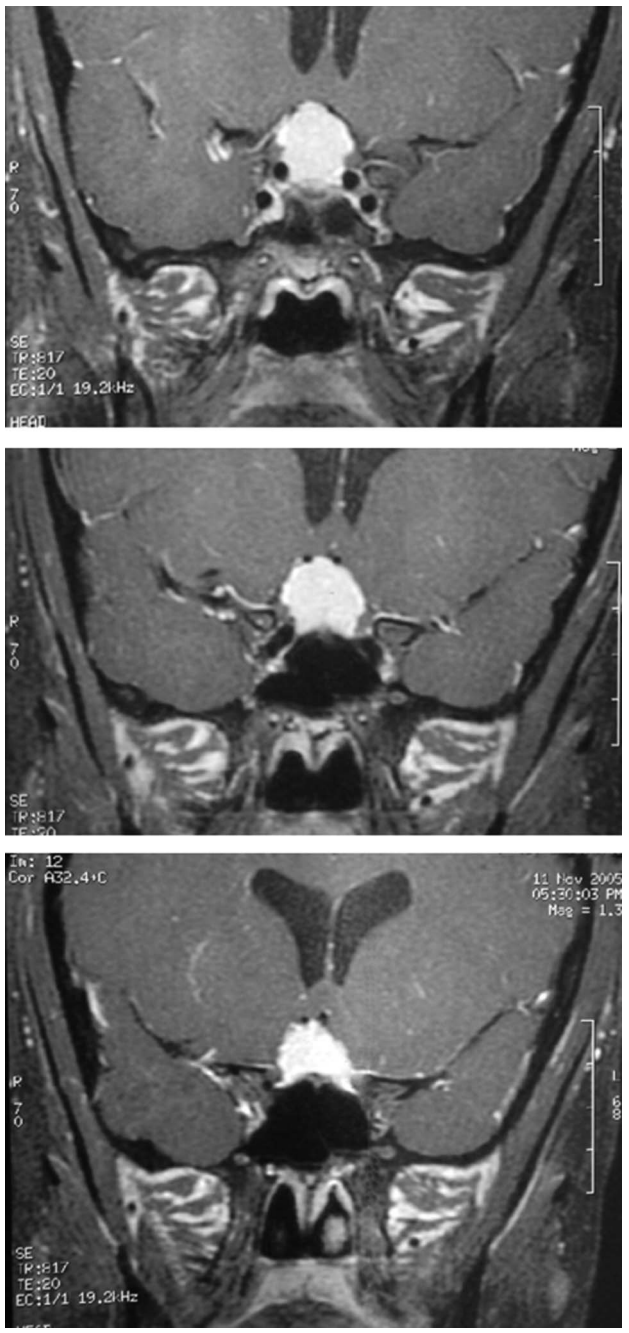

FIGURE 3. *A 49-year-old woman with visual loss.*

At the end of tumor resection, the skull base is reconstructed by placing a large free pericranial graft and attaching it with some circumferential microsutures. If the sphenoidal sinus is exposed by tumor resection, its upper portion is packed with a fat graft as well.

Dr Schwartz: This woman has a slightly larger tuberculum meningioma with bilateral invasion of the medial optic canals. The goals are similar to those of the prior case, GTR and preservation of vision and pituitary function, and many of the discussion points are similar. The A2 branches are outside the capsule of the tumor, and the tumor lies between the carotid bifurcations. On anatomic grounds, the EEA can achieve a GTR. Again, I favor EEA over craniotomy for the same reasons as in the prior case. The main difference in this case is the bilateral optic canal invasion; however, the invasion is medial and can be easily exposed by opening the optic canals within the sphenoid sinus. In fact, I would argue that the medial optic canals are more easily exposed through EEA because using an approach from above places the optic nerve between the surgeon and the pathology. When opening the optic canal endonasally, it is important to understand the location of the ophthalmic artery, which courses medial and inferior in the canal. In addition, the fact that the A2 branches lie along the capsule of the tumor is not a contraindication as long as the surgeon is comfortable with bimanual endonasal sharp and blunt microdissection. I favor bayonetted instruments for this type of surgery, but pistol-gripped instruments can be used as well.

Dr Couldwell: I chose to perform a transcranial approach to remove this meningioma. Although I agree with Dr Schwartz that medial optic canal involvement may be more easily addressed from below, the deciding factor for me was the enhancement of the dura over the anterior clinoid processes on both sides. As noted in my discussion of the previous case, this is best addressed from above with more ability to operate lateral to the carotid arteries and optic nerves. I performed a unilateral frontotemporal approach and prefer to remove all of the involved dura bilaterally and to drill the optic canals from above in such cases. All of the involved dura and bone are removed, with closure of the skull base defect as necessary (was not needed here). I prefer to do these tuberculum meningioma removals from a unilateral approach rather than a subfrontal or interhemispheric trajectory to avoid risk to olfaction and unnecessary violation of the frontal sinus. The side of approach is chosen with consideration of any lateral bias to the tumor, or, as in this case of a completely midline symmetrical tumor, a right-sided approach is preferred.

CASE 4

A 55-year-old woman with recurrent chordoma: Figure 4 demonstrates the imaging for this 55-year-old woman with recurrent chordoma.

Drs Sekhar, Mantovani, and Mortazavi: In this patient with a recurrent chordoma, the right cavernous sinus is involved, the cavernous internal cerebral artery is narrowed, and there is edema in the brainstem, indicating some brain adhesion/invasion. The basilar artery is pushed over to the left side and is also slightly narrowed. This patient may have had radiotherapy preoperatively.

Our current approach to chordomas is that patients with tumors involving the upper or mid clivus in the midline, without intradural invasion or with minimal intradural invasion, can be operated on an by EEAs. Tumors that extend laterally including the cavernous sinus and the petrous bone, that involve the carotid arteries, that have significant intradural invasion near the brainstem, or that occur at the foramen magnum–C1 area are best operated on with a traditional microsurgical skull base approach.

In regard to the patient under discussion, further workup should include an angiogram and a balloon occlusion test or at least

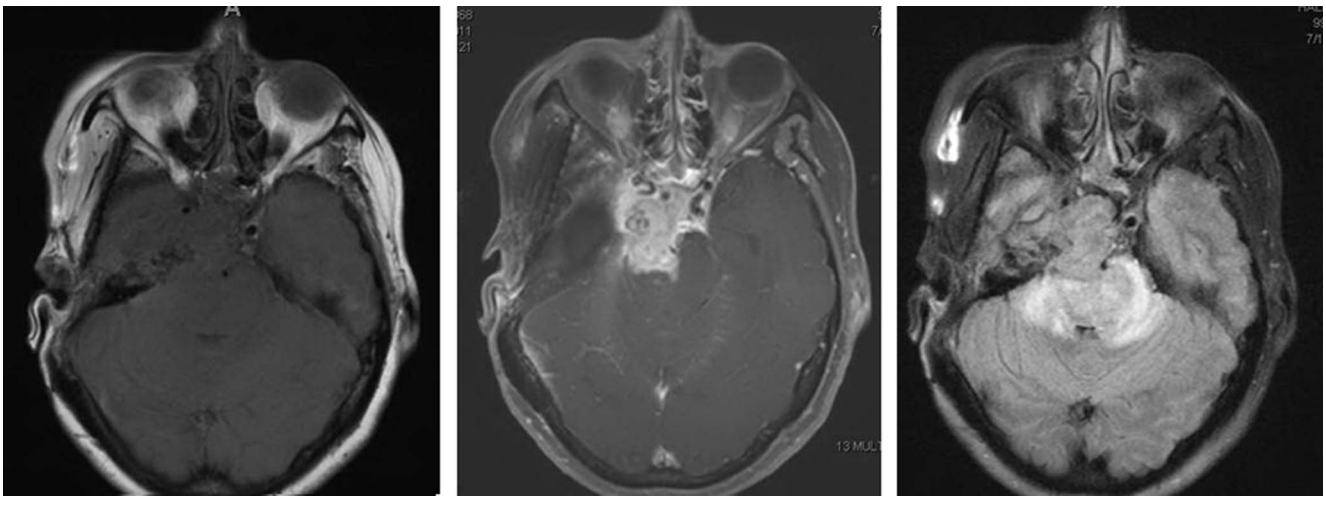

FIGURE 4. *A 55-year-old woman with recurrent chordoma.*

ipsilateral common carotid compression with contralateral carotid injection to check the collateral circulation. If the patient has an isolated circulation, a high-flow bypass should be performed as a first step through a frontotemporal craniotomy and an orbitozygomatic osteotomy. The second operation is a tumor resection through the same approach about 3 days later. A complete tumor resection should be performed, with drilling of the surrounding bone. Reconstruction is with a fascial flap sutured to the dural edges, with abdominal fat packing of the sphenoid sinus. The second operation may also be performed endonasally (endoscopically) after the bypass procedure because the risk of carotid injury is no longer there. In such case, a nasoseptal flap should be used for the reconstruction.

Dr Schwartz: This is a difficult case by any approach. The patient has had a prior right-sided craniotomy and what looks like a transpetrosal approach with clear damage and encephalomalacia of the temporal lobe and a titanium cranioplasty. The patient has probably undergone radiation already, and wound healing will be a significant issue through a craniotomy. It is unclear whether the patient is neurologically intact or already has sixth nerve palsies. In any event, the tumor is likely involving the carotid artery on the right and may be very adherent to the basilar artery, and there may be no clear plane of dissection off the brainstem, which is very compressed and edematous. This is likely worsened by the presumed prior radiation therapy. I do not think that this tumor can be completely removed safely through any approach. The morbidity of achieving a GTR will be extremely high, and a GTR is likely unachievable. For this reason, the goals of surgery, in my opinion, are a radical debulking with minimal morbidity to preserve quality of life for as long as possible in preparation for additional adjuvant therapy.

For these reasons, I favor EEA. I would very much like to see a sagittal view to determine how low the tumor goes and a computed tomography angiogram to more clearly see the relationship between the tumor and the arteries, which I would also use for intraoperative navigation. There is an adequate corridor between the carotid arteries to expose the tumor. A wide bone opening from carotid to carotid that extends down to the base of the tumor will be required. A new corridor for surgery is an advantage here because wound healing will not be an issue. Carotid injury is a consideration, and I would be prepared with interventional radiology assistance available. The risk of cranial nerve injury is probably higher with a transcranial approach, and I would monitor only motor evoked potentials, although additional monitoring would be reasonable. The dura should be opened in such a way as to minimize injury to the sixth nerve in the Dorello canal; I prefer an "I" shape. The surgeon should consider the possibility of this tumor being fibrous, and adequate instrumentation should be available, whether an ultrasonic aspirator with a transsphenoidal tip or a side-cutting aspiration device. Once the tumor is radially radically debulked, if there is a reasonable plane of dissection between the tumor and brainstem and basilar, I would try to use bimanual sharp dissection; however, if there is brain or vascular invasion, I would leave tumor behind to maximize functional preservation.

There is likely to be tumor remaining lateral to the carotid artery, in the cavernous sinus on the right, and possibly attached to the brainstem and basilar. This part of the tumor is likely not safely removable by any approach. Closure should not be a huge issue because the nasoseptal flap should easily reach and cover the defect. Bilateral flaps can be used. I would try to leave a thin rim of bone for a gasket seal closure as the first layer and leave a lumbar drain for 24 hours.

Dr Couldwell: This is an unfortunate patient who has experienced several recurrences of her chordoma, which now involves the upper clivus, cavernous sinus, and sphenoid. She has undergone previous transcavernous surgery and now presents with hemiparesis and ophthalmoplegia on the right side. Both radiation therapy and experimental chemotherapy protocols have failed.

When faced with a scenario such as this, the wishes of the patient must be central to the management. I contemplated an aggressive resection of the cavernous sinus, carotid bypass if necessary in the hope for GTR; however, in consideration of the risks of this extensive operation (as published by our group and others), the family and patient wished a lesser option for possible improvement of her progressive hemiparesis. I thought a transnasal debulking of the tumor might offer her some benefit. Review of the images demonstrates enhancing tumor at the anterior pons and extensive edema involving the pons and cerebellar peduncles.

During the transsphenoidal surgery, there was gross tumor within the sphenoid, and as expected, the clivus was eroded. We followed the tumor back to the interface with the pons and noted that the pons was clearly invaded by tumor. We performed what we thought was the maximal safe removal of the tumor in this location, closed the defect, and left the cavernous sinus component. As may be seen in such a case of surgical recurrences and after radiation, there was no ability to harvest a septal flap, so we closed the defect with a traditional fat and fascial closure.

Postoperatively, the patient awoke in unchanged condition and experienced continued progression of her hemiparesis. She succumbed to her disease several weeks after surgery.

I have experienced a few cases of recurrent chordoma with frank brain invasion, and this should be considered before deciding on surgical intervention. The tipoff in this case was the extensive edema in the adjacent brainstem. Although we did not hurt this unfortunate patient with our surgery, I am certain the ultimate outcome was not affected by our intervention.

CASE 5

A 38-year-old man with confusion: In case 5, a 38-year-old man presented with confusion (Figure 5).

Drs Sekhar, Mantovani, and Mortazavi: Although this is likely a craniopharyngioma, the differential diagnosis here also includes other cystic lesions in this area including a pilocytic astrocytoma and cysticercosis. A partially thrombosed basilar tip aneurysm should also be considered in the differential diagnosis. If the basilar artery is not well seen in the magnetic resonance

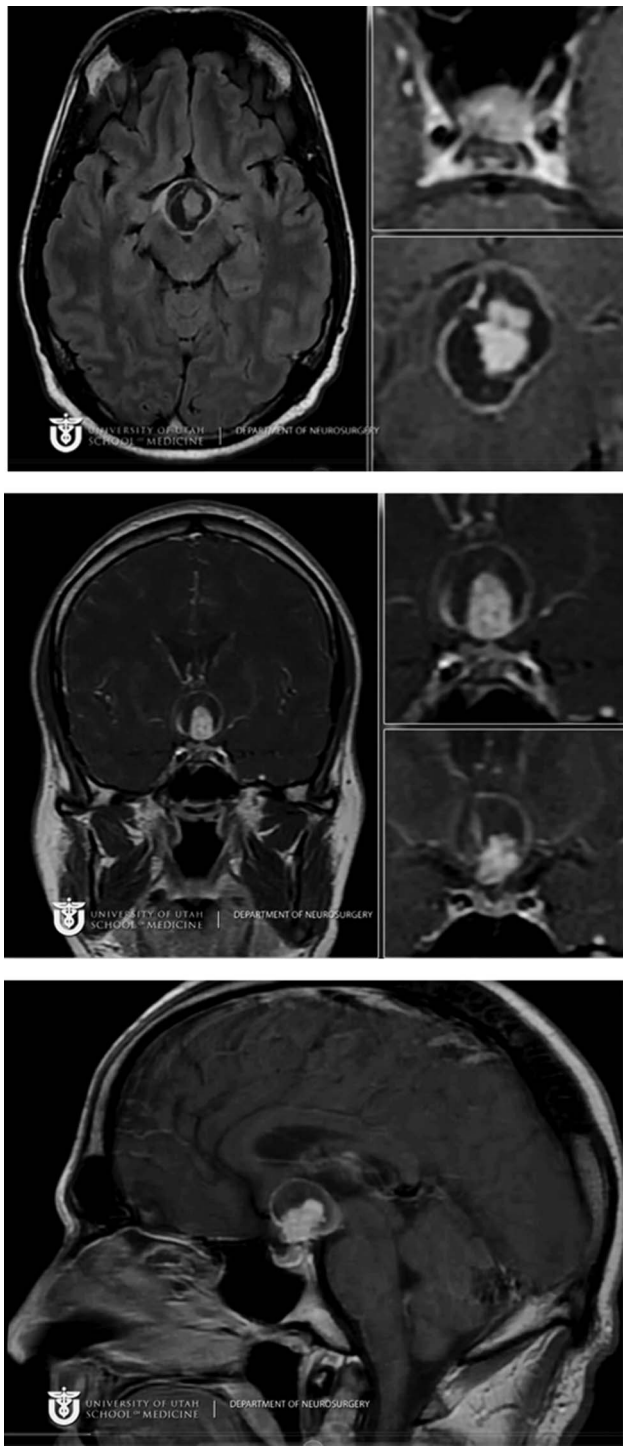

FIGURE 5. *A 38-year-old man with confusion.*

imaging, an intra-arterial digital subtraction angiogram is strongly recommended.

Assuming that this lesion is a craniopharyngioma that is retrochiasmatic, potential approaches include a frontolateral craniotomy with a translamina terminalis approach, a transpetrosal approach, and an EEA.

We personally favor a transpetrosal approach for a case like this because it gives a good retrochiasmatic exposure, and the basilar artery and its branches are seen under direct vision and safely dissected away from the tumor capsule. If the tumor is arising from a portion of the infundibulum or the pituitary stalk, the remaining healthy portion can be preserved.

Dr Schwartz: This case looks like a craniopharyngioma. The tumor is primarily suprasellar and in the third ventricle, although there may be some tumor extending into the sella and involving the pituitary gland. One cannot differentiate the stalk from the tumor. There is some edema in the optic tracts. Although the patient has some confusion, there is no hydrocephalus, and the confusion may be from compression of the mammillary bodies. The patient needs a complete endocrine evaluation and visual field testing. I would also obtain a computed tomography scan to look for calcifications. The goal of surgery here is GTR. Although preserving pituitary function is desirable, panhypopituitarism is likely if GTR is going to be achieved. I favor GTR over subtotal resection with radiation because refractory, recurrent craniopharyngiomas are very difficult to cure and pituitary hormones can be replaced medically. Visual preservation and avoiding hypothalamic injury are the more important factors here. Hypothalamic injury can lead to significant weight gain.

I favor EEA, which provides the best exposure for the pituitary gland, stalk, walls, and roof of the third ventricle; undersurface of the chiasm; and superior hypophyseal arteries. In addition, EEA avoids brain retraction and the risk of seizures. EEA also offers cosmetic advantages, but these are secondary to the improved visualization. The bone opening is not that large because the dissection will be carried out between the top of the gland and the bottom of the chiasm. The tuberculum sella must be removed but not much of the planum. I open below the superior intercavernous sinus and remove the diaphragma to aid in exposure of the tumor, intrasellar components, and stalk. It is more important to make the opening wide rather than high because the surgeon must be able to see around the sides of the tumor and clearly visualize the carotid arteries, superior hypophyseal arteries, posterior communicating arteries, and third cranial nerves.

The key to successful surgery is internal decompression to reduce the bulk of the tumor before extracapsular dissection and preservation of the stalk and superior hypophyseal arteries for as long as possible. The use of angled endoscopes is extremely helpful. If the stalk is sacrificed to achieve GTR, the branches of the superior hypophyseal that go to the stalk can be sacrificed, but those going to the chiasm should be preserved. Sharp dissection off the undersurface of the chiasm should lead to higher rates of visual preservation than through a craniotomy. The CSF leak rate is quite low because the nasoseptal flap will reach and the bone opening is

not so large. I would use a gasket seal covered with the nasoseptal flap and tissue sealant and would leave a lumbar drain for 24 hours.

Dr Couldwell: Dr Sekhar and colleagues have provided a good differential diagnosis for this lesion. As noted by all, the most likely preoperative diagnosis is craniopharyngioma. As can be noted from the various approaches posited here, many approaches can be used to achieve removal in this case.

I like to use all the imaging available, in all planes, to determine which approach to use. If one looks carefully at the coronal and sagittal magnetic resonance imaging studies, the pituitary stalk is not deviated from its native position. In fact, it is foreshortened from above, and this is a good tip that the tumor may reside in the third ventricle and be pushing the floor down. Given this, I prefer to use an approach to attempt to leave the floor of the third ventricle and the stalk intact. I chose to use a frontotemporal approach with translamina terminalis approach in this case. The tumor, which was partially cystic, was removed without difficulty. There was attachment to the lower walls and floor of the third ventricle. The floor was left intact after careful dissection. We also used endoscopic visualization through the lamina terminalis at the end of the resection to verify complete removal of the tumor from within the ventricle. Postoperatively, the patient experienced mild diabetes insipidus that resolved, and pituitary function was maintained in postoperative testing.

CASE 6

A 53-year-old woman with progressive lethargy and confusion: Figure 6 demonstrates the imaging obtained for evaluation of a 53-year-old woman who presented with progressive lethargy and confusion. Her initial laboratory values are shown in the Table.

Drs Sekhar, Mantovani and Mortazavi: This case is likely demonstrating a patient with a giant pituitary adenoma. The important caveat about this patient is that a prolactinoma should be ruled out. If the prolactin values are reported to be normal, they should be repeated with the benefit of dilution in a laboratory that handles many such specimens.

Assuming that this is a nonfunctioning adenoma, we recommend surgical removal by an interhemispheric, transcallosal approach. This approach will permit entry into the right lateral ventricle and removal of a large piece of tumor. After that, working between the 2 A2 vessels, or just anterior to the anterior cerebral complex, the remaining tumor can be removed completely.

Dr Schwartz: This last case looks like a giant macroadenoma. The tumor enlarges the sella and has significant suprasellar extension going into the right lateral ventricle through an enlarged foramen of Monro. The tumor extends into the interpeduncular cistern, and there is hydrocephalus. Although we have no history here, I am assuming that there is some visual loss. Endocrine workup is normal, and assuming there is no hook effect on dilution and the prolactin is indeed normal, then surgery is indicated. The goals of surgery are relieving the hydrocephalus, decompressing the optic chiasm, and then removing as much

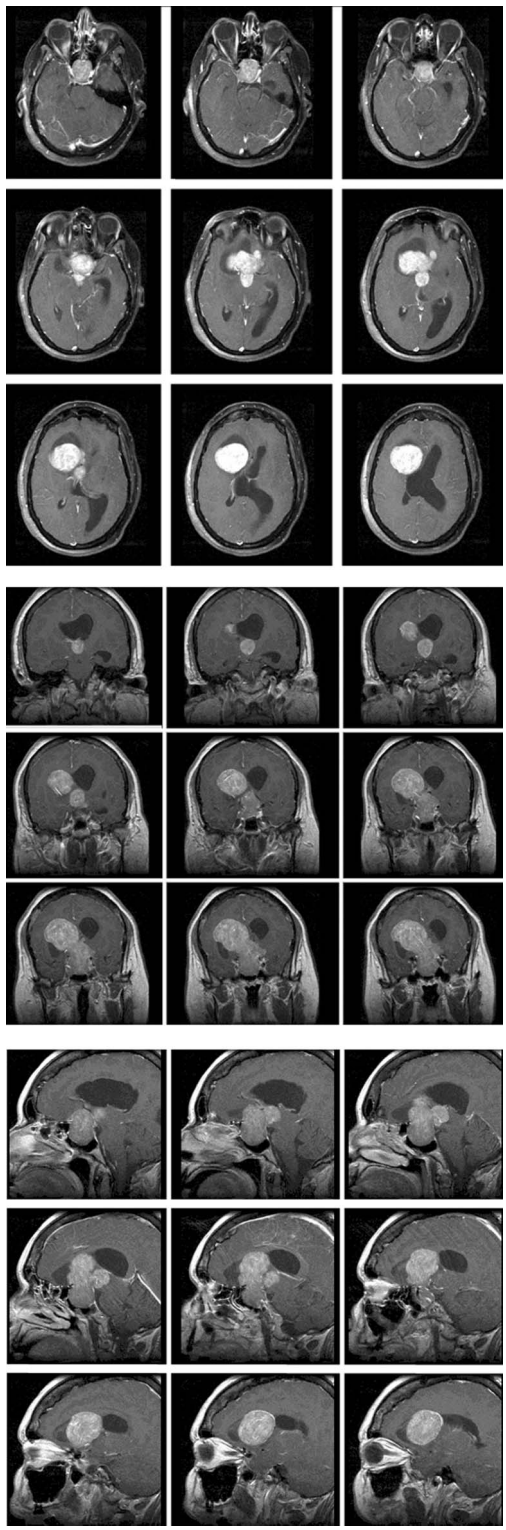

FIGURE 6. *A 53-year-old woman with progressive lethargy and confusion.*

TABLE. Initial Laboratory Study Results

Hormone	Level
Adrenocorticotropic hormone	11 pg/mL (Normal)
Serum cortisol	6.5 μg/dL (Normal)
Growth hormone	0.08 ng/mL (Normal)
Prolactin	14 ng/mL (Normal)
Thyroid-stimulating hormone	0.63 mU/L (Normal)
Free T4	1.1 ng/dL (Normal)

tumor as possible, ideally achieving a GTR. GTR rates for tumors this size range from 25% to 40%. Maintaining visual function and pituitary function and memory is a functional consideration because the tumor compresses the fornices.

I favor EEA as a first procedure in this case because it is possible that a GTR can be achieved, but I would let the patient and family know that a second procedure may be required. The EEA is preferable to craniotomy for the tumor that lies in the sella and below the chiasm because the chiasm is compressed from below and the optic nerves are thinly splayed out above the tumor. Likewise, the normal pituitary gland is thinly splayed out over the top of the tumor, and entering the tumor from above risks damage to both of these structures. It will be difficult to expose this whole tumor from above through any 1 approach, and significant brain retraction will be required. The EEA provides a direct corridor into the center of the tumor. An extended approach with removal of the tuberculum sella and part of the planum will be required for adequate exposure. The tumor within the sella extending up to the chiasm should be removed first. The surgeon can follow the path created by the tumor to remove the tumor in the interpedunculuar cistern, which is directly in the line of sight. Then, the tumor can be followed with an angled endoscope up through the enlarged foramen of Monro to remove the tumor in the lateral ventricle. This aspect of the tumor may not be completely removable with the EEA, although there is a reasonable chance of success. If tumor is left behind, a second transcranial procedure can be done to remove this residual tumor and should probably favor a transcortical transfrontal approach to the lateral ventricle using a narrow tubular retractor.

In planning the EEA, several considerations apply. First, I would place a left-sided ventriculostomy in the operating room as a first step to reduce intracranial pressure. I would leave this in place postoperatively to see if it can be removed, and if not, permanent CSF diversion will be required. Leaving it open for 1 or 2 days will also facilitate skull base closure. I would certainly harvest a flap and perform an extended approach as mentioned above. The pathway of the tumor will guide the surgery and be used as a corridor to access deeper aspects of the tumor using angled endoscopes. A side-cutting aspiration device can be helpful because the tumor may be quite fibrous. The first goal of surgery will be to see the entire chiasm decompressed and then the interpeduncular cistern, mammillary bodies, and finally the lateral ventricle; however, GTR should not be pursued with blind curettage or at risk of damaging the fornices or tearing a perforator off of the anterior cerebral arteries. It is preferable to leave residual tumor than to cause damage because a second approach or even radiation can be used as adjuncts after the initial EEA surgery.

Dr Couldwell: This woman presented with progressive confusion and a 100-lb weight gain over the past year. She was lethargic on presentation, so an external ventricular drain was placed on admission. We chose to start with a transnasal approach, understanding that we might not be able to resect the superior part of the tumor through this approach, as noted by Dr Schwartz. The sella was remarkably enlarged by the tumor, so by the time the floor was removed, we had a very adequate corridor. We removed approximately two-thirds of the tumor from below with an endoscopic approach but could not remove the most superior aspect of the tumor because it became very difficult to reach with our instruments and would not descend on its own accord. We followed up with a secondary transfrontal-transcortical approach the next day to remove the remainder of the tumor in this case.

An important consideration in the surgical management of a patient such as this is the real potential for apoplexy in the remaining portion of tumor if it is not removed in 1 surgical approach. We have witnessed clinical deterioration in such cases. The placement of an external ventricular drain offers some protection against acute hydrocephalus occurring from this in the present case; however, we prefer to control the significant mass of tumor with the initial approach to reduce this risk.

Although we attempted maximal surgical resection from a transnasal approach as the primary procedure in the present case (in an attempt to avoid a transcranial approach), I think an equal option in this particular case is a primary transcranial (either transfrontal or transcallosal) operation, which would remove the entire tumor from above. In my opinion, this latter option is more likely to ensure tumor removal through only 1 approach by following tumor all the way down to the enlarged sella from above.

Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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