ENDONASAL TRANSSPHENOIDAL TRANSCLIVAL REMOVAL OF PREPONTINE EPIDERMOID TUMORS: TECHNICAL NOTE

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OBJECTIVE: Prepontine retroclival tumors have typically been removed through a variety of anterolateral, lateral, and posterolateral cranial base approaches. Here, we describe an endonasal transclival cranial base approach for removal of prepontine epidermoid tumors.

METHODS: Two men, 40 and 52 years old, each presented with a history of headaches and cranial nerve deficits. In each patient, magnetic resonance imaging showed a large T1 hypointense/T2 hyperintense mass occupying the posterior suprasellar, premesencephalic, and prepontine cisterns, with significant mass effect on the brainstem. Both patients underwent an endonasal transsphenoidal transclival cranial base tumor removal with the operating microscope and endoscopic assistance. The dural and bony defects were repaired with abdominal fat grafts, collagen sponge, titanium mesh, and cerebrospinal fluid diversion. One patient developed a postoperative cerebrospinal fluid leak and meningitis requiring two reoperations to repair, ultimately with fat and fascia lata grafts.

RESULTS: At 1 year after surgery, both patients have improved compared with their preoperative neurological state, and volume analysis of preoperative and 1-year postoperative magnetic resonance imaging scans confirm a marked reduction in mass effect on the brainstem, with a 78% tumor removal in one patient and 76% removal in the other. Both patients have normal endocrine function.

CONCLUSION: The endonasal approach offers a minimally invasive, anatomically direct route for removing prepontine epidermoid tumors that obviates brain retraction. The use of angled endoscopes is essential for gaining lateral, cephalad, and caudal visualization to augment the limited microscope view. Inadequate repair of clival dural defects remains the greatest potential pitfall in attempting transsphenoidal transclival tumor removal.

KEY WORDS: Clivus, Endonasal approach, Epidermoid cyst, Prepontine, Transsphenoidal surgery

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Epidermoid tumors, or cysts, are relatively uncommon tumor-like lesions that account for only 0.2 to 1.8% of all intracranial tumors (2, 6, 32, 41, 42, 51, 54, 57, 63, 65, 67). These extra-axial tumors may arise in the cerebellopontine angle, the parasellar region, within the cerebral cisterns and fissures, hemispheres, and in the ventricles. Posterior fossa epidermoids are thought to originate in the lateral subarachnoid cisterns of the cerebellopontine angle and spread across the cranial base (6, 51, 65). Midline epidermoid cysts include those that are directly anterior to the midbrain, pons, and medulla and that may have more lateral extensions. These ventral epidermoids typically present with symptoms and signs attributable to cranial neuropathy, brainstem compression, obstructive hydrocephalus, and endocrinopathy (32, 41, 42, 57, 65). A variety of innovative cranial base approaches, including anterior, anterolateral, and posterolateral routes, have been developed to access extra-axial lesions ventral to the brainstem (3, 10, 11, 18, 21–24, 26, 32, 34, 44, 48, 50, 53, 56, 58, 60, 61, 63). These approaches have often been used alone or in combination as "staged approaches" for extensive tumors, such as petroclival meningiomas or chordomas. For clival chordomas in particular, the transsphenoidal approach has been well described (14, 16, 30, 36, 37, 45). However, in contrast to prepontine epidermoids, the bony destruction of the chordoma itself often creates the surgical pathway, and in the majority of cases, it remains extradural (19, 35, 47, 64).

In contrast to traditional cranial base surgical approaches, which often require extensive cranial base removal and neurovascular manipulation, the endonasal transsphenoidal route offers a direct and minimally invasive approach that obviates brain retraction (13, 16, 17, 25, 33, 37, 40, 45, 52, 62, 66). Here, we describe the use of the endonasal transclival approach for removal of epidermoid tumors ventral to the brainstem in two patients. This approach, which requires no sublabial incision and minimal nasal mucosal dissection, is a refinement of the technique originally described by Hirsh in 1910 (39, 43) and enhanced by Griffith and Veerapen in 1987 (20). This approach is being increasingly used for removal of pituitary adenomas and other parasellar lesions, often with endoscopic assistance (13, 66). As discussed below, successful use of this relatively restricted surgical corridor for removal of ventral brainstem lesions is dependent on both the operating microscope and angled endoscopes for adequate visualization and achieving an effective dural repair to prevent postoperative cerebrospinal fluid (CSF) leaks and meningitis.

PATIENTS and METHODS

Patient Positioning and Room Setup

The basic method used for the endonasal transclival cranial base approach is a modification of the endonasal transsphenoidal approach recently described by Zada et al. (66) for pituitary tumor removal and by Cook et al. (13) for suprasellar meningioma removal. After induction of general anesthesia, the patient's head is placed on the horseshoe head-holder and angled approximately 30 degrees toward the left shoulder. To obtain more direct access to the clival region, the patient's head is flexed slightly more than for a sellar tumor. The three-point Mayfield head holder is placed for attachment of the neuronavigation instrumentation but is not fixed to the operating table, so that the head can still be manipulated on the horseshoe head-holder. The patient's head is registered to the frameless neuronavigation system (VectorVision2; BrainLab AG, Kirchheim-Heimstetten, Germany) for trajectory guidance. Fluoroscopy is also used for trajectory control and to confirm stable positioning of the titanium mesh used for repairing the clival dural defect.

Surgical Technique

Initial Approach

As described previously, the approach through the nasal cavity and sphenoid sinus, performed with the operating microscope, begins by placing a hand-held speculum into the nostril and advancing on a trajectory along the middle turbinate (66). At the junction of the keel of the sphenoid and the posterior nasal septum, the mucosa is cauterized with the bipolar, and a vertical mucosal incision is made with a Cottle elevator. The nasal septum, with its intact mucosa, is then pushed off the midline, toward the contralateral nasal cavity, by the medial blade of the speculum. The mucosa over the keel of the sphenoid bone is elevated and reflected laterally, thus allowing the exposure of both sphenoid ostia. The hand-held speculum is then removed, and a thin modified Hardy speculum (Mizuho America, Beverly, MA) is placed up to the face of the sphenoid. By use of fluoroscopy or neuronavigation, the speculum is aimed directly at the clivus and just below the sella. Next, a large opening is made in the anterior wall of the sphenoid sinus with Kerrison rongeurs to widely expose the posterior wall of the sphenoid sinus. The anterior sphenoidotomy extends inferiorly to expose the floor of the sphenoid sinus, thereby maximizing clival exposure.

Clival Opening

The mucosa in the posterior sphenoid sinus is elevated, and the clival bone is opened initially with a small osteotome, then Kerrison rongeurs. A high-speed drill (Anspach, Inc., Palm Beach Gardens, FL) is used to remove more bone laterally and inferiorly. The neuronavigation greatly aids in determining the extent of bony removal, particularly inferiorly, where the tumor extends into the area ventral to the medulla. In Patient 2, because the tumor extended into the suprasellar cistern with chiasmal compression, the drill was also used to remove the upper sellar bone, the tuberculum sellae, and the proximal planum sphenoidale.

Dural Opening

Before the clival dura is opened, the micro-Doppler probe is used to insonate for vascular structures, particularly the basilar and carotid arteries. The dura is first opened along the midline and then opened laterally in a cruciate manner after the arachnoid has been freed from the overlying dura with microdissectors. In both of these patients, the clival dura was exceedingly vascular, which necessitated use of the bipolar and use of hemostatic agents.

Tumor Removal

The arachnoid membrane is opened by means of up- and down-angled nerve hooks or with straight and curved microscissors. The epidermoid is removed in a piecemeal manner with angled ring curettes and Decker forceps, first centrally then inferiorly, superiorly, and bilaterally. As the tumor is removed, the neurovascular structures of the retrosellar and retroclival areas come into view, including the basilar artery, the vertebrobasilar junction, the basilar apex, the pons and medulla, and the abducens nerve as they exit the pontomedullary sulcus. Copious irrigation is used to help loosen the tumor capsule and further fragments of the keratinaceous tumor from the surrounding neurovascular structures. In areas in which the tumor capsule is densely adherent to the brainstem, cranial nerves, or vessels, sharp dissection with microscissors is used to remove loosened capsule, leaving small capsular remnants behind. Intermittently, the 30-degree or 45-degree angled endoscopes (Karl Storz, Tuttlingen, Germany) are used to help to visualize and remove residual tumor by use of angled ring curettes and angled nerve hooks in areas not visualized with the microscope.

Closure of Dural and Bony Defects

After tumor removal, an appropriately sized abdominal fat graft is placed in the bony and dural defect and extending

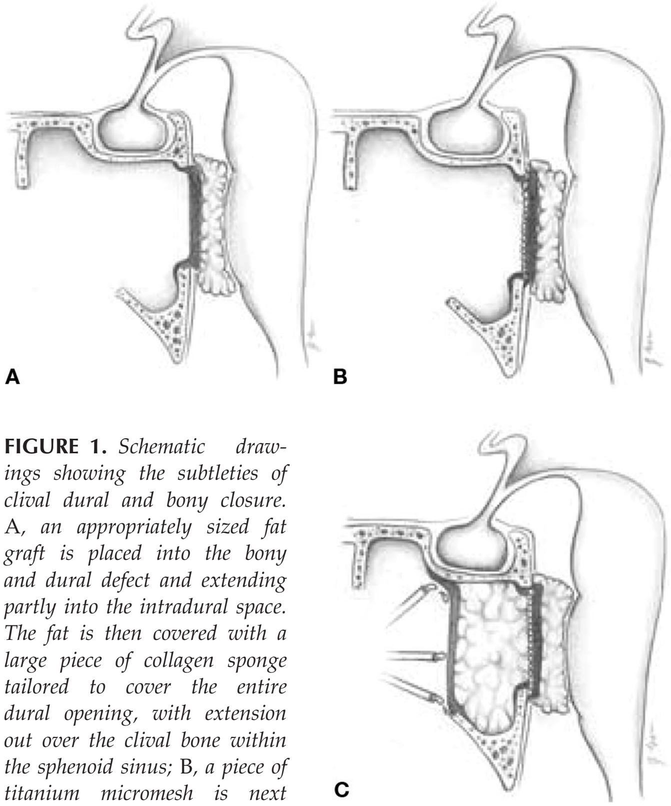

FIGURE 1. *Schematic drawings showing the subtleties of clival dural and bony closure. A, an appropriately sized fat graft is placed into the bony and dural defect and extending partly into the intradural space. The fat is then covered with a large piece of collagen sponge tailored to cover the entire dural opening, with extension out over the clival bone within the sphenoid sinus; B, a piece of titanium micromesh is next fashioned to conform to the bony defect and wedged into the extradural space to hold the collagen and abdominal fat in position; C, a larger piece of fat is placed over the titanium mesh, followed by a larger piece of collagen sponge. Tissue glue is then used to glue the repair into position.*

partly into the intradural space. The fat is then covered with a large piece of collagen sponge (Helistat; Integra LifeSciences, Plainsboro, NJ) tailored to cover the entire dural opening with extension out over the clival bone within the sphenoid sinus (*Fig. 1A*). A piece of titanium micromesh (Leibinger, 0.2 mm; Stryker Corp., Kalamazoo, MI) is next fashioned to conform to the bony defect and wedged into the extradural space to hold the collagen and abdominal fat in position (*Fig. 1B*). A larger piece of fat is placed over the titanium mesh, followed by a larger piece of collagen sponge. Tissue glue (BioGlue; Cryolife, Atlanta, GA) is then used to glue the repair into position (*Fig. 1C*). A Valsalva maneuver is performed by the anesthesiologist to help assess the effectiveness of the dural repair. Nasal packing is not used. Before extubation, a lumbar drain is placed for CSF diversion for 48 to 72 hours. Prophylactic antibiotics (cephalosporins) are given postoperatively while the lumbar drain is in use.

Tumor Volume Analysis

Postprocessing Hardware/Software

The preoperative and postoperative tumor volumes were obtained by use of a Vitrea 2 workstation (Vital Images, Minneapolis, MN) operating on an Intel R XEON CPU with the Microsoft Windows XP operating system, 3.5 GB RAM, by one of the coauthors (JPV).

Tumor Volume Extraction Method

We used the perimeter method for tumor volume extraction, whereby each data value that falls within a predefined signal intensity threshold is extracted from a user-defined region of interest with automated voxel extraction when that voxel intensity is at or above a dynamically calculated voxel value. The perimeter method permits the calculation of tumor volumes on the basis of tissue detector criteria that are also based on shape, opacity, and location of voxel values. Tumor values are calculated off of two-dimensional noninterpolated axial slices that account for slice thickness and interslice gap, if any. The method allows for the calculation of nonsolid, highly irregular, and discontinuous shapes with an error measurement of less than 30% for measures less than 8 mm^3, less than 15% for measurements 8 to 1000 mm^3, and less than 6% for measurements greater than 1000 mm^3.

Magnetic Resonance Imaging Scan Protocol

Both patients had preoperative and postoperative imaging by use of a 1.5-T magnetic resonance imaging (MRI) scanner. Preoperative sequences included axial T1-weighted, axial T2-weighted fast spin echo, axial fluid-attenuated inversion recovery, and axial and coronal T1-weighted postcontrast sequences. Postoperative sequences were the same, with the addition of axial diffusion-weighted imaging (DWI) and apparent diffusion coefficient sequences, given that epidermoid tumors are DWI hyperintense because of restricted water diffusion within tumor cells (7, 46). Slice thickness was 5 mm, skip 1.5 mm, field of view 24 cm, matrix 256 × 256, and number of excitations 1. Given that DWI images were not obtained on the preoperative MRI scans, initial tumor volumes were determined by use of the imaging sequences that best delineated the tumor mass from CSF in each patient. In Patient 1, preoperative T2-weighted axial images were used, and in Patient 2, preoperative T1-weighted sagittal images were used. Axial DWI images on MRI scans obtained at 1 year after surgery were used to determine residual tumor volumes.

Illustrative Cases

Patient 1

This 52-year-old man had a 1-year history of progressive headaches and a 3-month history of difficulty in swallowing, forgetfulness, decreased hearing, and gait unsteadiness. His neurological examination was notable for diminished sensation in the V_1, V_2, and V_3 dermatomes on the left. The left palpebral fissure was mildly widened, suggesting a partial peripheral VIIth cranial nerve palsy. Hearing was diminished on the left, and the gag reflex was diminished on the left. Cerebellar testing revealed difficulty with rapid alternating movements and mild dysdiadochokinesia. He had a wide-based unsteady gait and was unable to tandem walk. His MRI scan showed a 4.6 × 3 × 2.5-cm extra-axial mass predominantly in the prepontine cistern, causing severe distortion of the pons and midbrain as well as the medulla, with further extension to the left side. The clival bone was notably thinned (*Fig. 2, A–C*).

The patient underwent a right endonasal transclival tumor removal. A significant debulking of the prepontine epidermoid tumor was achieved on the basis of intraoperative endoscopy. He was discharged home on postoperative Day 5 after an uneventful postoperative course. One year after surgery, the patient has had resolution of his headaches and swallowing difficulties, improved sensation in the left side of the face, and improved gait. His left hypoacusia was unchanged. He has a normal sense of taste and smell and no endocrinopathy. A 1-year postoperative MRI scan with and without gadolinium and with DWI shows a residual rim of tumor against the brainstem and in the left perimesencephalic cistern, with the degree of brainstem distortion much improved (*Fig. 2, D–F*). On the basis of the volumetric analysis, the preoperative tumor volume (based on T2-weighted axial images) was estimated to be 24.8 cm^3, and the postoperative tumor volume (based on DWI axial images) was estimated to be 5.4 cm^3, indicating a 78% tumor resection.

Patient 2

This 40-year-old man had a 2-month history of headache, progressive decrease in vision in the right eye, and double vision. His neurological examination was notable for a dilated and minimally reactive right pupil, a partial right IIIrd cranial nerve palsy with impaired upward gaze, and right hypesthesia in the V_1 distribution. His MRI scan showed a 6.6 × 3.6 × 4-cm T1 hypointense/T2 hyperintense mass centered in the interpeduncular fossa with anterosuperior extension into the suprasellar cistern and lateral extension into the right choroidal fissure and the right pontomedullary junction. There was marked posterior displacement of the midbrain, pons, and upper medulla (*Fig. 3, A–C*).

Because the tumor extended into the suprasellar region and caused chiasmal and optic nerve compression, removal of the tuberculum sellae and a portion of the planum sphenoidale was necessary for tumor exposure (*Fig. 4*). The tumor's wide extent also necessitated a bilateral endonasal approach, although the majority of the tumor removal was performed through the left nostril, which provided the best access for the rightward tumor extension. A subtotal tumor removal was achieved, in part because tumor in the right choroidal fissure area was densely adherent to adjacent neurovascular structures. The patient's postoperative course was complicated by a CSF leak and *Escherichia coli* meningitis, requiring two reoperations for CSF leak repair and intravenous antibiotic therapy. At the second reoperation, the dural and bony defects in both the suprasellar and clival areas were repaired with a combination of fat and fascia lata grafts, titanium mesh, and CSF diversion through a lumbar drain.

One year after surgery, the patient has had resolution of headaches and has only mild intermittent diplopia, with a slight residual right ptosis. Hypesthesia in the right V_1 distribution also resolved, and right-eye visual acuity has improved. He has no endocrinopathy or rhinological complaints. A 1-year postoperative MRI scan with DWI sequences shows residual tumor in the left interpeduncular cistern, in the right prepontine and premedullary cisterns, and in the region of the right mesial temporal lobe. The degree of mass effect on the brainstem is greatly reduced. On the basis of the volumetric analysis, the preoperative tumor volume (based on T1-weighted sagittal images) was estimated to be 21.2 cm^3, and the postoperative tumor volume (based on DWI axial images) was estimated to be 5.0 cm^3, indicating a 76% tumor removal (*Fig. 3, D–F*).

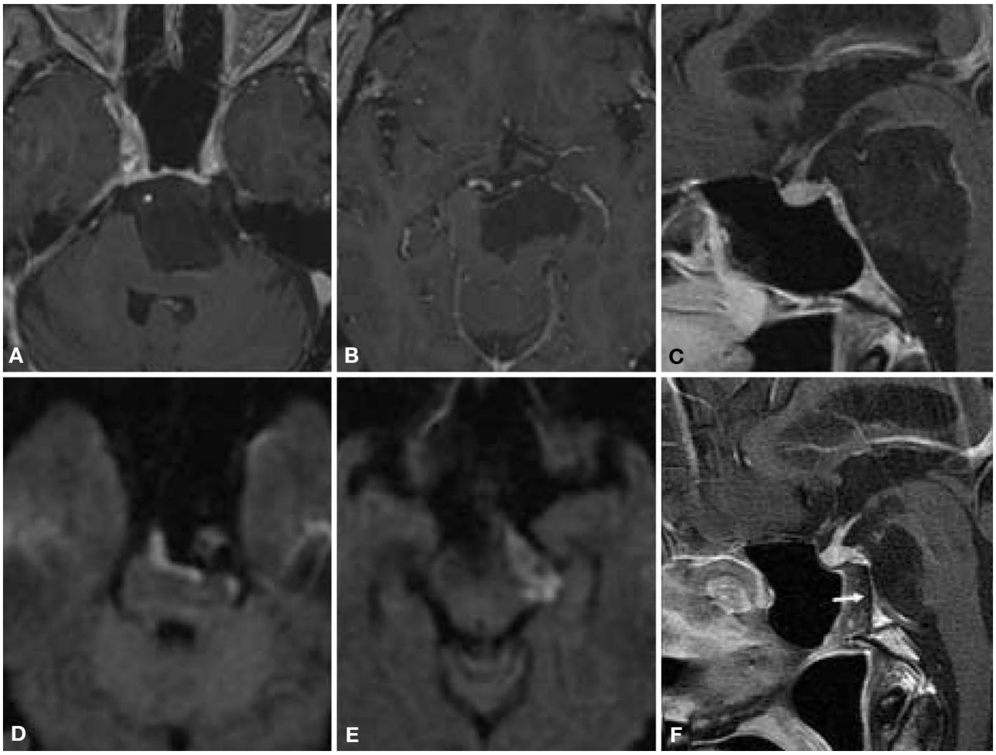

FIGURE 2. *Sellar MRI scans of Patient 1. Preoperative axial (*A and B*) and sagittal (*C*) images after intravenous gadolinium diethylenetriamine penta-acetic acid: a large ventral brainstem mass occupies the posterior suprasellar, interpeduncular, premesencephalic, prepontine, and perimedullary cisterns with extension to the left. The basilar artery is encased, and the other proximal major intracranial vessels are displaced. One-year postoperative axial DWI image (*D and E*) and sagittal postgadolinium image (*F*) show a thin rim of residual tumor against the brainstem, especially in the left interpeduncular, perimesencephalic, and prepontine cisterns. However, the degree of mass effect on the brainstem is greatly reduced. The titanium mesh buttress is seen covering the clival bony defect (*arrow*).*

DISCUSSION

Summary

In these two patients with large epidermoid tumors ventral to the brainstem, we demonstrate the feasibility of using a minimally invasive direct endonasal approach for their re-

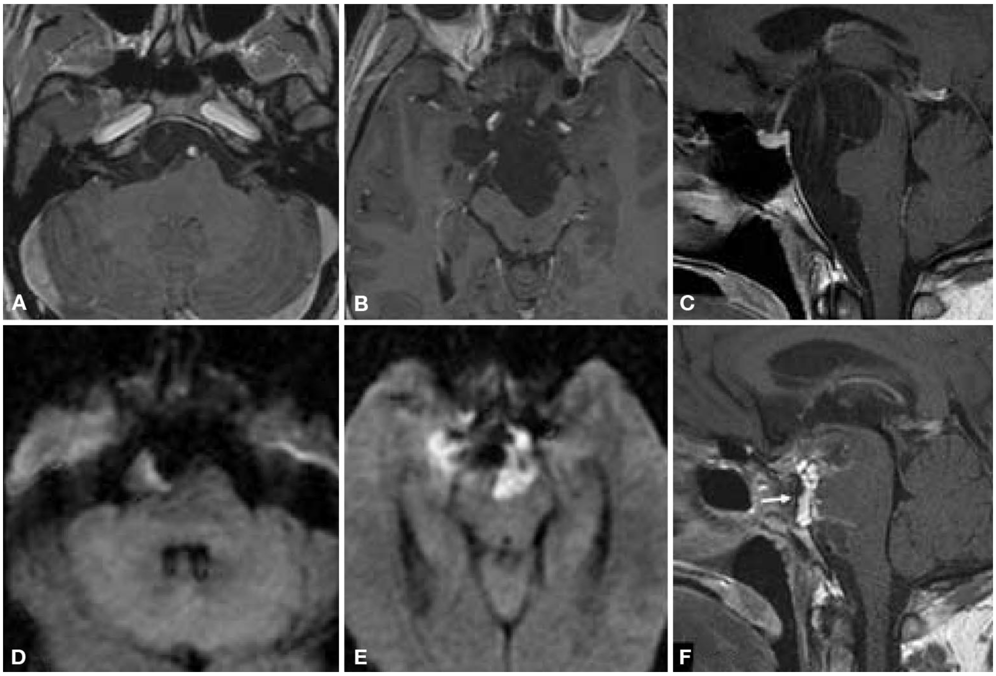

FIGURE 3. *Sellar MRI scans of Patient 2. Preoperative axial (*A *and* B*) and sagittal (*C*) images after intravenous gadolinium diethylenetriamine penta-acetic acid: a large ventral brainstem mass centered in the interpeduncular fossa with anterior extension to the suprasellar cistern, with surrounding of the infundibulum, rightward extension into the right choroidal fissure, inferiorly to the pontomedullary junction on the right, and superiorly invaginating into the chiasmatic and infundibular recesses of the third ventricle. One-year postoperative axial DWI (*D *and* E*) and sagittal postgadolinium images (*F*) show residual tumor in the interpeduncular right prepontine cistern, right premedullary cistern, and along the right mesial temporal lobe. The titanium mesh buttresses used for the planum/suprasellar and clival bony defects are visible (*arrow*).*

moval. The major advantage of this transclival approach for lesions ventral to the brainstem is that it provides the most direct anatomic route to the epicenter of the lesion yet does not traverse any major neurovascular structures, thereby obviating brain retraction. The potential disadvantages include the relatively restricted exposure and the danger of an inadequate dural repair with resultant CSF leak and meningitis. These issues are discussed below.

Total versus Subtotal Removal

Whether ventral brainstem epidermoids are removed through a basal frontal approach, a transsphenoidal route, or a lateral or posterolateral approach (subtemporal-infratemporal, transpetrosal, or extreme lateral), they are ideally removed completely at the first operation (3, 10, 11, 13, 15–17, 21–23, 25, 26, 31, 33, 34, 37, 40, 44, 45, 48, 50, 52, 53, 56–58, 60–62, 66). However, total removal is often not possible, as was the situation in these two patients, given the high risk of creating new neurological deficits (57). Considering their benign nature and relatively slow growth rate, subtotal removal of epidermoids is reasonable and prudent when dense adhesions exist between tumor capsule and neurovascular structures, particularly along the brainstem. Previous studies suggest that the rate of clinically significant recurrence is small, even with a small amount of residual tumor left in place. Lopes et al. (42) report a total or subtotal removal rate of 79.5% in a series of 44 patients with intracranial epidermoid cysts, with a recurrence rate of 4.5%; the postoperative morbidity and mortality were 13.6 and 8.9%, respectively. Zhou (67) reported a total resection rate of 72.7% in the microsurgical era and a recurrence rate of 16.6% in the series of patients with a nontotal resection. When epidermoids do recur, chronic granulomatous reaction often makes complete removal impossible (41, 55, 63). Yet, many such patients with subtotal removal do obtain a favorable long-term result. The two patients presented here will be followed up with serial MRI scans to assess for tumor progression.

Endonasal Exposure Challenges

The endonasal transsphenoidal transclival approach has several potential disadvantages, including the relatively restricted exposure and the slightly off-midline trajectory (13, 15, 66). These shortcomings, when combined with the deeper and narrower field owing to the nasal speculum, may lead to

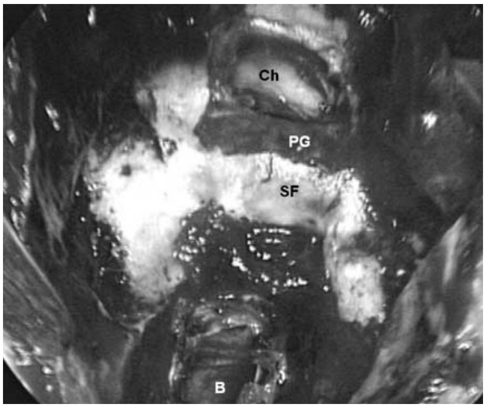

FIGURE 4. *Intraoperative endoscopic panoramic view, Patient 2. The 30-degree endoscope is inserted into the sphenoid sinus and shows the dural openings both into the planum and into the clivus. The normal pituitary gland (*PG*), covered with the sellar dura, is in the center of the surgical field.* Ch, *optic chiasm;* B, *brainstem;* SF, *sellar floor.*

relatively limited access to portions of the lesion that are ipsilateral to the approach. To try to minimize this problem, the choice of nostril should be contralateral to the side of greatest lateral tumor extension. In some instances in which bilateral tumor extension is present, a bilateral approach is needed, as was performed in Patient 2. If the nasal vestibule is too small, a relaxing alar incision will facilitate the insertion and a wider opening of the nasal speculum. Such incisions typically heal with an excellent cosmetic result.

The use of angled endoscopes is essential for gaining sufficient visualization beyond the relatively restricted view provided by the microscope to determine the extent of tumor removal and to avoid complications of limited visualization (16). Thirty-degree and 45-degree angled endoscopes enable one to see "around corners" and to determine whether tumor can be removed with either the endoscope or the microscope or to decide that dense adhesions preclude safe removal. In this context, the endoscope and operating microscope in combined use are complementary, and we believe essential, for maximizing the efficacy and safety of this approach. At present, however, the relatively large-bore (4-mm) rigid endoscopes limit the maneuverability of other instruments needed for safe tumor removal in these difficult access areas. One possible solution to this problem is the development of more low-profile, flexible, steerable, and high-resolution endoscopes that can be placed more out of the way of other instruments. With development of such a low-profile endoscope and with angled suction instruments and microforceps that are already available, more complete tumor removal could be achieved.

The lack of proximal control of circle of Willis vessels is another potential problem with the transclival approach, given that repair of a major vascular injury in this region would be difficult. Avoidance of vascular injuries can best be achieved by use of the micro-Doppler probe, neuronavigation systems, and angled endoscopes to identify these structures before sharply opening the dura or arachnoid membranes (12, 13, 16, 17, 25, 38, 49, 52).

Dural Closure and CSF Leak Avoidance

CSF leak is the most common postoperative complication of both transsphenoidal surgical approaches and posterior fossa approaches, with rates ranging from 1.5 to 6.4% for extended transsphenoidal approaches and from 5 to 30% for posterior fossa surgery (4, 8, 9, 12, 26–29, 38, 41, 53, 59, 60, 62, 66). The incidence of meningitis is directly associated with the incidence of CSF leakage. Most cases of "isolated" meningitis after epidermoid removal are aseptic in nature, most likely related to the epidermoid cyst contents (1, 5, 32, 41, 42, 57, 63). Our Patient 2 experienced a severe case of *E. coli* meningitis that may in part have been further exacerbated aseptic meningitis. This patient illustrates a key technical challenge of this transclival approach, namely, achieving an effective dural repair to avoid a CSF leak and meningitis. A related problem encountered in both of our patients is the highly vascular nature of the clival dura, which necessitates bipolar cauterization. Gaining hemostasis in this manner leaves little dura along the bony clival defect and thus increases the complexity of the dural repair. Further complicating this task is the very large CSF space ventral to the brainstem created as a result of tumor removal. Repair of such large defects requires 1) placing autologous tissue that spans the defect and effectively creates a water-tight seal, 2) creating an effective buttress to hold the autologous tissue in place, and 3) use of temporary decompression of the repair with 48 to 72 hours of CSF diversion. Typically, for repairing such large defects, we have used abdominal fat, collagen sponge, and a malleable titanium mesh buttress (13, 27, 66). This repair probably failed in the second patient because the initial fat graft was too small, allowing egress of CSF. Ultimately, the use of fascia lata was effective in combination with fat, collagen sponge, and titanium mesh for creating a lasting seal. The ideal repair method for these sorts of cranial base defects remains unclear, and certainly there are a variety of alternatives, including use of fascia lata or muscle for the tissue graft and autologous bone or cartilage and Teflon or Silastic materials for the buttress (9, 27–29). The collagen is most likely helpful as an additional "blanket" that rapidly promotes fibroblast ingrowth, resulting in a living scar (27). It remains unclear whether tissue glues such as Tisseel or BioGlue actually help to prevent such postoperative CSF leaks, but their use makes sense conceptually, at least in terms of helping to hold the repair in position.

CONCLUSIONS

The endonasal transsphenoidal transclival approach with the use of the operating microscope offers a direct and minimally invasive route for removing prepontine epidermoid tumors. Given their favorable texture, it seems that these tumors can be effectively decompressed, provided that angled endoscopes are used for panoramic visualization beyond the view provided by the operating microscope. Further progress needs to be made in perfecting reliable repair techniques for the large bony and dural clival defects that result from the approach. Whether other prepontine masses, such as petroclival meningiomas, can be removed from this route remains to be seen. Better instrumentation, including lower-profile high-resolution flexible endoscopes, will ideally allow this minimally invasive approach to be applied to a wider variety of cranial base pathological conditions.

DISCLOSURE

DFK is a consultant to Mizuho Corp. None of the other authors has a financial interest in the instrumentation or other products mentioned in this article.

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COMMENTS

The authors describe two patients with prepontine clival tumors. In one patient, the tumor had extended into the suprasellar cisterns, necessitating, in addition, the removal of the tuberculum and of the planum. The authors offer a very easy-to-follow and simple explanation of their technique. They also describe possible pitfalls of the operation in detail. The authors conclude that the transsphenoidal transclival approach to prepontine epidermoid tumors is a minimally invasive procedure especially well suited for epidermoid tumors, in view of their consistency.

Clearly, while technically reasonably straightforward, a transsphenoidal-transclival approach to prepontine epidermoid tumors can be associated with significant complications, as was the case in the authors' second patient. The incidence of 50% of meningitis cannot be taken lightly. There are many lessons to be learned from these two case reports. These include, among others, the lesson that the transsphenoidal microsurgical approach for the removal of pituitary tumors can be extended to removal of other cranial base lesions, as well as the obvious advantage of adding neuroendoscopy to the microsurgical technique for better visualization of the lesion, the pointers about avoiding neurovascular structures in the prepontine area, and finally, the description of the technique of closure, which I find especially interesting.

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This is an interesting article in that it discusses the important points in the extended transsphenoidal surgery, which is being performed more and more often. The points are applicable to extension along the planum as well as along the clivus. My major concerns are those discussed by the authors. How can the cerebrospinal fluid space be sealed in a successful manner in more than 95% of the patients, and how can the surgeon deal with serious bleeding from a limited approach with no proximal control? Extended visual exposure can be obtained with the endoscope, but the instrumentation for removing tumors and dealing with hemorrhage are not yet adequate. The very high incidence of cerebrospinal fluid leaks must be significantly reduced before these extended approaches can be promulgated. However, they do offer great potential for lesions that are otherwise difficult to approach without brain retraction.

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The authors describe a minimally invasive, direct route to the resection of prepontine epidermoid tumors via the endonasal transsphenoidal route. They describe their surgical technique and also discuss the potential pitfalls of the technique. Because these tumors are typically soft and avascular, this approach is certainly reasonable. It offers the advantage of being minimally invasive and offers the most direct trajectory. Clearly, cerebrospinal fluid leak and resultant meningitis, along with vascular injury, would be the greatest risks. The authors use micro-Doppler to minimize the risk of vascular injury while opening the dura. In addition, they did experience one case of severe meningitis. This article demonstrates the feasibility of this approach. However, more clinical experience will be necessary to evaluate the safety and efficacy of this approach compared with other approaches.

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