10.5005/jp-journals-10003-1078

REVIEW ARTICLE

Expanded Endonasal Approaches to the Anterior Skull Base

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ABSTRACT

Recent technological advances and growing cooperation between otorhinolaryngologists and neurosurgeons, coupled with an increasing knowledge of the anatomy of the ventral skull base, have led to the development of a series of surgical approaches to this region. Utilizing the nasal corridor, these expanded endonasal approaches (EEAs) benefit from the increased luminosity and definition provided by the endoscope to navigate through this corridor and reach a multitude of pathologies, both neoplastic and degenerative in nature. One of their common uses is to address tumors that arise from or invade the anterior cranial fossa; these lesions may include olfactory groove meningiomas, esthesioneuroblastomas and sinonasal malignancies. In order to safely resect these tumors through EEAs the surgical team must adhere to a series of steps, while planning the procedure as well as carrying it out. In this review article, the authors present these steps and describe the main patient selection criteria and complication avoidance strategies related to expanded endonasal approaches to the anterior skull base.

Keywords: Endoscopic surgery, Skull base, Cribriform plate, Endonasal approaches, Meningiomas, Esthesioneuroblastoma, Sinonasal Malignancies.

INTRODUCTION

Throughout the last two decades, growing cooperation between otorhinolaryngologists and neurosurgeons, supplemented by technological advances in endoscopy and instrumentation, have spawned a variety of approaches that utilize the nasal corridor to treat a host of anterior skull base pathologies.[4-7,17-19,22,23,25-27,29,31] These approaches are the direct result of translational studies from anatomical laboratories that furthered the knowledge of the surgical make up of this intricate region; as well as the exchange of techniques and perspectives between the two surgical specialties.

Although historically the sphenoid sinus has been routinely used as the main access route to reach sellar tumors,[10-12,14-16,33,37] these recent developments, through a series of modular approaches of increasing complexity and difficulty, have slowly expanded the possibility of using this path to reach virtually all the compartments of the ventral skull base, from the crista galli to the anterior arch of C2.[22,23] Among these are the anterior skull base modules, namely, the transcribriform and the transplanum/transtuberculum approaches; they can be employed separately, jointly or even in conjunction with the transsellar module, according to the pathology at hand.[9]

On this article, we present surgical strategies, approach selection criteria, pre- and postoperative nuances as well as complication avoidance methods in expanded endonasal approaches (EEAs) to the anterior skull base.

PATIENT SELECTION

The development of EEAs is linked to an attempt in providing patients harboring skull base lesions with less invasive, though still effective, direct routes with which to treat their tumors. With this premise in mind, EEAs seem to be advantageous in several instances:

- The approach itself demands the drilling and removal of the bony skull base, which is often infiltrated by disease; this feature is particularly useful in intracranial tumors that rise from the anterior skull base floor, such as meningiomas.
- Ligation or coagulation of tumor blood supply during the exposure provides early devascularization of the lesion and subsequently decrease blood loss.

- The cerebral parenchyma is only visualized toward the end of the procedure, after substantial tumor debulking has taken place; thus, manipulation of neural structures is hence kept to a minimum.

Though EEAs are typically portrayed as 'minimally invasive' techniques, they can nevertheless be employed in the treatment of complex skull base lesions, often with vascular encasement and cranial nerve involvement. Patient selection is, therefore, a crucial component of the safe use of these methods and must take into account the patient's regional anatomy, available equipment and hospital infrastructure and, above all, surgical team experience.

Several neoplastic processes that either arise from or transgress the anterior skull base are amenable to resection through an EEA; these are typically midline lesions, with or without an intradural component and include:

- Olfactory groove meningiomas
- Olfactory schwannomas
- Esthesioneuroblastomas
- Planum sphenoidale meningiomas
- Tuberculum sellae meningiomas
- Pituitary adenomas with suprasellar extension
- Craniopharyngiomas
- Sinonasal neoplasms with anterior skull base invasion
- Juvenile nasal angiofibromas (JNAs)
- Metastatic tumors

There are but a few contraindications to the use of EEAs (Fig. 1):

- Patients with active sinonasal bacterial or fungal infection require adequate antibiotic treatment prior to surgery;

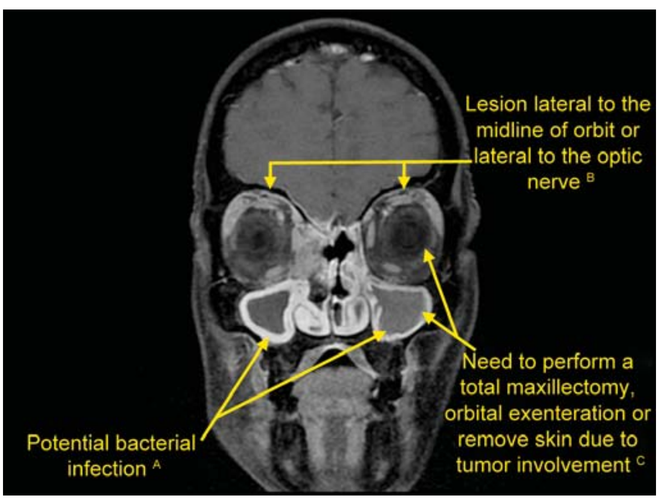


Fig. 1: (A) Purulent secretions should be analyzed with a Gram stain intraoperatively. A bacterial infection mandates treatment before entertaining a transdural approach. (B) Lesions that involve the skull base lateral to the midline of the orbital roof or lateral to the optic nerve are not amenable to an endoscopic resection (functional eye). (C) If the oncologic resection requires a maxillectomy (other than a medial maxillectomy), an orbital exenteration or resection of the facial skin, a pure EEA will not provide the desire exposure and resection. An EEA, however, can be used to complement an open approach

- Tumors that extend laterally across the midorbit cannot be entirely resected endonasally and may be best addressed by a lateral transcranial approach;
- Tumors that demand complete maxillectomy, orbital exenteration or skin removal to obtain safe margins.

As noted above, neither intradural pathology,nor involvement of the internal carotid artery (ICA) or any of its major branches, is a contraindication for an EEA. However, we strongly recommend that only teams with significant experience in both skull base endoscopy and cerebrovascular surgery treat such complex lesions through the nasal corridor.

Other nonneoplastic conditions that affect this region can also be managed through an endonasal route, especially encephaloceles and cerebrospinal fluid (CSF) leaks.[34] However, choosing an adequate method for reconstruction is just as important as adequately selecting patients for EEAs. In our experience the pedicled nasoseptal flap (Hadad-Bassagaisteguy flap, HBF)[13,20,30] is the most effective and reliable method of reconstruction; it can be used in the closure of up to two contiguous modular approaches.[36] Nonetheless, some patients' nasal septums may not provide enough tissue for closure and must be evaluated preoperatively, particularly when the patient has a history of previous sinonasal surgery or when sinonasal infection is present. If a HBF is not readily available, alternative methods of closure must be considered.

Age is usually not a major factor; although some pediatric patients may present with a partially pneumatized sphenoid sinus. Frameless stereotactic navigation and a thorough knowledge of the local anatomy render EEAs in this age group feasible and safe.[24] No major impact in craniofacial development has been associated with these approaches.

Similarly, adult patients with conchal pneumatization of the sphenoid sinuses may also be submitted to EEAs, provided the aforementioned safety measures are present.

SURGICAL TRAJECTORY PLANNING

Once the endonasal route has been elected, several steps are taken to safely plan the resection of an anterior skull base tumor and prevent complications. All cases are discussed between the otorhinolaryngology (ORL) and neurosurgery teams, in an attempt to predict technical difficulties of the procedure and to properly plan reconstruction strategies.

In general, the transcribriform approach is reserved for tumors that arise in the region of the olfactory groove (meningiomas, olfactory schwannomas) or that arise in the nasal cavity and erode the cribriform plate, to invade the cranial vault (esthesioneuroblastomas, sinonasal malignancies). Conversely, the transplanum/transtuberculum approach is best suited for more posterior lesions that either arise from the planum sphenoidale and tuberculum sellae

Table 1: Indications and structures involved in transcribriform and transplanum/transtuberculum approaches

Approach	*Main indications*	*Vascular structures involved*	*Neural structures involved*
Transcribriform	– Olfactory groove meningiomas – Olfactory schwannomas – Esthesioneuroblastomas – Sinonasal malignancies – Metastatic tumors	– Anterior ethmoidal arteries – Posterior ethmoidal arteries	– Olfactory bulb and fibers – Frontal lobes/gyrus rectus
Transplanum/ transtuberculum	– Planum sphenoidale meningiomas – Tuberculum sellae meningiomas – Pituitary macroadenomas – Craniopharyngiomas – JNAs – Sinonasal malignancies – Metastatic tumors	– Anterior cerebral arteries – Anterior communicating artery – Frontopolar arteries – Superior hypophyseal arteries – Superior intercavernous sinus (circular) – Cavernous sinuses	– Optic chiasm – Optic nerves – Hypothalamus – Pituitary stalk

regions (meningiomas), occupy the suprasellar space (pituitary macroadenomas, craniopharyngiomas) or arise in the nasal cavity and erode the planum-tuberculum complex (JNAs, sinonasal malignancies) (Table 1). However, tumor growth does not always respect these anatomical boundaries and a combination of both approaches is required; this is particularly true in large olfactory groove meningiomas that protrude posteriorly across the planum and into the sella.

Patients are submitted to a thorough preoperative clinical evaluation. Sinonasal anamnesis may reveal significant previous pathology mandating that the ORL team evaluates the patient endoscopically to detect active infection, local anatomy variants or deformities that may disrupt the approach or reconstruction stages of the procedure.

Also of particular interest is the neurological history, especially regarding the presence of preoperative cranial nerve deficits and signs or symptoms that may indicate an underlying cerebrovascular condition. If carotid or vertebrobasilar insufficiency/stenosis is suspected, the patient is submitted to a neurovascular evaluation. Visual function is also assessed and documented.

All patients undergo both computed tomographic angiography (CTA) and magnetic resonance imaging (MRI) studies of the head; these are fused and loaded into a frameless stereotactic navigation device that is used through the entire procedure. If signs of intracranial hypertension are observed, CSF diversion techniques (lumbar drain, external ventricular derivation) may be required in the postoperative period to prevent flap failure and leakage.

TECHNIQUES OF INSTRUMENTATION

Progressive expansion of endoscopic endonasal skull base surgery would not be possible without concomitant technological advancements and the development of procedure-specific instrumentation.[1,2] Initially, many of the devices were adopted from classical transsphenoidal microscopic surgery or from endoscopic sinus surgery. However, these tools did not have the length, angles and accuracy needed to allow safe procedures in the work corridor of the expanded endoscopic endonasal route.

The Hopkins rod lens system evolved along the years to achieve its actual design for skull base surgery. A rod-lens endoscope with a 4 mm-diameter narrow profile and a standard length of 18 cm allows its introduction through small apertures. 'Straight-view' (0^o) and 'angled-view' (30, 45, 70 and 90^o angled-lens endoscopes) enhance visualization. Xenon system light sources and high-definition digital cameras were also added to improve the image quality.

Gradually, new, dedicated instruments were also designed in order to give the surgeon the safety needed to accomplish secure endoscopic skull base approaches. Longer endonasal microinstruments, with secure grips and a variety of different tips are some of these new adjustments.

High-speed, low profile, extendable drills are currently available and are also mandatory for these approaches. Moreover, dedicated surgical Doppler ultrasonography, surgical image guidance systems and ultrasonic aspirators have been lengthened and became thinner to fulfill the new surgical requirements.

Tumor dissection within the confines of the nasal corridor requires specific training, a thorough knowledge of the ventral skull base anatomy and adequate instruments. One of the most recent developments in this field was the introduction of the NICO myriad (NICO Corporation, Inc.; Indianapolis, IN), a side-cutting device that provides simultaneous suction, traction and tissue resection.[3,8] This tool is particularly useful in debulking fibrous tumors and can be employed in both microscopic and endoscopic approaches; its long and narrow configuration makes it especially efficient during endonasal approaches.

Hemostasis can be challenging in endoscopic skull base surgery[21] and required particularly special devices and/or techniques. Customized endoscopic bipolars with protected sheaths and small microtips, for easy introduction, and pistol-grip handles give more precision during surgery. Other hemostastic systems, such as the Aquamantys bipolar sealer (Medtronic, Inc., MN), which simultaneously delivers radiofrequency energy and saline to the bleeding site, are being successfully used during EEAs.

RECONSTRUCTION

The main goal of skull base reconstruction after an EEA is to reestablish the natural segregation of the intracranial structures from the sinonasal cavity. Reconstruction is of critical importance, as it can inhibit the most unwanted postoperative complications: CSF leaks and intracranial infections.

The evolution and progression in complexity of the EEAs has made it feasible to reach and treat lesions in different compartments of the skull base, but also posed new challenges regarding reconstruction. Minor skull base defects may be reconstructed using a variety of free-grafting techniques, achieving an effective rate of success. However, larger defects or patients with an increased risk of CSF leaks (such as previous radiotherapy, morbid obesity or extrasellar tumors) are more reliably treated using vascularized tissue.

The HBF, used as part of a multilayer technique, is the preferred option when reconstructing the skull base.[13,20,30] The HBF flap vascular pedicle comprises the posterior septal artery (PSA); a terminal branch of the sphenopalatine artery (SPA). The HBF is harvested during the initial steps of the surgical approach, and is designed according to the size and shape of the anticipated defect. For anterior skull base approaches the flap is stored at the nasopharynx throughout the procedure and retrieved when needed. Recently, we adopted the use of a reverse mucoperiosteal anteriorly based flap (from the contralateral nasal septum mucoperiosteum) to reconstruct the donor site.[38]

Once the extirpative surgery is completed and hemostasis achieved, the multilayer reconstruction takes place with a subdural or epidural free graft (inlay) of collagen matrix (Duragen, Integra Lifesciences Corp., Plainsboro, NJ) or fascia lata. Care must be taken to avoid folds in the collagen matrix or fascia which could lead to channel formation and facilitate CSF flow.

The vascularized nasoseptal flap then covers the first layer. The flap must overlap the entire defect and its periosteal surface needs to be in direct contact with the denuded walls of the sinonasal tract. No foreign body or nonvascularized tissue should remain between the flap and the edges of the defect, in order to secure proper healing.

The flap is fixated in place by framing its edges with oxidized methyl cellulose and covering it with biological or synthetic glue. Gelatin sponges or other nonadherent materials are used to protect the reconstruction, creating a barrier between the flap and the nasal packing. Expandable sponge packing or a 12 French Foley catheter balloon are placed to press the multilayer reconstruction against the defect. If a Foley catheter is used, it must be slowly inflated with saline under direct endoscopic visualization, ensuring that it is not compressing intracranial structures or the flap vascular pedicle. Silicone splints are used to protect the septum.

COMPLICATIONS

The anterior cranial fossa contents are commonly accessed by the endoscopic endonasal approaches. A diversity of vascular and neural structures can be damaged as a consequence of improper technique (excessive pulling on tumor tissues, inadequate visualization of dissection planes, blind instrumentation) or from direct or indirect injury, such as thermal injury or mechanical trauma from drills, microdebriders and ultrasonic aspirators. Structures at risk vary according to the specific EEA module.[28]

Vascular Complications

Skull base lesions usually receive their major blood supply from branches of the ICAs. EEAs allow surgeons to early access and ligate these vessels, consequently promoting early tumor devascularization and decreasing the risk of bleeding during surgery.

A range of arterial structures may be vulnerable to injury during an EEA. The anterior and posterior ethmoidal arteries (AEAs/PEAs) are related to the transcribriform approach, the anterior cerebral arteries and their branches (fronto-orbital, frontopolar, Heubner arteries), as well as the anterior communicating artery (ACoA) present a closer relation to both the transplanum and transcribriform approaches. The ICAs can also be damaged during a parasellar dissection.

As most of these tumors grow centrifugally in respect to the skull base, the intracranial vasculature is displaced to the periphery; thus, vascular structures are frequently adherent or even encased by tumor capsule. To avoid vascular damage, the principles of microneurosurgery must be applied and respected. Internal tumor debulking and extracapsular sharp dissection are mandatory. Undue tumor retraction leads to vessel avulsion; thus, it must be avoided.

Complications related to the ethmoidal arteries usually occur when they are not correctly clipped or coagulated upon exposure. The AEAs canal must be identified and unroofed before the artery is ligated. Care must be taken to prevent retraction and bleeding from the proximal stump into the orbit, which may cause retrobulbar hematoma and increased intraocular pressure leading to blindness.

Low-flow capillary or venous bleeding, such as those from bone or mucosa, can be controlled by irrigation with warm saline (40-42°C) for some minutes. Bipolar electrocautery can be used selectively to achieve hemostasis in low-flow bleeding sites (veins or small arteries). Venous sinuses are better controlled with topical application of hemostatic agents (e.g. thrombin and gelatin paste).

Bleeding from the ICA, or any other high-flow arterial bleeding, mandates an effective teamwork. The surgeons must identify and isolate the source of bleeding with the large bore suction device, and then the endoneurosurgical bipolar device can be applied along the sidewall of the vessel, in order to weld the edges of the perforation. This requires that the tissue be in relatively close approximation (no loss of the vessel wall). Direct compression, compressive packing, aneurysm clips, suture repair are suitable alternatives. However, subsequent endovascular reconstruction or sacrifice of the vessel must be considered the definitive treatment.

Regarding venous structures, the cavernous and intercavernous sinuses are most important when targeting the anterior skull base through an EEA. Blood loss from the cavernous sinus must be managed quickly, considering it is usually a high-flow bleeding. Hemostatic material applied with cottonoids directly to the source of bleeding is an efficient technique to accomplish hemostasis; however, one must be careful with the amount of pressure applied to avoid cranial nerve damage. Bleeding from the superior intercavernous (circular) sinus can be anticipated in transtuberculum approaches and prevented by mechanical ligation (vascular clips) or bipolar cauterization through dural windows prior to actual dural opening. Hemorrhage from large veins can be controlled using the bipolar electrocautery.

Intraoperative Nerve Injury

Nerve injury is a feared postoperative complication. As expected, the literature demonstrates that the incidence of this type of complication is directly related to the complexity of the approach and is more common in extrasellar tumor surgery.

Some approaches are directly associated with postoperative neural deficits. A transcribriform approach generally produces olfactory impairment; however, a tumor in this location often causes anosmia. Olfaction can also be compromised in a transplanum/transcribriform approach, if the surgeon does not respect the anatomical limits of the approach and perform an excessively anterior resection of the skull base (anterior to the posterior ethmoidal artery), causing damage to the olfactory fibers and epithelium.

Tumors extending to the cavernous sinus, such as invasive adenomas, are also potential cases for cranial nerve damage, if proper microsurgical technique is not used. Tumor debulking under direct endoscopic visualization using two suctions, instead of blind curettage, enhances tumor removal and prevents trauma to the normal gland and cavernous sinus contents.

Nerves can also suffer indirect damage caused by extensive drilling of neighboring bony surfaces leading to thermal injury. Copious irrigation with saline during drilling is essential to avoid this complication.

Delayed postoperative neurological deficits can occur and should be promptly investigated. A compressive effect of the nasal balloon packing may cause visual deterioration on those patients whose medial optic canals have been decompressed. If suspected, the balloon must be immediately deflated. Patients presenting preoperatively with severe visual impairment must be kept at an adequate and stable blood pressure after surgery (mean arterial pressure around 85 mm Hg), to avoid ischemia of the nerves.

CSF Leak

Reported rates of postoperative CSF leaks after traditional skull base approaches are substantial, varying from 13 to 29% in the literature.[28] Skull base reconstruction is also a challenge when performing endoscopic endonasal skull base surgery.

As previously mentioned, a reconstructive paradigm shift from free tissue grafting to vascularized tissue has dramatically decreased the incidence of CSF leaks after EEAs. A multilayer technique using the HBF is our preferred option for reconstruction.

Postoperative management is also essential to prevent CSF leaks. Patients must be advised to avoid nose blowing and any activity that may increase intracranial pressure (e.g. lifting heavy objects, abdominal straining).

A CSF leak may not become apparent until nasal packing removal, 3 to 5 days postoperatively. Leaks are confirmed by tilt test, noncontrasted CT scan (increased intra-axial air), nasal endoscopy and if necessary, beta-2-transferrin test. We advocate immediate endonasal repair. A lumbar spinal drain is used in those select patients who are considered a high risk for failure of closure (large craniopharyngiomas invading the third ventricle).

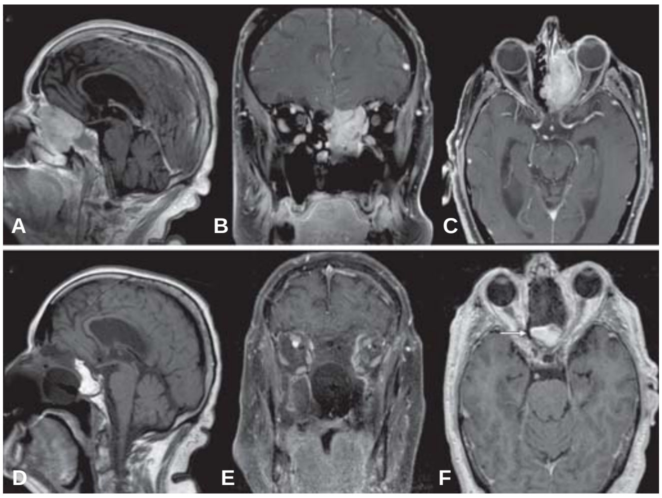
Infectious Complications

Bacterial sinusitis or rhinosinusitis can occur as a consequence of postoperative nasal edema, blockage of the airflow and crusting, leading to bacterial overgrowth. Infections of the paranasal sinus require medical treatment with antibiotics and intensive local care, such as douching and nasal debridement.

Postoperative intracranial infections after EEAs are extremely rare, with an incidence of 1.8%.[32]

Other Complications

Nasal morbidity is typically ‘minor’ and resolve within 6 months of the procedure.[35] Nasal splints are used until the fifth postoperative day to avoid synechiae. Crusting can be



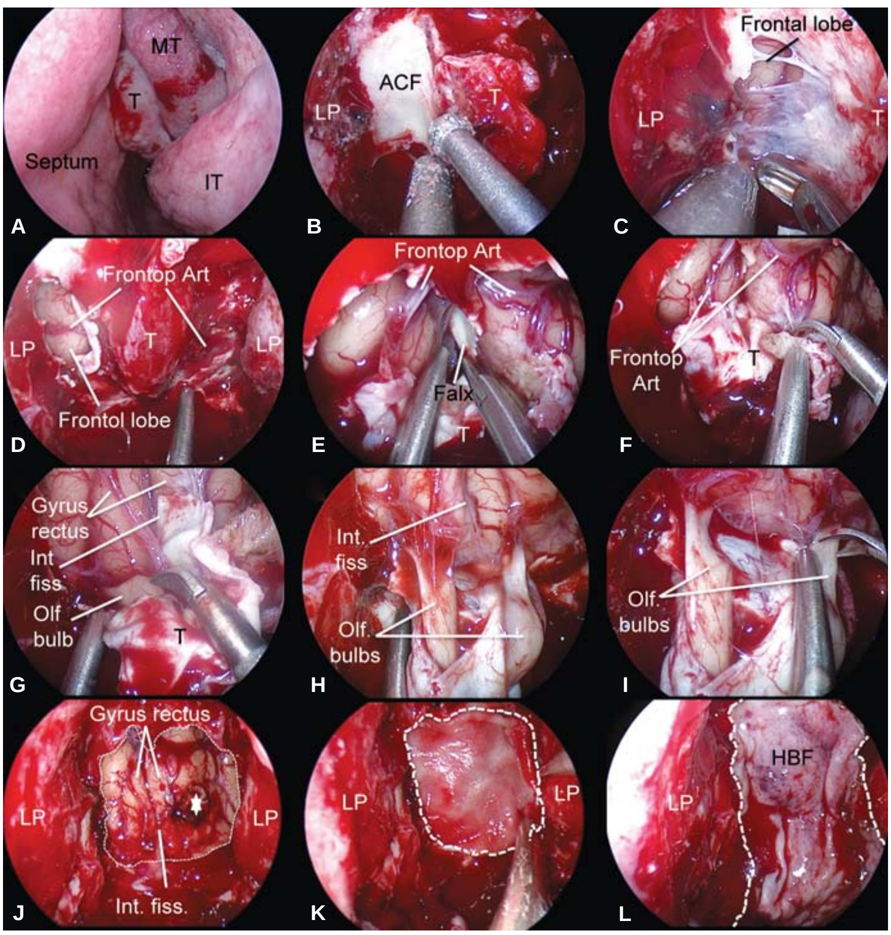
Figs 2A to F: Preoperative (A, B, C) and immediate postoperative (D, E, F) T1 weighted MR imaging of the case illustration. (A) Sagittal view, (B) coronal view (observe the invasion of the anterior cranial fossa), (C) axial view (observe infiltration and displacement of the left lamina papyracea with optic nerve compression), (D) sagittal view (observe the Foley catheter balloon used to secure the flap and the fat graft in position), (E) coronal view, (F) axial view (white arrow: enhancement of the HBF confirms appropriate vascularization)

reduced by continuous nasal hygiene with saline solution and by active debridement upon regular ORL consults in the postoperative period.

CASE ILLUSTRATION AND SURGICAL TECHNIQUE

A 76 years old male presented with an insidiously progressing headache, nasal congestion and anosmia. MRI detected an enhancing mass occupying the left posterior nasal cavity and sphenoid sinus, the left ethmoid cells and eroding the anterior skull base into the cranial cavity (Figs 2A to C). Endoscopic biopsy corroborated the presumed diagnosis of esthesioneuroblastoma, and after discussion of treatment alternatives the patient agreed with our recommendation to use an endoscopic endonasal transcribriform approach.

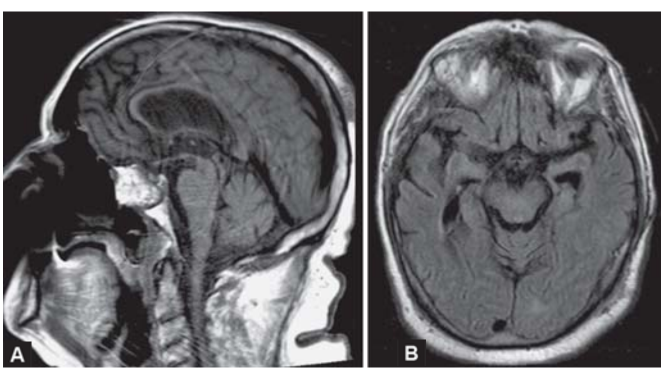
The patient was positioned supine, with the head fixed on a three-pin head-holder and slightly turned to the right. The patient's face and abdomen (in case a fat graft is needed) were prepared and draped in standard fashion while only



Figs 3A to L: Stepwise depiction of the case illustration. (A) Initial approach through the left nostril, (B) drilling of the anterior cranial fossa floor, (C) removal of the bone of the anterior cranial fossa, (D) midline view after bone removal and initial dural opening, (E) anterior dural opening and falx incision, (F) arachnoidal dissection, (G) identification of the olfactory bulbs, (H) exposure of the olfactory bulbs and dissection from the basal frontal lobes, (I) incision of the olfactory bulbs, (J) 30° endoscopic view of the dural defect after tumor resection (dashed line); observe the discrete cortical lesion (star) where an excisional biopsy was performed for suspicion of local infiltration, (K) placement of the collagen matrix sheet over the dural defect (shaded line), (L) placement of the HBF over the collagen matrix sheet (shaded line)

Abbreviation: ACF: Anterior cranial fossa; Frontop Art.: Frontopolar arteries; HBF: Hadad-Bassagaisteguy Flap; Int. Fiss.: interhemispheric fissure; IT: Inferior turbinate; LP: Lamina papyracea; MT: Middle turbinate; Olf. bulb: Olfactory bulb; T: Tumor the nostrils remained exposed. The entire procedure was performed under neurophysiological monitoring assisted by frameless stereotactic navigation. Standard preoperative antibiotics, typically a first generation cephalosporin, were administered intravenously during anesthetic induction.

The initial approach was performed under direct endoscopic visualization, through the predominantly involved nostril (in this case, the left). The tumor was identified occupying the posterior nasal cavity, just behind the head of the middle turbinate (Fig. 3A). The ipsilateral middle turbinate was resected and the tumor debulked. The posterior portion of the tumor was followed into the sphenoid sinus. A right sphenoidotomy was completed; thus, communicating the posterior nasal cavities into a single cavity. A HBF was raised on the healthy side and stored in the nasopharynx; a subsequent bony posterior septectomy and reverse flap followed, after corroborating negative margins at the superior aspect of both flaps. Next, bilateral ethmoidectomies are performed, exposing the implantation of the involved cartilaginous septum on the anterior cranial base. This tissue, basically composed of the remaining tumor 'stump' was preserved while drilling of the bone of the anterior fossa floor takes place (Fig. 3B). The bilateral AEAs and PEAs are also identified and coagulated. Once the bone is egg-shell thin, it was removed with Cottle elevator, Kerrison rongeurs and forceps (Fig. 3C). The dura of the anterior fossa was then visible, with the tumor 'stump' attached to the cribriform plate in the midline (Fig. 3D). Bone removal was extended laterally to include the lamina papyracea. This is usually done if involved by tumor (as it was the case on the left side of this patient), or to facilitate control of the ethmoidal arteries. The dura was opened in 'inverted U' fashion and the cerebral falx is incised (Fig. 3E); this allowed *en bloc* displacement of the residual tumor and the entire cribriform plate downward into the nasal cavity. With careful microsurgical technique, using gentle suction as traction and sharp dissection, all arachnoid adherences were freed (Figs 3F to H) and both olfactory bulbs were incised for margins (Fig. 3I); great care was taken to preserve the frontopolar arteries and the integrity of the frontal lobes. Once the lesion is fully dissected away from the cerebral parenchyma, the dural opening was completed posteriorly (Fig. 3J), thus completely liberating the surgical specimen. Once free margins were confirmed by pathology, hemostasis and reconstruction ensued. A single sheet of collagen matrix (Duragen, Integra Lifesciences Corp., Plainsboro, NJ) is placed inlay on the defect (Fig. 3K); the HBF previously stored in the nasopharynx is retrieved and positioned over it (Fig. 3L). Occasionally, as occurred in this case, a fat graft is applied prior to positioning the HBF; this measure simulates the skull base curvature after resection of large lesions with significant dead space, permitting optimal flap positioning. Finally, the reconstruction was secured in place with oxidized methylcellulose, synthetic glue and Foley catheter balloon.



Figs 4A and B: Control MR imaging at 3 months postoperative period. (A) T1-weighted sagittal view; observe the HBF-fat graft construct within the sphenoid sinus, (B) fluid attenuated inversion recovery (FLAIR) axial view confirms the integrity of the basal frontal lobes

Immediate postoperative imaging confirmed a complete resection of the lesion (Figs 2D to F); and the diagnosis of esthesioneuroblastoma was confirmed.Recovery was uneventful. Control imaging at 3 months confirmed complete resection of the lesion (Fig.4A) and showed no signs of any injury to the basal frontal lobes (Fig. 4B).

CONCLUSION

Expanded endonasal approaches appear to be safe and effective for the treatment of a variety of anterior skull base lesions. Nonetheless, they require proper equipment and experience in order to ensure their efficacy and safety.

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