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Endoscopy for Skull Base Surgery

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Abstract

The endonasal approaches for skull base surgery have evolved in the recent decade. There are many publications of this technical safety and good outcomes, comparable with conventional procedure and have less morbidities. In this chapter, the authors describe the approach and surgical technique for each area of the skull base.

Keywords: Endoscopy, Skull base

1. Introduction

Lesions of paranasal sinuses, as well as those within skull base region, have long been challenging to rhinologists and neurosurgeons for several decades. Historically, the only available surgical approaches for these pathologies have traditionally been extensive and, often, invasive open procedures. Despite ample corridor created by open surgery, its major drawbacks during the surgery have been the poor visualization due to suboptimal illumination and magnification of the surgical fields. This fact could become more significant in those with pathologies in deep, narrow or complex anatomical areas. In some cases, en bloc tumor resection can be more easily performed through an open technique while in deep and difficult lesion may not possible to obtain the precise and free surgical margin due to poor visualization. In addition to the limited visualization by open surgery, these massive maneuvers can result in significant blood loss, morbidity or mortality.

Based on important principles, any evolution of surgical equipment and techniques has the same crucial concepts. First, it needs to minimize the associated surgical morbidity/mortality.

Second, it should maintain the patients' functional outcomes, parallel to the high success rate of surgery, i.e., for neoplasms, to achieve oncological control.

Later, development of surgical technique utilizing microscopy has been applied to the operative management of intracranial pathologies. Microsurgery had proven better patients' outcome compared to the historic open procedures, likely from the improved visualization and magnification of the operative field. Consequently, smaller skin incision and less amount of bone removal can achieve similar, if not better, overall result of the same lesions. Patients' safety as well as satisfaction has been greater with microscopic surgery. Therefore, microsurgery has been recognized as the standard of care for many neurosurgical and otolaryngological procedures. However, despite the vast usefulness of the microscope in neurosurgery and otolaryngology, it is not perfect. For the fact, shadow from an outside light source, an operating microscope, can hinder clear visualization at corners of the lesions or critical structures. This drawback is very obvious if one performs an operation through a small and narrow passage, i.e., transsphenoidal route either by sublabial or transnasal technique. This may, indeed, result in a subtotal resection.

For the past few decades, innovation of endoscopy has been developed and accepted as a minimally invasive technique. Various endoscopic tools and techniques have been applied to appropriate organs in different surgical fields. Unlike an outside light source from an operating microscope as mentioned above, visualization under endoscope has the superiority, obtaining a panoramic view with minimal or no shadow due to its light coming off the end of an endoscope. This is very factual through the narrow corridor, i.e., transsphenoidal route. In addition, endoscope provides excellent magnification that enhances the critical anatomical view beyond the operating site. Furthermore, the variety of angled lens endoscope allows surgeons to inspect "hidden" areas, especially "around the corners." Hence, some surgeons have been utilizing endoscopy as an assisting tool along with open or microsurgery so that it enhances visualization around the corners to improve resection of the target pathology. It reassures the complete removal of the tumors.

The treatment of the sinonasal tumors by endoscopy has been widely employed after the evolution of the endoscopic application for the paranasal and sinus diseases in the 1980s, which was introduced by Wigand and Messerklinger.[1, 2] Subsequently, the more properly designed endonasal instruments were developed and adapted to the endoscopic methods. This was popularized and spread over the otolaryngologists world by Stammberger and Kennedy.[3, 6] The endoscopic surgery for the intracranial pathology was first described in 1920s. Then, it was mainly applied within the ventricular system for the treatment of hydrocephalus. In 1990s it was, for the first time, reported for the treatment of pituitary lesions via transsphenoidal route as a collaboration between the otolaryngologists and the neurosurgeons.[7, 11]

Recently, endoscopy has been employed for surgical treatment of various sinonasal pathologies. With the success of endoscopic sinus surgery, this approach has progressed further to the treatment of intracranial lesions namely in the vicinity of the skull base. In the aspect of skull base area, by accessing the cranial base via the natural anatomical corridors such as the nostrils or the oral cavity, endoscopic procedures can preserve critical and normal structures without leaving patients with cutaneous/visible scar. Moreover, better visualization with little, or no, brain retraction can be obtained. Hence, improvement of oncological control along with

minimal functional morbidities has been reported by many authors. To date, there have been several publications that reiterated excellent results of the surgical outcomes to prove the efficacy of this innovative technique. Therefore, in some pathology, endoscopic procedures are considered one of the available standard treatments.

The endoscopic surgery has been expanded for the treatment of the lesions along the skull base, including both the median sagittal and paramedian coronal planes in the fashion of the multidisciplinary team approach.[12, 14] True team work can enhance the most benefit of the surgical techniques. The maintaining of clear visualization simultaneous with the two-hand dissecting technique cannot be accomplished independently. Moreover, the team approach has more efficient potential to manage the inevitable crisis during surgery.

Parallel to the surgical technique advancement, the safety from the new surgical method should be assessed for clinical use. Although, the endoscopic surgery has been known as a minimally invasive technique, it also carries a risk of complications. The incidence of complication has the different degrees of possibility depending on the surgical pathologies and procedures. The death and neurological deficits (transient or permanent) are the definite sequelae of the major complications from the endoscopic skull base surgery that includes the cerebrospinal fluid (CSF) leak, the intracranial infection and the neurovascular injury. The following rhinological symptoms have been considered as the minor complications as they don't cause severe morbidities for the patients: the nasal obstruction, the change of smell and sinusitis.

2. Patient selection

Not all the diseases could manage with endonasal technique. If the disease involves subcutaneous of skin or skin itself, the external approach should be more proper. If the tumor extends lateral to the center of the orbit, the orbit itself will be in the axis of the surgical corridor and block the working space. However, the patient selection depends on surgeon's experience.

3. Instrument

Author recommends using a high-definition camera, 4-mm telescopes in various angles (0, 30, 45, 70 degree), a powered instrument (microdebrider, ultrasonic aspirator, drill), hemostatic materials and devices and material for skull base reconstruction. The image-guided surgery system is highly recommended.

4. Surgical approaches

Surgical approaches for endonasal skull base can be classified into two groups based on anatomical view: sagittal plane (Figure 1) and coronal plane (Table 1).

| Sagittal plane | Coronal view |
|----------------|-------------------------|
| Transfrontal | Anterior cranial fossa |
| Transcribiform | -Orbital approach |
| Transplanum | Middle cranial fossa |
| Transellar | -Pterygomaxillary fossa |
| Transclival | -Infratemporal fossa |
| Transodontoid | Posterior cranial fossa |
| | -Parapharyngeal space |

Table 1. Surgical approaches

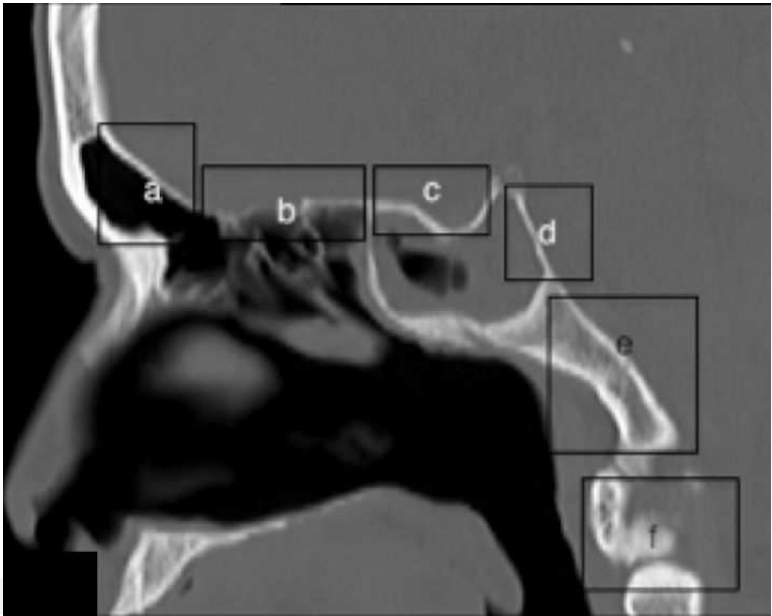


Figure 1. Endonasal approaches to the skull base in sagittal view. a) Transfrontal b) Transcribiform c) Transplanum d) Transsellar e) Transclival f) Transodontoid

4.1. Sagittal view

4.1.1. Transfrontal approach

This approach can be used in chronic frontal sinusitis, frontal fibro-osseous lesion and frontal sinus mucocele. This area can be reached by Draf III procedure or modified Lothrop which has to remove posterior part of nasal septum, remove the bone anterior to frontal sinus and connect both frontal sinus together by removing interfrontal sinus septum (Figures 3 and 4).

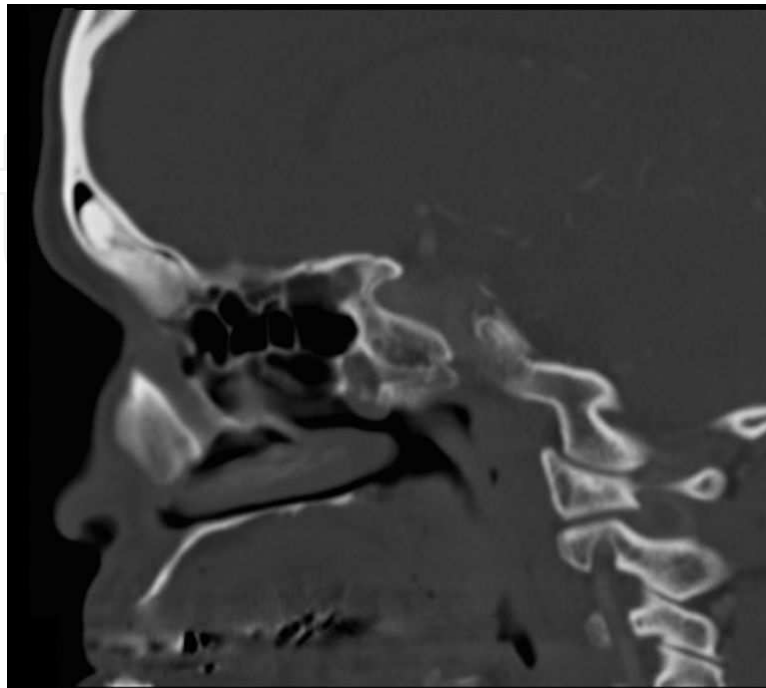


Figure 2. Sagittal view of CT scan shows osteoma in frontal sinus.

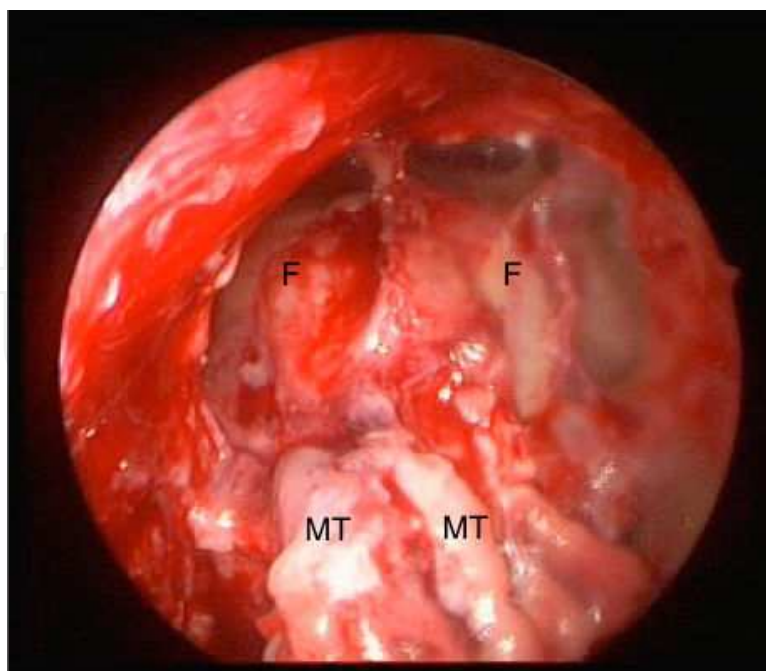


Figure 3. Endonasal view of both frontal sinus after Draf III procedure; F, frontal sinus; MT, middle turbinate.

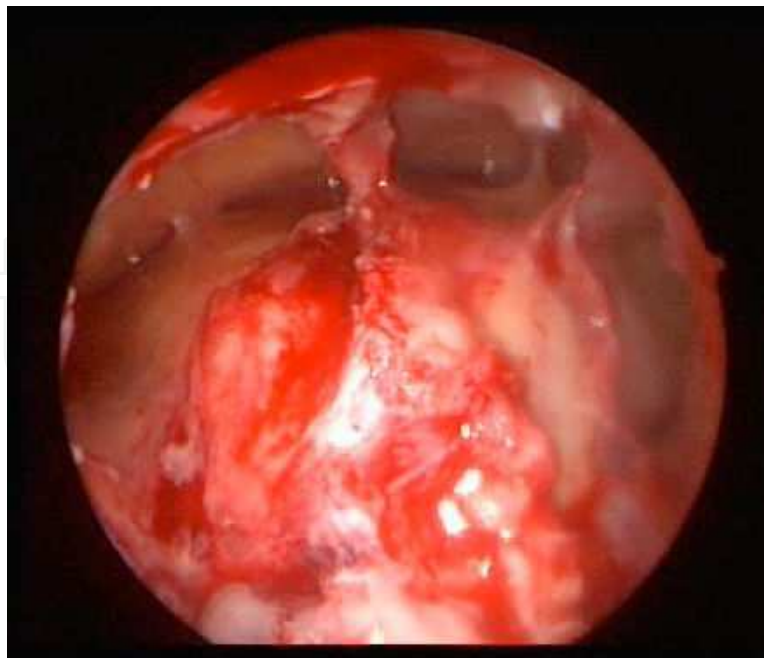


Figure 4. Endonasal view of both frontal sinus after Draf III procedure; F, frontal sinus; MT, middle turbinate.

4.1.2. *Transcribiform approach*

This approach is commonly utilized for olfactory area tumor such as olfactory neuroblastoma (esthesioneuroblastoma) and olfactory groove meningioma. This approach starts with complete sphenoidectomy and Draf IIa/b or Draf III. The nasal septum removal should start from the crista galli to the sphenoid sinus. The anterior ethmoidal artery and posterior ethmoidal artery should be cauterized and transected to prevent bleeding and decrease the blood supply to the tumor. Cribiform plate should be thinned with diamond burr prior to its removal by bone rongeur so that the dura is clearly seen. The required area of bone exposure usually depends on oncological margin. The maximal bone removal at the cribiform plate can be from posterior wall of frontal sinus to planum sphenoidale in sagittal view and from medial wall of orbit to the other one in coronal view. The crista galli is thinned and removed from its dural attachment, the falx cerebri. After dural opening, similar microsurgical technique for tumor dissection is employed by two-hand method.

4.1.3. *Transplanum approach*

Neoplasms at suprasellar area, such as tuberculum meningioma (Figure 9) or craniopharyngioma, typically require this particular approach. Bone removal at the posterior nasal septum and bilateral sphenoidotomy must be done as well as identification of optic nerves and optico-carotid recesses on both sides. Using similar steps as previously mentioned, the bone of skull base should be thinned and removed (Figures 10, 11). After dural opening, awareness of and early identification of critical structures, i.e., optic nerves and chiasm, internal carotid and anterior cerebral arteries and pituitary gland and its stalk (Figures 12, 13, 14), are critically



Figure 5. CT of an olfactory neuroblastoma. The tumor fully occupies the sino-nasal cavity and destroys the cribriform plate with intracranial extension.

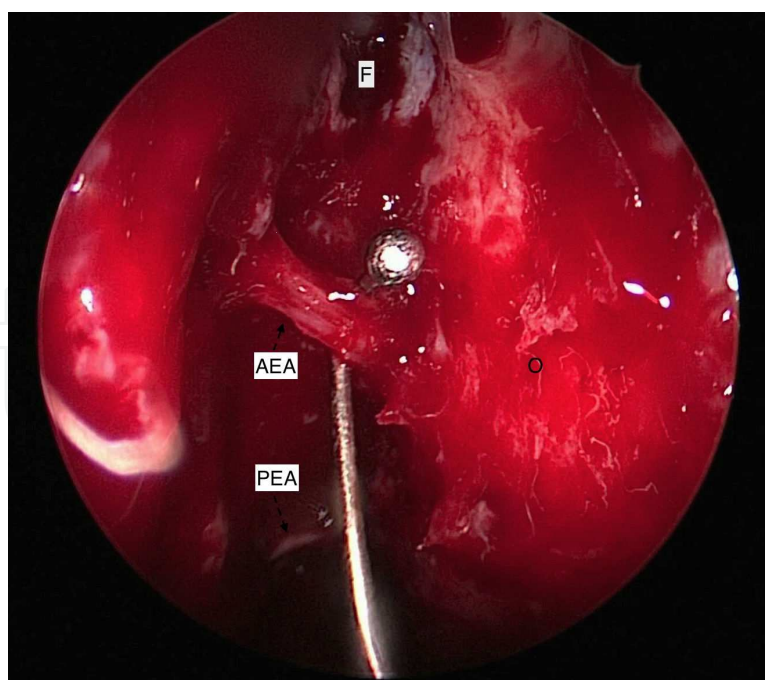


Figure 6. Left endonasal view, after endoscopic sinus surgery. The anterior ethmoidal artery was pulled with sinus seeker. F: frontal sinus O: orbit AEA: anterior ethmoidal artery PEA posterior ethmoidal artery

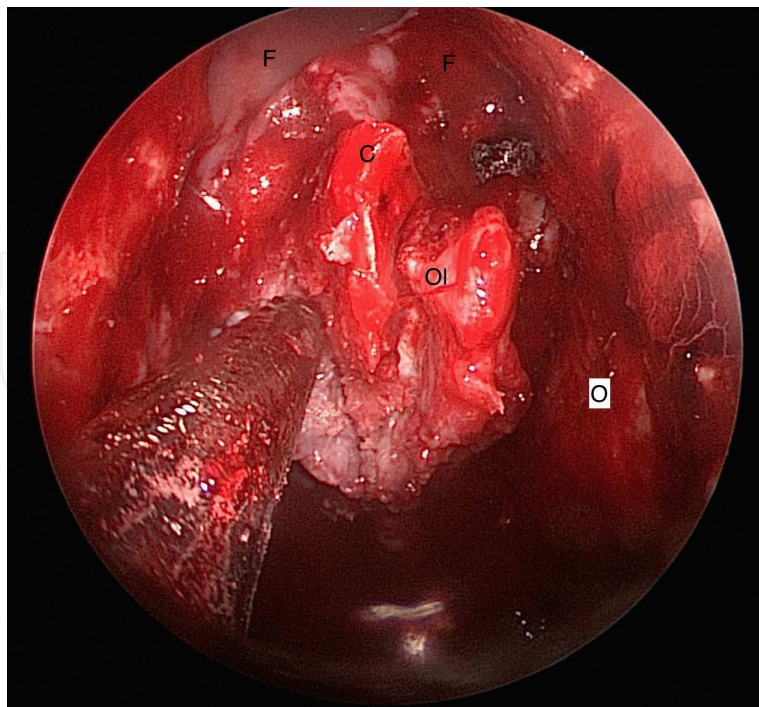


Figure 7. Endoscopic view of Draft III procedure and removal of nasal septum. The crista galli (C) in midline and first branch of olfactory nerve lateral to crista galli both sides are shown. F: frontal sinus C: crista galli OI: first branch of olfactory nerve O: orbit

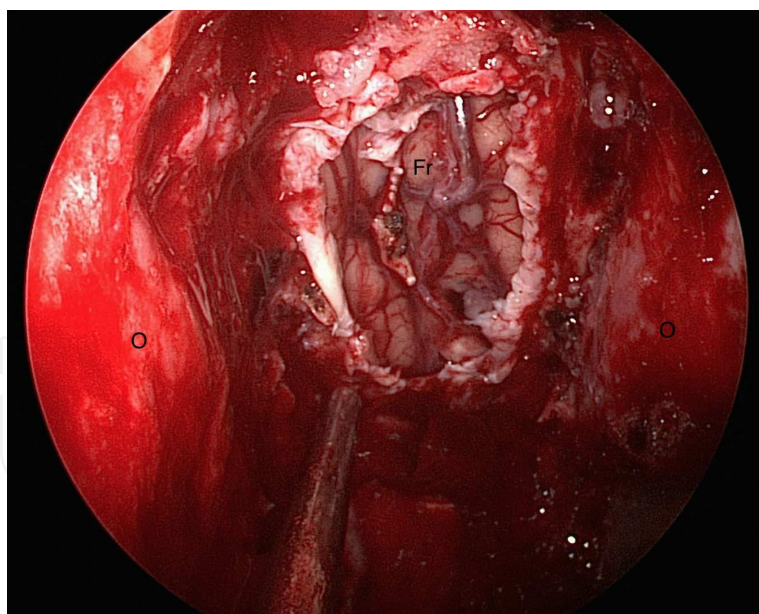


Figure 8. Endoscopic view after removing cribriform plate and dural opening demonstrates frontal lobe and orbit on both sides. O: orbit Fr: frontal lobe

important. Bi-manual technique, using similar microsurgical dissection, should be delicately performed. In some craniopharyngiomas, entry to the third ventricle is necessary for further tumor resection (Figures 15, 16).

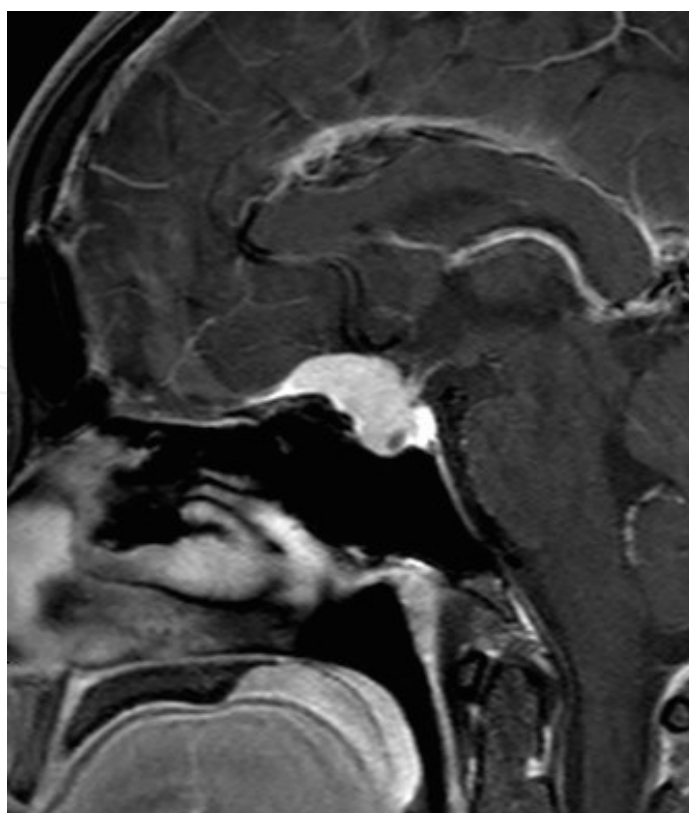


Figure 9. Sagittal MRI shows planum meningioma with compression of optic apparatus. The anterior cerebral artery complex is superior to the tumor.

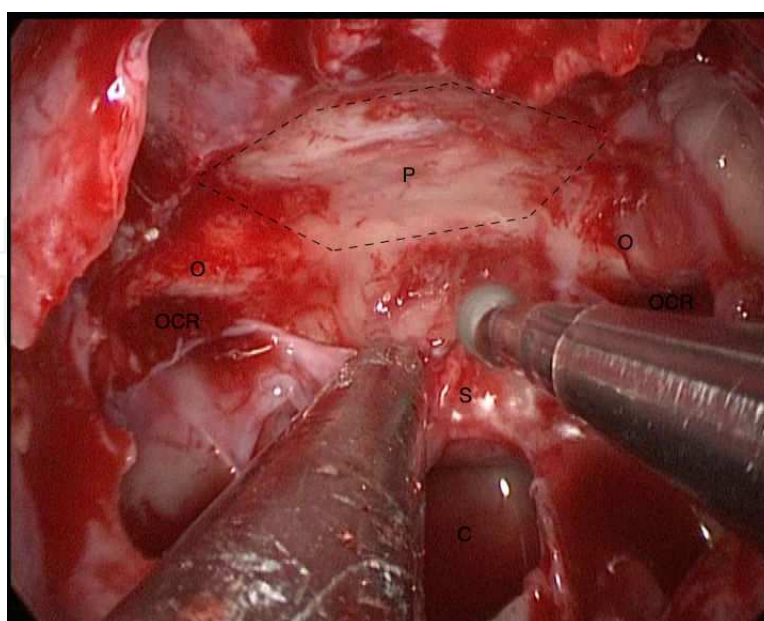


Figure 10. Endonasal view of planum sphenoidale and sella. P: planum sphenoidale (bony area within dashed line needs to be removed) O: optic nerve OCR: optico-carotid recess S: sella C: clivus

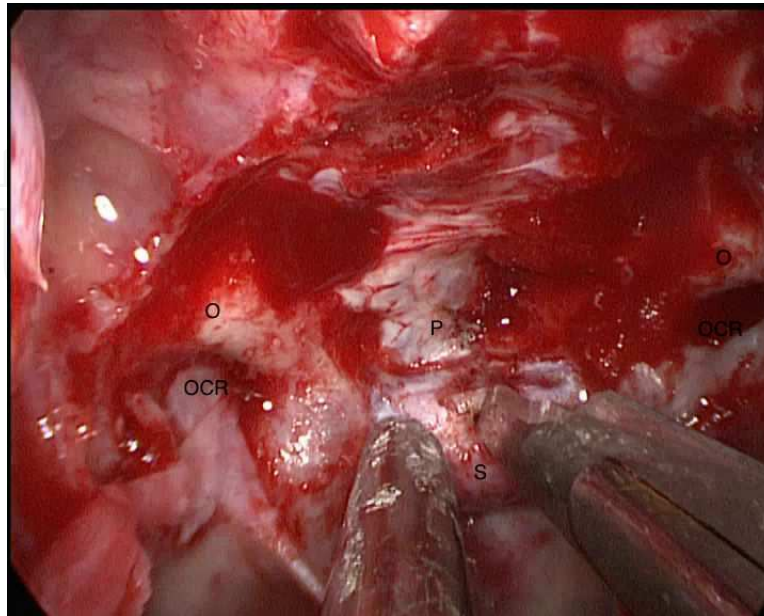


Figure 11. Endoscopic view demonstrates incision of the dura after removal of bony part of skull base. O: optic nerve OCR: optico-carotid recess P: planum sphenoidale S: sellar

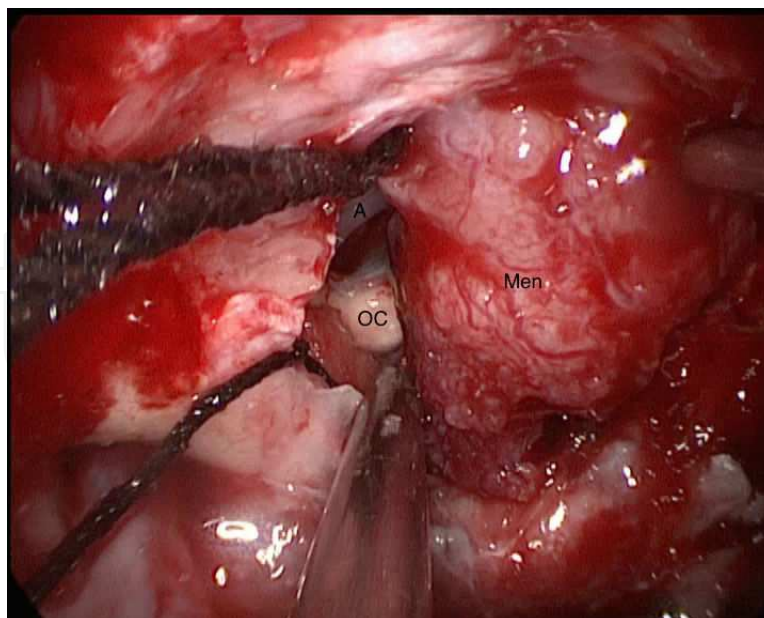


Figure 12. Endoscopic view after partial tumor removal illustrates the meningioma(Men), showing optic chiasm(OC) and anterior cerebral artery(A). Men: meningioma OC: optic chiasm A: anterior cerebral artery (A1 segment)

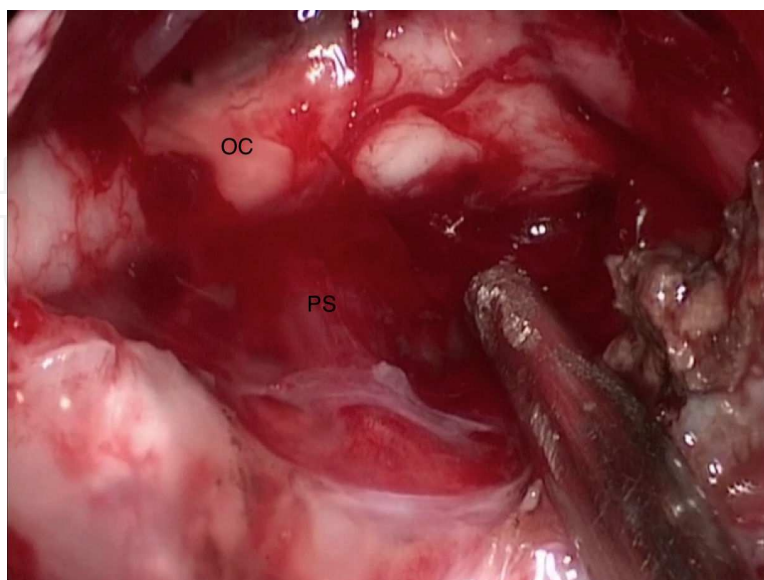


Figure 13. Endoscopic view after complete tumor removal depicts optic chiasm and pituitary stalk. OC: optic chiasm
PS: pituitary stalk

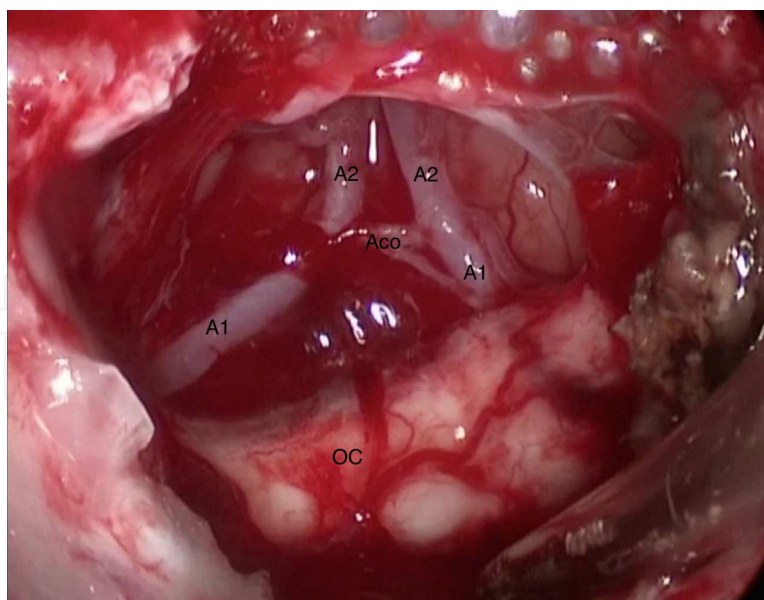


Figure 14. Endoscopic view of 30 degree angle lens, after complete tumor removal, shows more superiorly located structure. OC: optic chiasm A1: left and right anterior cerebral artery (A1 segment) Aco: Anterior communicating artery A2: left and right anterior cerebral artery (A2 segment)

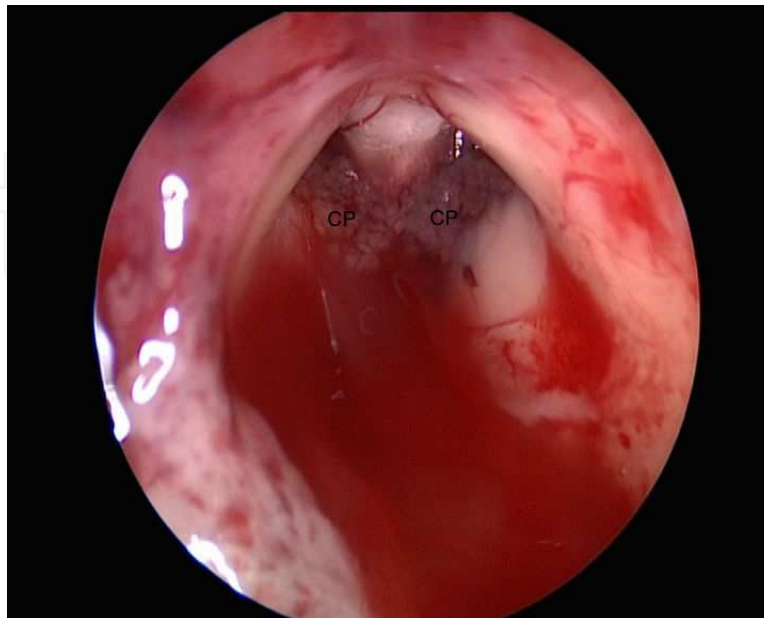


Figure 15. Endoscopic view using 30 degree lens looking upward after removal of craniopharyngioma depicts both foramen of Monroe. CP: choroid plexus running from both lateral ventricle into the third ventricle

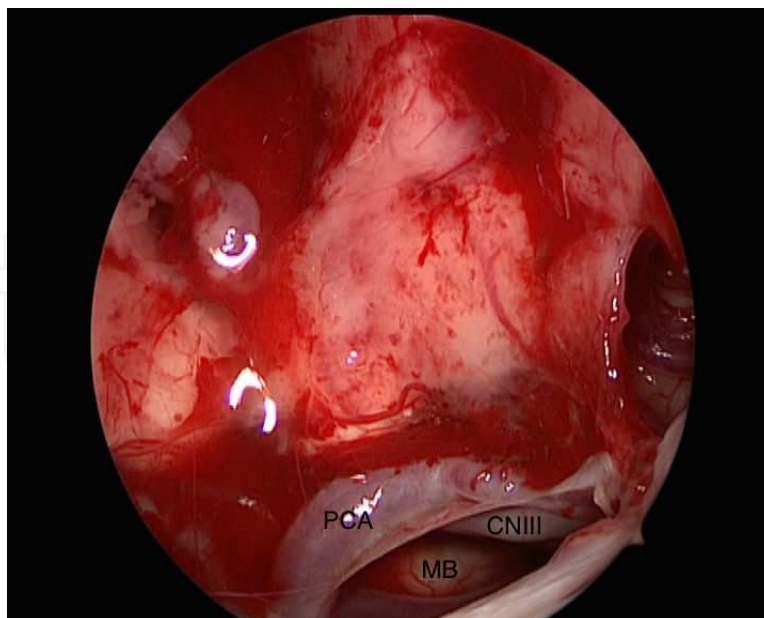


Figure 16. Endoscopic view using 30 degree lens looking downward after removal of craniopharyngioma reveals posterior structures. PCA: posterior cerebral artery CNIII: oculomotor nerve MB: mammillary bod

4.1.4. Transsellar approach

The most common disease for this approach is pituitary adenoma. This is the basic procedure of skull base that a surgeon should start to practice. After posterior nasal septectomy and bilateral sphenoidotomy, the sellar will come into the center of view. All the landmarks structures, e.g., internal carotid artery (ICA), optic nerve, optico-carotid recess, sellar, clivus and planum sphenoidale, should be identified. Sellar bone can be removed with diamond bur and manual instrument to expose the dura. The dura needs to be opened by using bipolar diathermy for hemostasis prior to incision with knife. The pituitary adenoma could be removed in a variety of techniques depending on the consistency of the tumor. The pituitary stalk, superior hypophyseal should be taken care for prevention of long-term endocrine malfunction.

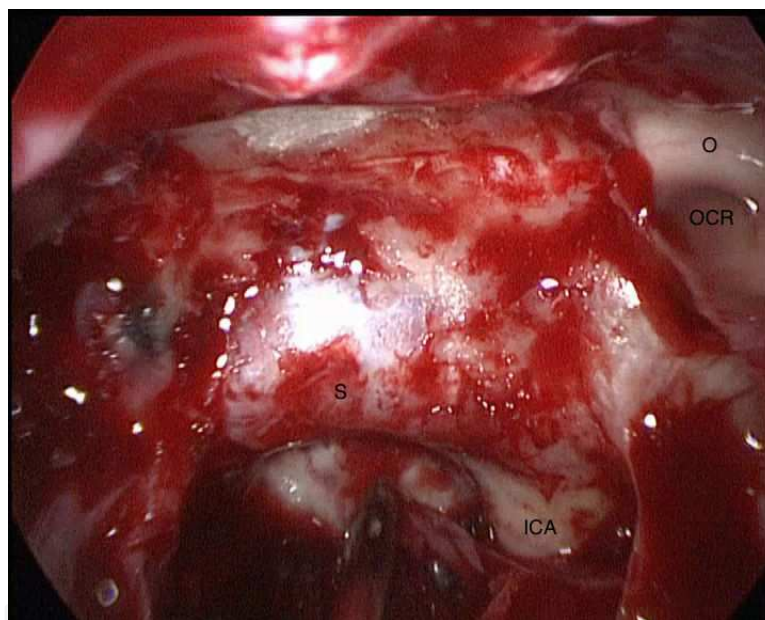


Figure 17. After removal of sellar bone, the sellar dura is exposed. O: optic nerve OCR: optico-carotid recess S: sellar ICA: internal carotid artery

4.1.5. Transclival approach

The clivus extends from sphenoid floor to foramen magnum. The common disease in this area includes meningioma and chordoma. This approach provides direct access to anterior surface of brainstem. The bony part of the clivus has a rich blood supply which surgeon should be cautious. After bony removal with diamond drill, the dura should carefully be incised because the 6th cranial nerve could be injured as it runs more superficially laterally. The vertebrobasillar artery should be carefully dissected and preserved.

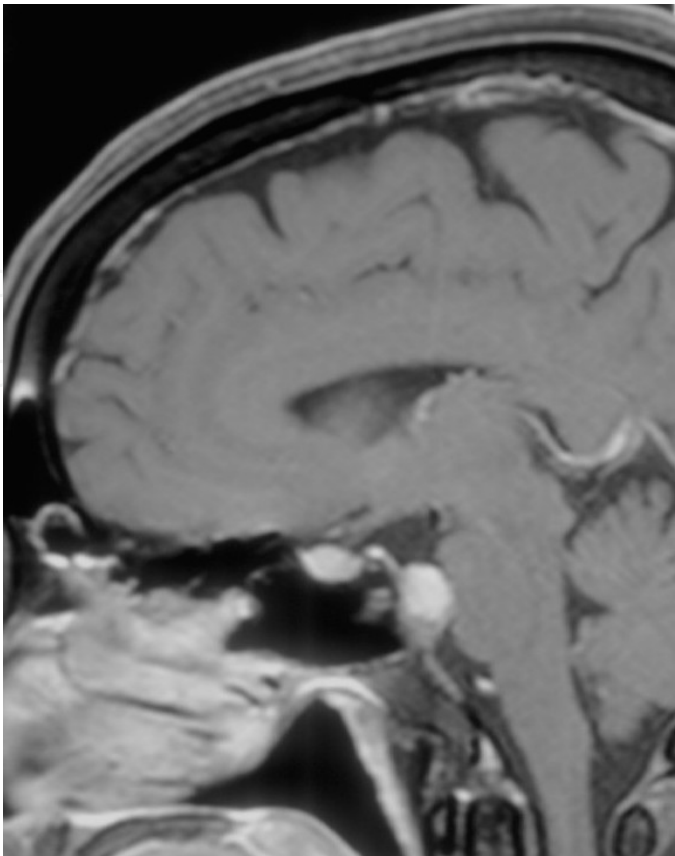


Figure 18. Sagittal MRI shows clivus chordoma pushing on brainstem, patient visit with diplopia from left lateral rectus muscle palsy.

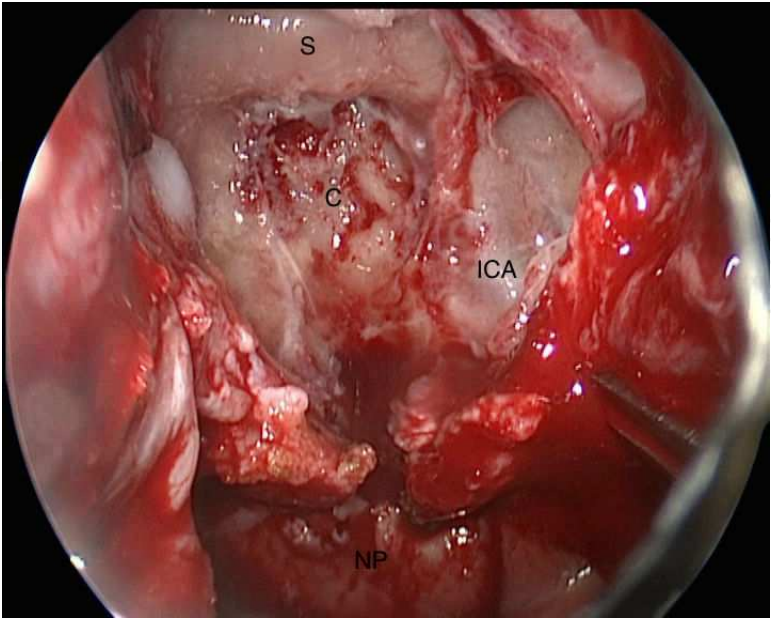


Figure 19. Endonasal view while drilling clivus. S: sellar C: clivus ICA: internal carotid artery NP: nasopharynx

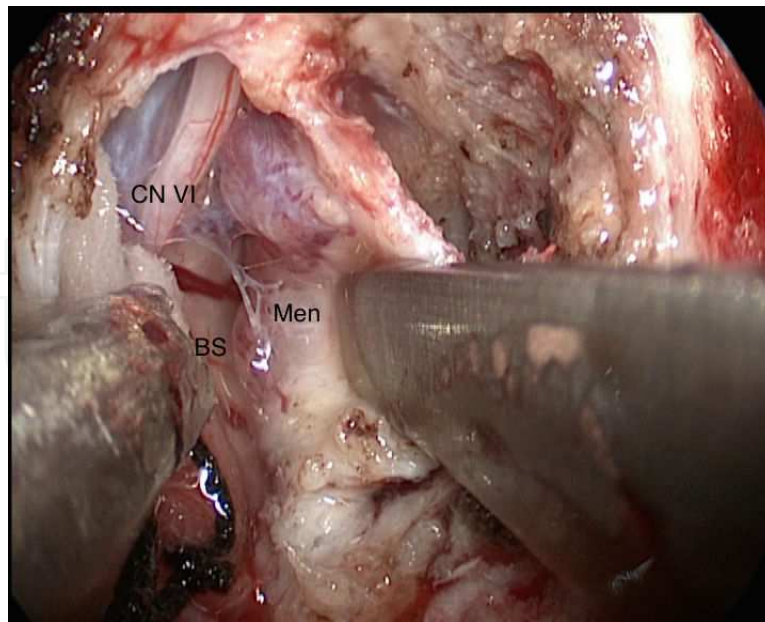


Figure 20. Endoscopic view after removal of bony clivus and incision of dura; meningioma was partially removed and retracted laterally. CN VI: abducens nerve Men: meningioma BS: brainstem

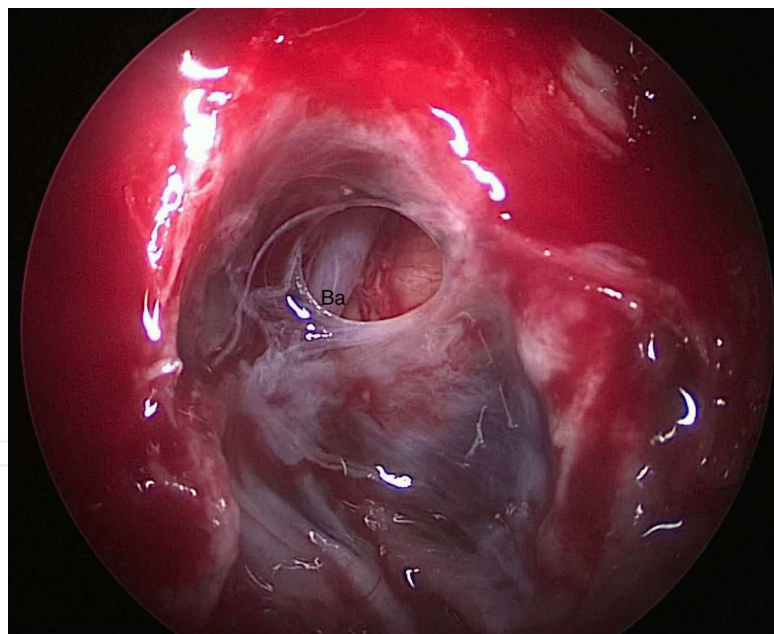


Figure 21. Endoscopic view after complete removal of tumor depicts the basilar artery lies posterior to arachnoid membrane, running vertically in front of the brainstem. Ba: basilar artery

4.1.6. Transodontoid approach

This approach allows access to foramen magnum and upper cervical spine (C1 and C2). Common diseases are pannus formation in rheumatoid arthritis and foramen magnum

meningioma. This procedure is identical with transclival approach but necessitates further inferior dissection of nasopharyngeal mucosa and muscular structures. Again, the bone of anterior C1 and C2 should be thinned with high-speed drill before its removal.

4.2. Coronal view

4.2.1. Orbital approach

This approach use for tumor involve orbit, orbital roof. Start with complete endoscopic sinus surgery (middle maxillary antrostomy, complete sphenoidectomy, frontal sinusotomy) and make a wide sinus cavity to ensure the orbital fat after decompression will not occlude to sinonasal drainage pathway. The lamina papyracea is elevated from periorbita like peeling an egg shell. The periorbita can be resected with sharp instrument. If the tumor is intraconal, the surgical corridor should be done between medial and inferior rectus muscle while having medial rectus retraction externally.



Figure 22. MRI shows tumor in left ethmoid sinus invading the left orbit.

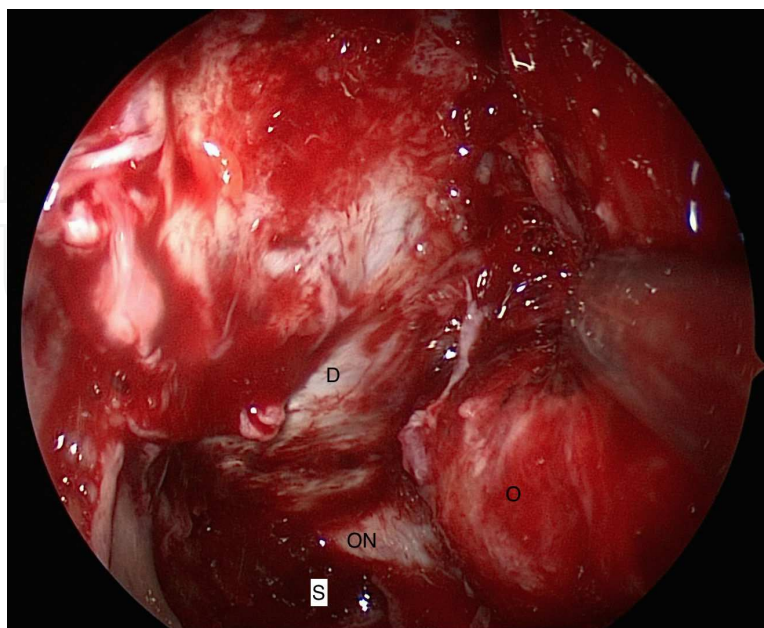


Figure 23. Endoscopic view after removal of the tumor, left cribriform plate, lamina papyracea and decompression of left optic nerve. The medial wall of orbit still bulging from the residual intraconal tumor. O: orbit D: dura ON: optic nerve S: sphenoid sinus (left)

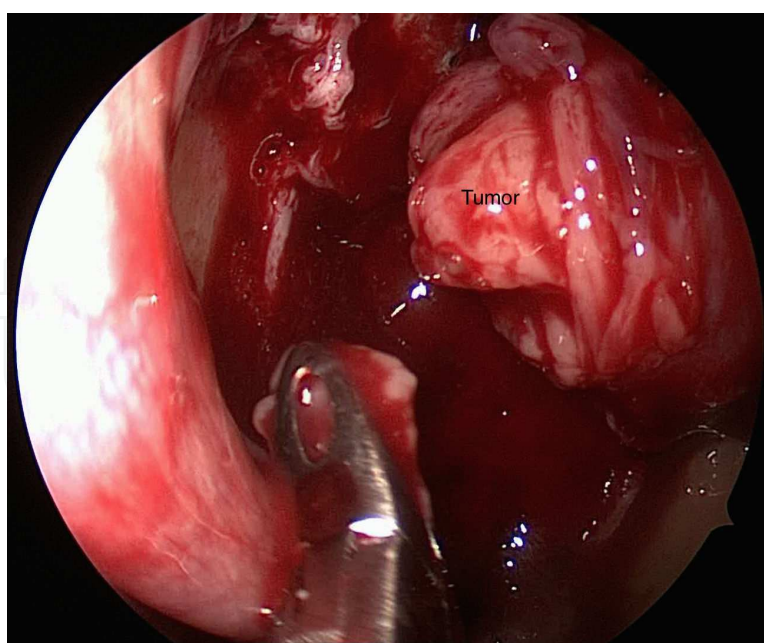


Figure 24. After incision of the periorbital, eye ball was gently compressed by assistant surgeon; the tumor will show up into the surgical field. The tumor could be removed by pushing externally and by intranasal dissection.

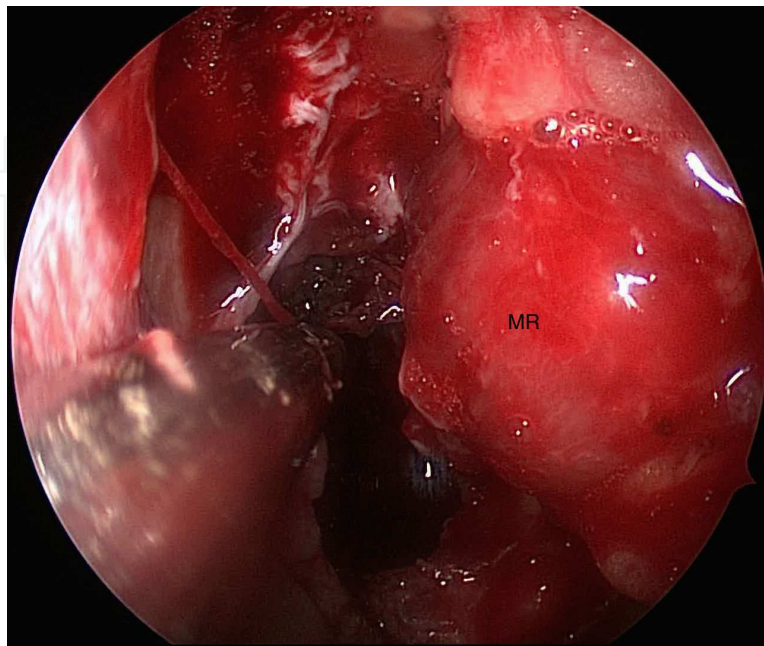


Figure 25. After total removal of the tumor, the medial rectus muscle can be clearly seen. The medial rectus muscle is retracted downward and upward for inspection with angle telescope to confirm that no tumor was left behind. MR: medial rectus muscle

4.2.2. Transpterygoid approach

This approach is utilized for access to middle cranial fossa. By removing the pterygoid bone, it can be used as a margin for tumor in sinus area, e.g., nasopharyngeal carcinoma. Other pathologies require access to the lateral recess of sphenoid such as meningoencephalocele and dural defect repair. This approach starts with maxillary antrostomy (medial maxillectomy is necessary if dissection has to be done at the lower level of inferior turbinate) and complete sphenoidectomy. The sphenopalatine artery, which runs just behind ethmoidal process of palatine bone, should be cauterized or ligated (Figure 26). High-speed drill is typically necessary for removing medial and lateral pterygoid plate. The medial and lateral pterygoid muscles lie beneath the bone plate where there is rich vascular supply; hence, careful hemostasis should be employed prior to performing deeper dissection (Figure 27).

4.2.3. Infratemporal fossa approach

The location of infratemporal space is lateral to the lateral pterygoid plate. This space contains fat, internal maxillary artery, CN V2 (infraorbital nerve) and CN V3 (mandibular nerve). The internal maxillary artery should be controlled with vascular clip or electrocautery. Infraorbital nerve is typically identified at the roof of posterior wall of maxillary sinus. For the mandibular nerve, it usually runs laterally to the lateral pterygoid muscle.

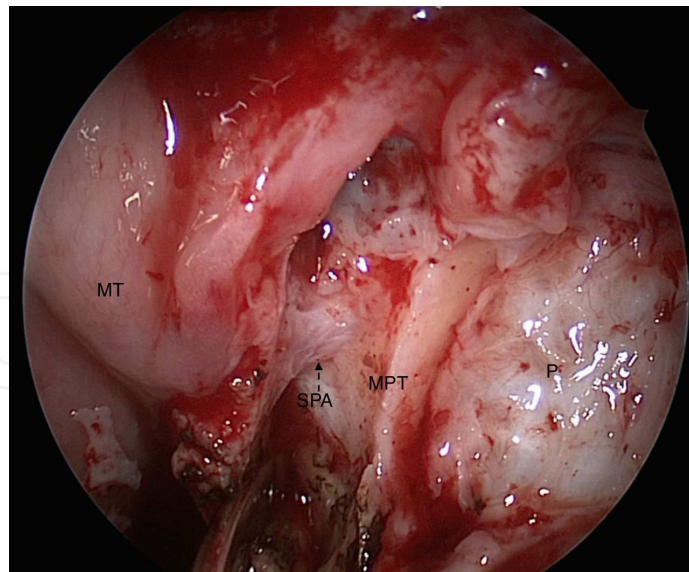


Figure 26. Endoscopic view of left nasal cavity after endoscopic sinus surgery and medial maxillectomy showing sphenopalatine artery running horizontally. MT: middle turbinate SPA: sphenopalatine artery MPT: medial pterygoid plate P: posterior wall of maxillary sinus

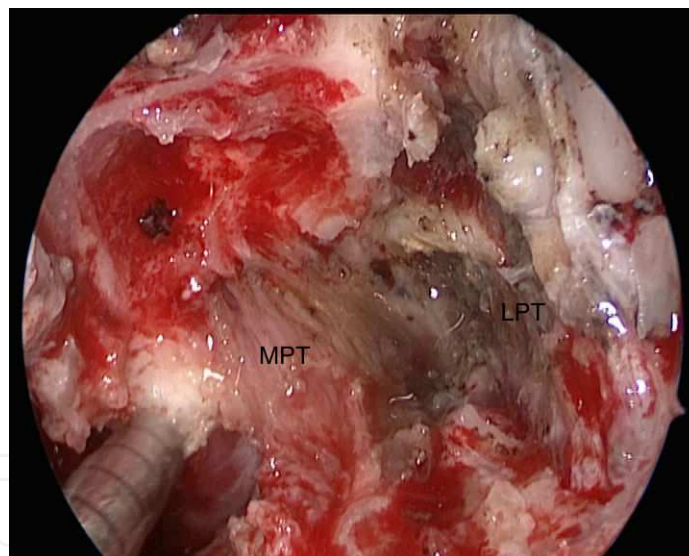


Figure 27. Endoscopic view after sphenopalatine artery is cauterized along with removal of pterygoid plate; the medial pterygoid and lateral pterygoid muscles can be identified. MPT: medial pterygoid muscle LPT: lateral pterygoid muscle

5. Reconstruction of skull base with endonasal technique

In the past, craniotomy for CSF leakage and reconstruction of skull base defect commonly utilized vascularized pericranial or fascial flap harvested from skull. In this new era of

endoscopy, with external scar and need for some brain retraction, craniotomy for CSF leak repair has been preserved for those who failed endonasal endoscopic surgery. Upon access from skull base, similar to approaches with violation of dura and arachnoid membranes, CSF leak is one of the most common complications reported by many endoscopic series. However, few studies found that the incidence of CSF leakage from conventional surgery was not less frequent than endoscopic method. Among endoscopic procedures, the probability for CSF leakage is usually higher for the extrasellar lesions than limited pituitary-sellar surgery. The postresection communication between intracranial and nasal cavity must be thoroughly repaired to prevent any possibility of intracranial infection. For small defects, repair is accomplished independently of techniques for reconstruction.[15, 16] Conversely, larger defects, particularly for the high flow CSF leak, need a vascularized mucosal flap reconstruction in addition to a multilayer closure (Figure 28). It has been proven to yield better outcome with the incidence of CSF leakage <5%.[17, 21] The advent of new technique for the intranasally harvested vascularized mucosal flap has been popularized. It has become well-known as the Hadad-Bassagasteguy flap (HBF).[22] The flap was developed from the mucoperiosteum and mucoperichondrium of the nasal septum that is supplied by the nasoseptal artery (Figures 29, 30, 31, 32, 33, 34). This reconstruction technique has improved the outcome of endonasal endoscopy for the skull base. Although the endoscopic skull base surgery via the endonasal corridor has the potential contamination from the sinonasal tract, the incidence of intracranial infections is still relatively low. The common intracranial infections are meningitis and intracranial abscess that have been reported in various incidences among the endoscopic series from less than 1% up to 10%.[23, 27] while the traditional approaches had the higher incidences from 15–30%.[28, 29] The intracranial infections were associated with the intradural resection, and some studies stated that they were related to the refractory postoperative CSF leak. Perioperative antibiotic prophylaxis is recommended to prevent the intracranial infections.

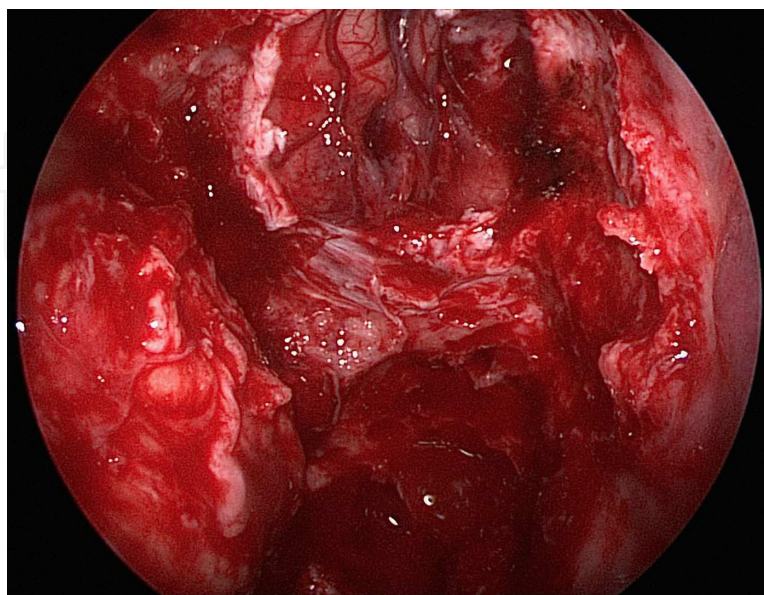


Figure 28. Endoscopic view of cribriform defect in pediatric patient after resection of fibro-osseous lesion.

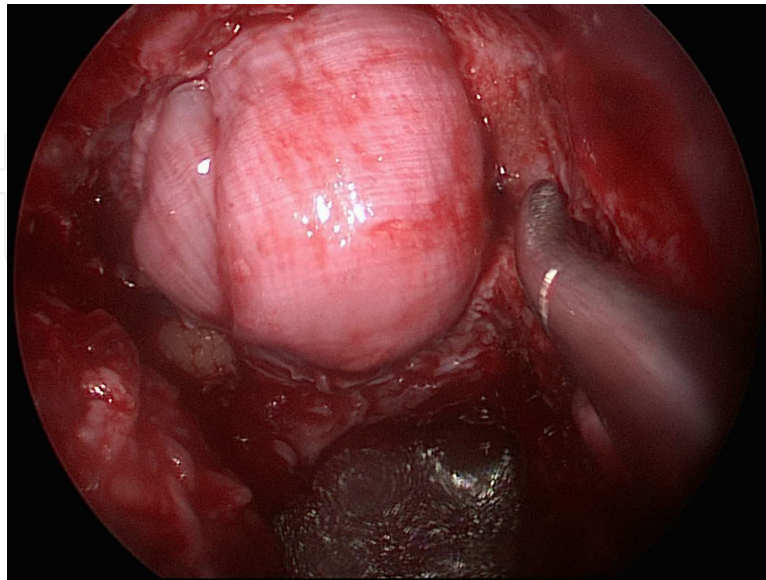


Figure 29. Endoscopic view of the same patient in Figure 28. The defect was reconstructed with multiple layers (fat graft and two layers of fascia lata).

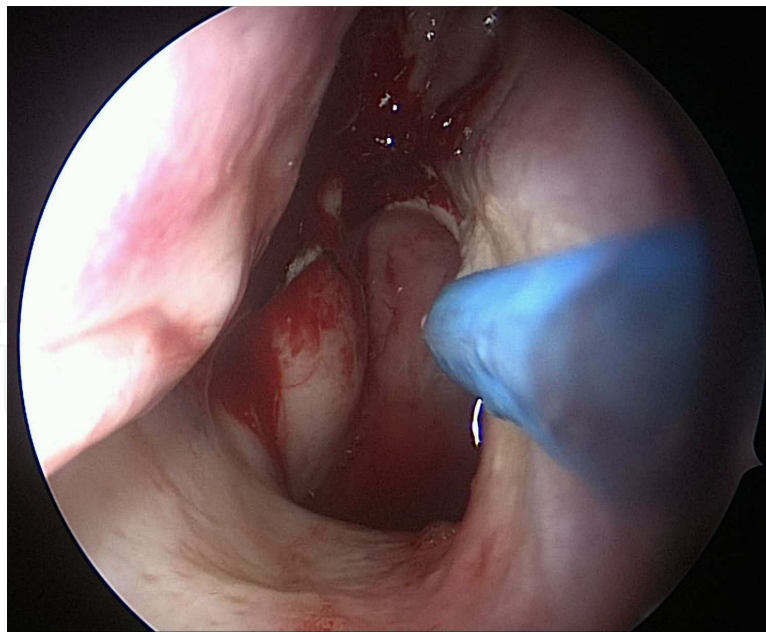


Figure 30. Endoscopic view, inferior incision for creation of nasoseptal flap is illustrated. This inferior incision typically starts at the roof of nasopharynx then advances anteriorly to mucocutaneous junction of nasal septum. Superior incision (not pictured) ideally starts at inferior level of sphenoid natural ostium and moves anteriorly to mucocutaneous junction of nasal septum.

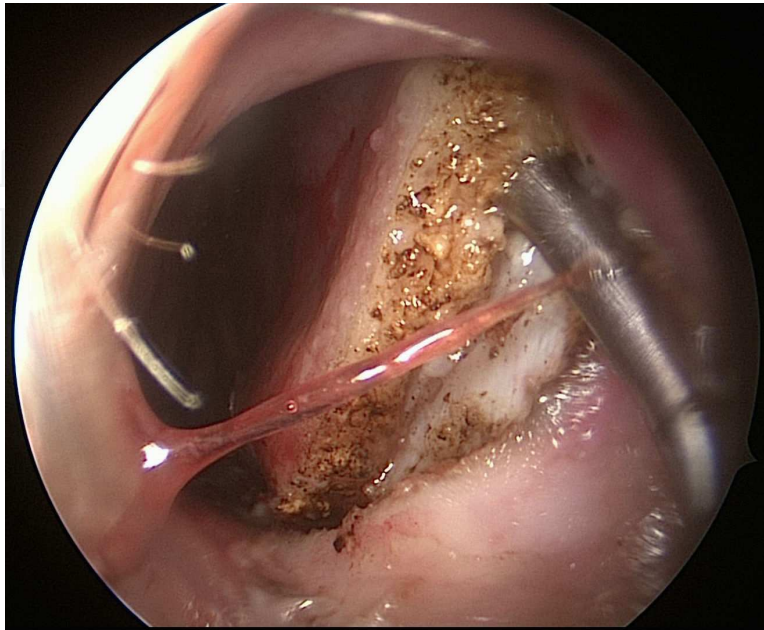


Figure 31. Endoscopic view of same patient in Figure 30. The superior and inferior incision will be connected by a vertical incision at mucocutaneous junction. Submucoperichondrium dissection should proceed from anterior to posterior toward its pedicle at the nasopharynx.

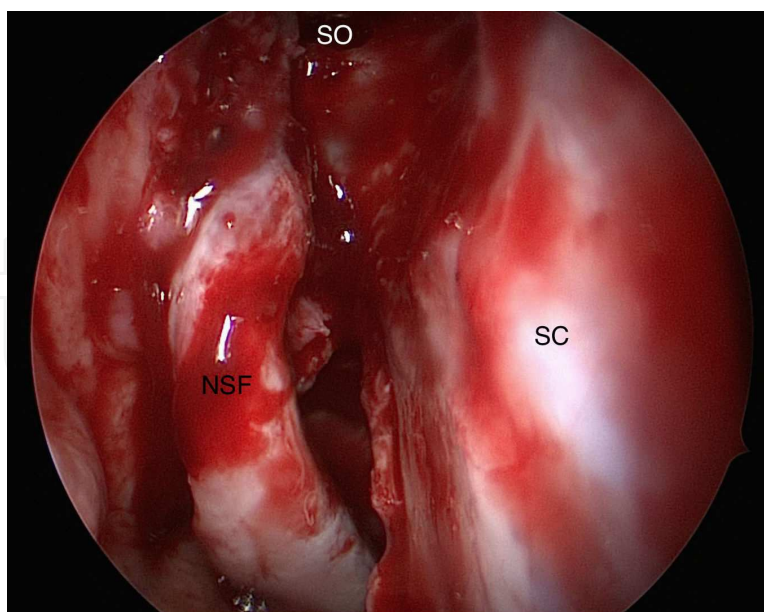


Figure 32. Endoscopic view of same patient in Figure 30. After elevation of nasoseptal flap, the pedicle is protected at posterior to preserve arterial supply by septal branch of sphenopalatine artery. NSF: nasoseptal flap SC: septal cartilage SO: sphenoid ostium

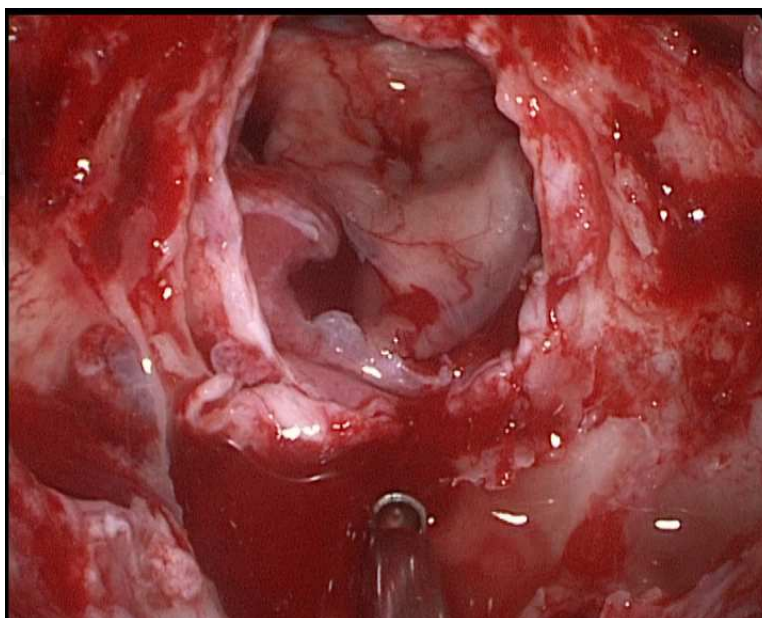


Figure 33. Endoscopic view of same patient in Figure 30 demonstrates the large skull base defect at sellar and planum after craniopharyngioma removal.

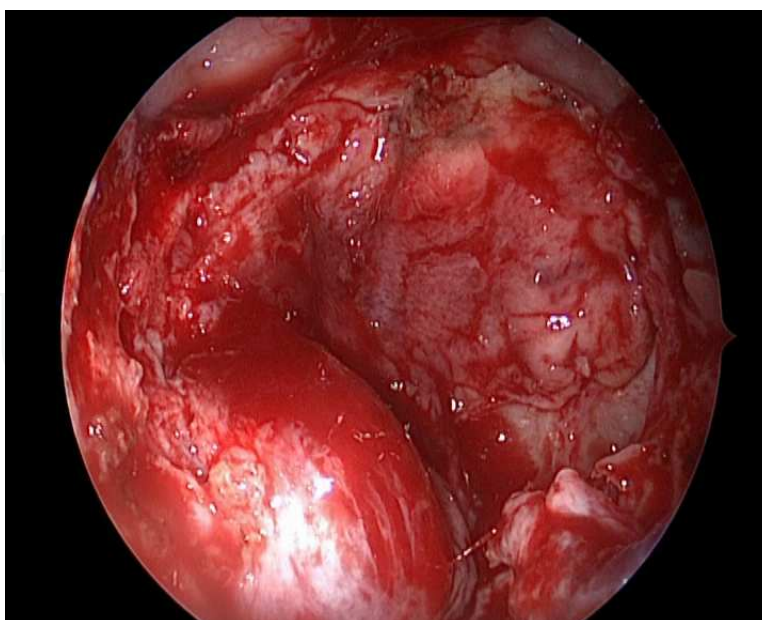


Figure 34. Endoscopic view of same patient in Figure 30. The nasoseptal flap was placed over the defect area after inlay placement of fat.

6. Surgical complications and morbidities

As mentioned earlier, although endoscopic skull base surgery creates direct communication between intracranial and nasal compartment, the incidence of intracranial infections is relatively low. Reports of the postoperative incidence of intracranial infection varied from less than 1% up to 10%.[23, 27]

Vascular injury during endoscopic procedures can be catastrophic, in particular when it involves the ICA. The ventral perspective of ICA that is perceived via endoscopic view is less familiar to surgeons than transcranial procedures. Higher rate of the ICA injury was more commonly associated with paramedian coronal plane dissection. Complete understanding of the ICA pathway and its surgical landmarks together with advanced intraoperative image-guided technology can minimize this feared intraoperative vascular complication. Fortunately, major ICA injury is uncommon with overall incidence of 0.9%. Experienced surgeons with multidisciplinary team approach as well as efficient instruments must be prepared to promptly deal with this critical event.[27] Though the ideal concept for management of an injured artery is to maintain lumen patency of the vessel, it is, unfortunately, extremely difficult to achieve in real situation. Direct repair with suture is close to impossible given the narrow corridor in light of profuse hemorrhage. Although several hemostatic agents or patches have varying success in damage control, at least temporarily, from our experience, crushed muscle has been the best. When all attempts fail, nasal packing is performed. Subsequently, angiographic study of the ICA is necessary. In some, balloon occlusion test is advocated in the preoperative plan in selected patients who carry high risk of vascular complications. Previous surgery or irradiation as well as tumor encasing ICA have been found to be factors predicting arterial injury.

Intraoperative neural injury from endoscopic series has been reported, with lower incidence than the traditional techniques. In addition, its majority was transient. The most commonly injured nerve was the CN VI. This could be related to its poor tolerance for manipulation.[27] Electromyographic cranial nerve monitoring during the surgery can signal surgeons of proximity to cranial nerves while dissecting a lesion. Dissection beyond the lateral limit of given cranial nerves is principally contraindicated for the endoscopic approach. Therefore, combined approaches from traditional craniotomy may occasionally be required for an extensive pathology.

The lower rate of overall complications from endonasal endoscopic approach seems more encouraging than the traditional techniques. Nevertheless, specialized training to gain experiences in this complex anatomical area along with advanced technological equipment is essential to surgeons to overcome obstacles in the course of his/her learning curve. With increased experience after several cases, the incidences of complication should typically approach acceptable reported incidence.

Over the past few decades, many authors have reported the feasibility and safety in the clinical uses of pure endoscopy in treatment of skull base pathologies. Understandably, with shorter follow-up time, endoscopic endonasal surgery cannot perfectly prove its efficacy, namely the long-term oncological control and functional outcome that has been its common target for criticism.

The general principle to achieve the oncological control is the complete resection of the tumor. The malignant pathologies, the surgical margins need to be extended. Via endoscopic approach, the en bloc tumor removal at the invasion site has been considered more fundamental than the en bloc resection of the entire tumor. The intraoperative frozen section is a tool to confirm the surgical margin after the en bloc resection at the tumor invasion site. The tumors arising in the sinonasal cavities usually have some parts situated in the air-filled space. The floating tumors in the cavities can be debulked in order to allow the surgeons comfortably insert the surgical instruments through the limited space and gain access to manage the tumors. At present, there is limited data to evaluate the oncological recurrence and disease-free survival rate. Many authors reported a small number of patients in the series of endonasal endoscopic surgery for skull base lesions for whom the oncological outcomes were favorable and comparable to the open techniques with lesser morbidities.[30, 33]

Although most of the surgeons have been experienced with the excellent functional outcomes and quality of life of the patients who underwent the endonasal endoscopic surgery, the published data has been limited. The obviously favorable outcomes include faster recovery without external scar and that the patients can regain normal or near-normal functions. The endonasal endoscopic skull base surgery has many steps of operation that can affect the patient's life in different ways. The further subanalysis of quality of life in each aspect of the procedure can lead to development of the completed data in the endoscopic surgical field.

7. Conclusion

Endoscopic endonasal surgery is challenging and dynamic. Coupling between the adjustments of the endoscopic lens position to acquire optimal view and the movement of instruments to provide the surgical freedom in the limited space requires tremendous experience and teamwork. It delivers enormous advantages for the various skull base pathologies which surgical corridor provides the most direct access to the ventral cranial base area. Proper selection of patients for endoscopic approach is crucial to achieve good outcome while avoiding untoward events. Comprehensive knowledge in complex skull base anatomy, training in advanced and high-volume institutes, advanced surgical technologies and strong teamwork are the keystones to gain the most benefit from this surgical method.

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