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CASE SERIES

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LIMITATIONS OF ENDOSCOPIC VENTRAL SKULL BASE SURGERY: A SERIES OF ELEVEN CHALLENGING CASES AND REVIEW OF LITERATURE- A RETROSPECTIVE STUDY

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ABSTRACT:

BACKGROUND:

The surgical outcome in different pathologies of skull base has significantly improved with endoscopic endonasal approaches. As the grass is not always green on all side, there remains some limitations to endoscopic skull base surgery. In our paper we will discuss preoperative imaging of common pathologies amenable to endoscopic treatment, instrumentations, and limitations of skull base surgery.

Retrospective analysis of the prospectively maintained records of the patients operated for skull base tumor was done between January 2016-Febuary 2019.

Patients having skull base tumors irrespective of age, sex. Tumors found inoperable endoscopically after a panel discussion of Neurosurgeon, Neuro-otologist and Neuro-anesthesiologist. Patients who underwent endonasal endoscopic surgical excision at our centre.

RESULTS (CASE DESCRIPTION)

Out of 383 skull base pathology patients operated through endoscopic endonasal approach between January 2016- February 2019, eleven(2.87%) patients of skull base tumours who were found inoperable endoscopically were included in our series. The limitations of endoscopic endonasal approach is shown in Table 1. We hereby discuss the technical nuances and details of each cases, in order to highlight the limitation of endo-nasal corridor.

CONCLUSION

Although endoscopic trans-nasal surgery is emerging as popular alternative to microscopic surgery and replacing it fast, one should not become tool dependent. A lot of conditions still required microsurgical expertize and demand proper training and anatomical considerations. Every case must be approached on individualized basis. A proper pre-operative evaluation is key to success.

KEYWORDS:

Limitations, endoscopic, ventral, skull base

INTRODUCTION

The surgical outcome in different pathologies of skull base has significantly improved with endoscopic endonasal approaches. Initially endoscopic endonasal surgery was limited to paranasal sinuses only, but now the horizon expands to involve ventral skull base, middle skull base and even Clivus tumors and cavernous sinus tumors. Anterior skull base tumors include

meningiomas ,estheisoneuroblastomas, orbital gliomas, nasopharyngeal carcinomas. Middle skull base tumours include meningiomas, pituitary adenomas, craniopharyngiomas, and the schwannomas arising from different cranial nerves. Posterior skull base tumours include chordoma, chondrosarcomas and metastasis. Endoscopic approach provides access to almost all regions of the skull base situated anterior to the foramen magnum through the natural opening. There is growing interest of otorhinolaryngologists and neurosurgeons in this 'minimally-invasive'approach. Better optical imaging, use of neuro-navigation, and ergonomically suitable instrumentation have largely contributed in the growth of the approach. The panaromic view, minimal access, low post op morbidity and reduced hospital stay (indirectly leading to reduced treatment cost) are some of the benefits of endoscopic surgery. As the grass is not always green on all side, there remains some limitations to endoscopic skull base surgery. Even with the significant progress made in field of endoscopic surgery, there is a learning curve and adaptation in hand-eye coordination during transition from microscopic surgeon to endoscopic surgeon. In our paper we will discuss preoperative imaging of common pathologies amenable to endoscopic treatment, instrumentations, and limitations of skull base surgery.

METHODOLOGY

Retrospective analysis of the prospectively maintained records of the patients operated for skull base tumor was done between January 2016-Febuary 2019.

Inclusion criteria- Patients having skull base tumors irrespective of age, sex. Tumors found inoperable endoscopically after a panel discussion of Neurosurgeon, Neuro-otologist and Neuro-anesthesiologist.

Exclusion criteria-Patients who underwent endonasal endoscopic surgical excision at our centre.

Decision regarding approach(transcranial or endoscopic) was based upon the type of tumor, location of the tumor and finally concluded by a panel of Neurosurgery team having Neurosurgeons, Neurologists and Neuro-anesthesiologist. Patient's records were retrived from the hospital information system (HIS) and patient record files from the departments of Neurosurgery and Pathology.

RESULTS (CASE DESCRIPTION)

Out of 383 skull base pathology patients operated through endoscopic endonasal approach between January 2016- February 2019, eleven(2.87%) patients of skull base tumours who were found inoperable endoscopically were included in our series. The limitations of endoscopic endonasal approach is shown in Table 1. We hereby discuss the technical nuances and details of each cases, in order to highlight the limitation of endo-nasal corridor

PRE-OPERATIVE EVALUATION IN ENDOSCOPIC SKULL BASE SURGERY

Pre-operative evaluation and radiological imaging

Computerized tomography PNS (CT Para nasal sinus) 1mm axial and coronal cuts/ CT Cysternography (for CSF leak) and Gadolinium contrast magnetic resonance imaging(Gd -MRI) head is pre-requisite. Imaging helps in visualizing the extent of tumour and plan operative strategy. CT scan provides information about bony framework, pneumatization of sinus and bony lesions and adjacent structures like internal carotid artery (ICA), skull base foramina. CT scan can help us to calculate the bony window needed for proper exposure of skull base, any abnormal situation like onodi cell, sellar pneumatisation, and lateral recess of sphenoid sinus. Further MRI (magnetic resonance imaging) delineates soft tissues and their invasion by the tumour, visualizing invasion of cranial nerves, orbit, infratemporal fossa, parapharyngeal spaces, and nasopharynx, dura mater and brain involvement. Contrast-enhanced sequences or TOF (time of flight) sequences show the course of blood

vessels, particularly the ICA, and their anatomical relations with the tumour. CT and MRI may be integrated with the navigation system for intra-operative confirmation of critical anatomical structures.

Role of Embolization and occlusion tests

Skull base tumours have high vascularity from feeders of nose or paranasal sinus and perforators from ICA. Bleeding is always a complication associated with these procedures. Embolization may be done to reduce the vascularity of tumour. This procedure should ideally be performed 48 to 72 hours before the surgery to avoid formation of collateral blood supply . Whenever there is risk of ICA compromise, the carotid balloon occlusion test (BOT) is done to look for cross flow from contra lateral side; however, the occlusion test is also not hundred percent perfect.

Exposure techniques

Endoscopic surgery is surgery of landmarks and moves from one landmark to another, so defining various endoscopic landmarks is the key to success of surgery. Both two handed and four handed techniques are available for getting a wider access. Surgical access may be made by removal of the middle turbinate, complete ethmoidectomy, resection of the septum and medial maxillectomy. These procedures allow creation of a large surgical corridor for four-hand surgery and also facilitate postoperative care.

Haemostasis

It is of paramount importance to have haemostasis from beginning of the surgery or else it will lead to lot of blood loss and poor visualization. Endoscopic approach provides direct access to blood supply of tumour and thus devascularisation of the tumour can be done efficiently in some cases. Arterial bleeding from sphenopalatine, ethmoidal and internal maxillary arteries must be prevented, whenever possible, by anatomical knowledge. Sudden retraction of proximal segment of anterior ethmoidal artery is responsible for dramatic retrobulbar haematoma. Bleeding can be controlled either by clips or by bipolar electrocoagulation, and also by packing. Venous bleeding, particularly due to damage of the cavernous sinus or pterygoid venous plexus is difficult to control by coagulation and haemostasis can be achieved by packing with oxidized cellulose polymer (Surgicel®) (prolonged if necessary). At the end of the operation, nasal packing should be done to prevent bleeding from mucosal surfaces and support reconstruction of nasal bridge.

Limitations of endoscopic skull base surgery

LUND VJ et. al supported the use of endoscopic techniques in the management of benign tumours like pituitary adenomas, craniopharyngiomas, inverted papillomas and nasopharyngeal fibromas [1]. Literature also supports endonasal management of cholesterol granuloma of the petrous apex , petrous apicitis, congenital malformations (meningo encephaloceles), or CSF leaks, showing a comparable or superior efficacy to conventional open surgery [2-4]. Even in peadiatric age group, role of endoscopic nasal surgery is well established. [5,6] Literature on malignant tumors shows that both the endoscopic surgery and conventional microscopic surgery are equally efficacious [6-10]. Nicolai et al, shared their experience on a series of 134 patients who underwent endoscopic resection of various malignant tumors, and reported a 5-year disease-specific survival of around 90% [11]. One of the popular criticisms on endoscopic techniques is that they do not allow en bloc resection of the tumour. However, principle of oncology remains same i.e R0 resection, so the tumour is fragmented or excised in piecemeal fashion. Endoscopic endo nasal approach often allows resection of the tumour without damaging the skin, bone, and sometimes dura mater also. We shall be discussing limitations of endoscopic ventral skull base surgery in various aspect in this issue.

(A) Anatomical limitations

The anatomical limitations in skull base surgery includes variaions in the bony architecture of nose or paranasal sinus and close proximity with vital structures like brain &orbits[12-16].With experience, certain structures may be mobilized or resected without causing any neurological damage. Likewise, in the osteocartilaginous skeleton of the nasal cavities, only the nasal bones and an 'L strut' of septal framework needed to be preserved to maintain the adequate functional shape of the nose. Medial maxillectomy provides wide access to the posterior wall of the maxillary sinus and removal of posterior wall of maxilla provides access to the infratemporal fossa and pterygopalatine fossa.

Case 1: Parasellarextension with more than 180-degree encasement of ICA

A 40-yearold patient presented with complains of headache and vision loss (Figure 1).MRI showed a pituitary tumor encircling more than 270 degree ICA. These tumors are difficult to remove completely through endoscopic route as there are chances of incomplete excision or inadvertent vascular injury; moreover it is difficult to mobilize all of the internal carotid segments [17].Therefore, digital subtraction angiography with cross flow test and balloon occlusion test is required to understand side of ICA dominance. A tran-sylvian approach, utilizing inter-optic, carotico-optic and retro-chiasmatic corridors are utilized to excise the tumor. Beforehand, neck control of ICA and CCA is needed. Considering the possibility that the middle cerebral artery may be draped around the tumor, complete sylvian fissure opening is required. In extreme case, if any vascular injury occurs, the open microsurgery offers simultaneously MCA-STA anastomosis also. The tumor extending in sylvian cisterns is nearly inaccessible by endoscopic trans-nasal approach.

Control by the autonomic nervous system

The filling of the venous sinusoids is under the control of the autonomic nervous system and predominantly the sympathetic component. Sympathetic activity causes vasoconstriction and drainage of the venous sinusoids.

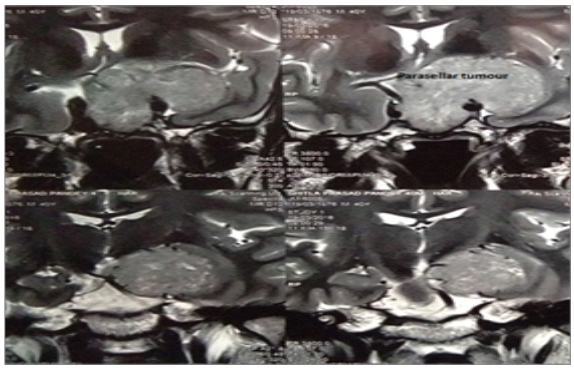

Figure 1: Parasellar tumour with more than 270-degree encasement carotid

Case 2: Kissing Carotids

A 37-year old patient presented with complains of headache and vision loss. MRI showed a giant aneurysm arising from cavernous segment of left ICA(Figure 2). Carotid aneurysms and kissing carotids have a risk of intra-operative rupture. Junjie Zhao et al stated that management of internal carotid artery aneurysm demands multidisciplinary approach. [18]. Carotid occlusion test should be performed prior to surgery to look for cerebral circulation (cross flow from contralateral side) as sacrifice of an ICA is associated with a major risk of neurological sequelae. Zanation et al. described mobilization technique of the paraclivalpart of the ICA. With endoscopic trans-nasal corridor, once an inadvertent injury occurs, the view is completely lost and surgeon becomes blind. To add-on, it is even difficult to attempt excision behind the kissing carotid. On the other hand, tran-sylvian corridor, provides safe access to suprasellar and sellar portion, without encountering the ICA loops. Even with parasellar extension, one can take trans-cavernous or sub-temporal corridors for safe excision.

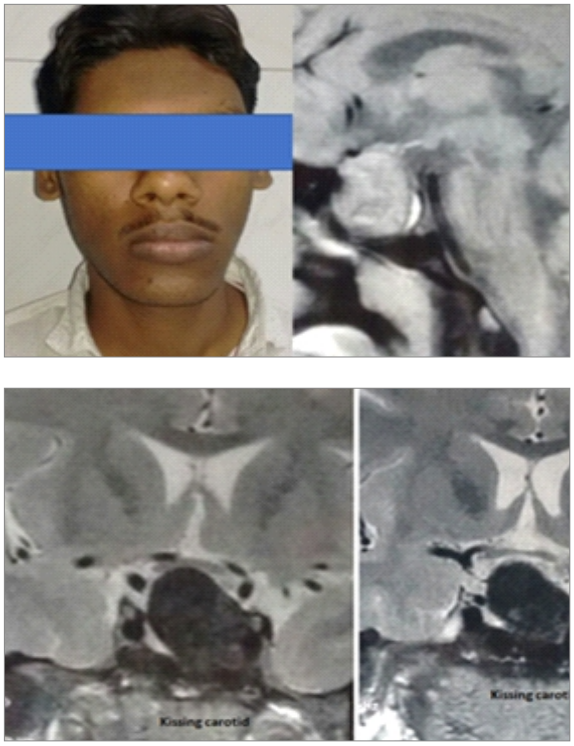

Figure 2: Kissing carotids

Case 3:Large cavernous sinus lesions

A 53-year male patient presented with headache, diplopia and hypoesthesia over right face. The T2-weighted MRI revealed large cavernous sinus lesion on right side (Figure 3). Juan C et al described compartmentalization around cavernous sinus and relation of various compartments with important structures [19]. Four compartments were divided on the basis of cavernous ICA; posterior related to GULFAR segment of abducent nerve, superior related to occulomotar nerve , inferior to distal cavernous , abducent and sympathetic nerve and lateral related to all other cranial nerves. Tumours of cavernous sinus are mostly multi-compartmental and there are chances of leaving behind residual tumour after endoscopic surgery. Residual tumour is defined as per the compartment involved; most common being lateral compartment. Lateral wall of cavernous sinus has multiple cranial nerves and involvement of lateral wall has a risk of various craniopathies. Edward D et al described endoscopic approach to cavernous sinus and said medial cavernous sinus tumour can be accessed by trans-sphenoidal trans-sellar approach and even lateral cavernous sinus tumour can be accessed through transmaxillary-transpterygoid approach but there are chances of various cranial nerve injury [20].Even with microscopic approach, there are chances of craniopathies, but accessibility of tumour is better. With endoscopic trans-nasal approach, nerves are identified first and then tumour is excised along medial or lateral ICA window. On the other hand, microscopic sub-temporal trans-cavernous or trans-sylvian trans-cavernous through anteriolateral or anteriomed - ialtraingles, maximal safe excision is achieved.

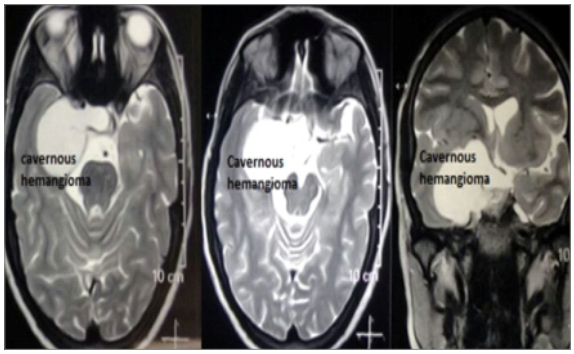

Figure 3: Lateral cavernous sinus lesion

Case 4: Extensive suprasellar tumors with cerebral involvement

A 48-year old female patientpresented in ouroutpatient department (OPD) with complaint of headache and vision loss. MRI showed a large pituitary tumour with large supra-sellarextension (Figure 4). Cerebral involvement of a skull base tumor in the form of extensive supra-sellar extension remains a surgical challenge[21] .The principle of endoscopic surgery is that one should work around the tumor without mobilizing major cranial nerves and artery. With an endoscopic approach, ACA perforators come head-on and further accessibility to supra-sellar part is hazardous. Contrarily, trans-cortical trans-sylvian or trans-ventricular corridors are safe from non dominant side and ensures complete excision with adequate decompression.

Amir R. et al described various complications with extended suprasellar approach like CSF leak, worsening of visual deficit, meningitis, pulmonary emboli [22]. Most common of which is CSF leak, leading to post op meningitis. Various endocrinal complications due to hypopituitarism and injury to pituitary stalk during surgery are also encountered by extended suprasellar approach. Suprasellar calcification is another difficult condition for endoscopic approach, while calcification is excised in piecemeal fashion through microscopic approach. An extended sub-frontal approach or inter-hemispheric corridor after dividing the Falx may be another option for safe excision of the tumor.

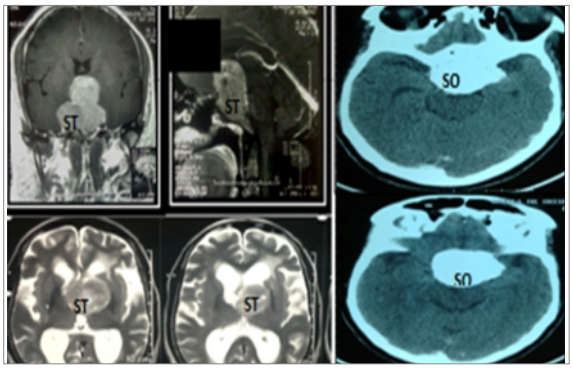

Figure 4: Extensive Suprasellar, tumors with cerebral involvement and suprasellar calcification of tumor
ST-suprasellar tumour, SO- suprasellar ossification

Case 5: Cavernous lesion with superior orbital fissure or intra-conal extension

A 38-year female patient presented with headache and vision loss of left side. CT revealed contrast enhancing mass involving orbit, optic nerve and tumor extended lateral to optic nerve.

Optic nerve invasion, lateral orbital tumor with intracranial extension are another major limitation to endoscopic trans-nasal surgery. Any resection or mobilization may result in permanent visual impairment and also it is difficult to operate lateral to orbital axis (Figure 5). All these conditions require lateral orbitotomy or Pterional approach with orbito-zygotomy or sometimes even orbital exenteration. Francesco Signorelli et al described the use of endoscopic approach for intra-conal tumors like cavernous hemangioma medial to optic nerve and advised use of combined or open approach for lateral orbital tumors [23]. The lamina papyracea corridor provides access to tumors situated medial to optic nerve only and in cases of tumors with lateral extension, microscopic surgery is the only option.

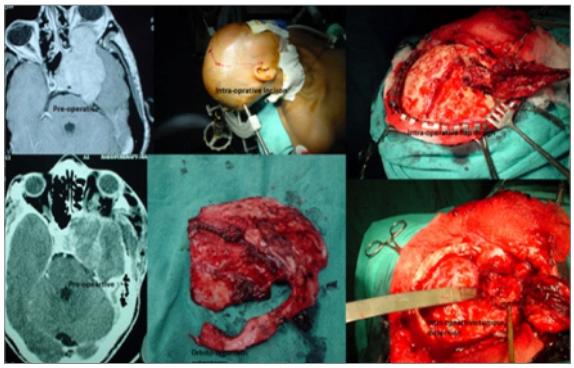

Figure 5: lateral orbital tumours with intracranial extension

Case 6: Lateral infratemporal fossa tumor with intracranial extension

An 18-year old female patient presented in OPD with facial pain.MRI revealed clival mass with lateral infratemporal fossa (ITF) extension. Lateral infratemporal fossa tumour with intracranial extension are also poor candidates for endoscopic approach (Figure 6).The lateral ITF tumors are placed more laterally so PTZA (preauricular-trans-zygomatic approach) is better to access these tumors. Jain et aldescribed preauriculartranszygomatic infratemporal fossa approach with pterional craniotomy for patients with such tumors [24].

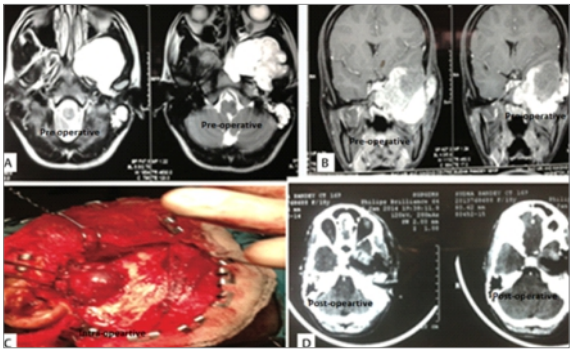

Figure 6: Lateral orbital tumours with intracranial extension

Case 7: CSF Rhinorrhoea with fracture of the posterior table of frontal sinus

A 27-year male patient presented to OPD, with a prior history of road traffic accident, followed by watery discharge from right nostril. CT scan revealed fractured posterior table of frontal sinus of right side (Figure 7).

Fractures of posterior table of frontal sinus are also considered a relative contraindication for endoscopic repair due to difficulty to access the defect. Bhavna K et al described minimal invasive technique for the repair of fractures of posterior table of frontal sinus [25].Enthony Echo et.al described management of fracture of frontal sinus and stated that posterior table fracture should be taken with care as they may cause CSF leak or entrapment of mucosa causing mucocele formation and may need cranialization as management [26]. Burr hole were made in anterior table to pass telescope through one hole and repair of the posterior table was done through another in this case. Moreover, bi-coronal skin flap with bifrontal craniotomy provides larger access to anterior skull base and a pedicle pericranium flap is used to cover whole of skull-base. Fat and fascia from thigh may be used to add-on coverage.

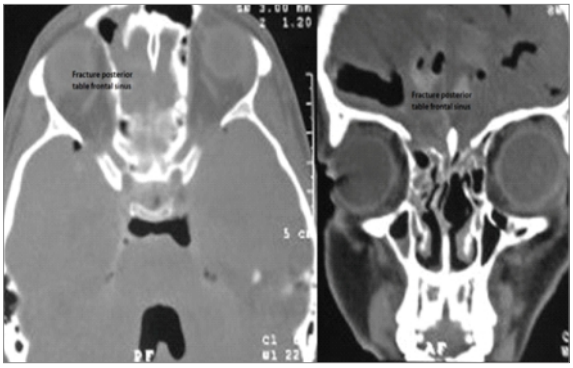

Figure 7: Fracture posterior table of frontal sinus

Case 8 : Active local site infection

Acute infections are contraindications to skull base surgery as infection spread to frank meningitis, encephalitis, and inflammation leading to failure of repair or even fatal sometimes [27]. In these conditions we should rather wait and give proper antibiotic coverage for 7-10 days for infection to settle down and then go for surgery.

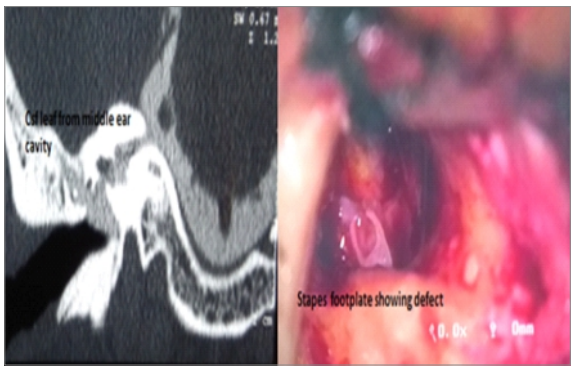

Figure 8: CT showing CSF leak in right middle ear, oval window encephalocele along with stapes footplate perforation

Case 9: Paradoxical CSF rhinorrhoea.

An 18-year female patient presented with history of recurrent meningitis with history of CSF rhinorrhoea (Figure 8). She underwent functional endoscopic sinus surgery (FESS) twice to identify site of leak but the defect could not be identified. CT cysternography (CTC) was done to confirm site of CSF leak. Surprisingly, CTC showed encephalocele in the middle ear. Cases of recurrentmeningitis withCSF rhinorrhoea orrecurrent failures of CSF leak repair should be

raise a possibility encephalocele in the middle ear or mastoid. In these cases, CSF leak in middle ear trickles through eustachian tube to nasopharynx and presents paradoxically as CSF rhinorrhoea[23].Proper exploratory mastoidectomy is needed in such cases and site should be properly identified and obliterated.The repair of oval window encephalocele was done in our case.

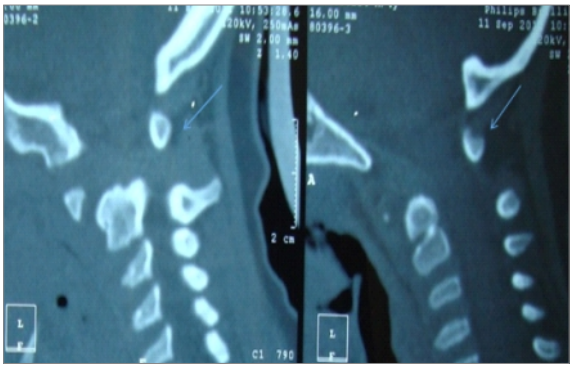

Figure 9: CT neck showing AAD (atlanto axial dislocation)

Case 10: Cranio-vertebral pathologies

Craniovertebral pathologies include like atlas and axis malformations(figure 9), clivus segmentation and odontoid dysplasia; developmental and acquired anomalies like foramen magnum stenosis, achondroplasia and secondary invagination; infection like Grisel's syndrome and tuberculosis;traumatic odontoid fracture; inflammation like rheumatoid arthritis; and tumors like chordoma andchondrosarcoma, and are surgical challenge for endoscopic approach.All these condition require decompression which can be achieved through various routes like trans-nasal, transoral andtrans-cervical. Endonasal route may provide access to the upper cervical spine and foramen magnum[28]. This approach is limited by parapharyngeal ICA and vertebral artery. Nasopalatine line(An imaginary line connecting the inferior edge of the nasal bones and cervical spine, intersecting the most posterior aspect of the hard palate) defines its inferior limit; therefore, an alternative approach (or combined approaches) is required if disease extends inferiorly to this line [29].Endoscopic approach may help in high basilar invagination to attain decompression only. However, additional fixation procedure is needed. Additional, the endoscopic approach introduces oral or nasal bacterial flora to spinal elements and may lead to implant failure. Contrarily, posterior fixation with distraction and reduction is much simpler alternative. shows a representative case of complex Atlanto-axial dislocation

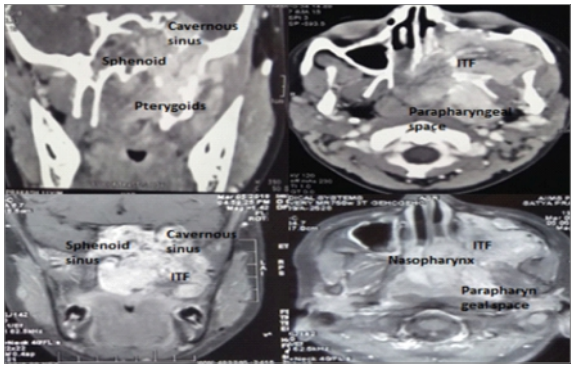

Figure: 10 CECT and MRI of JNA with intracranial extension

Case 11 Multi-compartmental Juvenile nasopharyngeal angiofibroma

A 12-year male patient presented in our OPD with history of left nasal bleeding along with left nasal obstruction since last one year(Figure 10). On examination there was left eye proptosis. CECT PNSand MRI revealed a left sided JNA Fisch stage-4 involving left cavernous sinus, middle cranial fossa. JNA with intracranial extension need removal along with extra-cranial component in the same sitting, followed by radiotherapy if needed [30].The JNA with intracranial extension needs removal in first attempt through mid-face degloving and combination of extended endoscopic endonasal procedure [31].The most common intra-operative complication is bleeding and endoscopic approaches may be used till Radkowski stage-3a. The tumors with cavernous sinus involvement and extensive intracranial extension should be treated with open approaches. We have operated JNA through mid-face degloving approach and combined it with extended endoscopic approach in single stage.

With only-endoscopic approaches it is very difficult to remove tumor completely. We removed tumor from cavernous sinus and middle cranial fossa but leave the tumor posterior to the pterygoid region. Massive intra-operative bleeding was the reason to stop the resection. Further hemostais was achieved and packing was done. Patient was referred for radiotherapy. With only-endoscopic approach it would have been very difficult mange bleeding because the operating field is blocked.

(B) Other miscellaneous conditions

Pediatric age group (age less than 2-years) is another relative challenge for endoscopic skull base surgery. The dimensions of sinonasal bony architecture is small and under-pneumatized. Various authors have showed that pyriform aperture is the only limitation, below 2 years of age, and Clival inter-carotid distance do not change significantly. Moreover the desired space can be achieved using drilling. [32]Tumours involving nasal bones and skin are also difficult to access through endoscopic approach.

(C) Limitations related to the surgical technique

Proper hand-eye coordination is the key for any endoscopic surgery. Anticipating difficulties reduces intra-operative complications. Hemostasis following bleeding can be achieved by using various techniques like SPA ligation, maxillary artery clipping, common carotid control. Hemostastic materials can also help in case of bleeding.Robust reconstruction of skull base lesion is mandatory to prevent CSF leak.

(D) Equipment limitations

Other than instruments used for regular endoscopic sinus surgery,dedicated instruments like motors equipped with longor angulated hand-pieces, and endonasal neurosurgical dissectioninstruments are needed for skull base surgery. Cost of these high-end equipment is high and sometimes out of reach for a beginner surgeon.Disposable items (microdebrider blades) make the surgery even costlier. Cost must be comparedwith thatof conventional opensurgery instrumentation (burr-holes, etc.). Recent studies tend to demonstratethe efficacy of intraoperative imaging in terms of the finalquality of resection [33,34].

(E) Surgeon-related limitations

Learning curve of hand-eye coordination is one of the major limitation.[35] Four-handed technique requires equal competence level of both surgeon and an ergonomically good coordination.[36]The articulated arm may be used to perform some procedures.

Morbidity related to endoscopic surgery

CSFleak , orbital complication and bleeding are the main complication of skull base surgery.Other disadvantages are related to healing ofthe operative cavitystates that almost all patients experienced nasal crustingand/or nasal discharge [37]. Our experience is also in concordance with similar nasal cavity problems[38]. In one of our study, we concluded that patients who had a transsellar approach surgery has a poor quality of life due to crusting and nasal obstruction.The main complications in post-operative period were nasal crusting, nasal obstruction,postnasal discharge, and sleep disorders. Nasal synechiae,alar sill burn, maxillary nerve hypoesthesia, serous otitismedia, taste disturbance, and malodorare other rare complications. Sinus symptoms can be limited by repeated debridement of the operative cavity and by daily nasal irrigation withsaline.

CONCLUSION

Although endoscopic trans-nasal surgery is emerging as popular alternative to microscopic surgery and replacing it fast, one should not become tool dependent. A lot of conditions still required microsurgical expertize and demand proper training and anatomical considerations. Every case must be approached on individualized basis. A proper pre-operative evaluation is key to success.

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Table 1 Limitations of Endoscopic Endonasal Anterior skull base approach

Parasellar extension with more than 180-degree encasement of c. ICA	Chances of incomplete excision or inadvertent vascular injury Difficult to mobilize all of the internal carotid segments If any vascular injury occurs, the open microsurgery offers simultaneously MCA-STA anastomosis also. The tumor extending in sylvian cisterns is nearly inaccessible by endoscopic trans-nasal approach.
Kissing Carotids	Risk of intra-operative rupture
Large cavernous sinus a. lesions	With endoscopic trans-nasal approach, nerves are identified first and then tumor is excised along medial or lateral ICA window. On the other hand, microscopic sub-temporal trans-cavernous or trans-sylvian trans-cavernous through anteriolateral or anteriomedial traingles, maximal safe excision is achieved.
4.Extensive suprasellar a. tumors or the tumors with cerebral involvement	With an endoscopic approach, ACA perforators come head-on and further accessibility to supra-sellar part is hazardous. Contrarily, trans-cortical trans-sylvian or trans-ventricular corridors are safe from non dominant side and ensures complete excision with adequate decompression.
Cavernous lesion with superior orbital fissure or intra-conal extension	Optic nerve invasion Lateral orbital tumor with intracranial extension The lamina papyracea corridor provides access to tumors situated medial to optic nerve only and in cases of tumors with lateral extension, microscopic surgery is the only option.
Lateral infratemporal fossa tumor with intracranial extension	Endoscopic approach allow limited acess to infratemporal fossa and tumours extending through skull base into brain, making combined approach feasible for such kind of tumours
CSF Rhinorrhoea with fracture of the posterior table of frontal sinus	Endoscopic approach allows limited acess of posterior table of frontal sinus, making transcranial approach feasible option for such kind of situations.
Active local site infection	Acute infections are contraindications to skull base surgery as infection spread to frank meningitis, encephalitis, and inflammation leading to failure of repair or even fatal sometimes. In these conditions, one should rather wait and give proper antibiotic coverage for 7-10 days for infection to settle down and then go for surgery.
Paradoxical CSF rhinorrhoea-	Defect mainly lies in lateral skull base so difficult to approach through endoscopic ventral skull base approaches.
Complex cranio-vertebral pathologies	a. Endonasal route may provide access to the upper cervical spine and foramen magnum. This approach is limited by parapharyngeal ICA and vertebral artery. Nasopalatine line defines its inferior limit; therefore, an alternative approach (or combined approaches) is required if disease extends inferiorly to this line. Endoscopic approach may help in high basilar invagination to attain decompression only. However, additional fixation procedure is needed. Additional, the endoscopic approach introduces oral or nasal bacterial flora to spinal elements and may lead to implant failure. Contrarily, posterior fixation with distraction and reduction is much simpler alternative.
Multi-compartmental Juvenile nasopharyngeal angiofibroma	High vascularity Proximity to vital structures like internal carotid artery, cavernous sinus