Expanded Endoscopic Endonasal Approach to Anterior and Ventral Skull Base: An Evolving Paradigm

Balwant Singh Gendeh

Faculty of Medicine, UKM Medical Center, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Kuala Lumpur, Malaysia

Correspondence should be addressed to Balwant Singh Gendeh; bsgendeh@gmail.com

Received 11 December 2012; Accepted 27 January 2013

Academic Editors: A. Maleddu and D. Stoyanov

Copyright © 2013 Balwant Singh Gendeh. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The transition from external approaches to an endonasal corridor has seen a significant decline in patient morbidity and inpatient care. Our Rhinology and Cranial Base Surgery Group has been able to focus on the management of certain pathologies, endoscopic access to various areas in the skull base, reconstruction of the defect, ensuring that clear anatomical landmarks can be identified during the surgery, and improving the quality of life/function after treatment. The focus on surgical treatment is always to control disease and cure patients by not only reducing recovery time and perioperative morbidity, but also decreasing the long-term impact of having a tumour removed. With a dedicated combined operating theater setting with updated instrumentation, the Neuro-ENT team is able to continue to expand and develop endoscopic care for a greater number of patients and wider range of pathologies. The collaborative Neuro-ENT to work closely via the nose using the two-hole and four-hand technique when performing the operation simultaneously is of added advantage in the diverse and expanding field of cranial base surgery. Our skull base team is joined by expert radiation and medical oncologists who provide essential adjunctive care in the multidisciplinary management of these patients.

1. Introduction

Skull base surgery is a dynamic subspecialty and the last decade has witnessed the application of endoscopic techniques to the ventral skull base using an endonasal corridor (Figure 1). The transition from external approaches to an endonasal corridor has seen a significant decline in patient morbidity and inpatient care. Multidisciplinary collaborations in managing complex pathologies of the skull base have defined the nascent field of Neurorhinology. For lesions encompassing the ventral skull base and paranasal sinuses, this interaction with multiple specialities, notably otolaryngologists and neurosurgeons, has allowed procedures to be developed that offer significant advantages over treatment modalities from 25 years ago. As technological advancements and novel surgical instruments were developed for use in inflammatory disorders, otolaryngologists, with neurosurgeons, have begun to perform complex procedures endoscopically via the nostrils. In Malaysia, our center is at the forefront of skull base surgery. Common endoscopic skull base tumour surgery at our center includes meningioma, pituitary tumours, craniopharyngiomas, and chordomas. Additionally, our tertiary referral center provides endoscopic approaches to some vascular lesions and the latest management of nose and sinus tumours. The anterior or ventral skull base has evolved with the introduction of endoscopes and high-definition cameras much like lateral skull base surgery did with the development of microscopic surgery in the 1960s. This progression to the endoscopic approach in the management of these complex lesions has been brought about by our greater understanding of the complex anatomy from an endoscopic perspective and advances in equipment. Much of this advancement was in endoscopes and the advent of high definition camera and recording systems. Critical to this has been the development of new instruments to allow the surgeon to complete removing large tumours via a nasal-only route. Skull base tumours and their treatment have an enormous impact on patients. These tumours (except for pituitary tumours) are relatively uncommon. The continuation of the department's skull base patient care is a priority.
Figure 1: Endonasal approaches to the base of skull.

for both Neurosurgery and Otolaryngology. Our skull base team is joined by expert radiation and medical oncologists who provide essential adjunctive care in the multidisciplinary management of these patients. At our center, we advocate endoscopic assisted craniofacial resection (EACFR) for all malignant tumours involving the dura [1].

2. Tumors of the Anterior and Ventral Skull Base

Endonasal tumour surgery consists of an oncologically correct resection under endoscopic control followed by an excision of defined histology tissue specimens from the healthy tissue margins. It involves adequate preoperative diagnostic imaging, histology diagnosis, and suitable set of instruments. It is important that the surgeon has a good knowledge of the local anatomy and comprehensive experience in performing endonasal endoscopic surgery. The patient should be informed about the special procedure and give informed consent in the event that it is necessary to expand or complement surgery via the external access route.

The management of tumors of the skull base should be done as part of a multidisciplinary team and the surgeon should be able to change it to an external approach if necessary and know how to deal with the majority of possible complications.

We are not advocating that the majority of the lesions in and around the skull base should be resected endonasally, but we believe that the endoscope can provide improved access and visibility in specific circumstances without compromising tumor resection. The following are examples of 275 cases of skull base endoscopic tumor resections performed at our center:

(i) benign tumors (187 cases)

encephaloceles (31/187 cases)
osteoma (4/187 cases)
mucocoeles (15/187 cases)
angiofibroma (13/187 cases)
odontogenic masses (8/187 cases)
schwannoma (7/187 cases)
ossifying fibromas and cementomas (5/187 cases)

(ii) intermediate tumours (48 cases)

inverted papilloma (35/48 cases)
hemangiopericytoma (3/48 cases)
meningioma (2/48 cases)
hemangioma (8/48 cases)

(iii) malignant tumors (40 cases)

squamous cell carcinoma (7/40 cases)
adeno carcinoma (4/40 cases)
adeno cystic carcinoma (6/40 cases)
sarcomas (3/40 cases)
olfactory neuroblastoma (9/40 cases)
plasmacytoma (5/40 cases)
malignant melanoma (6/40 cases).

3. The Role of Endoscopic Endonasal Surgery in Resection of Benign Tumors

3.1. Encephaloceles. An encephalocele is a herniation of a part of the intracranial contents through a defect in the skull base. Basal encephaloceles can be classified on the basis of their location into transethmoidal, transsphenoidal, frontospheno- noidal, or rarely basioccipital-nasopharyngeal. Encephaloceles may be congenital in origin. Acquired encephaloceles may be posttraumatic or follow neurosurgery or sinonasal surgery. Endoscopic endonasal repair of encephaloceles using naso-septal flap is usually rewarding.

3.2. Osteoma and Fibroosseous Lesions. Osteomas are relatively rare, benign, slow-growing, well-defined neoplasms arising mainly in the frontal and ethmoid sinuses in close proximity of the nasofrontal duct, mostly on cranial sutures. Literature report noted a 30% incidence of people having paranasal sinus osteomas. It is present in 1% of all radiographs [2] and even higher number of CT scans [3]. Presenting in the third to fourth decade of life, osteomas have a preponderance to occur in men (1.5:1). It arises most commonly from the frontal and ethmoid sinuses and less commonly from the maxillary and sphenoid sinuses [3–5].

The majority of osteomas are found incidentally and are blamed for causing headaches, and excision is recommended before they cause symptoms [6]. Osteomas rarely cause any problems other than cosmetic. If they cause symptoms by obstructing the frontal recess, the history should include symptoms that are worse after respiratory tract infections and there should be endoscopic and CT scan signs of mucosal disease. Some osteomas become symptomatic in the second to fifth decade of life with headache in majority not related to the size of the lesion and epistaxis being the most common symptoms of tumours limited to the sinus.
Headache being the most frequent symptom usually results from the tumour pushing out the sinus tables and walls and obstructing the sinus ostium causing chronic inflammation of the mucous membrane lining the sinus [7]. Mucoceles arise as a consequence of obstruction of ostial region of the sinuses by the tumour subsequent impairment of mucociliary transport and chronic inflammation of the adjacent mucous membrane [3]. Lesions bigger than 3 cm in diameter are considered giant tumours. Due to enlarging tumour growth, severe sequels may develop, including orbital and intracranial complications.

Endoscopically, it appears as simple, smooth, mucosal-covered mass. Two subtypes are recognized, namely, ivory and mature osteomas [8]. Ivory osteomas have hard dense bone with few fibrous components and thus require extensive drilling. Mature variants have cancellous bone and interosseous spaces. The aetiopathology can be due to development, trauma, or infection [3]. Extensive osteoma with anterior frontal or anterior orbital attachment may require open approaches (osteoplastic flap or Lynch procedures). Removal of the lateral wall of the frontal recess via external approach can result in frontal stenosis [9–11].

Osteomas should be removed surgically if they extend beyond the boundaries of the sinus, keep enlarging, are localized in the neighbourhood of the frontonasal duct or if signs of chronic sinusitis are present and irrespective of their size, and if patients with osteoma complain of headaches when other causes of headache have been excluded. Treatment of small osteomas and asymptomatic osteomas is problematic. It can be observed if there is no noticeable increase in size in serial CT scans. Resection of small and medium size osteomas of paranasal sinuses can be safely and radically performed using endoscopic techniques which allows radical removal and very good cosmetic effects. The removal of osteomas depends on how accessible they are. The endoscope can be used to shell out the osteoma and then its walls can be removed or fractured inwards. As the most symptomatic ones are in the frontal recess, it is important to reconstruct the mucosal lining with a septal flap or a free mucosal graft or to combine their removal with a median drainage procedure. Giant frontal sinus osteomas can be effectively approached by a combine external and endoscopic procedure. Obliteration of the sinus is not mandatory if the mucous membrane is intact. Recurrences of properly removed tumours are rare.

Fibrous dysplasia is also common within the bones of the skull base. It is usually monostatic and can present as a nasal mass. The classic radiologic features of a ground glass appearance make this condition easier to confirm without surgical intervention. Management is generally conservative [12], because many of these lesions have slow growth rates and often slow or regress after puberty.

3.3. Mucoceles. Mucocele is a chronic, expansive, benign cystic lesion limited by the mucosa of the paranasal sinus, with thick, translucent mucous secretions. Although considered a benign lesion, the expansive character of the mucoceles promotes slow erosion of the adjacent bone via compression and consequent bone absorption. It is believed that this disease is secondary to obstruction to sinus drainage, leading to stagnation of the secretion within the cavity. The predisposing factors can be fractures, mucosal edema, polyps, tumors, surgical trauma, and chronic sinusitis. Mucoceles are classified according to the sinus of origin. The frontal sinus is the most common site, followed by the ethmoid, maxillary, and sphenoid sinuses.

Frontoethmoidal sphenoidal and the rare maxillary sinus mucoceles are ideal cases for endoscopic approach, provided large marsupialization can be achieved [13]. Mucoceles accessible with the endoscope should be opened as widely as possible using through-cutting forceps in order to minimize the amount of scar tissue that forms around the edges and which might lead to recurrence. Coronal CT scan is helpful to show whether the lesion can be approached via the nasal cavity and whether the lesion is uni- or multilocular. Abnormally thick bone as in Paget’s disease, fibrous dysplasia, and those mucoceles secondary to malignancy may not be suitable for an endoscopic approach [14]. In the frontal sinus, a small mucocele may be drained via the endoscopic approach but mucoceles with lateral extension may be difficult to access via the nose. In this cases, an external and endoscopic approach can be usefully combined, preserving lateral support of the frontal recess and avoiding a stent.

The majority of mucoceles can be marsupialized endoscopically with minimal morbidity and with long-term results that are as good as if not better than those done by the conventional external approach. The wider the mucocele is marsupialized, the better the result. Once a frontal and/or ethmoid mucocele has been marsupialized, the expanded “shell” of bone that remains can often be pushed manually in order to correct any bony swelling that may cause a cosmetic defect or displacement of the orbit.

3.4. Angiofibroma. Angiofibroma is an uncommon tumour of the sinonasal system [15]. It is a misnomer with the site of origin being an area in the lateral nasal wall near the sphenopalatine foramen. The lesions occur almost exclusively in men and during the second and third decades of life. Angiofibroma may represent a vascular malformation rather than a tumour [16]. Spontaneous regression has been reported. It has been encountered 25 times more frequently in those carrying the familial adenomatous polyposis gene [17, 18].

The tumour appears as a purple-grey pedunculated mass centred on the sphenopalatine foramen. Histologically, there is a vascular component of thin-walled vessels of varying sizes which lack elastic fibres and have a partial or incomplete smooth muscle layer [19]. Androgen receptors have been detected within the stroma [20]. The classic radiological feature of angiofibroma is anterior bowing of the posterior maxillary sinus wall, the Holman-Miller sign [21]. Intracranial extension of angiofibroma may occur with tumour spreading through well-described routes to the skull base dominated by extradural pattern [22].

The endoscopic route has become widely accepted for managing most tumours [23]. Even large tumours involving the middle cranial fossa can be successfully removed...
endoscopically (Figure 2). The midface degloving approach is occasionally used for extensive intracranial involvement [24, 25]. A careful devascularization of the tumour before removal is the key to successful endoscopic surgical management which can be achieved by lateral ligation of the feeding arteries or by preoperative embolization. Radiotherapy and hormonal therapy have little role in modern management.

Angiofibromas originate from the sphenopalatine foramen at the junction of the sphenoid process of the palatine bone and the pterygoid process of the sphenoid. Whether endoscopic excision of an angiofibroma is possible depends on its size, blood supply, and on whether it can be embolized safely. It is not possible to excise them endoscopically without preoperative embolization. Total removal depends on accessibility and control of its blood supply. The conventional approaches are via a lateral rhinotomy and medial maxillectomy, midfacial degloving [26], or transpalatally [27]. Larger lesions require the addition of a lateral infratemporal approach.

Angiofibromas at stages Ia, IIa, or IIb according to Fisch may be suitable for endoscopic excision [28]. These lesions comprise only a fifth of all angiofibromas [29]. It is essential that any surgeon embarking on an endoscopic resection should be able to convert it to an open approach as bleeding can necessitate this. It is necessary to have blood saved and at least six units of blood cross-matched and to have access to fresh frozen plasma.

Endoscopic resection consists of type III maxillary sinusotomy, an ethmoidectomy, and removal of the posterior wall of the maxillary sinus to define and clip the terminal branches of the maxillary artery and its sphenopalatine branches. Invariably, sphenoidectomy is performed and the tumor is removed. The aim is to remove the whole lesion in one piece, but is often removed in several pieces. It is often necessary to pack and apply pressure to the area temporarily to reduce bleeding before the next attempt is made to remove any remnant. Large suckers are helpful to remove enough blood quickly and allow the lateral wall to be visualized. A suction catheter passed through the other nostril into the nasopharynx also reduces the reservoir of blood in the nasopharynx and helps visibility. The main problem area is removing disease that goes behind and lateral to the pterygoid plates and clivus. The 45-degree endoscope helps visualize this area. It is helpful to have one surgeon holding the endoscope while the other has two hands free.

4. Odontogenic Masses

Infected odontogenic masses include periapical or radicular cysts. Developmental conditions are dominated by dentigerous cysts (an ectopic or unerupted tooth) (Figure 3) and odontogenic keratocysts (OKCs). An OKC is a benign but locally aggressive developmental odontogenic cyst. It is thought to arise from the dental lamina. Ameloblastoma and calcifying epithelial tumour contribute to the majority of neoplastic odontogenic lesions.

4.1. Schwannoma and Neurofibromas. Schwannoma and neurofibromas are indolent tumours arising from peripheral nerve components. Schwannoma is an isolated encapsulated lesion, whereas a neurofibroma is woven into the nerve and is often one of multiple lesions. The tumours cause symptoms through slow progressive growth that may distort tissues by pressure or become symptomatic by obstruction of sinus ostium. A contrast-enhanced CT scan may be performed. Neuromas and neurilemmomas demonstrate a characteristic irregular patchy appearance [30]. Malignant transformation occurs in about 1 in 8 patients with multiple neurofibromatosis (von Recklinghausen’s disease) [31].

Unusual isolated lesions can occasionally be resected endoscopically but their suitability for this approach depends on their extent and size. The majority of the schwannomas removed endoscopically at our center from the paranasal sinuses originated from trigeminal nerve (V2) (Figure 4).
4.2. Ossifying Fibromas and Cementomas. Inspite being sometimes difficult to be histologically differentiated from fibrous dysplasia, ossifying fibromas may be diagnosed by including clinical and radiographic criteria (Figure 5). They occur in primarily young adults and are typified radiographically by a sclerotic bony margin that is evident at surgical resection [31].

Cementomas are described as a variant of ossifying fibromas with a cementum-like osseous element. These are appropriately managed by endoscopic excision.

4.3. Chordoma. Chordomas often present with late neurological or ophthalmological symptoms but occasionally present earlier with nasal symptoms of obstruction or epistaxis. Radiological imaging (CT scanning and MRI) is important in assessing their extent. Biopsy must differentiate it from chondrosarcoma. Large lesions often require a transfacial approach, access via Le Fort 1 osteotomy, or lower lesions by mandibular split. Some lesions based on the anterior aspect of the sphenoid can solely be removed endoscopically. It involves a bilateral sphenoid sinusotomy type III when the sphenoidotomy is extended superiorly to the planum, to the floor of the sinus, and laterally to the vital structures. The carotid arteries and optic nerves can almost be skeletonized using a long-shanked drill and a well-irrigated coarse diamond drill (Figure 6).

Chordomas are moderately radiosensitive and radiotherapy is often performed in conjunction with surgery. Cure is rare as recurrence is common and while the long-term prognosis is poor, they often grow slowly and patients can live for several years.

4.4. Chondroma. Chondromas can be localized in the ethmoid sinuses, maxilla, or septum and can be removed endoscopically. If it is large and spreads beyond the paranasal sinuses, they may need to be excised via a lateral rhinotomy or midfacial degloving.

4.5. Pleomorphic Adenoma. It can involve the septum and can be excised endoscopically with a small but macroscopically clear margin to leave a perforation. This can be inspected for recurrence and reconstructed after disease free interval. It is essential to have a clear margin and remove it in one piece meal, otherwise recurrence is likely.

4.6. Pituitary Adenoma. Pituitary adenomas account for about 10% of intracranial neoplasms [32]. They often remain undiagnosed and small pituitary tumours have an estimated prevalence of 16.7% [32]. The diagnosis is entertained either on the basis of visual impairment arising from the compression of the optic nerve by the tumour or on the basis of manifestations of excess hormone secretion. Pituitary adenomas can be differentiated by measuring the size of the tumour. The radiological classification of pituitary adenomas is listed in Table 1. Pituitary microadenomas are defined as intrasellar adenomas of less than 1 cm in diameter without sellar enlargement whereas pituitary macroadenomas measure larger than 1 cm in diameter with generalized sellar enlargement, and may cause symptoms of mass effect.
Current direct endoscopic endonasal transsphenoidal hypophysectomy is considered the technique of choice when pituitary surgery is indicated and is a useful approach in overcoming the postoperative complications (Figure 7). The advantages of this approach are that it does not utilize a nasal speculum, gives a clear panoramic view, allows more complete removal, and does not require postoperative packing.

The latest invention to reduce the incidence of CSF leaks employs vascularized mucosal flaps which hastens the healing process. Hadad and Bassagasteguy from Argentina developed the nasoseptal flap, supplied by the posterior nasoseptal arteries which are branches of the posterior nasal artery. A mucoperichondrial/mucoperiosteal flap pedicle on the posterior nasal arteries provides a long flap that has a wide arc of rotation and a potential for area of coverage that is superior to any other flap previously described (Figure 8). The flap may be harvested to cover the entire skull base from the frontal sinus to the sphenoid or cover a clival defect from the sella to the second cervical vertebra. The use of this flap has to be anticipated in advance, since a posterior septectomy and a wide large sphenoidotomy remove the vascular pedicle. This flap is very reliable and typically positioned over a fascial graft or fat graft and held in place with fibrin glue and a balloon catheter. We have not observed any significant donor site morbidity with the use of this flap and the septum becomes remucosalized within several months of surgery. Developments that have decreased the incidence of postoperative CSF leaks include a multilayered closure, direct suturing of grafts to dural edges, use of biological glues, and coverage with vascularized septal mucosal flap. With the advent of the septal mucosal flap, the Pittsburgh group suggest an incidence of 6% of CSF leak [33, 34].

The mortality rate related to pituitary tumours is low. Morbidity related to pituitary macroadenomas is associated with suprasellar expansion of the tumour into the optic chiasm and the cranial nerves adjacent to the cavernous sinus and may include permanent visual loss, ophthalmoplegia, and other neurological complications. Partial or complete engulfment of the carotids may occur in macroadenoma due to lateral extension. The grading scheme for suprasellar extension is listed in Table 2. For pituitary microadenomas the cure rate is greater than 50% on complete excision [35]. Tumour larger than 1 cm has higher residual tendency and may require additional treatment such as radiotherapy or radiosurgery. Reports of incidence of postoperative CSF leak in the literature range from 1.5 to 4.2% [36]. The incidence of CSF leak was 50% higher with macroadenoma surgery.

Table 2: The grading scheme for suprasellar extensions.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 to 10 mm suprasellar extension occupying the suprasellar cistern</td>
</tr>
<tr>
<td>2</td>
<td>10 to 20 mm extension and elevation of the third ventricle</td>
</tr>
<tr>
<td>3</td>
<td>20 to 30 mm extension occupying the anterior of the third ventricle</td>
</tr>
<tr>
<td>4</td>
<td>Larger than 30 mm extension, beyond the foramen of Munro or Grade C with lateral extension</td>
</tr>
</tbody>
</table>

4.7 Other Benign Pathological Lesions. Almost every type of benign lesion has been reported in the paranasal sinuses [37]. Endoscopic surgical management depends usually on the anatomical location.

5. The Role of Endoscopic Endonasal Surgery in Resection of Intermediate Tumors

5.1 Inverted Papilloma. Inverted papillomas usually present as polypoid unilateral nasal mass (Figure 9). Occasionally, it may be found in association with allergic nasal polyps which accounts for the need to always submit labeled, separate specimens from each side of nose when performing routine polypectomy. It is the most common benign epithelial tumour of the sinonasal tract and its aggressive and recurrent nature is well known and there is approximately 10% risk of development of malignant transformation. Traditional surgical management involves lateral rhinotomy and ipsilateral medial maxillectomy. Sinonasal papilloma was first described by Ward [38] in 1854 but it was Hyams [39] who assisted in defining the pathoclinical condition. It is important that all macroscopically diseased tissue is examined in order to avoid malignancy being missed.
A review of the literature shows that while malignant transformation does occur, it is very unusual [40]. The histologic findings consist of infolded epithelium that may be squamous, transitional, or respiratory. Even when not malignant, these lesions must be treated with respect because inadequate excision is likely to result in recurrence. The subdivisions of inverted, septal (fungiform), and oncogenic (cylindric) are widely accepted today [20]. It comprise less than 5% of all tumours of the nose [41], but IP is frequently encountered in the clinical environment because of its potential for growth, malignant change, and high recurrence rate. IP occurs in the fifth to eighth decade of life and is generally more common in men than in women. An association of IP with inflammatory polyps is well described but most are isolated lesions. Only 4.9% of patients present with bilateral or multifocal disease [42]. A human papilloma virus origin has been widely investigated. The presence of osteitis within the mass can often identify the site of attachment [43–45]. Precancerous condition (atypia, dysplasia, and carcinoma in situ) and squamous cell carcinoma can all occur in papilloma. Published case series have reported a synchronous carcinoma rate of 7.1% and metachronous rate of 11% [46]. A collation of the literature reports recurrence rates of 12.8% for endoscopic resection, 17% for lateral rhinotomy, and 34.2% for other limited resections [47].

Endoscopic removal of inverted papillomas has become the treatment of choice in situations in which the lesion is small and can be easily removed with a margin of normal tissue. With skull base extension in the area of the ethmoid or sphenoid sinuses, the endoscopic approach allows the tumor to be resected as completely as any approach except the more massive craniomaxillary operation which most surgeons feel is not required for this benign lesion. The medial wall of the maxillary sinus can be removed by retrograde uncinctomy using backbiting forceps to create an opening that extends inferiorly to the floor of the nose, anteriorly to the nasolacrimal duct, and posteriorly to the pterygoid plate. The most difficult areas of excision are the frontal sinus, the anterior wall of the maxilla, and the nasolacrimal system. Attachment of the tumour within the frontal sinus is usually a contraindication of the endoscopic approach. A retrospective evaluation revealed that 17% of patients treated endoscopically experienced recurrence while 19% who were treated extranasally experienced recurrence [48]. In the author’s experience, however, the endoscopically managed tumours tended to be smaller. According to the literature report, there was no incidence of recurrence when endoscopy was clear for 3 years and over 90% whom were disease free after a mean of 10 years following endoscopic medial maxillectomy [48].

5.2. Hemangiopericytomas. Hemangiopericytomas typically occur in the nose but may involve the sinuses. Clinical behavior may vary considerably from a slowly enlarging rubbery mass to an infiltrating aggressive neoplasm. These tumours are locally aggressive and must be respected as tumours that are likely to recur and associated with delayed recurrence making 5-year survival an inadequate measure of cure [49].

5.3. Meningiomas. Extracranial meningiomas which arise from ectopic arachnoid tissue are very rare tumours. Occasionally, an intracranial meningioma will invade the sinuses or orbit. Plain skull films may reveal hyperostosis of the ethmoidal region. Further evaluation includes CT scanning and angioigraphy or MRI. Surgical excision is the only form of definitive management although radiotherapy may be effectively used to stabilize inoperable lesions.

5.4. Hemangioma. Hemangiomas are typically asymptomatic and extirpation is only indicated for bleeding or major discomfort. Lobular capillary hemangioma (LCH) dominates the vascular neoplastic masses in the nose and paranasal sinuses (Figure 6). They can emulate pyogenic granulomas, which is due to a florid reaction as a result of local trauma, typically in the third trimester of pregnancy. They are common throughout life but are uncommon in persons younger than 16 years age [20]. LCH presents as a red-purple, lobulated, smooth mass frequently arising from the septum and occasionally from the head of inferior turbinate. Atypical mitosis may be associated but there is little evidence of transformation to angiosarcoma [20]. Cavernous hemangiomas are much less common in the sinonasal tract than LCH. It is more frequently located in the middle turbinate, in lateral nasal wall, and within bony structures. Hemangiomas are typified by rarefaction on radiographs although they may become sclerotic as they mature. Most hemangiomas that appear in childhood involute spontaneously and no intervention is required. Occasionally, they can enlarge, endangering vital structures. Here, steroids or interferon-2 have a role [50]. Later in life, smaller capillary, venous or cavernous hemangiomas can present, often with epistaxis. They can originate from the septum (Figure 10) or the turbinates and alarm the patient and the primary care physician, who may suspect malignancy. Outpatient endoscopic examination along with gentle palpation
6. The Role of Endoscopic Endonasal Surgery in Resection of Malignant Tumors

Only a small minority of cases are suitable for endoscopic resection for malignancy involving the paranasal sinuses [51]. While the endoscope has the potential to help visualize the paranasal sinuses and reduce the morbidity associated with the resection of the lesion in this area, it is vital that the surgical resection and its margin are not compromised by the use of these techniques. Usually the endoscope is used to assist in defining the intranasal extent of the tumor in conjunction with a craniofacial resection [52]. While more recent techniques have extended what can be resected, such as lesions involving the cavernous sinus, there is no evidence that these increase life expectancy or reduce morbidity [53]. An understanding of the pathology of tumor in this region and formulation of the treatment plan with an oncological team are important. Moreover, the management of all malignant lesions should be performed in conjunction with a multidisciplinary team.

The surgeon’s main aim is the en bloc resection of the malignant tumors. However, this is not always possible and in some circumstances where tumor is abutting the internal carotid artery, the optic nerve, or cavernous sinus, removal without a clear margin or incomplete removal will occur. Additional treatment such as radiotherapy or chemotherapy is often given, depending on the pathology, the patient’s condition, and the relative benefit compared to the morbidity these may produce. Longer term followup is currently available and comparative trials are needed before the endoscopic resection of malignant tumors can be advocated.

Craniofacial en bloc resection remains the gold standard that has increased life expectancy in skull base tumors [54]. The integrity of the dura is critical in the management of this condition. A tumor invading the dura is associated with a poor prognosis. The endoscopic resection of malignant skull base lesions may have a role in small tumors where a margin of resection is possible. However, it is often necessary to de-bulk a tumor hanging into the airway in order to improve the visibility of its margins and the roof of the sinuses. Powered instrumentation helps but all material must be collected in a trap for histological examination. Preoperatively, the radiographs and the endoscopic appearance need to be studied to estimate the extent of the lesion. When the margin of the tumor is not clear, it is advisable to take endoscopic biopsies at the commencement of the procedure and send this for frozen section. The craniofacial resection can then proceed and the wait for the pathologist’s reply will not prolong the procedure.

A through frontosphenoethmoidectomy can be performed away from the tumor margin if possible to add to the margin of the resection. The septum can be divided endoscopically to help the specimen be delivered en bloc via the craniotomy. If the tumor extends to involve the medial wall of the orbit, this can be removed via the craniotomy and the endoscope can help in ensuring that its inferior margin is cleared.

6.1. Squamous Cell Carcinoma. Squamous cell carcinoma is the most common histologic type with an incidence of roughly 80%. Patients affected are usually above 50 years and there is a male predominance. Endoscopic endonasal resection may have a role in early tumours followed by adjuvant radiation therapy where needed.

6.2. Adenoid Cystic Carcinoma. Adenoid cystic carcinoma accounts for about 10% incidence and is the most common minor salivary gland tumour of paranasal sinuses with a predilection for perineural spread. Endoscopic endonasal resection may have a role in early tumours followed by adjuvant radiation therapy where needed.

6.3. Adenocarcinoma. Adenocarcinoma accounts for about 10% incidence. Endoscopic endonasal resection may have a role in early tumours followed by adjuvant radiation therapy where needed.

6.4. Sarcomas. Osteogenic sarcomas and chondrosarcomas of the facial skeleton are encountered more commonly in the mandible than in the maxilla. The most successful therapy is based on wide endoscopic resection with 5-year survival being in the 10% to 20% range. Irradiation seems to be an effective adjuvant for both tumours.
6.5. **Olfactory Neuroblastoma.** Endoscopic resection has been advocated for tumors of Kadish stages A or B with no evidence of intracranial extension. Endoscopically, it is possible to resect the cribriform plate, the crista galli, the olfactory bulbs, and their surrounding dura along with the top of the septum and the middle turbinates where they are attached to the skull base [55]. The primary determining factor affecting prognosis is the degree of differentiation. Since poorly differentiated tumors usually metastasize, it is best to minimize surgical morbidity and mortality by endoscopic resection. Craniofacial resection has a complication rate of almost one in four [56].

6.6. **Plasmacytoma.** Granuloma, pseudolymphoma, reactive plasmacytic hyperplasia, olfactory neuroblastoma, lymphoma, anaplastic carcinoma, and metastatic tumors all have a similar appearance to plasmacytoma. The management of these lesions depends on the understanding of their pathology, since their behavior and management differ. Therefore, biopsy is important. The diagnostic classification of plasma cell neoplastic disorders includes

(i) solitary plasmacytoma
(ii) extramedullary plasmacytoma
(iii) myelomatosis
(iv) plasma cell leukemia.

Solitary plasmacytoma of bone commonly presents as a single large osteolytic lesion, often with multicystic areas of rarefaction. Moreover, almost 50% of solitary plasmacytomas will be converted to multiple myeloma [57]. It is essential to look for evidence of systemic involvement and the presence of paraprotein. Solitary lesions (Figure 11) can be excised but since they are highly radiosensitive, they should be only removed if it can be performed with minimum morbidity. Radiotherapy is the treatment of choice. Adjuvant chemotherapy is occasionally indicated in an attempt to delay conversion to myeloma. Extramedullary plasmacytomas present as sessile, pedunculated, or polypoid masses with a pale yellow hue and fewer patients convert to multiple myeloma.

6.7. **Malignant Melanoma.** Melanomas of the paranasal sinuses are usually advanced at the time of discovery. Frequently regional or distant metastasis exists at the time of initial examination. An en bloc resection with radiotherapy is associated with a lower recurrence rate and metastatic rate in spite of its relatively low radiosensitivity. However, the prognosis is poor with approximately only 1 in 4 surviving 5 years. The endoscope is useful for examining the nasal lining for evidence of satellite lesions although about one-third are amelanotic.

6.8. **Other Malignant Skull Base Tumors.** There is no much evidence to suggest that the endoscope is of benefit in resecting other malignant tumors affecting the skull base or paranasal sinuses, namely, nasopharyngeal carcinoma, neuroendocrine tumors other than olfactory neuroblastoma, lymphoma [58], undifferentiated carcinoma, small-cell carcinoma, and metastases. However, some malignant tumors can be resected with a wide margin as can be obtained using other techniques in the hands of an experienced endonasal surgeon. This should only be performed in conjunction with a multidisciplinary team.

6.9. **Recurrent or Residual Malignant Disease.** The endoscopic debulking of tumor can sometimes help in palliation by providing a nasal airway. The KTP laser is particularly useful in debulking hemorrhagic lesions.

7. **Complications**

Complications of endoscopic surgery of the paranasal sinuses can be classified according to the severity as minor or major and according to the time of appearance as immediate or delayed. Minor complications occur in between 2 and 21% [59, 60] of cases which include synechiae, crusts, minor bleeding, nasal septum perforation, headache, facial pain, alteration of dental sensitivity, edema, local infection, periorbital ecchymosis, palpebral edema, subcutaneous emphysema, stenosis of sinus ostia, hyposmia, epiphora, exacerbation of bronchial asthma, and postoperative sinusitis.

The principal major complications anticipated are vascular injury and orbital and intracranial complications which vary from 1 to 3% [61].

The most frequent immediate complications are CSF leak [1], intraoperative bleeding, orbital hematoma and injury to brain. Delayed complications include progressive loss of vision or smell, meningitis, bleeding, synechiae, and infection.

8. **Conclusion**

Benign sinonasal masses are common as compared to malignant masses and can be a cause of significant morbidity. The minimally invasive endoscopic surgery of the cranial base and the pituitary fossa is an interactive real-time live
surgical team effort. The collaborative effort between the otolaryngologists and the neurosurgeon is critical and valuable in effectively managing pituitary fossa and cranial base tumors with minimal morbidity and avoidance of medicolegal implications. A sound approach is required to balance carefully the need for removal with the impact of surgery on the patient's life. Endoscopic endonasal surgery is indicated when control of symptoms directly related to pathologic findings is required, when there are pending complications, or when the potential or suspicion of malignancy exists. Maximal endoscopic exposure, aggressive bone removal, and reconstruction of functional components of the sinonasal system should be paramount. The morbidity of surgery around the dental roots, dura, periorbita, or exposed critical structures (e.g., ICA) should influence the aggressiveness of surgical resection. Endoscopic surgical resection has replaced transfacial approaches at many institutions. Pain, recovery, hospital stay, and disfigurement can all be reduced with aggressive endoscopic approach. However, the potential for complications differs little from the days of open surgery.

References


