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Chapter 8

Endoscopy - An Advancement in Sinus and Skull Base Surgery

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Additional information is available at the end of the chapter

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1. Introduction

Skull base and sinus surgery has evolved dramatically throughout the past century. It is not long ago that the maxillary sinus would principally be reached via an anterior approach through the gingivobuccal sulcus of the oral cavity. The earliest days of endoscopy date back to the early 1900s, when Hirschmann used a modified cystoscope to examine the sinuses. Thereafter, modern endoscopy has seen advances not only in the types of endoscopes available, but also the types of interventions amenable to the endoscopic approach.

However, even in this modern era of refined endoscopic instrumentation and technique, opinion remains split regarding the optimal approach to certain areas of the skull base. For example, areas such as the anterior cranial fossa and the infratemporal fossa are often approached through external transcutaneous approaches despite the development of adequate and safe transnasal endoscopic pathway.

The current chapter aims to provide a complete comparison of endoscopic versus open approaches of routinely performed sinus and skull base surgical procedures. It will also emphasize the advantages of endoscopy versus traditional approaches for sinus and skull base surgery, including management of tumors, infectious processes, congenital anomalies and traumatic injuries.

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2. Evolution of endoscopic sinus surgery

2.1. History of the emergence of endoscopes

The historical evolution of endoscopic sinus surgery is quite fascinating. Hippocrates can be considered one of the first practitioners of rhinology. He was one of the first to document treatment of nasal polyps using snares or sponges on a string.[1] Thereafter, there were many ancient rhinology physicians that contributed to the evolution of rhinology, however we will focus on the evolution of endoscopic sinus surgery in this chapter.

The first reports of endoscopic visualization of the sinuses date back to 1901 when Hirschman used a small cystoscope with an electric bulb to examine the maxillary sinus through an oroantral fistula.[2] Thereafter, in 1902, Reichert performed the first known endoscopic sinus surgery, performing maxillary sinus manipulation through an oroantral fistula.[3] Continuing this trend, in 1922, Spielberg employed antroscopes to access the maxillary sinus via the inferior meatus.[2] The term "sinuscopy" was later popularized by Maltz in 1925.[2]

At that time, these endoscopes were not surprisingly restricted in terms of optical quality, field of view and illumination, relying on flame or electric bulbs.[2] In the 1960s, Hopkins developed the rod optic endoscope. Hopkins, also known for the development of the fiber optic gastroscope and zoom lens for cameras, revolutionized the optical quality available to surgeons.[3] Thereafter, Karl Storz in Germany created angled endoscopes ranging from 0 to 120 degrees, thus allowing visualization of a field of view never previously imagined.[2]

In the 1970s, this new and exciting armamentarium of endoscopic tools allowed surgeons such as Messerklinger, Stammberger, Draf and Wigand to transition sinus surgery from a radical operation to a minimally invasive procedure.[2,3] In 1978, Messerklinger published the landmark reference "Endoscopy of the nose", due to large part from this remarkable evolution in endoscopic sinus surgery tools. He thoroughly examined the mucociliary clearance pattern and endoscopic changes of the osteomeatal complex,[3] thus further understanding sinus disease.

At that time, Draf published his own work on the sinuses and it was his experience that made frontal sinus access more realistic and safe.[4] Stammberger was also enthusiastic and prominent in the field of endoscopic surgery and popularized Messerklinger's ideas worldwide. The immense work of these pioneers remodeled sinus surgery. The principle of treating sinus disease from a functional point of view at the site of obstruction replaced the traditional mucosal stripping approach to treat inflammatory disease.[3] This work led to the term "functional endoscopic sinus surgery," which was coined by Kennedy in 1985.[2] In the same year, the first two established courses in North America on endoscopic sinus surgery were given at the Johns Hopkins Hospital.[3]

Furthermore, more contemporary surgeons, following the work of the pioneers of rhinology, expanded the limits to which nasal endoscopy could treat disease. Areas of the skull base were also accessed and different types of procedures amenable to this approach revolutionized the field of rhinology. The first description of trans-sphenoidal approach to the sell-

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ar region dates back to 1907, perfored by Schloffer.[4,5] Another prominent surgeon, Cushing, performed this procedure for many years, but abandoned this approach in 1927 due to the high complication rate. The procedure rapidly lost popularity until Dott, a disciple of Cushing, created a lighted speculum as an aid for trans-sphenoidal visualization.[6] In the 1960s, Guiot, a disciple of Dott, popularised this approach.[4] He was the first neurosurgeon to perform transsphenoidal surgery.[6]

In 1967, Jules Hardy reported the use of the surgical microscope for transsphenoidal surgery.[5]He is credited for developing the fundamental principles of pituitary surgery upto this day.[5] Jankowski published the first series on endoscopic pituitary surgery procedures in 1992.[7] The term "functional endoscopic pituitary surgery" was coined by Cappabianca and de Divitiis.[6]

However, the endoscopic approach to the skull base didn't end at the sella region. Weiss, in 1987, was the first to publish about extending the transsphenoidal approach to access suprasellar lesions.[5] Thereafter, the first report of endoscopic transsphenoidal approach for resection of a large clivus chordoma was published in 1996 by Jho.[8] More contemporary surgeons have continued this endoscopic advacement towards the skull base with new approaches to areas such as the infratemporal fossa and the anterior cranial fossa.

With the evolution of endoscopes, also came an evolution in surgical instruments used in sinus surgery. Early endoscopic surgery was performed using grasping forceps, which often stripped mucosa and denuded bone. At first, this was considered ideal as the theory of removing all the diseased mucosa was preached. However, with endoscopes, surgeons were able to visualize the sinuses on post-operative follow-ups and discover the osteitis, scarring and osteoneogenesis that their surgery had caused. Thus, there was a movement to create new endoscopic fine-cutting instruments, originally developped for orthopedic cartilage work, to perform minimally invasive "functional" surgery. Later, an evolutionary descendent of the through cutting instruments, was the emergence of the microdebrider, also originally used in orthopedics. Setliff and Parsons introduced the microdebrider to sinonasal surgery.[3]

It is important to emphasize the work of pioneers such as Messerklinger, Draf, Wigand and others as a focal transition point in the medical community's understanding of sinus disease. In fact, before their reports, sinus disease treatment was based on an invasive exenterative approach of removing all the inflammed mucosa of the sinuses. The main focus of treatment was to obliterate and remove all the sinonasal regions of disease. However, the work of these legendary surgeons allowed physicians to understand the functional aspect of sinus anatomy. They demonstrated that a large amount of sinus disease was based on an impairment of adequate drainage and that resolution of the latter obstruction would allow symptomatic relief.

This concept of mucosal preservation still applies today and is the basis of a large portion of rhinology practice. In fact, rhinologists are careful to avoid mucosal stripping that can potentially cause impaired mucociliary clearance or neo-osteogenesis.[9] This has motivated

the development of precise instrumentation including sharp through-cutters and microdebriders that mimise trauma to adjacent healthy tissue.

2.2. Endoscopes of the 21ST century

Endoscopes today have offered sinus surgeons the ability to increase the potential applications of endoscopic sinus surgery. There is a strong movement by manufacturers to improve optical quality of their endoscopes. One such improvement is the use of the xenon light, which was an upgrade to the halogen light source, with advantages such as durability, diminished heat production and energy consumption. Another improvement is the diameter of the endoscopes with some available as small as 2 mm. The most common scopes currently employed in sinus and skull base surgery are 4 mm in diameter by 20 cm long; 2.7 mm diameter scopes are commonly reserved for pediatric cases. These scopes are available in various angles ranging from 0 to 30, 45, and 70 degrees and provide high quality imaging.[9]

Furthermore, there have been improvements in the processing camera used for endocopic surgery. Modern cameras have gone from 1 silicone chip to 3 silicone chip cameras in order to process the three primary colors [red, blue and green] as a means to enhance contrast and balance of the projected image.[2] High definition cameras have replaced traditional cameras, working through a progressive scanning mechanism instead of an interlaced scanning manner. This refers to the way each frame is scanned by the camera, and results in an upgrade of 60 frames per second being seen by the high definition cameras instead of 30 frames per second provided by the older generation. The previously used interlaced scanning provided a significant amount of flickering, which was compensated by image blurring.

Finally, as the image viewed is dependent on the resolution of the monitor, even the latter has evolved dramatically. With the advent of high definition monitors, 16:9 aspect ratio has replaced the traditional 4:3 aspect ratio provided by standard definition monitors, translating in an increase in pixel density from 640x480 to 1929x1080.[2] What this means for the surgeon is better color, contrast, resolution and peripheral visualization of the surgical field.

3. Endoscopic surgery versus open traditional approach

Sinus surgery traditionally was performed via open approaches, be it a Caldwell-Luc procedure for the maxillary sinus or an osteoplastic flap approach to the frontal sinus. With the advent of the endoscopes, these traditional invasive extenterative methods have largely been replaced by functional endoscopic sinus surgery. In this section, we examine the different sinuses and contrast these approaches.

3.1. Frontal sinus

The first report of frontal sinus surgery was by Rimge in 1750, where he used an external approach to obliterate the sinus.[10] In 1884, Ogston and Luck described an anterior wall perforation technique using a trephine to create a drainage pathway into the anterior eth-

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moid cells.[10,11] Thereafter, in 1891, Kuhnt proposed anterior wall ablation.[11] Similarly, in 1893, Jansen published his procedure where he removed the floor of the frontal sinus and collapsed the anterior table against the posterior wall.[10] The latter procedure was elaborated by Reidel-Schenke who promoted breaking down the anterior and inferior walls of the sinus and collapsing the skin of the forehead against the posterior wall.

	Traditional Approach	New Approach
Frontal Sinus	Osteoplastic flap	Frontal Drillout
Maxillary Sinus	Caldwell-Luc	Endoscopic Antrostomy
Ethmoid Sinus	External ethmoidectomy	Endoscopic ethmoidectomy
Sphenoid Sinus	Transantral approach	Endoscopic sphenoidotomy

Table 1. Comparison of traditional and new approaches to the paranasal sinuses.

Later in that decade, Schonborn and Brieger performed frontal osteoplastic flaps. As one can imagine, these were associated with poor cosmetic results. Thus, in the early 1900s, transorbital approaches were attempted to access the frontal sinus. Knapp was a pioneer in this access way, performing one of the first external frontoethmoidectomies through the medial orbital wall, resecting the frontal sinus floor and preserving the frontal duct. The latter was made famous by Lynch in 1921.[10]

At that time, intranasal access was also attempted, but the poor visual field caused a large amount of intracranial complications and deaths. It was thus abandoned for other approaches until the emergence of endoscopes. In 1991, Draf published his experience with transnasal frontoethmoidal surgery using a microscope.[12] He published variations on the dissection of the frontal recess and floor, known today as the Draf 1, 2 or 3 procedures. With his descriptions and the advent of the endoscope, the often disfiguring open approaches were largely replaced by transnasal minimally invasive accesses. Today, angled telescopes and angled instruments produce success rates equal to the traditional morbid procedures with decreased morbidity.[12]

Along with better cosmesis, endoscopy is associated with decreased morbidity, preservation of mucociliary drainage and decreased hospital stay.[10] The disadvantages include potential difficulties in managing complications such as severe bleeding and in achieving margins for malignant lesions. Also, large lesions affecting the fronto-ethmoidal region may need to be managed by an osteoplastic flap technique, lateral rhinotomy or anterior direct approach.[11,13]

Open surgery has the advantage of a wide field of view, better management of complications and an increased ease of obtaining adequate margins for malignant lesions. The disadvantages are longer hospital stay, increased morbidity including possible injury to the superior branches of the facial nerve. However, although endoscopic sinus surgery of the

frontal sinus is often highly effective, certain select cases nevertheless still require open approaches with osteoplasties.

3.2. Maxillary sinus

The first descriptions of open approaches to the maxillary sinus date back to the early 1700s. Over a century later, in 1893, in the United States, Caldwell described an anterior approach via an incision in the gingivobuccal sulcus coupled with an inferior antrostomy. This procedure was almost simultaneously popularized in Europe by Luc, and was later coined the Caldwell-Luc procedure.[14] A century after that, Stammberger and then Kennedy introduced the middle meatus antrostomy in the 1980s.[15] At that time, inferior and middle meatal antrostomies were being performed by different group of surgeons. When compared, middle meatal antrostomies demonstrate better resolution of symptoms and longer patency rates.[14] The reason for this is believed to be the fact that the normal mucociliary clearance patterns of the maxillary sinus tend to move secretions toward the natural ostium in the midle meatus, and not toward the inferior meatal antrostomy.

With the emergence of endoscopes, especially angled telescopes to look within the maxillary sinus, as well as the development of the coronal bone view on CT scans in 1987, the approach to the maxillary sinus changed dramatically. A study performed by Penttila et al. demonstrated that patients undergoing surgery for chronic maxillary sinusitis reported improvement in 50.7% of the Caldwell-Luc group and in 76.7% of the endoscopic sinus surgery group.[16] Also, higher complication rates have been described in patients undergoing the Caldwell-Luc procedure.[17] These include pain, facial swelling and numbness, dental numbness, persistent oroantral fistulas, wound dehiscence, dacrocystitis, tooth decay, persistent symptoms and bleeding.[15]

Although endoscopic surgery has largely replaced Caldwell-Luc procedures, there is still a role for the latter in certain cases. Cutler et al. performed the procedure in 37 patients who had failed endoscopic sinus surgery for refractory sinusitis and reported a 92% response based on follow-up endoscopic examination or computed tomography scan imaging.[18] Other possible indications include the removal of dentigerous cyst and benign tumors located within the maxillary sinus.

3.3. Ethmoid sinus

The management of ethmoid sinus disease has been the source of a lot of controversy in the past. Many surgical methods for ethmoidectomies have been described, ranging from intranasal, transantral, external approaches employing a headlight, to endoscopic approaches.

In 1912, Mosher described intranasal extirpation of the ethmoid labyrinth.[19] He promoted the complete resection of the middle turbinate along with the ethmoid sinuses, which was debated by opposing surgeons, including Pratt. The latter preached the importance of the middle turbinate as a landmark to reduce operative morbidity.

In 1929, Mosher and Smith, a well-known rhinologist, promoted a transition towards an external approach as means to reduce complications.[19] At the same time, other surgeons

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promoted a transantral approach, originally described by Jansen in the 1800s. All these approaches were being practiced without any consensus as to the optimal technique.

The transnasal approach, which was popularized by Mosher, consisted of progressive exenteration of the ethmoid air calls in antero-posterior direction. As mentioned, certain surgeons removed the middle turbinate as well. Along with the ethmoidectomy, the nasofrontal duct was also unroofed. In this method, the procedure was performed through a nasal speculum with a headlight. Magnification was provided by loupes or insertion of lenses onto the headlight. Certain surgeons, namely Dixon and Heermann, advocated the use of microscopes during the transnasal approach to the ethmoids.[19] However, the high incidence of complications and the availability of the transantral and external approaches, caused this method to fall in popularity over the next few decades.[19]

These procedures have all been replaced by endoscopic sinus surgery. The latter permits controlled removal of the diseased tissue and obstructing bony partitions in a stepwise fashion, with decreased complications. Ethmoidectomies are also commonly performed in conjunction with other procedures, thus a vast access with the endoscope is essential.

3.4. Sphenoid sinus

The history, indications and approaches to the sphenoid sinus will be discussed in details in the skull base section. The open, microscopic approach versus the endoscopic approach to sphenoid sinus surgery and access to the skull base will be contrasted.

4. Septoplasty

Apart from the sinuses, the nasal septum is also amenable to open or endoscopic surgery. In 1842, Langenbeck first described the entities of septal crests and spurs.[1] Thereafter, in the early 1900s, Freer published about the removal of thickened portions of the septal cartilage. He invented a number of instruments to perform this procedure. Simultaneously, Killian further developed many of the techniques of septal surgery.[1]

Cottle first described septoplasty in 1947 to treat nasal obstruction.[20] It is only in 1991 that the endoscopic technique to treat septal deformities was first popularized by Lanza et al. and Stammberger.[21] Thereafter, Lanza described isolated septal spur surgery using endoscopic access.[21,22]

Advantages over the open technique include targeted approach to the septal deformity, limited mucosal flap dissection, superior magnification of the field and less physical distortion as there is no need of a nasal speculum. Finally, it is a superior teaching tool as trainees can visualize the surgery on a screen in real-time.[23] Furthermore, endoscopic visualization allows assessment of deformities in the nasal valve region and posterior septum.[21]

Proponents of endoscopic surgery advocate the minimally invasive aspect of this approach as only the mucosa overlying the deviated segment is elevated through a Killian incision.

This may explain why authors have reported higher degrees of septal tears with the open technique.[23] This is particularly useful in revision cases, where fibrosis adheres the septal mucosa in areas previously operated. Other advantages of the endoscopic approach include shorter operative time, decreased bleeding, decreased pain[24,25] and decreased synechiae formation.[20]

Rotenberg's group recently demonstrated that there was no difference in post-operative outcomes in terms of nasal obstruction between both groups,[23] in support of previous surgeons' findings.[25] However, other authors have stated significant differences in nasal symptoms with endoscopic groups doing better in follow-up assessments.[20,24]

The endoscopic septoplasty has gained popularity in recent years. Nevertheless, certain cases still require an open approach. The relative contraindications to endoscopic septoplasty are when the deformity involves a deflection of the caudal septal cartilage, and when external nasal deformities require a concomitant open rhinoplasty.[20,21]

5. Skull base

Through the years, the work of Messerklinger and other pioneers in nasal endoscopy helped to develop functional endoscopic sinus surgery as a means to treat sinus disease from a mechanical point of view. However, contemporary surgeons have expanded the limits to which nasal endoscopy can treat disease. In fact, the areas of the skull base accessible and the types of procedures amenable to this approach have revolutionized the field of rhinology.

Traditional methods required external skin incisions, translocation of the cranium or maxillofacial skeleton and retraction of the brain.[26] Endoscopic access is based on modular anatomical approaches in the sagittal planes, for anterior cranial fossa, pituitary, and transclival posterior cranial fossa surgery; and coronal planes, for pterygopalatine fossa and infratemporal fossa surgery.[27]

Endoscopic endonasal approaches have improved visualization and decreased collateral trauma to the craniofacial tissues. They provide faster healing and recovery time, decreased neurovascular injuries, complete oncologic resections and better endocrinologic outcomes. Potential limitations of the endoscopic approach include location, extent and nature of the disease and importantly surgeon expertise and available equipment, including image guidance.[26]

There are multiple approaches available to the skull base depending on the location of the disease, namely the transcribriform, transsellar, transplanum [drilling the planumsphenoidale and the tuberculum sellae, transclival and the transodontoid approaches.[6] The latter apply to sagittal plane. In terms of coronal plane, the skull base can be divided into medial petrous apex, petroclival region, Meckel's cave, cavernous sinus and infratemporal fossa.[6]

In this section, we explore endoscopic surgery as it relates to the pituitary gland, the anterior cranial fossa, the clivus and the infratemporal fossa.

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	Traditional Approach	New Approach
Sella	Open microscope	Endoscopic transsphenoid
Anterior cranial fossa/ Suprasellar area	Craniofacial approach	Endonasal endoscopic approach
Clivus	Traditional clival approach	Endoscopic transclival approach
Infratemporal fossa	Transtemporal/Transmaxillary approach	Endoscopic transmaxillary approach

Table 2. Comparison of traditional and new approaches to the skull base.

5.1. Pituitary surgery

Sir Victor Horsley performed the first transcranial pituitary operation in 1889.[5] It is only in the next century that the first description of trans-sphenoidal approach to the sellar region was made, dating back to 1907, performed by Schloffer.[4,5] Another prominent surgeon, Cushing, performed this procedure for many years, using a sublabial approach, but abandoned this approach in 1927 due to the high complication rate and difficult nature of the surgery.

Simultaneously, Hirsch, an Otolaryngologist in Vienna, introduced the technique that is the basis of today's surgical practice. He made a submucosal resection of the nasal septum, then opened the sphenoid sinus and resected the sphenoid septum. He then perforated the floor of the sella and the dura.[5] After Cushing abandoned the transsphenoidal technique, it rapidly lost popularity until Dott, a disciple of Cushing, created a lighted speculum as an aid for trans-sphenoidal visualization.[6] In the 1960s, Guiot, a French surgeon and a disciple of Dott, gave new life to this approach.[4] He was the first neurosurgeon to perform transsphenoidal surgery.[6]

The use of the surgical microscope by Jules Hardy in 1967 was a major step in transsphenoidal surgery.[5] It allowed better illumination, provided magnification and stereoscopic visualization. His contribution credits him with developing the fundamental principles of pituitary surgery upto this day.[5] In 1992, Jankowski published the first series on endoscopic pituitary surgery procedures.[7] Later, Jho standardized the procedure.[4] Thereafter, Cappabianca and de Divitiis coined the term "functional endoscopic pituitary surgery" and developed improved instrumentation.[6]

Endoscopic access is considered by many to be superior to traditional neurosurgical access.[28] Currently, the technique involves posterior septectomy, followed by bilateral anterior sphenoidotomies, sellar floor resection and dural incision. This provides improved field of view around the tumor, as well as better magnification.[4] Some authors promote that tumor resection using the endoscope is superior to the microscope because of the improved view resulting from the magnification, illumination and angled views that modern telescopes provide.[29,30] Moreover, Graham and colleagues demonstrated significant superior rhinology-specific quality of life after the endoscopic approach.[29]

With the increasing popularity of trans-sphenoidal sellar surgery, the concept of approaching parasellar regions through this pathway gained massive enthusiasm. Weiss, in 1987, was the first to publish about extending the transsphenoidal approach to access suprasellar lesions.[5] Therefore, anterior cranial fossa lesions, for example craniopharyngiomas, can be well managed through endoscopic routes.[31]

Compared to traditional approaches, transsphenoidal approaches for craniopharyngiomas and Rathke's cyst of the anterior cranial fossa demonstrate lower recurrence rate and decreased complications.[4,32] Couldwell and colleagues published about 105 patients undergoing extended transsphenoidal approaches to the cavernous sinus, suprasellar region and clival region. They concluded this approach to be a safe alternative to cranial approaches.[33] This approach has the advantage of less operative time, less brain manipulation and thus, decreased infarction and decreased neurovascular risk.

Exclusive endoscopic transsphenoidal technique, without an accompanying microscope, was described in the 1990s.[34] Jho and Carrau, considered the pioneers of the pure endoscopic endonasal approach, published a series of patients in 1997.[5,34] An advantage of the improved visualization with the endoscope over the microscope includes the decreased need of fluoroscopy intraoperatively, as vital structures are more easily identified.

5.2. Anterior cranial fossa

Among the most recent advances in skull base surgery is the fully endoscopic approach for lesions of the anterior cranial fossa. These include esthesioneuroblastomas, olfactory groove meningiomas, and select sinonasal malignancies with extension to the skull base. Devaiah and colleagues published a meta-analysis of articles with patients undergoing resection of esthesioneuroblastomas.[35] They found that there was a significantly greater survival rate for endoscopic resections versus open surgery. However, patients undergoing open resections had higher tumor stage thus biasing results to a certain degree.[35] This, however, is secondary to the mentality of a number of surgeons who believe that larger tumors should be resected via an open approach. Komotar and colleagues similarly demonstrated better resection of tumors in the endoscopic group.[36] They also demonstrated better results in terms of post-operative CSF leaks and recurrence rates.

The concern of adequacy of piecemeal resections of neoplasms obtained via the endoscopic approach has been a motivating factor for many surgeons to prefer an open approach for certain tumors. However, Wellman and colleagues presented cases of malignancies of the paranasal sinuses that either underwent en-bloc resection or piecemeal resection through an anterior craniofacial approach.[37] They demonstrated less complication and improved survival in the piecemeal group with an average follow-up of over four years. Thus, given the recent experience of surgeons with these tumors, the current practice for esthesioneuroblastoma is to obtain negative margins, regardless of which approach is utilized.[36,38]

Cushing was one of the first to report the resection of olfactory groove meningiomas through a unilateral frontal craniotomy.[39] Thereafter, other approaches such as a wide bi-

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frontal craniotomy, a pterional approach and more recently the endoscopic pathway have been described.

The advantages of the open approaches, consisting of the bifrontal or unilateral frontal craniotomy, include wide exposure for large tumor resection. Other than the risk to neurovascular structures such as the optic nerves, the disadvantages are the need to retract the brain, thus a potential for cerebral infarction[40] and brain edema resulting in brain herniation into the craniotomy window. The latter may even sometimes necessitate a partial frontal lobectomy.[39] Furthermore the open approach limits access to the sellar, suprasellar and retrochiasmal regions.[40]

The pterional approach is a more recent approach that doesn't require frontal sinus transections and thus the risk of CSF leaks. However, it does not provide a good field of view due to its narrow pathway and may require a lot of brain retraction.[39]

The endoscopic 2-surgeon technique has replaced the open approach to anterior cranial fossa meningiomas in certain cases. In their review, Komotar and colleagues found that meningiomas were the most challenging in terms of isolated endoscopic approach, thus demonstrating a need for more research and technical innovation. Wormald's group published a large series on endoscopic resections of anterior cranial fossa meningiomas.[40] They demonstrated complete resections in over 90% of cases. Other then the obvious cosmetic benefit of the endoscopic approach, another advantage is the avoidance of brain retraction. Furthermore, this access allows the surgeon to identify the dural attachment of the meningioma early in the procedure and thus minimise bleeding.[40] Another major benefit is that the main site of recurrence, namely the anterior cranial fossa bone floor, is adequately resected in order to visualize the mass.[39] It is known that recurrence of these tumors is thought to be prevented by proper resection of surrounding bone and dura, which is more easily performed by endoscopic access. Also, similarly to other skull base resections, the angled endoscopes allow superior visualization of the tumor and the surrounding vital structures.

In terms of CSF leak post-endoscopic resections, Wormald's group demonstrated a decrease in incidence with use of the vascularized pedicled septal flap.[40] Cases where the endoscopic approach may not be suitable include those with major optic canal extension or encasement of the internal carotid or anterior communicating arteries.[40]

5.3. Clivus

Traditionally, clival lesions were treated through an anterior approach, necessitating large facial incisions and significant brain retraction. In fact, clivus region lesions often necessitated extensive dissections such as transfacial maxillotomy, lateral transcranial skull base approaches, transoral approaches and petrosal approaches.[41,42] However, despite these wide facelifts, the view of this region was still limited.

The use of endonasal microscopic transsphenoidal approach has also been described.[43] However, the narrow field of view doesn't expose the petrous apex, optic canal, parasellar region, lower clivus, and ventral craniocervical junction adequately.[44] Furthermore, the

close proximity of vital structures such as the carotid arteries, the basilar arteries, the brainstem and the cavernous sinuses make resection even more difficult and dangerous.

Despite the obvious cosmetic complications of these open approaches, there was also significant risk of neurovascular injury, cerebral infarction, carotid artery and optic nerve injury.[44] Furthermore, the transoral approach involved splitting the palate, with the potential for velopharyngeal insufficiency.

Considering the above, endoscopic techniques were tried with improved illumination, magnification, as well as wider field of view which are essential in the narrow space of work. The first report of endoscopic transsphenoidal approach for resection of a large chordoma was published in 1996 by Jho.[8] Thereafter, this technique has been reported by several surgeons for the clivus.[42,45]

Another advantage of the endoscopic technique relates to the theory of surgical seeding of chordoma tumor cells during dissection. Thus, it is not surprising that traditional methods with extensive tissue dissection have conferred a high recurrence rate.[44] In order to avoid the latter, dissection should be limited to the shortest distance possible. This is provided through a transnasal route, as the floor of the nasal cavity is at the level of the inferior border of the clivus.[42] Finally, some may feel that the endonasal route may lead to increased intracranial infections. However, authors have shown that the incidence of meningitis did not increase after endonasal approach with antibiotics.[46]

The experience of our institution with endoscopic endonasal approaches to this region has been quite positive. This has been echoed by other authors who have demonstrated that regions such as the clivus[27] and petrous apex[27,47] are well accessible endoscopically. However, in our experience, certain cases may require a combined approach with a craniotomy, such as tumors with a large intradural component. Thus, careful pre-operative planning with imaging is essential in these cases with the two key components of decision making being safety and adequate resection of the tumor.

5.4. Infratemporal fossa

Authors have described the Caldwell-Luc procedure[48], a trans-facial access[49,50] and trans-oral approach[51] to access the infratemporal fossa abscesses. For tumors of this region, peri-auricular, transtemporal and transmaxillary approaches have been described.[52,53] However, these approaches are associated with significant complications such as facial nerve dysfunction, facial deformities, conductive hearing loss and dental malocclusion.[54]

With the rising use of endonasal approaches to the skull base, many surgeons have started to perform adequate resections of ITF tumors through the nasal cavity. There are multiple variations described to achieve access to the ITF such as the transseptal approach[54], the use of Denker's approach and different degrees of turbinate resection.[55] The indications for endoscopic approach to the ITF are evolving, however there no established contraindications.

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At our institution, our method consists of performing a medial maxillectomy with a tailored resection of the nasal turbinates. We also prefer the 2-surgeon transseptal technique for tumor resection, achieved using a contralateral Killian incision and an ipsilateral horizontal mucosal incision after removal of a window of cartilage. The transseptal technique was reinforced by Robinson et al. who described that a key aspect of endoscopic removal of disease in the ITF is the ability of a second surgeon to apply traction to the tumor.[54]

6. Future

During the past three decades, the world has witnessed an immense evolution in rhinological practice. However, there is a lot more developments that are being trialed even today. In fact, there are multiple researchers and surgeons attempting to innovate the field of rhinology through various new tools and procedures. In this section, we focus on 3-dimensional endoscopes and robotics.

Similar to our colleagues in urology and head and neck oncology, rhinologists have attempted to use new tools to ameliorate our approach to the skull base. Many innovators have attempted to develop adequate three-dimensional endoscopic technology but no commercially-viable technology has been created. Attempted techniques include two channel endoscopes, image splitters and electronically generated three-dimensional displays.[3] Amongst other issues, difficulties with camera orientation and surgeon annoyance and fatigue have challenged the adoption of 3-dimensional endoscopes.

Another growing field of endonasal surgery is robotics. The latter confers proper three-dimensional visualization and increased ability to accomplish two-handed surgery through small openings.[4,56] Some authors have published feasibility studies using robotic surgery to access the skull base. O'Malley et al. used transoral combined with a transcervical approach with robotic surgery to access infratemporal fossa.[57] Similarly, Hanna et al. employed robotic surgery using Caldwell-Luc antrostomies with maxillary antrostomies to access the midline skull base.[58] However, application of robotic surgery in rhinology is still at the animal model stage. It will require technical and feasibility assessments prior to its incorporation in patient care.

7. Conclusion

Endoscopic sinus and skull base surgery has an extensive evolutionary history. It is evident that we have come a long way from the traditional treatment modalities of sinus disease, thanks to pioneers in the field of rhinology. Endoscopic surgeons today are enthusiastic about the innovations that are being employed to our current endoscopic armentarium. At this rate of evolution, it is imaginable that in a few short decades, our current endoscopic techniques will be historical.

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References

[1] Frenkiel, S., & Wright, E. D. (2001). The specialty of rhinology, part 1: a historical glimpse. J Otolaryngol. 30[Suppl 1]: , 26-31.

[2] Chandra, R. K., Conley, D. B., & Kern, R. C. (2009). Evolution of the Endoscope and Endoscopic Sinus Surgery. OtolaryngolClin N Am , 42, 747-752.

[3] Govindaraj, S., Adappa, N. D., & Kennedy, D. W. (2010). Endoscopic sinus surgery: evolution and technical innovations. The Journal of Laryngology & Otology , 124, 242-250.

[4] Castelnuovo, P., Dallan, I., Battaglia, P., & Bignami, M. (2010). Endoscopic endonasal skull base surgery: past, present and future. Eur Arch Otorhinolaryngol , 267, 649-663.

[5] Gandhi, C. D., Christiano, L. D., Eloy, J. A., Prestigiacomo, C. J., & Post, K. D. (2009). The historical evolution of transsphenoidal surgery: facilitation by technological advances. Neurosurg Focus 27[3]: , E8 EOF.

[6] Prevedello, D. M., Kassam, A. B., Snyderman, C., Carrau, R. L., Mintz, A. H., Thomas, A., Gardner, P., & Horowitz, M. (2007). Endoscopic cranial base surgery: ready for prime time? ClinNeurosurg , 54, 48-57.

[7] Jankowski, R., Auque, J., Simon, C., Marchal, J. C., Hepner, H., & Wayoff, M. (1992). Endoscopic pituitary tumor surgery. Laryngoscope , 102, 198-202.

[8] Jho, H. D., Carrau, R. L., Mc Laughlin, M. R., & Somaza, S. C. (1996). Endoscopic transsphenoidal resection of a large chordoma in the posterior fossa. Neurosurg Focus 1[1]:e3.

[9] Wright, E. D., & Frenkiel, S. (2005). Advances in the surgical management of chronic rhinosinusitis. Allergy Asthma ClinImmunol. 1[1]: , 21-27.

[10] Chiu, A. G. (2006). Frontal sinus surgery: its evolution, present standard of care, and recommendations for current use.." Ann OtolRhinolLaryngolSuppl , 196, 13-19.

[11] Castelnuovo, P., Giovannetti, F., Bignami, M., Ungari, C., & Iannetti, G. (2009). Open Surgery Versus Endoscopic Surgery in Benign Neoplasm Involving the Frontal Sinus. The Journal of Craniofacial Surgery, 180-3.

[12] Draf, W. (1991). Endonasal micro-endoscopic frontal sinus surgery: the Fulda concept.."OperTechnOtolaryngol Head Neck Surg , 2, 234-240.

[13] Constantinidis, J., Weber, R., Brune, M., et al. (2000). Cranialization of the frontal sinus. Indications, technique and results.." HNO , 48, 361-366.

[14] Lund, V. (2002). The Evolution of Surgery on the Maxillary Sinus for Chronic Rhinosinusitis. Laryngoscope 112[3]:, 415-9.

[15] Kim, E., & Duncavage, J. A. (2010). Prevention and management of complications in maxillary sinus surgery. OtolaryngolClin North Am 43[4]: , 865-873.

[16] Penttila, M. A., Rautiainen, M. E. P., Pukander, J. S., & Karma, P. H. (1994). Endoscopic versus Caldwell-Luc approach in chronic maxillary sinusitis: comparison of symptoms at one-year follow up.." Rhinology , 32, 161-165.

[17] Närkiö-Mäkelä, M., & Qvarnberg, Y. (1997). Endoscopic sinus surgery or Caldwell-Luc operation in the treatment of chronic and recurrent maxillary sinusitis." ActaOtolaryngolSuppl , 529, 177-180.

[18] Cutler, J. L., Duncavage, J. A., Matheny, K., Cross, J. L., Miman, M. C., & Oh, C. K. (2003). Results of Caldwell-Luc after failed endoscopic middle meatus antrostomy in patients with chronic sinusitis." Laryngoscope 113[12]: , 2148-2150.

[19] Lawson, W. (1994). The Intranasal Ethmoidectomy: Evolution and an Assessment of the Procedure." Laryngoscope 104[6 Pt 2]:, 1-49.

[20] Jain, L., Jain, M., Chouhan, A. N., & Harshwardhan, R. (2011). Conventional Septoplasty verses Endoscopic Septoplasty: A Comparative Study." People's Journal of Scientific Research 4[2]: , 24-28.

[21] Hwang, P. H., Mc Laughlin, R. B., Lanza, D. C., & Kennedy, D. W. (1999). Endoscopic septoplasty: indications, technique, and results." Otolaryngol Head Neck Surg 120[5]: , 678-682.

[22] Lanza, D. C., Rosin, D. F., & Kennedy, D. W. (1993). Endoscopic septal spur resection.." Am J Rhinol , 7, 213-216.

[23] Paradis, J., & Rotenberg, B. W. (2011). Open versus endoscopic septoplasty: a single-blinded, randomized, controlled trial." J Otolaryngol Head Neck Surg. 40 [S1]: S, 28-33.

[24] Nayak, D. R. B. R., & Murty, K. MurtyKD[1998-1] [(1998). An Endoscopic approach to the deviated nasal septum- a preliminary study.." The Journal of Laryngology and Otology, , 112, 934-939.

[25] Bothra, R., & Mathur, N. N. (2009). Comparative evaluation of conventional versus endoscopic septoplasty for limited septal deviation and spur." J Laryngol Otol. 2009 Jul; 123[7]: , 737-741.

[26] Kasemsiri, P., Carrau, R. L., Prevedello, D. M., Ditzel, Filho. L. F. S., de Lara, D., Otto, B. A., & Kassam, A. B. (2012). Indications and Limitations of Endoscopic Skull Base Surgery." MEDSCAPE.

[27] Kassam, A. B., Gardner, P., Snyderman, C., Mintz, A. A., & Carrau, R. (2005). Expanded endonasal approach: a fully endoscopic, completely transnasal approach to the middle third of the clivus, petrous bone, middle cranial fossa and infratemporal fossa." Neurosurg Focus 19[1]: E6.

[28] Sethi, D. S., & Leong, J. L. (2006). Endoscopic pituitary surgery." OtolaryngolClin N Am , 39, 563-583.

[29] Graham, S. M., Iseli, T. A., Karnell, L. H., Clinger, J. D., Hitchon, P. W., & Greenlee, J. D. (2009). Endoscopic approach for pituitary surgery improves rhinologic outcomes." Ann OtolRhinolLaryngol 118[9]: , 630-635.

[30] Zada, G., Kelly, D. F., Cohan, P., Wang, C., & Swerdloff, R. (2003). Endonasaltranssphenoidal approach for pituitary adenomas and other sellar lesions: an assessment of efficacy, safety, and patient impressions." J Neurosurg , 98, 350-358.

[31] Stamm, A. C., Vellutini, E., Harvey, R. J., Nogeira, J. F., & Herman, D. R. (2008). Endoscopic transnasal craniotomy and the resection of craniopharyngioma." Laryngoscope , 118, 1142-1148.

[32] Landolt, A. M., & Zachmann, M. (1991). Results of transsphenoidal extirpation of craniopharyngiomas and Rathke's cysts.." Neurosurgery , 28, 410-415.

[33] Couldwell, W. T., Weiss, M., Rabb, C., Liu, J., Apfelbaum, R., & Fukushima, T. (2004). Variations on the standard transsphenoidal approach to the sellar region, with emphasis on the extended approaches and parasellar approaches: surgical experience in 105 cases." Neurosurgery , 55, 539-550.

[34] Jho, H. D., & Carrau, R. (1997). Endoscopic pituitary surgery: an early experience." SurgNeurol , 47, 213-223.

[35] Devaiah, A. K., & Andreoli, M. T. (2009). Treatment of esthesioneuroblastoma: a year meta-analysis of 361 patients." Laryngoscope 119[7]: 1412-1416., 16.

[36] Komotar, R. J., Starke, R. M., Raper, D. M., Anand, V. K., & Schwartz, T. H. (2012). Endoscopic skull base surgery: a comprehensive comparison with open transcranial approaches." Br J Neurosurg.Epub.

[37] Wellman, B. J., Traynelis, V. C., Mc Culloch, T. M., Funk, G. F., Menezes, A. H., & Hoffman, H. T. (1999). Midline anterior craniofacial approach for malignancy: results of en bloc versus piecemeal resections." Skull Base Surg 9[1]:, 41-6.

[38] Soler, Z. M., & Smith, T. L. [. (2012). Endoscopic versus open craniofacial resection of esthesioneuroblastoma: what is the evidence?" Laryngoscope 122[2]: , 244-245.

[39] Adappa, N. D., Lee, J. Y., Chiu, A. G., & Palmer, J. N. (2011). Olfactory groove meningioma." OtolaryngolClin North Am 44[4]: , 965-980.

[40] Padhye, V., Naidoo, Y., Alexander, H., Floreani, S., Robinson, S., Santoreneos, S., Wickremesekera, A., Brophy, B., Harding, M., Vrodos, N., & Wormald, P. J. (2012). Endoscopic Endonasal Resection of Anterior Skull Base Meningiomas." Otolaryngol Head Neck Surg.Epub.

[41] Al-Mefty, O., & Borba, L. A. B. (1997). Skull base chordomas: a management challenge.." J Neurosurg 86[2]:, 182-9.

[42] Holzmann, D., Reisch, R., Krayenbühl, N., Hug, E., & Bernays, R. L. (2010). The transnasaltransclival approach for clivuschordoma." Minim Invasive Neurosurg. 53[5]: , 211-217.

[43] Cooke, R. S., & Jones, R. A. (1994). Experience with the direct transnasaltranssphenoidal approach to the pituitary fossa." Br J Neurosurg 8[2]:, 193-6.

[44] Hong, Jiang. W., Ping, Zhao. S., Hai, Xie. Z., Zhang, H., Zhang, J., & Yun, Xiao. J. (2009). Endoscopic resection of chordomas in different clival regions." ActaOtolaryngol 129[1]: , 71-83.

[45] Jho, H., , D., & Ha-G, H. (2004). Endoscopic endonasal skull base surgery: Part The clivus and posterior fossa." Minim InvasNeurosurg 47[1]:16-23., 3.

[46] Brown, S. M., Anand, V. K., Tabaee, A., & Schwartz, T. H. (2007). Role of perioperative antibiotics in endoscopic skull base surgery." Laryngoscope 117[9]:, 1528-32.

[47] Snyderman, C. H., Kassam, A. B., Carrau, R. L., & Mintz, A. (2006). Endoscopic approaches to the petrous apex." Op Tech Otolaryngol , 17, 168-173.

[48] Weiss, B. R. (1977). Infratemporal fossa abscess unusual complication of maxillary sinus fracture." Laryngoscope. 87[7]: , 1130-1133.

[49] Diacono, M. S., & Wass, A. R. (1998). Infratemporal and temporal fossa abscess complicating dental extraction.." J AccidEmerg Med 15[1]: , 59-61.

[50] Kamath, M. P., Bhojwani, K. M., Mahale, A., et al. (2009). Infratemporalfossaabscess: a diagnostic dilemma." EarNoseThroat J 88[5]: E23.

[51] Akst, L. M., Albani, B. J., & Strome, M. (2005). Subacuteinfratemporal fossa cellulitis with subsequent abscess formation in an immunocompromisedpatient " Am J. Otolaryngol , 26, 35-38.

[52] Fisch, U., Fagan, P., & Valavanis, A. (1984). The infratemporal fossa approach for the lateral skull base." OtolaryngolClin North Am , 17, 513-552.

[53] Mansour, O. I., Carrau, R. L., Syderman, C. H., et al. (2004). Preauricularinfratemporal fossa surgical approach: modifications of the technique and surgicalindication. Skull Base 2004;Skull Base 14: 143-151., 14, 143-151.

[54] Robinson, S., Patel, N., & Wormald, P. J. (2005). Endoscopic management of benign tumors extending into the infratemporal fossa: a two-surgeon transnasal approach." Laryngoscope 115[10]: , 1818-1822.

[55] James, D., & Crockard, H. A. (1991). Surgical access to the base of the skull and upper cervical spine by extended maxillotomy." Neurosurgery , 29, 411-416.

[56] Virgin, F. W., Bleier, B. S., & Woodworth, B. A. (2010). Evolving materials and techniques for endoscopic sinus surgery." OtolaryngolClin North Am 43[3]: , 653-672.

[57] O'Malley, B. W. J., & Weinstein, G. S. [. (2007). Robotic anterior and midline skull base surgery: preclinical investigations.."Int J RadiatOncolBiolPhys 69[Supplement 2]: S, 125-128.

[58] Hanna, E. Y., Holsinger, C., De Monte, F., et al. (2007). Robotic endoscopic surgery of the skull base: a novel surgical approach.." Arch Otolaryngol Head Neck Surg 133[12]: , 1209-1214.

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