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Original Article

Evaluation of Complications and Outcome of the Extended Endoscopic Endonasal Approach for Anterior, Middle and Posterior Skull Base Lesions

Mohamed Hassan Mahmoud,[1] Mohamed Okasha,[2] Abd-El-Azim Abd-El-Azim El-Sayed,[1] Khaled Elsayed Mohamed,[1] Ahmed Mohammed Abdelmonem[1]

[1]Department of Neurosurgery, Faculty of Medicine, Suez Canal University, Ismailia, EGYPT

[2]Department of Neurosurgery, Ninewells Hospital and Dundee Medical School, University of Dundee, UNITED KINGDOM

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BACKGROUND: The endoscope in neurosurgery started since the beginning of the 20th century in the ventricular system. Later, the pituitary was added as an indication for endoscopy followed by skull base lesions.

OBJECTIVE: The study aimed to assess the safety and effectiveness of using the endoscopic endonasal approach for resecting skull base tumors.

METHODS: A prospective clinical study of thirty patients with various types of anterior and middle skull base lesions managed with the endoscope. Thirty patients were operated upon at Suez Canal University Hospitals (Ismailia, Egypt) between 2020 and 2022. The study included 30 subjects, including 11 males (36.7%) and 19 females (63.3%). Their mean age was 51.2+12.5 years with a median of 50 years with a range from 19-73 years.

RESULTS: Regarding the intra-operative complications, one patient had excessive bleeding and cerebrospinal fluid (CSF) leakage occurred in 13.3% of the patients (4 patients); however, only one patient (3.3%) had persistent CSF leakage which mandated management with a lumbar drain.

CONCLUSION: Using the endoscope in the extended endonasal transsphenoidal surgery speeds up recovery time due to its minimally invasive characteristics. Its main target is midline sellar and parasellar lesions and gives a panoramic view instead of a narrow microscopic view with very well-concentrated illumination which allows inspection and removal of lesions of the sellar, parasellar, and suprasellar compartments.

KEYWORDS: Anterior skull base, Brain tumors, Endoscope, Middle skull base, Posterior skull base.

INTRODUCTION

Beginning with the ventricular system at the turn of the 20th century, endoscopy was employed in neurosurgery and then the pituitary was included in its indications. Over time, endoscopes and/or microscopes became indispensable instruments for any pituitary procedure.[1]

Its efficacy improved significantly as new endoscopically adapted optical technologies, such as low-profile tools, micro drills, ultrasonic aspirators and adapted suction instruments, were developed.[2] A new era known as "extended or expanded endoscopic endonasal approaches," or "EEEA," witnessed the development of new ideas to "extend" the use of the endoscope to reach new locations in the skull base. This era saw an increase in the use of endoscopy in various lesions in the skull base.[3,4] The expertise of otorhinolaryngologists in paranasal sinus surgery and nasoseptal flap repair for the skull reconstruction base helped enable the EEEA.[5]

While numerous trials have demonstrated the efficacy of this surgery, its safety and effectiveness, particularly regarding CSF leakage have not been confirmed. Thus, the purpose of this study is to assess the efficiency, safety and results of our institute's experience in the extended endonasal endoscopic technique.

Correspondence:
Mohamed Hassan Mahmoud
Department of Neurosurgery, Faculty of Medicine, Suez Canal University, Ismailia, EGYPT
Email: m.h.mahmoud@med.suez.edu.eg

PATIENTS AND METHODS

Thirty patients with midline anterior and middle skull base tumors were operated upon at Suez Canal University Hospitals (Ismailia, Egypt) between 2020 and 2022 and the ethical committee approval was obtained. Written informed consent was obtained from all included patients for participation in the research as well as the routine preoperative consent. All patients had small (<3-4 cm) anterior and middle skull base lesions without lateral extension beyond the optic nerves.[6]

Personal history was taken from the patients or their relatives including sex, age, and occupation. Present history data included full endocrinological history, in addition to past history of any endocrinological or visual problems and medical co-morbidities. General examination, detailed neurological examination, and detailed endoscopic nasal examination were performed. The radiological investigations were done including a magnetic resonance imaging (MRI) of the brain with contrast (skull base protocol); with emphasizing on specific lesion MRI Protocols for example, diffusion weighted imaging (DWI), fat suppression imaging or other MRI modalities, and computerized tomography (CT) paranasal sinuses or anterior skull base with coronal, sagittal and axial reconstruction. Laboratory, and endocrinological assessments (prolactin, growth hormone, insulin-like growth factor-1, cortisol, free T4, and thyroid stimulating hormone (TSH) were done. Visual perimetry (automated Humphrey perimetry) was also done.

Surgical Technique:

Operative Data

The procedure started with induction of general anesthesia and preoperative antibiotics and a stress dose of short-acting prednisolone were administered. A lumbar drain was inserted pre-operatively and the head was placed on donut gel or in rigid pin fixation with the patient's neck slightly extended and the head raised just above the level of the heart.[7,8]

Nasal Part

A routine betadine and xylocaine nasal mucosal preparation was carried out. Septal flap harvesting could also be customized for individual situations and surgical preferences. After the naso-septal flap was dissected using sharp dissection and then mobilized using blunt dissection, the mucosal side of the septal vascularized flap was pushed into the nasopharynx until the tumor was completely removed. **(Fig. 1)** The operator carefully monitored the flap's pedicle to avoid twisting and subsequent ischemia. Bipolar cauterization was used to stop any bleeding. The first steps in the procedure included partial posterior ethmoidectomies, lateral mobilization of the middle turbinate bilaterally, sphenoid ostia identification, posterior septectomy, sphenoid mucosa removal, and drilling of the sphenoid sinus's bony septations. Sometimes the middle turbinate was removed on one side to make room for the endoscope and avoid interfering with the instruments' handling, but most of the time the turbinate could be left in place. The preceding procedures were customized according to the underlying pathology.

Sphenoidal Part

Complete sphenoid mucosa excision eliminates the risk of a postoperative mucocele, reveals significant bony landmarks required for further steps in the treatment, and provides the bony substrate required for the pedicled nasoseptal flap to adhere to. The posterior part of the planum sphenoidale, the tuberculum sellae, and the sella turcica were removed using an ultrasonic curette or a high-speed diamond-bit drill. Laterally, bone was removed up to the medial opticocarotid recesses. The drill was used to first shell out or thin the bone, and a Kerrison rongeur was used to extract it **(Fig. 2)**. Rather than the remains of the anterior sphenoid wall, the nasal turbinates confined the lateral aspects of the surgical corridor. The planum sphenoidal was entirely exposed during posterior ethmoidectomy. This maneuver broadened the operational corridor, improved working angles, and avoided instrument manipulation and visualization obstruction caused by the overhanging bone, even though the lesion may not reach this level. When the bone was removed in this location, venous bleeding occurred; nevertheless, even severe venous bleeding was typically managed using gel foam packing and light pressure. The superior intercavernous sinus was coagulated after navigation verified that sufficient bone had been removed.

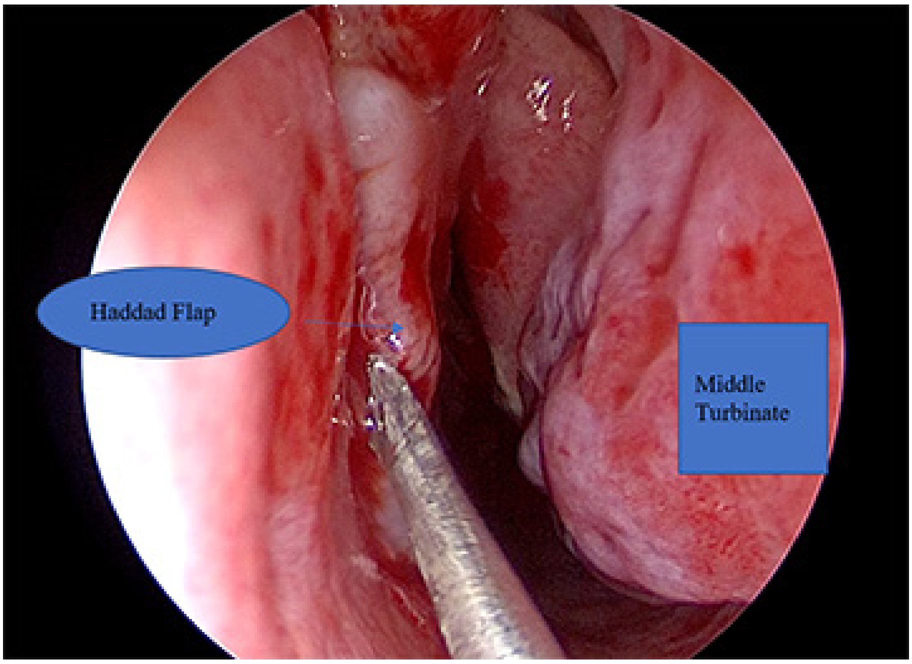

Fig 1: Harvesting of nasoseptal (Hadad) flap.

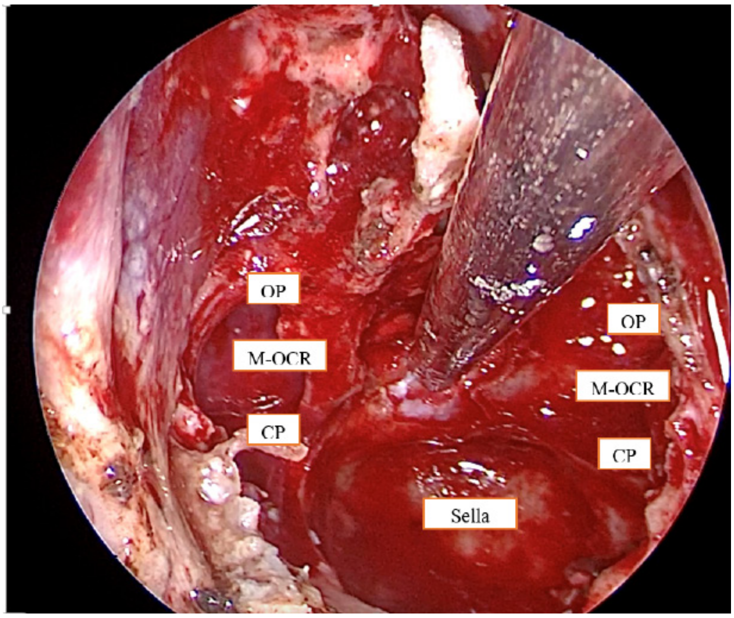

Fig 2: Sphenoidal phase.
OP: Optic prominence, CP: Carotid prominence, M-OCR: Medial opticocarotid prominence recess.

Post-Sphenoidal Part

A cruciate opening was made to the dura and to improve visibility, the dural edges were cauterized and shrunk. The operating corridor could potentially be extended by excising the dural margins with Kerrison rongeurs. If available, micro doppler ultrasonography was frequently employed before dural opening to prevent damage to the internal carotid artery (ICA), particularly given that its proximal supraclinoid section runs medially. The inferior and posterior tumor borders were identified following a broad dural incision. There are specific bone and intradural surgical procedures for each pathology. For instance, in the case of tuberculum sella meningioma, the optic canals and bilateral carotid arteries were slightly covered by the osteotomy. For not pulling on the tumor or dissecting it blindly, a wide bony exposure was required. Navigation determined the anterior extent of bone removal, and the mid sellar floor was reached by the posterior extent. The whole floor of the sella was left in place to facilitate skull base repair at the conclusion of the treatment. Frequently, the tumor could be effortlessly removed from the pituitary gland and diaphragma sellae, eliminating the requirement for extensive posterior exposure **(Fig. 3)**.

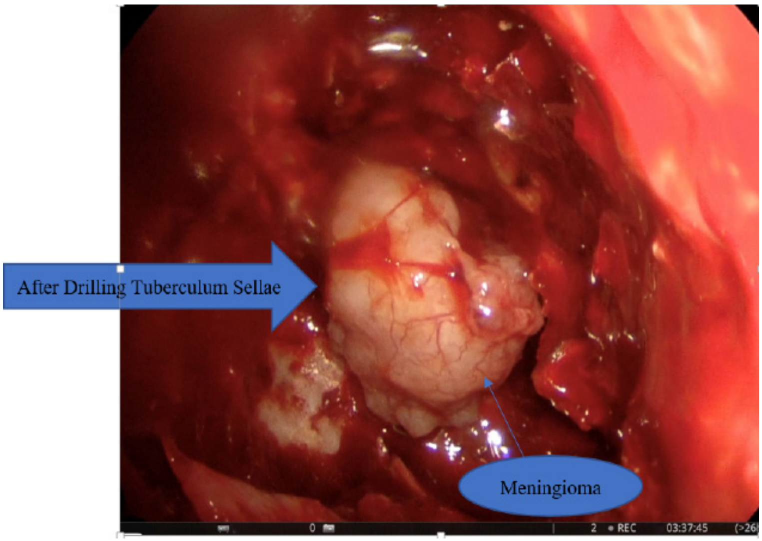

Fig 3: The tuberculum sellae meningioma after manipulation is now "floating".

The excision of bone reached the anterior portion of the tumor and its dural tail down the planum. Because of the sharp and steep working angles involved in this osteotomy, it could be quite difficult technically. At this point, 30-degree angled endoscopes were utilized extensively to drill. Bipolar electrocautery was utilized to cauterize both the dura and the intercavernous sinus to devascularize the meningioma. Internal decompression came first, followed by tumor devascularization and exposure. Depending on the consistency of the tumor, enucleation was done utilizing a variety of tools, such as an ultrasonic aspirator, pituitary rongeurs, and/or suction. The anterior tumor bulk could be more easily seen and removed thanks to an endoscope that was inclined 30 degrees. The ability to expose and debulk the tumor early in dissection to accomplish prompt optic apparatus decompression before adjusting the nerves and chiasm is a significant benefit of the endonasal technique. The anterior tumor margin was found after the tumor had been internally debulked. By taking this step, it was certain that enough planum had been removed. To further understand the safe limits of tumor enucleation, this was the safest portion of the tumor capsule to dissect. The operator then proceeded to more cautious dissection maneuvers along the inferior and lateral margins after performing more aggressive debulking while following the anterior tumor margin.

Additional central tumor removal was carried out after the tumor margins on the anterior and inferior sides. All arachnoid attachments were sharply detached, and the remnant central tumor was softly peeled away from the optic system if sufficient central decompression had been carried out. Using this technique, the tumor collapsed medially, away from the optic nerves, mobilizing the mass's lateral extents. An enlarged dural substitute or fascial graft was originally employed to cover the bone defect to create a gasket closure technique after the tumor had been removed and the relevant dura had been excised and/or cauterized.

An alternative closure strategy was possible if the bone defect was big and not receptive to the gasket closure approach. The dural substitute may be inserted intradural and the nasoseptal flap extradural in a layered closure utilizing harvested or autograft dural reconstruction materials. Before attempting the next stage of reconstruction, Valsalva maneuver was performed to check for any evident CSF leaking. The nasoseptal flap was then positioned over the first closure technique of choice, aligning the flap with the surrounding bony skull base. Fibrin glue or DuraSeal (Covidien, Dublin, Ireland) was then used to secure the flap in place **(Fig. 4)**. For bigger deformities in the skull base, bilateral nasoseptal flaps were employed. To prevent mucosal bleeding, floseal (Baxter, Deerfield, IL) (hemostat matrix) was given. To improve closure and reduce postoperative nasal discharge, we first placed a absorbable gelatin sponge and then nasal tampons.

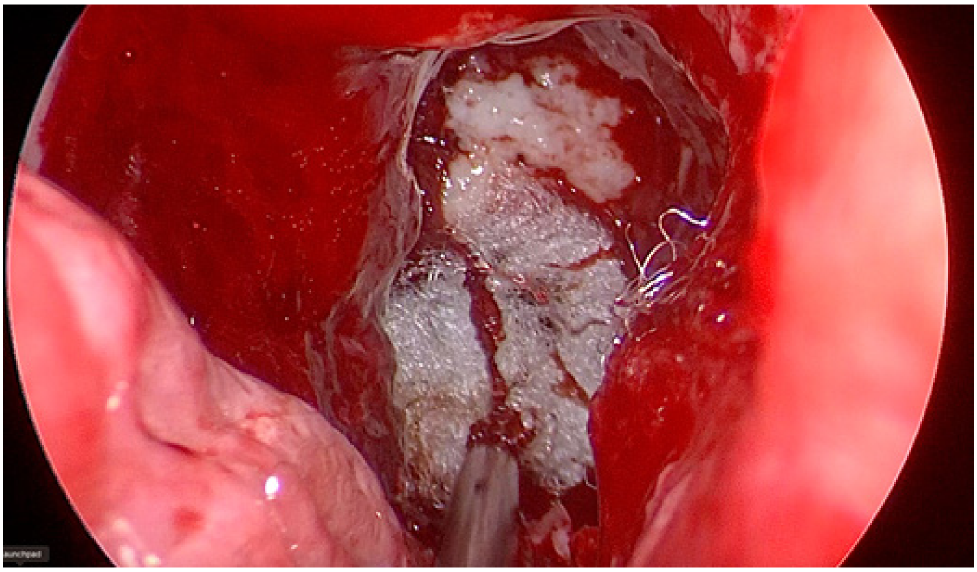

Fig 4: Oxidized regenerated cellulose hemostat after excision of tuberculum sella meningioma.

Statistical analysis

The data was analyzed using the statistical package for social sciences (SPSS 20.0). P Value <0.05 was considered as statistically significant.

RESULTS

Thirty patients were included in the study as illustrated in **Table 1**, including 11 males (36.7%) and 19 females (63.3%). Their mean age was 51.2±12.5 years and a median of 50 years with a range from 19-73 years.

Seventy percent of the patients presented with headache, 23.3% with frontal manifestations, 6.7% with seizures, and 3.3% with ptosis. Regarding their visual state, 43.3% had a normal visual function, 6.7% with bilateral affection, more on the left, 10.0% with bilateral affection, more on the right, 23.3% with bitemporal hemianopia, 10.0% with only left eye affection, and 6.7% with only right eye affection. All of the patients had a normal endocrinological state.

The lesions were distributed regarding their location into 6 clival lesions (20.0%), 7 olfactory groove lesions (23.3%), 6 tuberculum sellae lesions (20.0%), 5 patients (16.7%) with planum sphenoidal lesions, 2 patients with seller suprasellar lesions and 2 patients with suprasellar lesions with a percentage of 6.7% each. One optic canal lesion and one petrous apex lesion with a percentage of 3.3 % each **(Table 2)**. The study included 17 meningiomas, 3 chordomas, 2 craniopharyngiomas, and one of each of arachnoid cyst, chondrosarcoma, glioma, hepatocellular metastasis, papilloma and plasma cell myeloma **(Table 3)**. This makes up 6 tuberculum sellae meningiomas, 2 suprasellar craniopharyngioma, 6 olfactory groove meningioma, 5 planum sphenoidale meningioma, 3 clival chordomas, and 1 lesion of each of sellar suprasellar arachnoid cyst, petrous apex chondrosarcoma, olfactory groove glioma, clival hepatocellular metastasis, sellar suprasellar meningioma, optic canal meningioma, clival papilloma, and clival plasma cell myeloma **(Table 4)**.

In our study, complications occurred in 3 of the 11 male patients (27.3%) and in 3 of 19 the female patients (15.8%). The most common complication was meningitis representing 6.67% of the patients involved in the study, with following complications each represented 3.33%: Excessive bleeding therefore cottonoid patty left in the clivus as packing, persistent CSF leakage, transient postoperative diabetes insipidus, anosmia, facial numbness, subarachnoid hemorrhage, hydrocephalus which mandated external ventricular drainage, and a lethal vasospasm. Noticeably, the percentage of complications that occurred in sub-totally resected lesions (33.4 %) was higher than in totally resected lesions (10 %). Regarding the lethal complications, it was 11.1 % in the subtotal group versus. 10% in the total group. This can be explained by the more difficult and less accessible lesions in the subtotal group. No complications occurred in the biopsy group.

The excessive bleeding was in an elderly patient with hepatocellular clival metastasis, in which bleeding was persistent despite traditional surgical techniques which mandated leaving a cottonoid patty on the bleeding area, Surgicel (Ethicon, NJ, USA), and fibrin glue. This patty was removed 2 weeks later safely. Facial numbness occurred in one patient of petrous apex chondrosarcoma during manipulation and dissection of mass in the Gasserian ganglion and the numbness improved with time. The most common location having complications is the olfactory groove and the most common pathology having complications is meningiomas. Mortality occurred in an olfactory groove meningioma patient and a planum sphenoidale meningioma patient due to meningitis and occurred in a suprasellar craniopharyngioma following deterioration with subarachnoid hemorrhage, vasospasm then external ventricular drainage insertion, later the MRI showed an ischemic insult. Regarding CSF leakage, 13.3% of the patients (4 patients) experienced CSF leakage, however, only 1 patient (3.3%) had persistent CSF leakage which mandated management with a lumbar drain. A very interesting and expected feature in CSF leakage patients was that 75% of patients occurred in totally resected lesions while 25% occurred in partially resected lesions.

Regarding the visual functions, preoperatively, there were 13 patients (43.3%) with normal eye function, 5 patients (16.7 %) with bilateral eye symptoms (3 affected more of the right eye and 2 affected more of the left eye), and 7 patients (23.3%) with bitemporal hemianopia. In addition, there were only 2 patients (6.7%) with only right eye involvement and there were only 3 patients (10%) with only left eye involvement. Among the 17 patients with preoperative visual affection, 9 patients with an improvement in visual field (7 in totally resected lesions and 2 in partially resected lesions). Additionally, we had 8 stationary visual fields (5 in totally resected lesions, 2 in a partially resected lesion, and 1 in a biopsy surgery). Fortunately, we did not have any deteriorated visual function.

Regarding the endocrinological state of the patients, preoperatively, 100 % of the patients had a normal endocrinological state and post-operative permanent diabetes insipidus occurred only in the totally resected group representing 5 % of the lesions mandating long term hormonal replacement. There were no other abnormal hormonal affections.

Table 1: List of the involved subjects

No	Age/Gender	Diagnosis	Skull Base	Dural Relation
1	60 F	Clival plasma cell myeloma	Middle	Extradural
2	45 F	Sellar suprasellar arachnoid cyst	Middle	Intradural
3	25 F	Planum sphenoidale meningioma	Anterior	Intradural
4	36 F	Sellar suprasellar meningioma	Middle	Intradural
5	48 F	Olfactory groove glioma (fronto-basal glioma)	Anterior	Intradural
6	49 F	Tuberculum sellae mesothelial meningioma	Anterior	Intradural
7	69 M	Clival hepatocellular metastasis	Middle	Extradural
8	49 F	Tuberculum sellae fibroblastic meningioma	Anterior	Intradural
9	49 F	Optic canal meningioma	Anterior	Intradural
10	54 M	Clivus papilloma	Middle	Intradural
11	19 M	Suprasellar craniopharyngioma	Middle	Intradural
12	73 F	Petrous apex chondrosarcoma	Middle	Extradural
13	58 M	Olfactory groove meningioma	Anterior	Intradural
14	69 F	Olfactory groove meningioma	Anterior	Intradural
15	34 M	Suprasellar craniopharyngioma	Middle	Intradural
16	44 M	Planum sphenoidale meningioma	Anterior	Intradural
17	59 M	Tuberculum sellae meningioma	Anterior	Intradural
18	57 F	Clival chordoma	Middle	Extradural
19	51 F	Clivus chordoma	Middle	Extradural
20	56 F	Planum sphenoidale meningioma	Anterior	Intradural
21	59 M	Tuberculum sellae meningioma	Anterior	Intradural
22	48 F	Olfactory groove meningioma	Anterior	Intradural
23	54 F	Tuberculum sellae meningioma	Anterior	Intradural
24	44 M	Planum sphenoidale meningioma	Anterior	Intradural
25	69 M	Olfactory groove meningioma	Anterior	Intradural
26	58 M	Planum sphenoidale meningioma	Anterior	Intradural
27	48 F	Clivus chordoma	Middle	Extradural
28	44 F	Olfactory groove meningioma	Anterior	Intradural
29	65 F	Tuberculum sellae meningioma	Anterior	Intradural
30	43 F	Olfactory groove meningioma	Anterior	Intradural

Table 2: Location of the lesion of the subjects involved in the study

Lesion Location	Number	Frequency (%)
Clivus	6	20 %
Olfactory groove	7	23.3 %
Optic canal	1	3.3 %
Petrous apex	1	3.3 %
Planum sphenoidale	5	16.7 %
Sellar suprasellar	2	6.7 %
Suprasellar	2	6.7 %
Tuberculum sellae	6	20 %

Table 3: Pathology of the lesion of the subjects involved in the study

Pathology	Number	Frequency (%)
Arachnoid cyst	1	3.3 %
Chondrosarcoma	1	3.3 %
Chordoma	3	10 %
Craniopharyngioma	2	6.7 %
Glioma	1	3.3 %
Hepatocellular metastasis	1	3.3 %
Meningioma	17	56.7 %
Papilloma	1	3.3 %
Plasma cell myeloma	1	3.3 %

DISCUSSION

Surgery of the skull base is a technically and physically demanding task that requires a high level of concentration and surgeon's maturity.[8] Several transcranial and/or craniofacial approaches, such as anterior, anterolateral, and posterolateral, have been used in the last several decades to reach the entire skull base in its various sections, Tissue disruption, brain retraction, and neurovascular manipulation are common features of these procedures, which can lead to cosmetic problems and/or a higher rate of morbidity and mortality. Continuous technical advancements and surgical developments over the last few years have led to a considerable reduction in the invasiveness of these approaches, culminating in the concept of accessing the skull base through a different surgical corridor, the nose. This technique is particularly adaptable since it allows the surgeon to get access through a natural cavity, the sphenoid sinus, and expose almost the entire midline skull base through the nose.[9] The sphenoid sinus cavity could be characterized as the "primary entry" to numerous parts of the skull base, according to Perneczky's "keyhole" theory.[8] In transsphenoidal surgery, the endoscope was first used in so-called endoscope-assisted surgeries and then as the sole visualizing instrument throughout the process.[10-13]

Table 4: Location and pathology of the lesions

Pathology and Location	Number	Frequency (%)
Sellar suprasellar arachnoid cyst	1	3.3 %
Petrous apex chondrosarcoma	1	3.3 %
Clival chordoma	3	10 %
Suprasellar craniopharyngioma	2	6.7 %
Olfactory groove glioma	1	3.3 %
Clival hepatocellular metastasis	1	3.3 %
Tuberculum sellae meningioma	6	20 %
Olfactory groove meningioma	6	20 %
Planum sphenoidale meningioma	5	16.7 %
Sellar suprasellar meningioma	1	3.3 %
Optic canal meningioma	1	3.3 %
Clival papilloma	1	3.3 %
Clival plasma cell myeloma	1	3.3 %

The endoscope's larger and panoramic view prompted the development of several changes to this method, focusing on the entire midline of the skull base, from the anterior skull base to the craniovertebral junction and surrounding areas. Unlike the typical endoscopic method, which requires the development of a new surgical corridor to expose and work around the sella, the extended approach necessitates the creation of a new surgical corridor to get access to the sellar region.[9]

The endoscopic endonasal approach is a direct and minimally invasive route to the suprasellar, retrosellar, and retroclival area that avoids brain retraction, allows for safe and effective visualization of the surgical field, and provides the lowest rates of morbidity and mortality. The endoscopic endonasal approach, however, necessitates specific endoscopic skills and the use of a variety of instruments, including an endoscope, fiberoptic cable, light source, camera, monitor, and video recording system.[9] It should be disucssed in detail with the anesthetist. The usage of lumbar drainage is of ultimate importance in relaxing the brain before operation, so, no brain retraction is required.[8]

A post-operative CT should be done to exclude significant complications like brain edema, ischemia, hematoma, or pneumocephalus.[8] Because of the possibility of delayed hydrocephalus after skull base surgery, close observation for leakage is important. If it; if it does not respond to temporary lumbar drainage or definitive operative repair, it may need a ventriculoperitoneal shunt. Tumors in general and meningiomas specifically should be first de-vascularized, debulked, and then dissected, this is the 3 "D"s approach.[8]

Skull-based lesions are always a challenge for neurosurgical intervention. The extended endoscopic endonasal approach represented an alternative to the transcranial approaches for the management of skull base lesions. It is safe and effective; however, its success depends mainly on appropriate case selection and the surgeon's expertise.[14] Trans-sphenoidal surgical approaches to the midline skull base were introduced more than 100 years ago.[15] At first, these approaches were only limited to the pituitary fossa.[16–18] Today, by this approach, we can reach and excise all midline lesions from the frontal sinus to the odontoid process.[16,19–21]

This approach is an advancement of the endoscopic pituitary surgery. It has the great advantage of avoiding brain retraction, safe visualization, and effective reach to the surgical target.[9] The advancement of tools enhanced and assisted in improving the surgical technique.[14] In spite of the narrow passage, high-resolution images from different angles can be obtained. The detailed endoscopic view is an important advantage of this approach.[11] Another great advantage is avoiding the traditional transcranial approach which creates cosmetic defects like incision scars, resorption of bone flap, temporal muscle atrophy, bleeding that may occur in the temporal muscle, and inadequate healing of burr holes.[14,22,23] It requires cooperation between the neurosurgeon and otolaryngologist working together throughout the procedure.[15]

Complications

Regarding postoperative complications, the percentage of complications that occurred in sub-totally resected lesions (33.4 %) was higher than in totally resected lesions (10 %). The most common location having complications is the olfactory groove and the most common pathology having complications is meningiomas. Regarding lethal complications, it was 11.1% in the subtotal group versus. 10% in the total group. This can be explained by the more difficult and less accessible lesions in the subtotal group. No complications occurred in the biopsy group. It occurred in 3 of 11 male patients (27.3%) and in 3 of 19 female patients (15.8%). The most common complication was meningitis representing 6.67% of the patients involved in the study. The following complications each represented 3.33%: cottonoid patty was left in the clivus due to excessive bleeding and was removed later, persistent CSF leakage, transient postoperative diabetes insipidus in 5%, anosmia, facial numbness, subarachnoid hemorrhage, hydrocephalus which mandated external ventricular drainage, and lethal vasospasm. Mortality occurred in 3 out of 30 patients (10%); in an olfactory groove meningioma patient and planum sphenoidale meningioma patient due to meningitis and occurred in a suprasellar craniopharyngioma following deterioration with subarachnoid hemorrhage, vasospasm then external ventricular drainage insertion, later the MRI showed an ischemic insult. A paper published in 2009 experienced lethal meningitis in 8.3%.[24] Another paper in 2018 stressed the risk of high-flow CSF leakage in the elderly along with post-operative subdural hematomas.[25] In a 2018 Korean paper, the most common complication was hyposmia (12.5%), 15% had endocrinologic affection with half of them permanent, and 7.5% having post-operative infarction.[26] Another paper had different types of complications including intracerebral hematoma and tension pneumocephalus. The mortality rate was 0.9%.[27] Culebras et al. did not experience any mortality in their chordoma and chondrosarcoma series.[28] Another team declared having meningitis in 6.6%, transient injury to the hypothalamus in 6.6%, transient injury to the third cranial nerve in 6.6%, and postoperative epistaxis in 6.6%.[29] Wannemuehler et al. stated that half of their extended endonasal approach experienced CSF leakage.[30] Ceylan et al. found CSF leakage in 38.5% and all of them were managed with lumbar drain and 7.7% needed re-operation.[31] In Song et al. study, 18.8% of their patients have CSF leakage.[26] A Turkish Team's overall rate of CSF leaks was 8.4%.[27] Culebras' most common complication was CSF fistula, occurring in 28.6% of the cases, with only one case requiring surgery to repair it.[28] With the Sankhla team, the most common postoperative complications were CSF rhinorrhea (20%).[29] Kalinin et al. experienced postoperative cerebrospinal fluid rhinorrhea occurring in 10.7% of craniopharyngioma patients.[32] The complications between this study and the comparative studies are very close. The percentage of persistent CSF leakage in this study is low (3.33%) due to the multilayer closure, usage of a vascularized nasoseptal flap, and usage of fibrin glue.

Visual Function State

Regarding visual function, preoperatively, there were 13 patients (43.3%) with normal eye function, 5 patients (16.7%) with bilateral eye function (3 affected more of the right eye and 2 affected more of the left eye), and 7 patients (23.3%) with bitemporal hemianopia. In addition, there were only 2 patients (6.7%) with only right eye involvement and there were only 3 patients (10%) with only left eye involvement. Post-operatively, among the 17 patients with preoperative visual affection, 9 patients had an improvement in visual field (7 in totally resected lesions and 2 in partially resected lesions). Additionally, we had 8 stationary visual fields (5 in totally resected lesions, 2 in a partially resected lesion, and 1 in a biopsy surgery). Fortunately, we did not have any deteriorated. Song et al. had 86.9% of their patients presented with visual disturbance.[26] A Korean team in 2018 documented in their series that tuberculum sellae meningioma patients stated having improved visual function in 97.8%, and 2.3% with deteriorated visual function.[26] A 2016 Italian paper reported a favorable visual outcome in 80.1%.[33] The Turkish team's overall rate of improvement in visual fields was 86%.[27] Wannemuehler et al. stated that 100 % of their patients had similar or improved visual outcomes compared to pre-operatively.[30] Chabot et al. in their retrospective review of the evaluation of outcomes after endoscopic endonasal surgery for large and giant pituitary macroadenoma documented that all their patients had an improvement or a stationary course of visual field and acuity. They did not have any visual deterioration.[34]

Endocrinological State

In this study, 100% of the patients had a normal endocrinological state and post-operative permanent diabetes insipidus occurred only in the totally resected group representing 5% of the lesions. Wannemuehler et al. had 55.5% of his patients with a permanent diabetes insipidus.[30] Cavallo et al. in 2014 published 48.1%, Jane et al. in 2010 shared 44% and in 2016 Jeswani et al. had 52.9%.[35–37] Ceylan et al had post-operative transient diabetes insipidus in 23.1% of their patients, however, none of them persisted.[31] While the Korean team study had transient diabetes insipidus in 2.6% of patients, permanent diabetes insipidus in 1.9%, and postoperative panhypopituitarism in 3.3%.[26] Ditzel Filho et al. reported endocrinologic complications in the form of transient (2.6%) or permanent diabetes insipidus (1.9%) and postoperative panhypopituitarism (3.3%).[38] With the Sankhla team, the endocrinological complications were 20% diabetes insipidus and 13.3% panhypopituitarism.[29]

Conclusion

Using the endoscope in the extended endonasal transsphenoidal surgery speeds up the recovery time due to its minimally invasive characteristics. Its main target is midline sellar and parasellar lesions. The endoscope gives a panoramic view instead of a narrow microscopic view with very well-concentrated illumination which allows inspection and removal of lesions of the sellar, parasellar, and suprasellar compartments. The main drawback of the approach is the CSF leakage and the inability for total excision in some lesions and locations. The rate of CSF leakage decreases with improving the surgical technique and improvement of the team skills. Experienced neurosurgeons in endoscopy, with proper surgical tools and their application in properly selected patients, could achieve better results than conventional microscopic techniques.

List of Abbreviations

CSF: Cerebro-spinal fluid.
CT: Computed tomography.
CP: Clinoid process.
DWI: Diffusion weighted imaging.
EEEA: Extended or expanded endoscopic endonasal approaches.
ICA: Internal carotid artery.
M-OCR: Medial optico-carotid recesses.
MRI: Magnetic resonance imaging.
SPSS: Statistical package for social sciences.
TSH: Thyroid stimulating hormone.
OP: Optic prominence

Disclosure

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