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Evaluation of the efficacy and outcome of extended endoscopic endonasal approach for resection of skull base tumors

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Abstract

Background: Endoscopic endonasal surgery represents a minimally invasive approach that enables surgeons to access and treat various lesions located at the skull base through the nasal cavity. The objective of this study was to assess the outcomes associated with the extended endoscopic endonasal technique in patients diagnosed with skull base tumors, focusing on its safety and effectiveness.

Methods: This investigation involved 20 patients presenting with midline skull base lesions, including craniopharyngiomas with intrasellar and moderate suprasellar components, large or giant pituitary adenomas extending significantly into the suprasellar region and anterior cranial base, recurrent skull base masses, and small lesions measuring less than 3-4 cm without lateral extension beyond the optic nerves.

Results: Notable improvements were observed in the visual field function of the patients. Statistically significant differences were identified between the preoperative and postoperative functional outcomes ($p<0.001$).

With 24-hour computed tomography follow-up 1 lesion (5%) had minimal resection, 8 lesions (40.0%) had subtotal resection and 11 lesions (55%) with total resection. Also, with follow-up with magnetic resonance imaging (MRI) after 6 months duration, 1 lesion (5.0%) had minimal resection, 8 lesions (40.0%) had subtotal resection and 11 lesions (55.0%) had total resection. There was post-operative improvement, it was not significant which may be due to small sample size (P>0.005).

Conclusions: The extended endoscopic endonasal approach represents a minimally invasive, safe, and less traumatic surgical technique for managing patients with various skull base tumors.

Keywords: Outcome, extended endoscopic endonasal approach, resection, skull base tumors, clival chordoma

Introduction

One of the most fascinating and complex anatomical areas is the base of the skull, both in terms of anatomy and surgical intervention. To diagnose pathological disorders that affect the structures of the skull base, such as the cranial nerves and cerebral vasculature, a thorough understanding of skull base anatomy is essential [1, 2].

This knowledge is also vital for accurately interpreting imaging studies and effectively planning surgical approaches to the skull base. The advent of endoscopy in skull base surgery has significantly enhanced surgical outcomes. Originally, sellar lesions were the focus of the development of the endoscopic endonasal technique [3]; however, over the past twenty years, its applications have broadened due to advancements in technology and increased surgical proficiency, allowing for extended midline and paramedian approaches. Many specialized centers now safely perform procedures from the anterior skull base to the odontoid with favorable results [2, 4, 5, 9].

The growing preference for this technique is largely due to its perceived minimally invasive characteristics and lower complication rates, especially when compared to traditional transcranial methods, which often require brain retraction, early devascularization of lesions, restricted access to the sellar, suprasellar, and retrochiasmal regions by modification of neurovascular systems [10, 11].

With an emphasis on safety and effectiveness, this research attempts to evaluate the results of the extended endoscopic endonasal method in the treatment of patients with skull base tumours.

Patients and Methods

This clinical interventional study involved 20 patients diagnosed with skull base lesions located in the midline and suitable for endoscopic surgical intervention. Small lesions measuring less than 3–4 cm without lateral extension beyond the optic nerves, recurrent skull base masses, large or giant pituitary adenomas exhibiting significant suprasellar and anterior cranial base extension, and craniopharyngiomas with intrasellar and moderate suprasellar components that were extra-arachnoidal were among the conditions. With permission from Tanta University Hospitals' ethical committee in Tanta, Egypt, the study was carried out between November 2020 and November 2022. Every participant provided written, informed permission. Patients encased in vital neurovascular structures, such as the anterior cerebral arteries and internal carotid arteries, as well as those with unfavorable anatomical features, including a small sphenoid sinus or reduced space between the internal carotid arteries were excluded. Patients who had osteolysis of the greater wing of the sphenoid along with posterior extension into the infratemporal fossa, large craniopharyngiomas completely located in the supradiaphragmatic space, and large tuberculum sellae/planum sphenoidale or olfactory groove lesions larger than 4 cm enclosing the anterior cerebral arteries were also excluded.

All participants underwent a comprehensive assessment, which included a detailed medical history, clinical examination, ophthalmologic evaluation, endocrine screening, and radiological investigations comprising magnetic resonance imaging (MRI) and computed tomography (CT).

Endoscopic endonasal approach surgery using Storz Endoscopic Tower with HD camera, monitor and light source.

Surgical technique

On the operating table, the patient is positioned supine, with their head rotated 15° to the right and 15° flexed towards their left shoulder. In addition to allowing for easy access to the nasal cavity and facilitating an ideal trajectory, this placement also allows for a 5–10° head extension to better view of the front skull base.

Intraoperative imaging guidance is utilized to enhance anatomical orientation, proving invaluable during the processes of bone removal, dural opening, and tumor excision. Betadine is used to prepare the nostrils on the outside, then pledgets dipped in adrenaline are placed within the nasal cavity and held there for ten to seven minutes.

The preparation of the nasal mucosa involves the application of betadine and xylocaine, with the harvesting of the septal flap being customized according to the specific case and surgical preferences. The mucosal side of the vascularised septal flap is advanced into the nasopharynx until the tumour resection is finished, making sure that the pedicle stays untwisted to prevent ischaemia, after the naso-septal flap is disconnected by sharp dissection and then mobilised by blunt dissection. Hemostasis is achieved using bipolar cauterization for any bleeding encountered. The sphenoid mucosa is removed, partial posterior ethmoidectomies are performed, the middle turbinates are mobilised bilaterally laterally, the sphenoid ostia is identified, a posterior septectomy is performed, and the bony septations within the sphenoid sinus are drilled. While turbinates may usually be preserved, in certain cases the central turbinate on one side may be removed to allow for endoscopic access and avoid interfering with the manipulation of instruments.

The aforementioned steps are adapted based on the specific underlying pathology. The thorough removal of the sphenoid mucosa is crucial to avert the formation of a postoperative mucocele, as it uncovers vital bony landmarks necessary for the subsequent phases of the operation and offers the essential bony foundation for the attachment of the pedicled nasoseptal flap. A high-speed diamond-bit drill was utilized to excise bone from the sella turcica, tuberculum sellae, and the posterior aspect of the planum sphenoidale. The bone removal procedure extended laterally to the medial opticocarotid recesses. Initially, the bone was either shelled out or thinned using the drill, followed by extraction with a Kerrison rongeur. The lateral limits of the surgical corridor were determined by the nasal turbinates rather than by any remnants of the anterior sphenoid wall. A complete posterior ethmoidectomy facilitated full exposure of the planum sphenoidale; although the lesion may not extend to this region, this approach widened the operative corridor, improved working angles, and prevented overhanging bone from obstructing visibility and instrument handling. While venous bleeding was encountered during bone removal in this region, even significant bleeding was typically manageable with Gelfoam packing and gentle pressure. After adequate bone removal, confirmed through navigation, the dura was incised in a cross-shaped pattern. The edges of the dura were cauterized and reduced in size to enhance visibility, and it was also possible to remove the dural edges using Kerrison rongeurs to further expand the surgical corridor. Before making the dural incision, micro Doppler ultrasonography was consistently employed to avoid damaging the internal carotid artery (ICA), especially given that its proximal supraclinoid segment is located medially. Upon extensive dural opening, the inferior and posterior margins of the tumor were delineated, with each pathology necessitating specific bony and intradural surgical techniques. In the scenario involving a tuberculum sella meningioma, the osteotomy was designed to extend slightly beyond the carotid arteries on both sides and the optic canals, as achieving extensive bony exposure was essential to prevent blind dissection or undue traction on the tumor. The anterior boundary of the bony resection was established through navigational techniques, while the posterior boundary reached the mid sellar floor. To aid in skull base reconstruction at the end of the procedure, the entire sella floor was preserved. The tumor was often dissected with relative ease from the pituitary gland and diaphragm sellae, negating the need for extensive posterior exposure. Bone removal was conducted along the planum to the anterior edge of the tumor and its dural tail. This osteotomy posed considerable technical difficulties due to the steep and acute working angles; thus, a drill was employed extensively during this phase, assisted by 30-degree angled endoscopes. The dura and intercavernous sinus were cauterized using bipolar electrocautery, effectively de-vascularizing the meningioma. After achieving exposure and tumor de-vascularization, the first step involved internal decompression. Enucleation was performed using various instruments suited to the tumor's consistency, including suction, pituitary rongeurs, and/or an ultrasonic aspirator. The angled endoscope (30 degrees) improved visualization and facilitated the resection of the anterior tumor mass. A notable advantage of the endonasal approach was that it allowed the surgeon to expose and reduce the tumor early in the dissection process, enabling timely decompression of the optic apparatus before any manipulation of the nerves and chiasm. Once the tumor was internally debulked, the anterior tumor margin was located, ensuring that an adequate portion of the planum had been removed. A layered closure was executed using harvested or autograft dural reconstruction materials, which included the intradural placement of a dural substitute and the extradural placement of a nasoseptal flap. Valsalva maneuvers were employed to check for any evident cerebrospinal fluid (CSF) leakage before proceeding to the next phase of reconstruction. The nasoseptal flap was then placed over the selected method for initial closure, ensuring direct contact with the surrounding bony skull base. It was subsequently secured with DuraSeal (Covidien, Dublin, Ireland) or fibrin glue, utilizing bilateral nasoseptal flaps for larger skull base defects. To enhance the closure and reduce postoperative nasal discharge, a Gelfoam® sponge was inserted, followed by the placement of nasal tampons. Figure 1

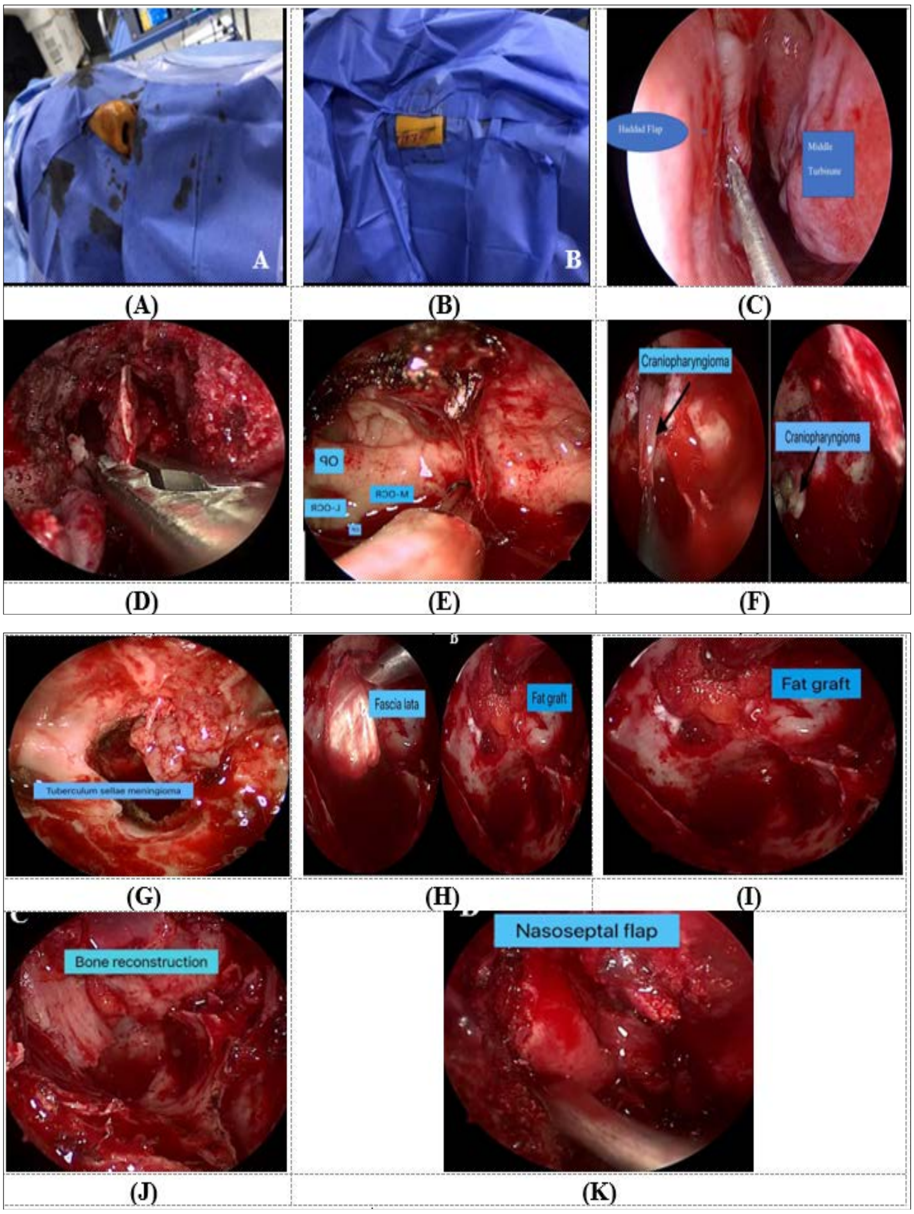

Fig 1: (A, B) The patient position during operation, (C) harvesting of nasoseptal (Haddad) flap, (D) identification of the sphenoid ostia performing posterior septectomy, (E) Sphenoid Phase (OP: Optic prominence CP: carotid prominence M-OCR: Medial- OpticoCarotid prominence Recesses), endoscopic excision (F) craniopharyngioma, (G) Tuberculum sellae Meningioma, Skull base reconstruction using (H) fat graft, (I) fascia lata graft, (J) bone graft and (K) nasoseptal flap

Post-Operatively, all patients were admitted in the Intensive Care Unit (ICU), CT Brain was done within 24 hours to detect early complications such as hematoma or pneumocephalus, contrasted MRI Brain was done within the first 3 days postoperatively, hormonal Profile was done on the first day post-operatively, incidence of CSF leakage was followed, intracranial infection was followed clinically and radiologically, nasal functional smelling, aeration and Nasal Crusts) assessment for the smell was followed by fellow otorhinolaryngologists, endocrinological, visual follow-up and any remote cranial complications.

Follow up evaluation
Contrasted MRI Brain was done 3 and 6 months later to assess the gross total resection ratio, hormonal Profile 1 month later and pre-Operative and Post-Operative Functional Outcome was assessed by Karnofsky scoring

Results
Distribution of the studied cases according to demographic data, lesion location and pathology, presenting symptoms and signs and presenting visual function were enumerated in this table. Table 1

Table 1: Distribution of the studied cases according to demographic data, lesion location and pathology, symptoms and signs and visual function

		N=20
Age (Years)		45.75±11.76
Sex	Male	8(40.0%)
	Female	12(60.0%)
Lesion location and pathology		
Clival (1 case plasma cell myeloma and 2 cases clival chondroma)		3(15.0%)
Sellar suprasellar macroadenoma		4(20.0%)
Suprasellar craniopharyngioma		4(20.0%)
Planum sphenoidale meningioma		3(15.0%)
Tuberculum sellae meningioma		3(15.0%)
Olfactory groove meningioma		2(10.0%)
Pre-pontine Epidermoid		1(5.0%)
Symptoms and signs		
Headache		14(70.0%)
Frontal behavioral changes		6(30.0%)
Seizures		2(10.0%)
TGN		1(15.0%)
Facial nerve palsy		1(5.0%)
6^{th} nerve palsy		1(5.0%)
Endocrine affection (increased prolactin)		4(20.0%)
Visual Function		
Normal		7(35.0%)
Bilateral visual field defect, more on left eye		2(10.0%)
Bilateral visual field defect, more on right eye		3(15.0%)
Bitemporal Hemianopia		5(25.0%)
Left eye visual field defect.		2(10.0%)
Right eye visual field defect.		1(5.0%)

Data are presented as mean ± SD or frequency (%). TGN: Trigeminal neuralgia.

Descriptive analysis according to operative time and operative blood loss and distribution according to intraoperative resection percentage and complications of the studied cases were enumerated in this table. Table 2

Table 2: Descriptive analysis according to operative time, operative blood loss and intraoperative resection percentage and complications of the studied cases

	N=20
Operative time (minutes)	216.4±35.7
Operative blood loss (milliliters)	254.5±60.22
Intraoperative resection percentage	
Biopsy	1(5.0%)
Subtotal resection	8(40.0%)
Total resection	11(55.0%)
Complications	
Excessive bleeding	1(5.0%)
Transient post-operative diabetes insipidus	2(10.0%)
Transient CSF Leakage	1(5.0%)
Facial Numbness	1(5.0%)
Hydrocephalus	1(5.0%)
Vasospasm	1(5.0%)
Meningitis	1(5.0%)

Data are presented as mean ± SD or frequency (%). CSF: cerebrospinal fluid.

With 24-hour CT follow-up 1 lesion (5%) had minimal resection, 8 lesions (40.0%) had subtotal resection and 11 lesions (55%) with total resection. Also, with follow-up with MRI after 6 months duration, 1 lesion (5.0%) had minimal resection, 8 lesions (40.0%) had subtotal resection and 11 lesions (55.0%) had total resection. There was no significant association between (lesion location and pathology and the degree of resection). There was significant improvement in visual field function of the cases. Table 3

Table 3: Relation between (the degree of resection intra-operative, 24-hour CT, 3-month MRI and 6-month MRI), (lesion location and pathology and the degree of resection) and (pre- and post-operative visual function)

		Intra-Operative (Gross eye)	**24-hour CT**	**3-month MRI**	**6-month MRI**	
The degree of resection intra-operative, 24-hour CT, 3-month MRI and 6-month MRI						
Intraoperative resection percentage	Biopsy	1(5.0%)	1(5.0%)	1(5.0%)	1(5.0%)	
	Subtotal resection	8(40.0%)	8(40.0%)	8(40.0%)	8(40.0%)	
	Total resection	11(55.0%)	11(55.0%)	11(55.0%)	11(55.0%)	
The degree of resection						
		Biopsy (n=1)	Subtotal resection (n=8)	Total resection (n=11)	χ^2	P
Lesion pathology	Clival plasma cell myeloma	1(100.0%)	0(0.0%)	0(0.0%)	19.022	0.115
	Clival chordoma	0(0.0%)	2(25.0%)	0(0.0%)		
	Pre-pontine epidermoid	0(0.0%)	1(12.5%)	0(0.0%)		
	Sellar suprasellar macroadenoma	0(0.0%)	0(0.0%)	4(36.4%)		
	Suprasellar craniopharyngioma	0(0.0%)	1(12.5%)	3(27.3%)		
	Tuberculum sellae meningioma	0(0.0%)	2(25.0%)	1(9.1%)		
	Planum sphenoidale meningioma	0(0.0%)	1(12.5%)	2(18.2%)		
	Olfactory groove meningioma	0(0.0%)	1(12.5%)	1(9.1%)		
Pre- and post-operative visual function						
		No change (n=10)	Improved (n=10)	Worse (n= 0)	χ^2	P
Presenting visual function affection	Normal	7(70.0%)	0(0.0%)	0(0.0%)	13.981*	0.001*
	Bilateral visual field defect more on left eye	1(10.0%)	1(10.0%)	0(0.0%)		
	Bilateral visual field defect, more on right eye	1(10.0%)	2(20.0%)	0(0.0%)		
	Bitemporal Hemianopia	0(0.0%)	5(50.0%)	0(0.0%)		
	Left eye visual field defect.	1(10.0%)	1(10.0%)	0(0.0%)		
	Right eye visual field defect.	0(0.0%)	1(10.0%)	0(0.0%)		

Data are presented as frequency (%). CT: Computed tomography, MRI: Magnetic Resonance Imaging, χ2: Chi square test.

There was no significant association between complication and sex, lesion location and pathology and resection. Table 4

Table 4: Relation between sex, resection, lesion location and pathology with complication

		Complications			**χ^2**	**P**
		Present (n = 5)		**Absent (n = 15)**		
Sex	Male	2(40.0**%)**		6(40.0%)	0.000	1.000
	Female	3(60.0**%)**		9(60.0%)		
Lesion location and Pathology	Clival Plasma Cell Myeloma	0(0.0%)		1(6.7%)	0.351	1.000
	Clival Chondroma	1(20.0%)		1(6.7%)	0.741	0.447
	Olfactory Groove meningioma	0(0.0%)		2(13.3%)	0.741	1.000
	Planum sphenoidale meningioma	0(0.0%)		3(20.0%)	1.176	0.539
	Tuberculum Sellae Meningioma	0(0.0%)		3(20.0%)	1.176	0.539
	Sellar Suprasellar Macroadenoma	2(40.0%)		2(13.3%)	1.667	0.249
	Suprasellar Craniopharyngioma	1(20.0%)		3(20.0%)	0.0	1.000
	Pre-pontine Epidermoid	1(20.0%)		0(0.0%)	3.158	0.250
Resection						
		Biopsy (n = 1)	Subtotal resection (n =8)	Total resection (n =11)	χ^2	P
Post-operative complications	None	1(100.0%)	6(75.0%)	8(72.7%)	0.612	1.000
	Facial Numbness and Excessive bleeding	0(0.0%)	1(12.5%)	0(0.0%)	2.769	0.454
	Meningitis, Hydrocephalus and Vasospasm	0(0.0%)	1(12.5%)	0(0.0%)	2.769	0.454
	Transient diabetes insipidus	0(0.0%)	0(0.0%)	2(18.2%)	2.138	0.528
	Transient CSF leak	0(0.0%)	0(0.0%)	1(9.1%)	2.132	1.000

Data are presented as frequency (%).χ2: Chi square test, CSF: cerebrospinal fluid.

There were significant differences between preoperative and postoperative functional outcome (karnofsky score) (p<0.001). There were no significant differences between preoperative and postoperative functional outcome (median karnofsky score with lesion location) and (median karnofsky score with lesion pathology). There was post-operative improvement, it was not significant which may be due to small sample size (P>0.005). Table 5

Table 4: Statistical relation of pre-operative and post-operative functional outcome Karnofsky score, with lesion location and pathology

		Preoperative (n = 20)	Postoperative (n = 20)	T	P
Functional outcome (Karnofsky score)		74.0±8.21	84.50±8.87	11.917*	**<0.001***
Median Karnofsky Score					
Lesion Location	Clivus	60	70	35	0.243
	Olfactory Groove	70	80		
	Planum Sphenoidale	70	80		
	Sellar Suprasellar	80	90		
	Tuberculum Sellae	80	90		
	Pre-pontine Epidermoid	60	80		
Median Karnofsky Score					
Pathology	Chordoma	70	80	30	0.224
	Craniopharyngioma	80	90		
	Pituitary macroadenoma	80	90		
	Meningioma	80	90		
	Pre pontine Epidermoid	60	80		
	Plasma cell myeloma	60	70		

Data are presented as mean ± SD. * significant p value <0.05.

Case 1: 62-years old female patient with clival chordoma presented with normal endocrine function, headache, unsteadiness and 6th nerve palsy. Operation: Subtotal Excision was done in 180 minutes and 300 ml blood loss. No intra-operative complications experienced. MRI follow-ups documented subtotal excision. Visual apparatus remained stationary. Figure 2

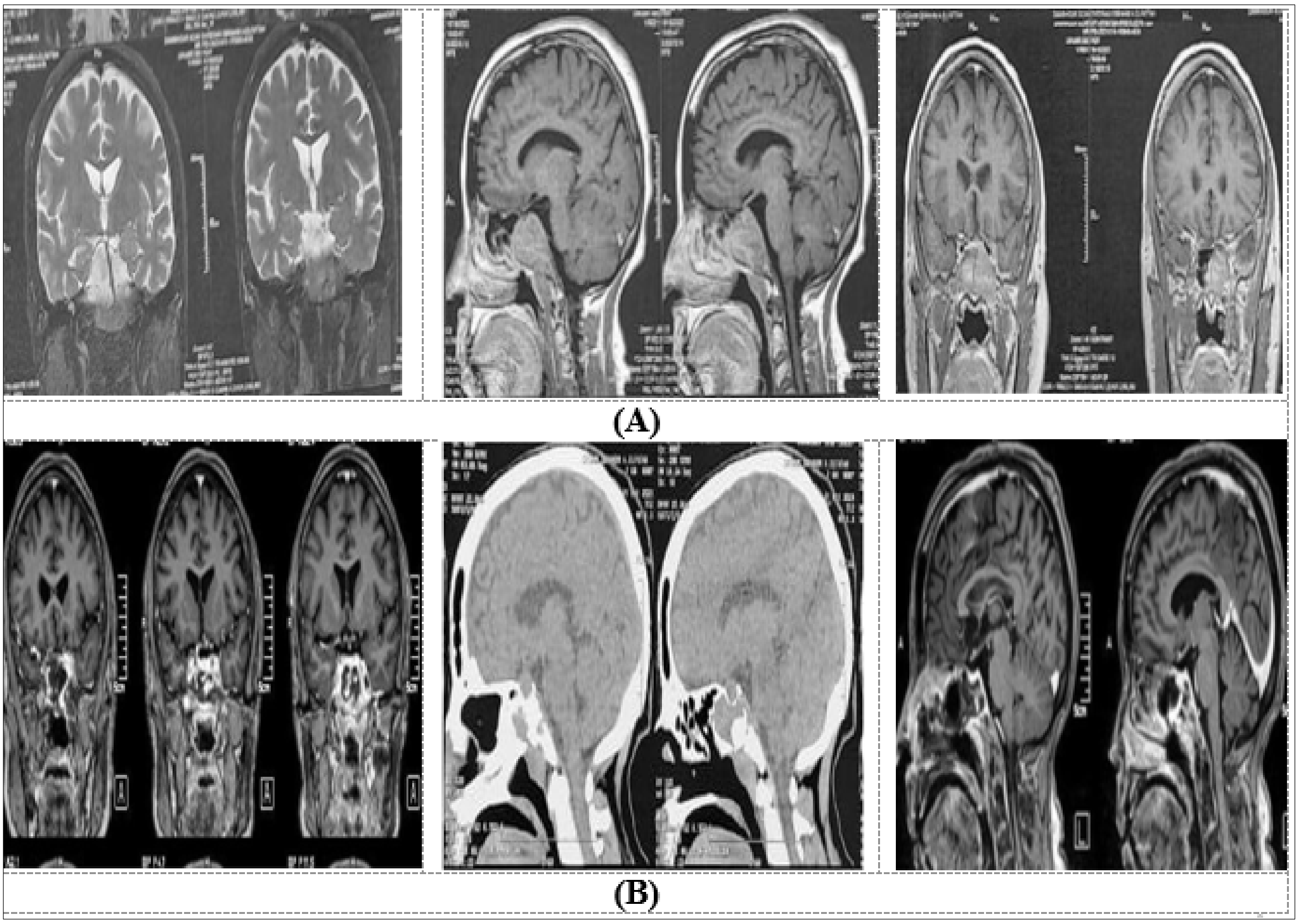

Fig 2: Computed tomography and contrasted magnetic resonance imaging brain of clival lesion chordoma (A) Pre-operative and (B) Post-operative follow up

Case 2: 37-years old female patient presented with headache and bilateral visual field affection (left eye no PL and right eye three quadrant hemianopia). Operation: subtotal excision in 200 minutes and 300 ml blood loss. No intra-operative complications experienced. MRI follow-ups documented subtotal excision. Visual field show improvement of the right eye and no CSF leak was reported. Figure 3

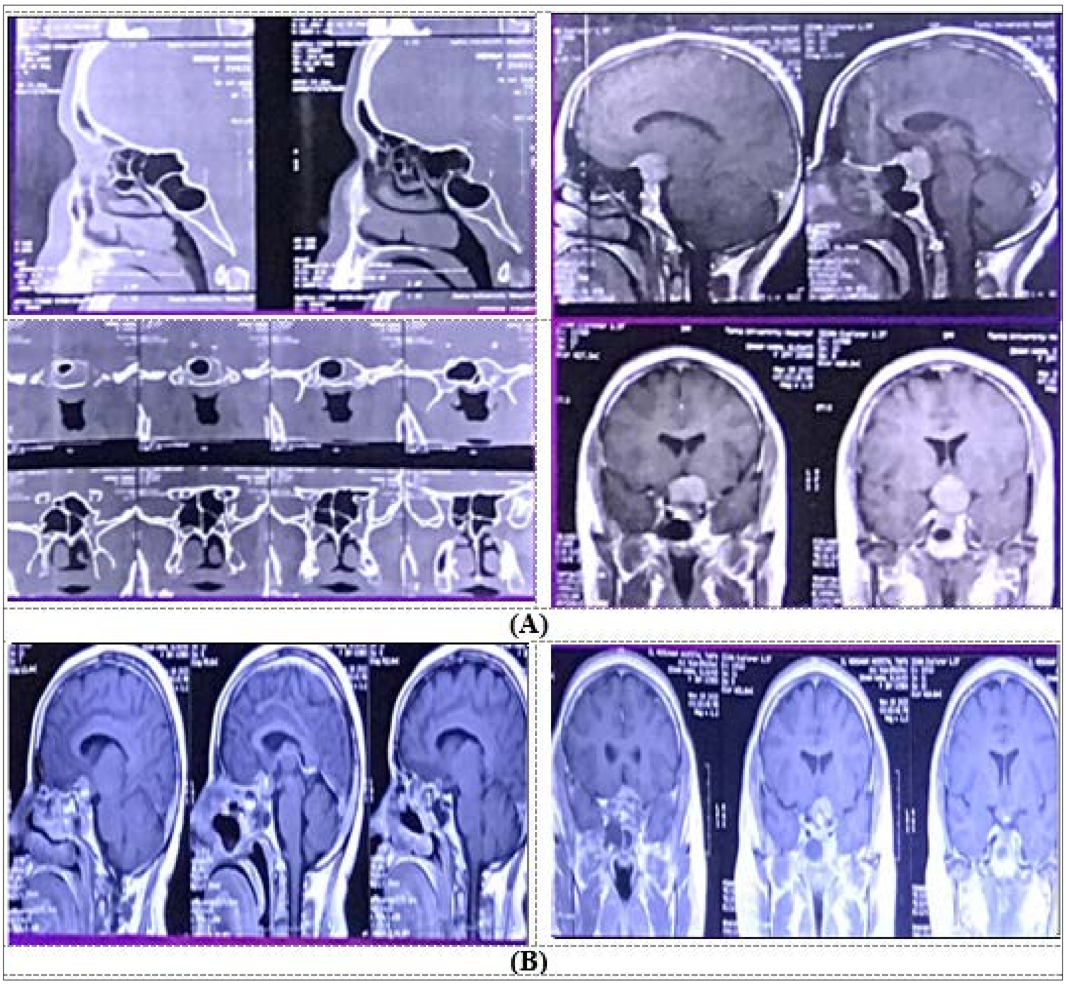

Fig 3: Contrasted MRI brain and CT paranasal sinuses of Tuberculum Salle Meningioma (A) Pre-operative and (B) Post-operative

Case 3: 63-years old female patient presented with headache, seizures and blurring of vision. Operation: gross total excision in 200 minutes and 300 ml blood loss. No intra-operative complications experienced. MRI follow-ups documented gross total excision no CSF leak was reported. Figure 4

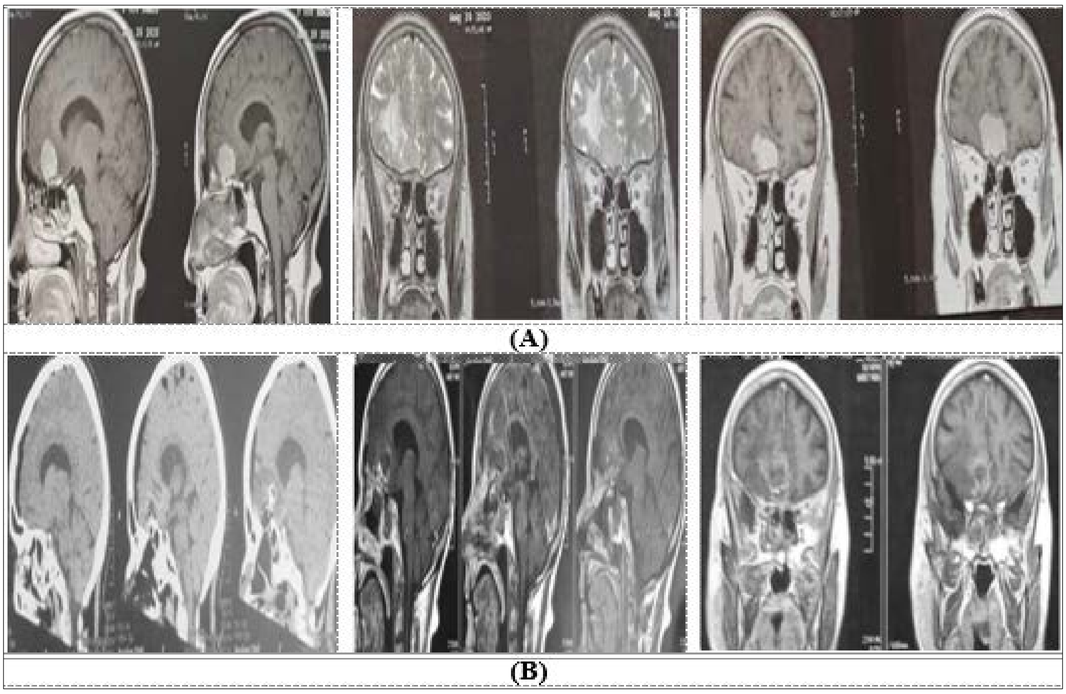

Fig 4: Contrasted magnetic resonance imaging brain and computed tomography of olfactory groove meningioma (A) Pre-operative and (B) Post-operative

Discussion

The complex architecture near the base of the skull, which includes the brainstem, venous sinuses, major cerebral arteries, and cranial nerves, makes surgery there extremely difficult. Furthermore, the surgical methods used to remove tumours from the base of the skull may have an effect on other anatomical areas, including the orbits, paranasal sinuses, craniocervical junction, and head and neck [14].

Intraoperatively, the approach operative time was 140.0 – 285.0 minutes with a mean value of 216.4±35.7 and median of 220 minutes. With Song *et al.* [15] study the EEA operation time was about 257±98 minutes and with Felisati *et al.* [16] the intraoperative blood loss during the operation was minimal.

Types of lesions in the study, histopathologically, the patients in the present study were 2 cases with clival chordomas, 1 case clival plasma cell myeloma, 4 cases with sellar suprasellar macroadenoma, 4 cases with suprasellar craniopharyngioma, 3 cases with planum sphenoidale meningioma, 3 cases with tuberculum sellae meningiomas, 2 cases with olfactory groove meningioma and 1 case with pre pontine epidermoid. This provides insight into the various types of skull base tumors that can be addressed using the extended endoscopic endonasal approach in our research. Consistent with our findings, Ceylan *et al.* [17] reported that total tumor removal was accomplished in nine patients (69.3%), while subtotal removal was noted in four patients (30.7%). The authors concluded that the endoscopic technique facilitates access to the lesion without necessitating brain retraction, thereby reducing neurovascular manipulation. In a similar vein, Arbolay *et al.* [18] reported the application of the extended endoscopic endonasal approach in 127 patients presenting with various lesions, which included 61 invasive adenomas affecting the cavernous sinus, 10 clival chordomas, 21 craniopharyngiomas, 26 meningiomas, 4 instances of cerebrospinal fluid leakage, one case of meningoencephalocele, 2 malignant tumors, and 2 occurrences of thyroid ophthalmopathy. Regarding tumoral lesions, a gross total resection was achieved in 82.5% of cases, with the highest success rate noted in craniopharyngiomas at 90.5%, followed by invasive adenomas at 85.2%, and meningiomas at 84.6%. Furthermore, gross total resection was accomplished in 66.7% of cases, while subtotal resection was performed in 25%.

Transsphenoidal surgery is a method utilized to access pituitary tumors or sellar masses.

The literature exhibits considerable variability concerning the incidence of transient diabetes insipidus (DI) following transsphenoidal pituitary surgery. This discrepancy is likely attributed to the various definitions of transient DI and the inclusion of postoperative physiological polyuria within this classification [19]. The current study recorded postoperative complications in five cases, comprising two male patients (40.0%) and three female patients (60.0%). Similar findings were reported in the study by Ceylan *et al.* [17], which noted a 23.1% occurrence of postoperative transient diabetes insipidus among their patients, although none of these cases were persistent. Cavallo *et al.* [20], which noted a 23.1% occurrence of postoperative transient diabetes insipidus among their patients, although none of these cases were persistent. Cavallo *et al.* The Karnofsky Performance Scale (KPS) is a commonly utilized tool for evaluating a patient's functional status. Péus *et al.* [21] showed that the pre-operative Karnofsky score ranged between 60.0-80.0 with the mean ± SD. was 74.95±8.21with a median of 80 while 6-month post-operatively follow up, the range between 80.0 – 90.0 with the mean ± SD was 84.50±8.87 and a median of 90. There were significant differences between pre- and postoperative Functional Outcome (Karnofsky score), $p<0.001$. Also, it showed the post-operative improvement of the median Karnofsky score by the comparison of preoperative and postoperative median Karnofsky score with lesion location and lesion pathology.

Limitations of the study included that the sample size was relatively small. So, we recommended that endoscopic endonasal approach seems like a safe, effective and well tolerated treatment modality for different skull base lesions and strict preventive and follow up measures should be taken for different complications with relatively long follow-up time. Further studies with large number cases can be done to ensure the use of the endoscopic endonasal approach for the treatment of different skull base tumors.

Conclusions

A promising less invasive, secure, and less stressful surgical technique for treating patients with various skull base tumours is the extended endoscopic endonasal approach.

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Conflict of Interest: Nil

References

1. Lin J, Zhou Z, Guan J, Zhu Y, Liu Y, Yang Z, *et al.* Using three-dimensional printing to create individualized cranial nerve models for skull base tumor surgery. World neurosurg. 2018;120:142-52.
2. Kassam AB, Snyderman C, Gardner P, Carrau R, Spiro R. The expanded endonasal approach: A fully endoscopic transnasal approach and resection of the odontoid process: technical case report. Operative Neurosurg. 2005;57:200-60.
3. Carrau RL, Jho HD, Ko Y. Transnasal - transsphenoidal endoscopic surgery of the pituitary gland. L. 1996;106:914-8.
4. Alfieri A, Jho H-D. Endoscopic endonasal approaches to the cavernous sinus: surgical approaches. Neurosurg. 2001;49:354-62.
5. Messerer M, Cossu G, George M, Daniel RT. Endoscopic endonasal trans-sphenoidal approach: minimally invasive surgery for pituitary adenomas. JoVE. 2018;30:500-30.
6. Dehdashti AR, Karabatsou K, Ganna A, Witterick I, Gentili F. Expanded endoscopic endonasal approach for treatment of clival chordomas: Early results in 12 patients. Neurosurgery. 2008;63:299-309.
7. Buchfelder M, Schlaffer S-M. Novel techniques in the surgical treatment of acromegaly: applications and efficacy. Neuroendocrinology. 2016;103:32-41.
8. Puxeddu R, Lui MW, Chandrasekar K, Nicolai P, Sekhar LN. Endoscopic - assisted transcolumellar approach to the clivus: An anatomical study.The Laryngoscope. 2002;112:1072-8.
9. Cappabianca P. Evolution of transsphenoidal surgery, in de Divitiis E, Cappabianca P (eds): Endoscopic

Endonasal Transsphenoidal Surgery. New York: Springer; c2003.
10. Chakrabarti I, Amar AP, Couldwell W, Weiss MH. Long-term neurological, visual, and endocrine outcomes following transnasal resection of craniopharyngioma. J of neurosurg. 2005;102:650-7.
11. Dehdashti AR, Ganna A, Witterick I, Gentili F. Expanded endoscopic endonasal approach for anterior cranial base and suprasellar lesions: indications and limitations. Neurosurg. 2009;64:677-89.
12. Esposito F, Becker DP, Villablanca JP, Kelly DF. Endonasal transsphenoidal transclival removal of prepontine epidermoid tumors. Operative Neurosurg. 2005;56:443-20.
13. Yamasaki T, Moritake K, Hatta J, Nagai H. Intraoperative monitoring with pulse Doppler ultrasonography in transsphenoidal surgery: technique application. Neurosurg. 1996;38:95-8.
14. Di Maio S, Sekhar LN. Skull base tumors: Evaluation and microsurgery. J Neurol Surg. 50. 2nd ed: Elsevier; c2018. p. 682-94.
15. Song SW, Kim YH, Kim JW, Park C-K, Kim JE, Kim DG, *et al*. Outcomes after transcranial and endoscopic endonasal approach for tuberculum meningiomas-a retrospective comparison. World neurosurg. 2018;109:434-45.
16. Felisati G, Lenzi R, Pipolo C, Maccari A, Messina F, Revay M, *et al*. Endoscopic expanded endonasal approach: Preliminary experience with the new 3D endoscope. Acta ORL Ital. 2013;33:102-6.
17. Ceylan S, Koc K, Anik I. Extended endoscopic approaches for midline skull-base lesions.Neurosurg Rev. 2009;32:309-19.
18. Arbolay O, González J, González R, Gálvez Y. Extended endoscopic endonasal approach to the skull base. Minim Invasive Surg. 2009;52:114-8.
19. Canelo Moreno JM, Dios Fuentes E, Venegas Moreno E, Remón Ruíz PJ, Muñoz Gómez C, Piñar Gutiérrez A, *et al*. Postoperative water and electrolyte disturbances after extended endoscopic endonasal transsphenoidal surgery. Frontiers in Endocrinol. 2022;13:963-707.
20. Cavallo LM, Frank G, Cappabianca P, Solari D, Mazzatenta D, Villa A, *et al*. The endoscopic endonasal approach for the management of craniopharyngiomas: a series of 103 patients. Journal of neurosurg. 2014;121:100-13.
21. Péus D, Newcomb N, Hofer S. Appraisal of the karnofsky performance status and proposal of a simple algorithmic system for its evaluation. BMC Med Inform Decis Mak. 2013;13:1-7.