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RESEARCH

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Basal interhemispheric approach for sellar and juxta-sellar lesions

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Abstract

Background Sellar and juxta-sellar lesions represent a surgical challenge due their deep and complex relationships to surrounding important neurovascular structures. The basal interhemispheric (BIH) approach, as a midline approach, has an advantage over the lateral approaches as it allows for the safe removal of these challenging tumors.

Aim To describe the technique of BIH approach in a prospective cohort of 17 patients with sellar and juxta-sellar lesions with different pathologies presented to Alexandria Main University and affiliated hospitals. As well as the clinical outcome and complications of this technique, these cases were followed up for a mean period of 20 weeks.

Results Gross total resection was achieved in 9 cases (52.9%), subtotal resection was achieved in 5 cases (29.5%), while partial resection was carried out in 3 cases (17.6%). Visual status improved following surgery in 10 patients (58.8%), remained stationary in 5 patients (29.4%) and worsened in 2 cases. Post-operative shunt was needed in three cases, and severe water and electrolyte disturbance was recorded in 3 cases and pan-hypopituitarism in a single case. A single mortality was recorded, but it was due to pulmonary embolism and was not related to the approach.

Conclusion BIH could be a panoramic safe approach that allows tumor removal from multiple corridors with identification of the regional anatomy of the tumor thus elaborating the surgical strategy for gross total tumor removal.

Keywords Basal interhemispheric approach, Sellar tumors, Juxta-sellar tumors, Craniopharyngiomas

Introduction

Basal interhemispheric (BIH) approach is one of the modifications of the anterior interhemispheric approach described originally by Lougheed [1] and employed later by Ito [2] in the management of ruptured Acom aneurysms. Ito [2] described the relative advantage of this approach over the lateral frontobasal approach (pterional).

Sellar and juxta-seller lesions constitute a threat to patients and a surgical challenge for the surgeons. Several approaches can be used including transsphenoidal route, subfrontal approach or pterional approach. Furthermore, transcallosal approach can be used for tumors with third ventricular extension. Moreover, the BIH approach represents a valid choice for these group of tumors. [3]

BIH has been utilized by many surgeons for tumors in the sellar and juxta-sellar region; Suzuki et al. [4] as well as Oi et al. [5] used it for tumors occupying the anterior part of third ventricle, while Fahlbusch et al. [6]used it to resect formidable craniopharyngiomas [4–6].

BIH approach provides a wide operative field and a good visualization of the neurovascular structures in the suprasellar region, hence less chance to injure them, with minimal retraction to both frontal lobes. This allows retrochiasmatic lesions as well as lesions extending into third ventricle to be reached through opening of lamina terminalis [3, 7, 8]. Of course, this approach has some drawbacks, post-operative mental problems and injury to olfactory tracts; hence, loss of smell have been reported [3].

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Sellar and juxta-sellar lesions incorporate a wide range of pathologies including optic gliomas, giant pituitary adenomas, craniopharyngiomas, Rathke's cleft cysts, meningiomas, cavernous angiomas, hypothalamic hamartomas, and rarely, giant aneurysms [9].

For that reason, the aim of this study was to describe the technique of BIH approach in patients with sellar and juxta-sellar lesions with different pathologies presented to Alexandria Main University and affiliated hospitals. Moreover, to discuss the clinical outcome and complications of this technique.

Methods

Between 2016 and 2020, this prospective study included 17 patients with different pathologies in the sellar and juxta-sellar region chosen for BIH approach and operated in Alexandria main university and affiliated hospitals.

This study incorporates few number of cases that make statistical analysis of results a bit difficult, and this work should be continued to involve more cases.

Preoperative evaluation including; patients' demographics and present history were recorded. Thorough neurological examination was performed to detect presence of any neurological deficits; with special emphasis on hypothalamic dysfunction (obesity, hyperphagia, apathy and sleep disturbance), followed by complete visual assessment (acuity, field and extra ocular muscles assessment). Laboratory investigations including sophisticated preoperative and endocrinological evaluation were ordered (morning serum cortisol, thyroid stimulating hormone (TSH), triiodothyronine (T3), thyroxine (T4), Follicle-stimulating hormone (FSH), luteinizing hormone (LH), serum prolactin and insulin growth factor (IGF-I) in case of short stature in children). Lastly, neuroimaging studies were requested including one or a combination of the following; computerized tomography (CT) with contrast, Magnetic resonance imaging (MRI) with contrast and angiography whether conventional or CT angiography.

In critical patients presenting to emergency department in an unconscious state, with CT showing ventricular dilatation; urgent tapping was done with placement of either permanent ventriculo-peritoneal shunt or temporary external ventricular drain.

All patients were then definitively managed through BIH approach. All patients underwent general anesthesia with good dehydration using intravenous mannitol and furosemide, we did not use lumbar drain. The operative steps were carried out as follows:

1. Bicoronal skin incision

Surgery was done in the supine position, placing the head in extension, the skin was cut through the galea, starting in front of the tragus and behind the hairline. A pericranial flap was elevated using sharp dissection and left anterior.

2. Bifrontal craniotomy

A triangular bone flap was elevated; the craniotomy was performed as basal as possible on the orbital roof, making bone flap flushed with supra-orbital ridge. In cases where the frontal sinus was opened, antiseptics were applied with packing of the sinus at the end of the procedure with a piece of temporalis muscle.

3. Dural incision

The dura was opened parallel to the orbital bone edge in a straight fashion, staying as close as possible to the base in order to minimize injury to the frontal bridging veins. The falx cerebri was also incised as far anterior as possible, and bleeding from the superior and/or inferior sagittal sinus was controlled by electro-cautery.

4. Elevation of both frontal lobes, dissection of the olfactory bulb and tract

The olfactory bulb, together with the olfactory tract, was dissected from the orbital surface of the frontal lobe bilaterally as far as the olfactory stria. After finishing dissection of both olfactory tracts, the first area of both optic nerves was visualized.

5. Exposure of the chiasm, lamina terminalis, cisterns, and A com complex

After extensive dissection, the lamina terminalis, chiasm cistern, the anterior communicating artery, and bilateral A1 and A2 were visualized.

6. Tumor removal

Tumor removal starts from the prechiasmatic area. In cystic lesions, the capsule was opened with fluid drainage to decompress the tumor. Retrochiasmatic exposure was done by a midline incision in the lamina terminalis, and the two areas were eventually connected to each other. If the third ventricle was elevated but not invaded by the tumor, the thin tissue layer of the distended lamina terminalis was incised without opening the third ventricle.

7. After exposing the tumor, it was debulked from within the capsule for decompression so that the capsule could be gently dissected from the surrounding tissue. Perforating vessels are dissected away, and the capsule was bluntly removed from the surrounding reactive gliotic layer or from the arachnoid covers.
8. Gross total resection (GTR) was attempted in all cases, in certain occasions subtotal resection (STR) or partial resection were carried out.

To sum up, 3 corridors can be used for tumor removal; the inter-optic corridor, retrochiasmatic corridor in front of the anterior communicating artery and retrochiasmatic behind the acom artery (Fig. 1) [10].

Results

This prospective study included 17 cases with different pathologies in the sellar and juxta-sellar region chosen for BIH approach and operated in Alexandria main university hospitals and affiliated hospitals. They were followed up for a mean period of 20 weeks.

They included 9 cases of craniopharyngiomas, 3 cases of invasive pituitary adenomas, 2 cases optic hypothalamic gliomas, 2 cases of tuberculum sellae (TS) meningioma and a single case of chondrosarcoma.

Most of our cases 14 cases (82.35%) were adults, and their age ranged from 45 to 72 years. In the 3 pediatric cases (17.65%), their age ranged from 2 to 10 years. Distribution of the demographic data among our cases is displayed in Table 1.

Fig. 1 Three routes for tumor removal (**A**, **B**, **C**) in basal interhemispheric approach. [10]

Table 1 Demographic characteristics of the cases according to the different tumor pathologies

	Male	Female	Age range (years)
Craniopharyngiomas	4	5	3–62
Invasive pituitary adenomas	2	1	45–58
Optic hypothalamic gliomas	–	2	2—10
TS meningioma	–	2	56–72
Chondrosarcoma	1	–	48

TS Tuberculum sellae

Clinical presentation

In the current study, most of the cases 13 cases out of 17 (76.47%) presented with visual deterioration, followed by headache in (52.94%), and the distribution of the different clinical presentation among different pathologies is illustrated in Table 2. One of the craniopharyngioma cases presented in a comatosed state to the emergency department and urgent CT was done, hydrocephalus was detected, and urgent shunting was needed before the definitive surgery.

Operative outcome

BIH approach was done for all cases with attempted GTR in every case. Unfortunately, GTR was achieved in only 9 cases (52.9%), GTR was recorded by surgeon's post-operative remarks and confirmed by post-operative imaging, STR was achieved in 5 cases (29.5%), while partial resection was carried out in 3 cases (17.6%).

The decision to perform a STR or partial resection was made by the main surgeon during the operation, based on the operative findings. The distribution of the extent of resection in each pathology is demonstrated in Table 3.

Clinical outcome and complications

Following surgery, the visual status improved in 10 patients (58.8%), 7 of them were craniopharyngioma patients and, one pituitary adenoma and one tuberculum sellae meningioma. Five patients (29.4%) showed arrest in visual deterioration, and visual status was maintained stationary following surgery. While, worsening of visual status occurred in 2 cases: one was a craniopharyngioma and the other was an optic glioma.

Olfaction was preserved in 13 cases out of 17 (76%), while 4 cases suffered permanent anosmia for reasons related to the approach (24%).

Regarding morbidity, there was a need for post-operative shunt in three cases of craniopharyngiomas. Severe water and electrolyte disturbances due to development of diabetes insipidus (DI) were recorded in 3 cases of craniopharyngiomas, and pan-hypopituitarism was recorded

Table 2 Distribution of the different clinical presentations among the different tumor pathologies

	CP no (9)	Invasive pituitary adenoma no (3)	TS meningioma no (2)	Optic glioma no (2)	Chondrosarcoma no (1)
Headache	5	2	1	0	1
Visual complaints	6	3	2	2	0
Endocrinal disturbances	3	2	0	0	0
Other symptoms:					
Hydrocephalus with coma	1	0	0	0	0
Motor deficit	1	0	0	0	0
Hypothalamic manifestations	2	0	0	1	0
Cranial nerve affection	0	1	0	0	1

CP craniopharyngioma, *TS* Tuberculum sellae

Table 3 Extent of tumor resection among different pathologies

	CP No (9)	Invasive pituitary adenoma no (3)	TS meningioma no (2)	Optic glioma no (2)	Chondrosarcoma no (1)
GTR	6	0	1	2	0
STR	2	1	2	0	0
Partial	1	1	0	0	1

CP craniopharyngioma, *TS* Tuberculum sellae

in another case of craniopharyngioma that was managed by hormonal replacement therapy.

Recurrence of craniopharyngioma with regrowth of the tumor was reported in 2 cases; one recurred following STR, where the visual symptoms recurred after initial improvement 1.5 years after the first surgery, this was managed surgically by removing the recurrent cystic tumor through the same approach with insertion of Ommaya reservoir in the tumor cavity with post-operative visual improvement, and the other one recurred following partial resection of the tumor 1.8 years after the initial surgery, this patient refused to undergo second surgery and was referred to stereotactic radiosurgery.

Mortality was recorded in a single case only. The patient died one week following surgery after GTR of his intra and extra-ventricular craniopharyngioma, where the patient recovered completely without any neurological deficits in the early post-operative period. Unfortunately, one week post-operatively he started to deteriorate rapidly, followed by sudden cardiac arrest. This was secondary to DVT and pulmonary embolism.

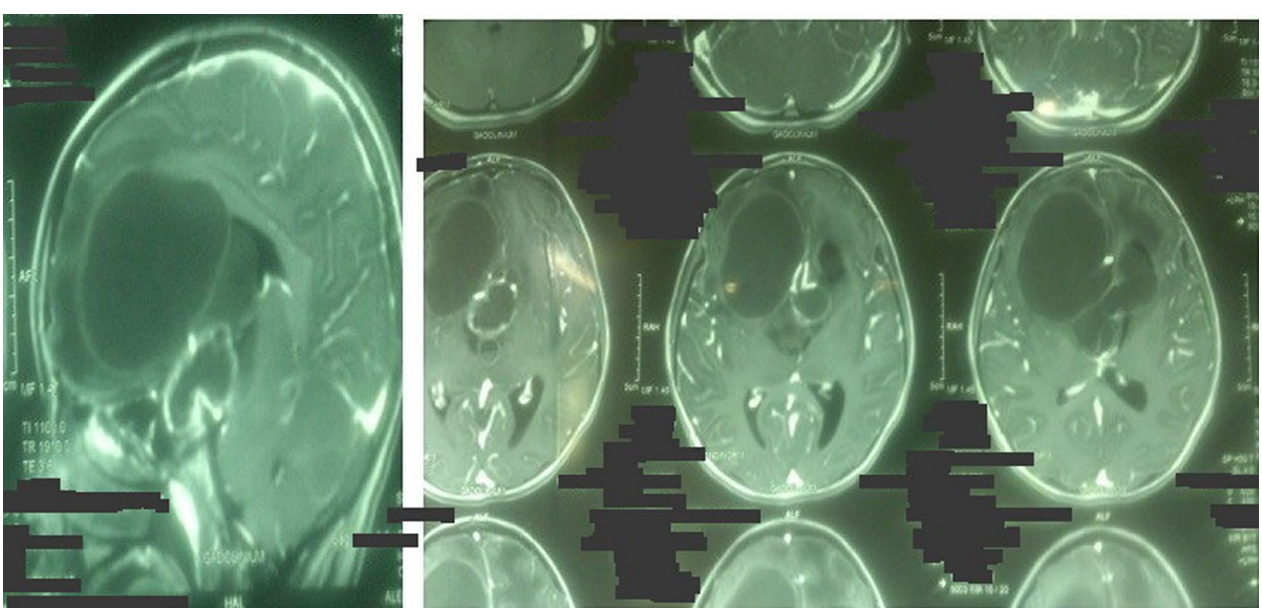

Fig. 2 Preoperative MRI of patient 1

Illustrative cases

Patient 1

A 12-year-old girl presented with pan-hypopituitarism and visual failure. The patient was primarily operated elsewhere by insertion of Ommaya reservoir (Fig. 2). The patient was then referred to our department, and definitive surgery was carried out through BIH approach with GTR of the cystic tumor and removal of the Ommaya reservoir, as shown in MRI done 3 months post-operatively (Fig. 3).

Patient 2

A 34-year-old male patient presented with hypogonadism and hypothalamic manifestation in the form of apathy and somnolence (Fig. 4). The patient was operated through BIH approach for this retrochiasmatic

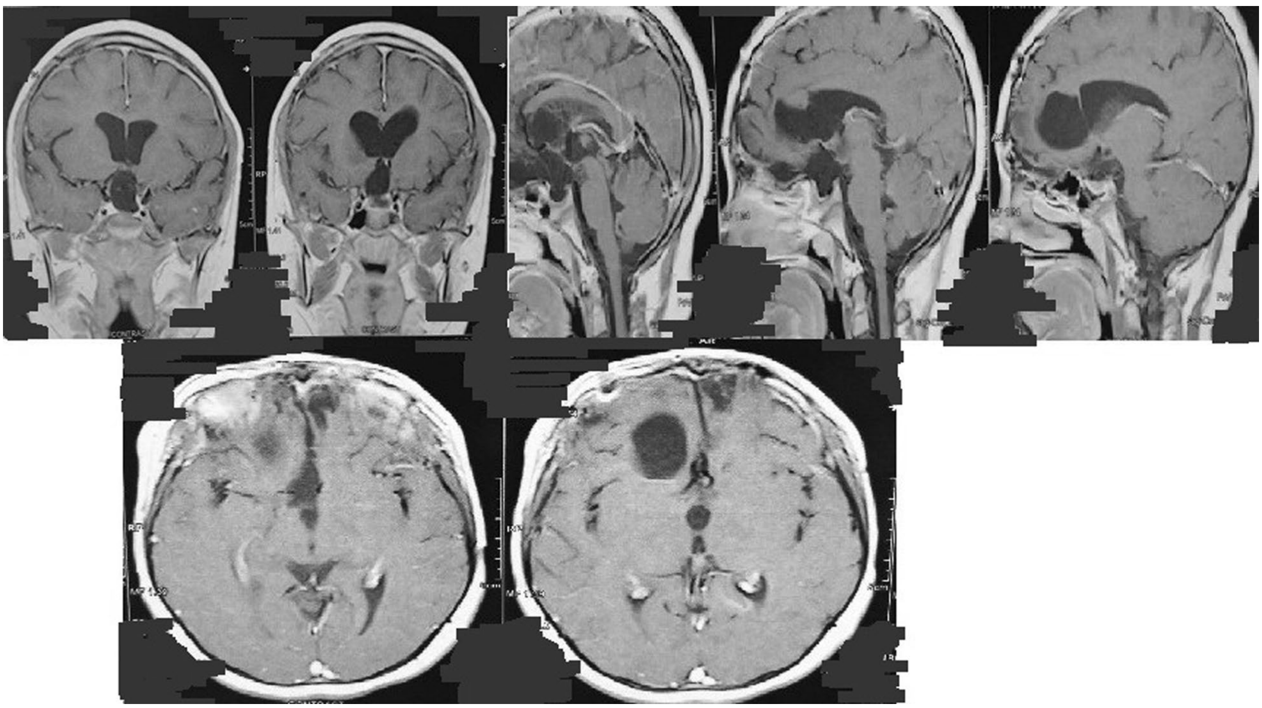

Fig. 3 Post-operative MRI of patient 1

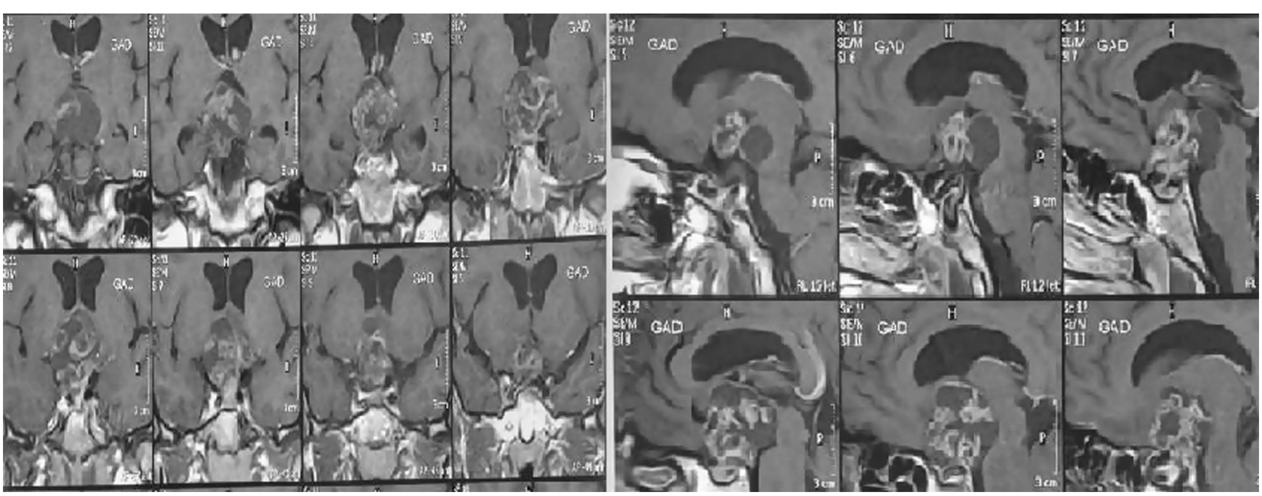

Fig. 4 Preoperative MRI of patient 2

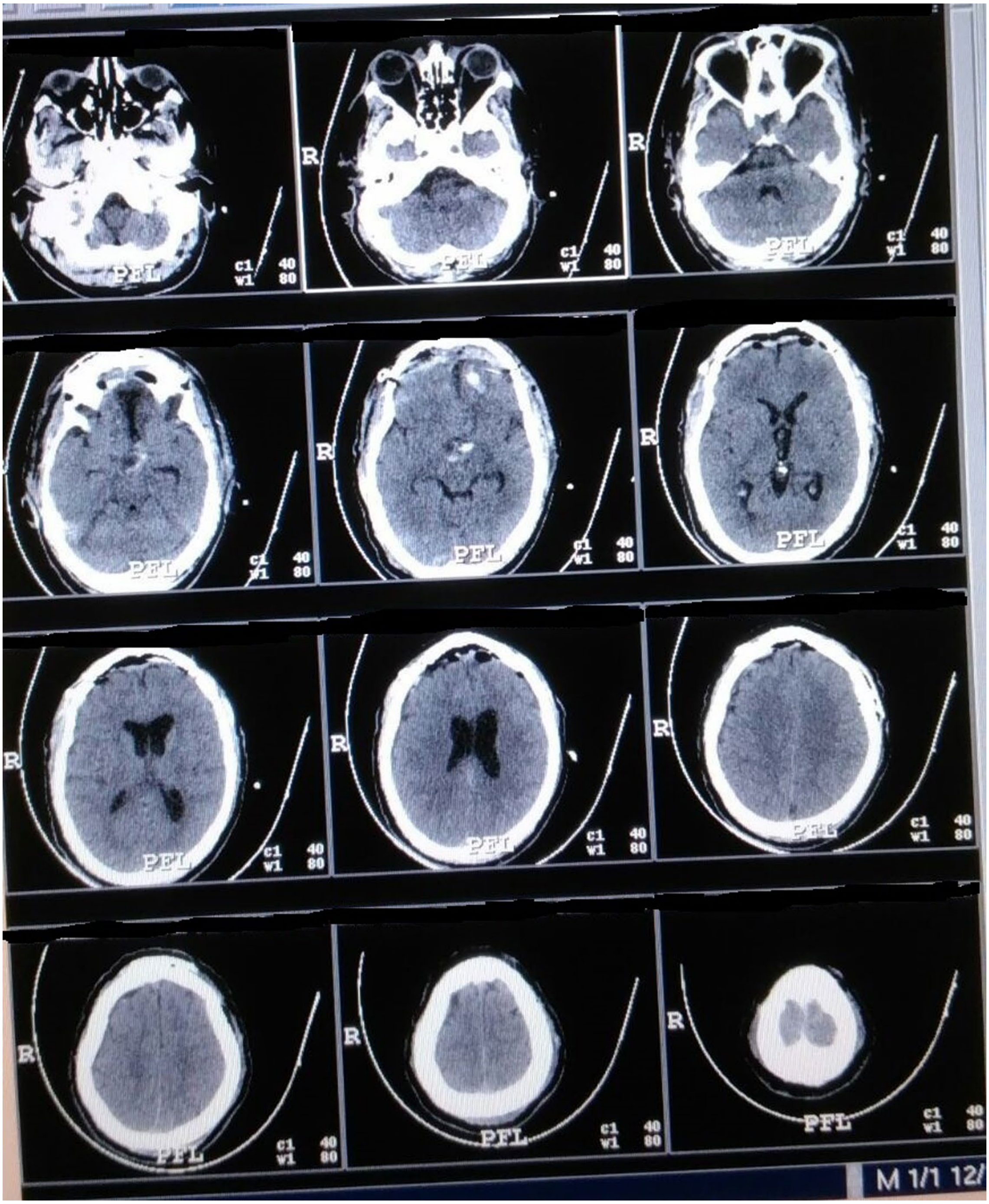

Fig. 5 post-operative CT scan of patient 2

tumor, with preservation of the pituitary stalk (Fig. 5). The patient recovered completely without any neurological deficits in the early post-operative period (first week). Then, he started to deteriorate rapidly, followed by sudden cardiac arrest secondary to DVT and pulmonary embolism.

Patient 3

A 54-year-old male presented with disturbed consciousness level and right sided hemiparesis, where external ventricular drain was inserted. Later on the patient regained consciousness, but suffered from hypothyroidism, hypocortisolism and right blind eye (Fig. 6). The

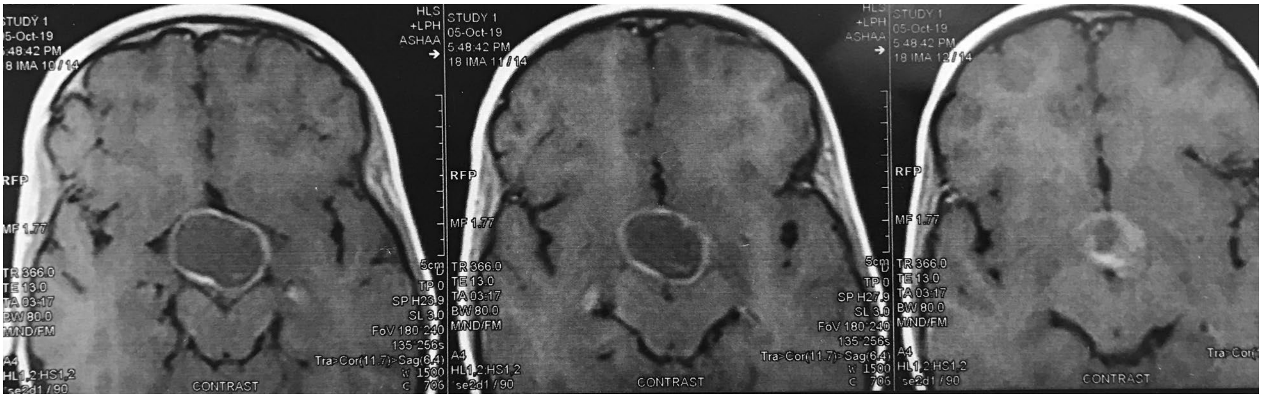

Fig. 6 pre-operative MRI of patient 3

Fig. 7 Intraoperative pictures of patient 3; left side showing preservation of the stalk at the end of surgery, right side showing retrochiasmatic corridor behind the chiasm and in front of Acom

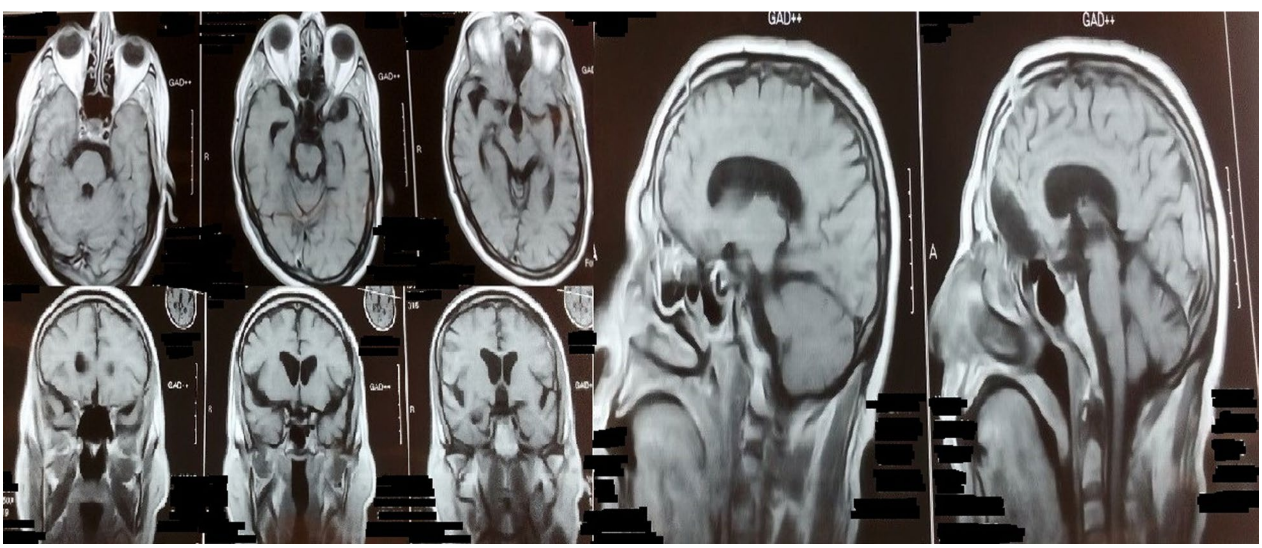

Fig. 8 Post-operative MRI of patient 3

patient was operated through BIH approach, and GTR was achieved. Stalk (PS) was identified and preserved, we can also see the optic chiasm(Ch) and a-com artery behind it (Fig. 7). After follow up for 9 months, the patient's hemiparesis improved and he can now see hand movement with his right eye (Fig. 8).

Discussion

The BIH approach has been described in the literature for management of sellar and juxta-sellar lesions [4–6, 11, 12].

The advantages of the older version, anterior interhemispheric approach, are that it provides a wider view with excellent delineation of arteries of the anterior circulation, optic chiasm and tracts, and tumor within this area. However, there is risk of injury to the anterior draining veins resulting in venous infarction of the inner side of the frontal lobes bilaterally, especially when associated with retraction of these lobes for long time [12].

Advantages of the BIH approach lie in the fact that it involves less brain retraction, thus allowing protecting the arteries and veins along the inner and outer surfaces of the frontal lobes. Furthermore, it requires less extensive dissection of the interhemispheric fissure which is confined only to the basal part as the entry to the BIH fissure should be down forward in an overhanging position such that the distal A2 segments of the anterior cerebral arteries will appear [3, 13].

Moreover, the BIH approach provides a steep angle for good exposure of third ventricular tumor and retrochiasmatic lesions, as compared to conventional anterior interhemispheric or pterional approaches.

Performing BIH entails extensive dissection and opening of many cisternal spaces with drainage of good amount of CSF; moreover, we had a good access to the ventricular system and third ventricle through lamina terminalis, and this allowed us to provide very good brain relaxation and obviate the need for lumbar drain pre-operatively.

The bilateral midline approaches provide a true midline panoramic perspective, good neurovascular structure identification, tumor exposure from different angles allowing sharp tumor dissection and avoiding traction over the tumor and important structures, thus providing safe GTR of the tumor. On the contrary, the unilateral approaches (like pterional and subtemporal approach) for sellar and juxta-sellar lesions located in the midline, such as craniopharyngiomas and hypothalamic gliomas, might blind structures on the opposite site in certain circumstances and the presence of contralateral important perforators might endanger the surgery.

One of the drawbacks of this approach is loss of olfaction, but because of the presence an arachnoidal cistern around all the olfactory structures on the under surface of both frontal lobes this makes a good microsurgical plane for dissection. It is crucial to sharply separate the olfactory tracts in parallel, alternatingly between both sides, because if dissection is started for one tract to the end before beginning dissection of the opposite track, avulsion of the contralateral tract may occur [3].

In order to preserve the olfactory function, it is crucial to save olfactory artery. In 53% of cases, the vascular supply of the olfactory bulb arises from the lateral side of the anterior cerebral artery, distal to the anterior communicating artery. In the remaining 47% of patients, the olfactory artery arises from a side branch of the medial frontobasal or orbitofrontal artery [14].

Another drawback is the exposure of the frontal air sinus, to guard against infection meticulous management of the frontal sinus must be done. In this series, the frontal sinus mucosa was removed, followed by removal and cranalization of the sinus, through removal of its internal bone lamina, then pericranial flap was harvested to cover the sinus, through plugging of frontonasal canal with temporalis muscle and gel foam soaked in antibiotic powder, thus preventing CSF rhinorrhea.

Only a single case developed flap infection, which was managed conservatively with strong intravenous antibiotic in the form of, ceftazidime 1gm intravenously twice daily and linezolid 600 mg orally twice daily for 4 weeks.

In the present series, GTR was achieved in 6/9 (67%) of the patients with craniopharyngiomas and all patients with TS meningioma 2/2 (100%).

Diabetes insipidus was seen in 3/9 (33%) of craniopharyngioma patients, and hormonal disturbances requiring replacement therapy were seen in only one craniopharyngioma patient with permanent post-operative pan hypopituitarism 1/9 (11%). Visual deterioration occurred in 2/17 (11.7%) patients. The mortality rate was 5.9% (1/17).

In comparison with other approaches, the pterional approach may be adopted by most surgeon as they used to do it frequently, the pterional approach provides an easy route to the suprasellar area where the sylvian fissure is opened in cases of larger tumors. The tumor is usually removed through the opticocarotid triangle and through the prechiasmatic space. The pterional approach also provides access to the third ventricle through the lamina terminalis to remove tumor from the lower and anterior third ventricle; however, pterional approach has certain limitations. The surgical corridor is narrow in the case of prefixed optic chiasm. Furthermore, the lateral view through the opticocarotid triangle may be obstructed by perforating arteries. In addition, a large retrosellar craniopharyngioma is insufficiently visualized by the pterional approach because of the surgeon's restricted view.

Endoscopic Transsphenoidal surgery is suitable for resecting small intrasellar lesions with small suprasellar extension. The limitations of this approach are that it is more difficult than surgery for pituitary adenomas as we need extended approach to reach these tumors from below; for this reason, a wide exposure and a large opening in the sphenoid sinus and sellar floor are mandatory, and of course the high risk of post-operative cerebrospinal fluid leak with its sequelae of dangerous intracranial infections is always existing.

The extent of resection and complication rate was comparable to those reported in the literature. Shirane et al. [10] achieved GTR in 71% of patients with craniopharyngiomas using frontobasal interhemispheric approach, and hormonal dysfunction was observed in 81% of their patients. They had four cases that developed subdural effusion and managed by subduro-peritoneal shunt. Two cases developed major complications in the immediate post-operative period, one was thalamic infarction due to injury to one of the perforators during surgery and this patient took long time to recover. They reported a mortality rate of 7.1% (3/42), and they did not mention the cause of death or any details about them [10].

Similarly, Shibuya et al. [11] achieved GTR of craniopharyngiomas in 22 patients via same approach. Visual complications were seen in two of the patients (9%). All except one of their patients suffered hormonal deficiencies, with mortality of three patients (13.6%), one patient died of acute subdural hematoma caused by a fall 5 years after the operation. Another man with deteriorated mental function post-operatively was found dead in an abandoned house 1 year after surgery. The third patient, an 18-year-old girl, died probably due to acute pituitary insufficiency [11].

Furthermore, Hori et al. [13] performed GTR in 80.4% of patients using anterior interhemispheric approach; however, the rate of post-operative hypothalamic dysfunction and electrolyte imbalance was relatively high. DI occurred in 62.2% of patients after surgery. Visual complications happened in 10.7% of patients caused by manipulations of the optic nerve or optic chiasm during operation and injury to the perforators [13].

Moreover, Yasargil et al. [15] followed a radical approach toward craniopharyngiomas in their series of 144 patients and performed GTR in 90% of patients; however, they had a high mortality rate of 16.7%, these mortalities were attributed to difficulties in dissection due to adhesions in patients who underwent secondary procedure in comparison with patients who underwent primary surgical removal, and also they had a high percentage of post-operative hypothalamic syndrome in 79% of patients [15].

Finally, Sinha et al. [12] reported GTR in 21/25 (84%) of the patients with craniopharyngiomas and 6/8 patients (75%) with meningiomas, DI was seen in 15 (33%) patients and hormonal dysfunction mandating hormonal therapy was seen in 19 (40%) patients post-operatively. Visual complications were observed in 4 (8.3%) patients, while the mortality rate was 6.2% (3/48). The causes of death in these patients were hypothalamic dysfunction, sepsis and respiratory failure [12].

Conclusion

The topographical relationship of sellar and juxta-sellar tumors with the optic chiasm, and with the hypothalamic structures must be delineated using preoperative radiological workup to define the best surgical approach. BIH approach is a panoramic safe approach that allows tumor removal from multiple corridors with identification of the regional anatomy of the tumor, thus elaborating the surgical strategy for GTR of the tumor.

Recurrence is a common outcome in those tumors especially craniopharyngiomas and poses therapeutic dilemmas. So the first surgery is the best chance to cure the patient; and BIH approach provides this good opportunity to accomplish safe maximal resection without injury to the important neurovascular structures.

However, this approach needs persistence and has a long learning curve in order to master it. With more experience, the surgical time was shortened without injuring to the olfactory nerves or their blood supply.

Abbreviations

BIH	Basal interhemispheric
TSH	Thyroid stimulating hormone
T3	Triiodothyronine
T4	Thyroxine
FSH	Follicle-stimulating hormone
LH	Luteinizing hormone
IGF-I	Serum prolactin and insulin growth factor
CT	Computerized tomography
MRI	Magnetic resonance imaging
GTR	Gross total resection
STR	Subtotal resection
TS	Tuberculum sellae
DI	Diabetes insipidus
Acom	Anterior communicating artery

Author contributions

MA analyzed and interpreted the patients' data regarding the risk factors, operative details, and clinical outcomes. All authors performed English editing. All authors performed clinical evaluations of patients, and surgical interventions, and helped in reviewing and editing the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The research protocol was approved by the ethical committee in the Faculty of Medicine at Alexandria University in its monthly session. Informed written consent was obtained from each patient. The reference number is: Member of ICLAS, http://iclas.org/members/member-list, http://www.hhs.gov/ohrp/assurances/index.html. IRB NO: 00007555-FWA NO: 00018699, serial no.:0304260

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References
1. Lougheed WM. Selection, timing, and technique of aneurysm surgery of the anterior circle of Willis. Clin Neurosurg. 1969;16:95–113.
2. Ito Z. The microsurgical anterior interhemispheric approach suitably applied to ruptured aneurysms of the anterior communicating artery in the acute stage. Acta Neurochir (Wien). 1982;63(1–4):85–99.
3. Dehdashti AR, de Tribolet N. Frontobasal interhemispheric trans-lamina terminalis approach for suprasellar lesions. Oper Neurosurg. 2005;56(4):418–24.
4. Suzuki J, Katakura R, Mori T. Interhemispheric approach through the lamina terminalis to tumors of the anterior part of the third ventricle. Surg Neurol. 1984;22(2):157–63.
5. Oi S, Samii A, Samii M. Operative techniques for tumors in the third ventricle. Oper Tech Neurosurg. 2003;6(4):205–14.
6. Fahlbusch R, Honegger J, Paulus W, Huk W, Buchfelder M. Surgical treatment of craniopharyngiomas: experience with 168 patients. J Neurosurg. 1999;90(2):237–50.
7. Ohata K, Hakuba A, Nagai K, Morino M, Iwa Y. A biorbitofrontobasal interhemispheric approach for suprasellar lesions. Mt Sinai J Med. 1997;64(3):217–21.
8. Maira G, Anile C, Colosimo C, Cabezas D. Craniopharyngiomas of the third ventricle: trans-lamina terminalis approach. Neurosurgery. 2000;47(4):857–63 (**discussion 63-5**).
9. Friedman DP, Gandhe AR. Chapter 3: imaging of craniopharyngiomas and radiologic differential diagnosis. In: Evans TJKJ, editor. Craniopharyngiomas. Boston: Academic Press; 2015. p. 59–94.
10. Shirane R, Hayashi T, Tominaga T. Fronto-basal interhemispheric approach for craniopharyngiomas extending outside the suprasellar cistern. Child's Nerv Syst: ChNS: Off J Int Soc Pediatr Neurosurg. 2005;21(8–9):669–78.
11. Shibuya M, Takayasu M, Suzuki Y, Saito K, Sugita K. Bifrontal basal interhemispheric approach to craniopharyngioma resection with or without division of the anterior communicating artery. J Neurosurg. 1996;84(6):951–6.
12. Sinha S, Kumar A, Sharma BS. Bifrontal basal interhemispheric approach for midline suprasellar tumors: our experience with forty-eight patients. Neurol India. 2013;61(6):581–6.
13. Hori T, Kawamata T, Amano K, Aihara Y, Ono M, Miki N. Anterior interhemispheric approach for 100 tumors in and around the anterior third ventricle. Neurosurgery. 2010;66(3 Suppl Operative):65–74.
14. Passagia JG, Chirossel JP, Favre JJ, Gay E, Reyt E, Righini C, et al. Surgical approaches to the anterior fossa, and preservation of olfaction. Adv Tech Stand Neurosurg. 1999;25:195–241.
15. Yasargil MG, Curcic M, Kis M, Siegenthaler G, Teddy PJ, Roth P. Total removal of craniopharyngiomas: approaches and long-term results in 144 patients. J Neurosurg. 1990;73(1):3–11.

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