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Original Article

Feasibility of the Frontobasal Interhemispheric Approach for Managing Large Olfactory Groove Meningiomas

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BACKGROUND: Olfactory groove meningiomas develop into enormous sizes at the time of diagnosis. This favors a wide surgical corridor to ease surgical excision. The frontobasal interhemispheric approach is a feasible variant sparing additional unwanted frontal lobe traction aiming for better functional outcome.

OBJECTIVE: Our aim was to assess the feasibility and safety of the approach in managing large olfactory groove meningiomas.

PATIENTS AND METHODS: Retrospective study of 15 consecutive patients with large olfactory groove meningiomas (maximum diameter ≥ 4cm) managed between 2016 and 2020. We analyzed functional surgical outcome with respect to patients' performance, Karnofsky Performance Status scale (KPS), and cognitive status using Mini-Mental State Examination (MMSE).

RESULTS: Our records showed that we have operated on 12 females and 3 males with an age range of 39-64 years (mean age: 50.4 years). No major complications were encountered. Three patients had minor complications (20%). The mean postoperative KPS score (81.6±2.4) was significantly improved. Cognitive impairment was reported in 7 patients, with varying MMSE. Improvements were seen in all 5 cases with mild impairment, however, one patient with severe impairment needed further cognitive consultation and support. As regards visual outcome, unfortunately no patients with preoperative reported visual deficits had any improvements, with no reported worsening of preoperative vision.

CONCLUSION: The interhemispheric approach could be considered as a safe and quite feasible approach for managing large olfactory groove meningiomas with an accepted impact on postoperative patient performance.

KEYWORDS: Interhemispheric, Meningioma, Olfactory groove, Skull base, Transbasal.

INTRODUCTION

Olfactory groove meningioma (OGM), arise in the midline arachnoid cells of the frontal base, typically the frontosphenoidal suture and the cribriform plate, which comprise the majority of frontobasal meningiomas. Such lesions endure an insidious growth pattern and start presenting after the lesion has reached a greater than average size.[1-5] Manifestations vary depending on the size of the tumor reached. Commonly, patients suffer headaches, anosmia, behavioral/cognitive changes, visual impairments, and what is known as Foster Kennedy syndrome.[6,7]

We have found a variety of surgical modalities in the literature managing OGM, with an ongoing debate of which supersedes the other. This included the classic bifrontal approach, unilateral skull base approaches such as pterional and supraorbital approaches, and the more technically demanding endoscopic transnasal approach.[1,2,4,7] The frontal basal interhemispheric approach (FBIA) is among the vast options that have been advocated to manage such lesions with satisfactory outcomes when compared to what is encountered utilizing the classic bicoronal approach. The literature considers the FBIA an extension of the conventional interhemispheric approach (IHA), primarily used to address anterior communicating artery (ACom) aneurysms with notable success.[8] However, it was further modified to expose the anterior skull base from a more direct basal interhemispheric view, giving access to pathoanatomical conditions that used to require more extensive retraction and tissue manipulation to encounter, such as midline pathologies[9-17]

Although there is a rising interest in minimal access approaches for managing such lesions,[2,5,14] an open surgical approach always remains an important weapon in every neurosurgeon's armamentarium, with advantages compared to narrow access approaches.

The aim of the study was to analyze the surgical outcome in a series of 15 patients with large OGM managed by the FBIA from different perspectives, besides aiming to outline feasibility and technical nuisances that could apply to our still ongoing learning of the best approach for managing such lesions aiming for utmost patient safety.

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PATIENTS AND METHODS

Study design and parameters

The data presented in this study was for 15 patients

with large OGM that were retrospectively reviewed. Patients were operated on by the FBIA via a bicoronal incision. All patients underwent primary surgery for their pathologies by our surgical team between June 2016 and January 2020 in our institutions. We opted to use this approach, switching from the classic subfrontal approach aiming for less morbidity from frontal lobe retraction and a better chance for higher cognitive improvements, which were the major drawbacks limiting the classic subfrontal approach. We classified tumors according to their maximum diameter on magnetic resonance imaging (MRI) into; small (<4 cm), large (4-6 cm), and giant meningioma (>6 cm). Complete tumor excision was our goal, aiming at gross total resection; Simpson grade I was considered an optimal outcome. The purpose of the study was to analyze surgical outcomes and emphasize the feasibility of the approach. The ethical and research committee of our institutions approved all study procedures.

Medical records, radiological investigations, surgical notes, and in-patient records were all thoroughly reviewed. We reviewed preoperative clinical data with a special consideration on neurological symptoms, Karnofsky Performance Status scale (KPS), and cognitive/behavioral status using the Mini-Mental State Examination (MMSE). Following surgery, we re-examined all patients during their ward stays and follow-up appointments using the same criteria. Hospital stays and complications in the early postoperative period were all recorded and analyzed besides reviewing outpatient clinic notes. We reviewed the events and patient outcomes during the follow-up period (of at least 1 year following surgery). We recorded this at 2 weeks, 2 and 6 months following surgery.

Neuroimaging findings review emphasized tumor size (assess the largest dimensions, length/width/height), relation to the surroundings, frontal lobe edema, vascular relations, and optic apparatus involvement, if any. Tumors were classified according to the maximum diameter of the lesion on MRI. The extent of tumor resection was decided based on 3 months follow-up MRI scans with contrast. It was defined according to Simpson Grading. We also reviewed operative notes for operative timing, blood loss, and intraoperative complications. Statistical analysis was completed using Statistical Packages for the Social Sciences (SPSS).

Highlights on the surgical approach

The patient is put in a supine position with the head fixed in a 3-pin fixator system. The head of the bed is elevated about 30 degrees and the neck slightly extended, allowing the frontal lobe to fall off the frontal base and avoiding any venous obstruction. One essential step that we always opted was to administrate antibiotics immediately before skin incision. We always use a bicoronal skin incision after prepping and draping following thorough sterilization. Harvesting a wide pericranial flap was the next important step followed by hinging it on the frontal rim to be used during cranializing and obliterating the sinus during closure. We performed a low-lying bifrontal craniotomy with special consideration of being flush with the frontal base, usually intersecting the frontal sinus. Afterwards, opening the dura parallel to the orbital rim arching laterally was performed. The superior sagittal sinus should be ligated and divided as far anterior as possible, followed by dividing the falx posteriorly along the Crista Galli. Dissection of the basal interhemispheric fissure follows with subsequent gentle lateral retraction of the frontal lobe, detaching them from the falx posteriorly with great caution taken to avoid injury to the anterior cerebral artery or the anterior communicating artery. We then removed the tumor successively following early devascularization of the tumor, reaching from the basal aspect of the tumor. At the end, the dura is tightly closed in a waterproof manner followed by cranializing and obliterating the frontal sinus, leaving betadine-soaked gel foam/muscle tissue in the sinus. The bone flap is replaced and fixed using sutures placed between the previously drilled holes and craniotomy edges, followed by skin closure in layers over a drain.

RESULTS

Patient presentation

Fifteen surgical cases were included in the study. The mean age of operated patients was 50.4 years (range, 39-64 years). A remarkable sex difference was seen in the patient population with an 80% female predominance **(Table 1).** Two patients (13.3%) had no preoperative symptoms and were addressed as incidental lesions. The most common presenting manifestations were headache (13 patients), followed by anosmia (9 patients), and cognitive/behavioral changes (7 patients) **(Table 2).** Mean presenting KPS and MMSE were 81.6(+/-2.4) and 23.4, respectively **(Table 1).**

Surgical outcome

We globally summarized the operative outcome from our study in **Table 3**. Based on 3 months follow-up MRI; Simpson Grade I was achieved in 10 patients (66.6%) and Grade II in 3 patients (20%), with meningothelial meningiomas as the most common histopathological finding (80%) of the series. The mean operating time was 230.8 minutes (range: 215-255 minutes). Although blood loss was not accurately recorded in most cases because of technical difficulties, 7 patients required blood transfusions at some point following the procedure based on laboratory findings.

Unfortunately, we encountered few complications, however, there were no mortalities related to them. We had 2 patients with postoperative computerized tomography (CT) scans that showed frontal hematomas and were managed conservatively. One of the 2 patients that developed hematoma, had deterioration of his preoperative normal olfactory function. One patient

had an infection at the operative site, requiring drainage and debridement in addition to medical treatment. Two patients had temporary cerebrospinal fluid (CSF) leak that needed only conservative management.

Two patients with pre-operative visual disturbances did not show any improvements following their surgery, even with follow-up, and were attributed to very long-standing pathology. Noticeable improvement of KPS following surgery reached a global average of 86 (+/-2.1) (at 12 months follow-up). Seven patients reported having preoperative cognitive impairment with varying MMSE, most prominently seen as behavioral changes, mood swings, memory problems, and intellectual degrading. Six out of 7 cases with pre-operative impairments had appreciable improvement of their cognitive functions. Unfortunately, one patient with severe impairment did not improve following surgery and required further cognitive/behavioral specialized consultation and therapy.

Fig 1: MRI image, T1 with contrast, coronal view, showing a large OGM, growing into the interhemispheric fissure and displacing the left frontal lobe, opening the desired surgical corridor required for the FBIA, facilitating surgical excision without extra instrumental retraction. Tumor extension into the ethmoid sinus is also seen and the approach made same setting excision achievable.

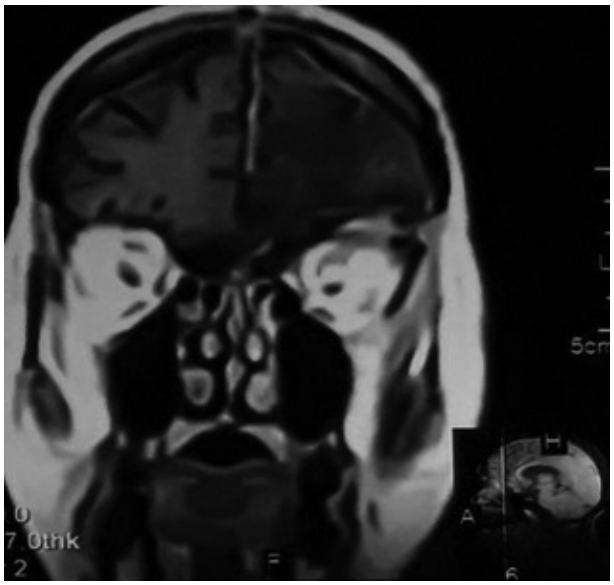

Fig 2: MRI T1 with contrast, coronal view, of the 3 months follow up scan. The scan shows gross total excision (Simpson Grade I) of the previously presented lesion in figure 1. It could be noted that the left frontal lobe is almost normal, with a completely normal right frontal lobe emphasizing the advantage of less instrumental retraction with the FBIA.

Table 1: Patient characteristics and global functional assessment

Sex	
Male	3 (20%)
Female	12 (80%)
Age	
Mean	50.4 years
Range	36-64 years
Presenting KPS*	
Mean	81.6 (+/- 2.4)
Presenting MMSE**	
Mean	23.4

*KPS: Karnofsky Performance Status scores.
**MMSE: Mini-Mental State Examination.

Table 2: Main presenting symptoms and signs in the 15 patients with OGM

Preoperative findings	
Headache	13
Anosmia	9
Visual impairment	2
Seizures	1
Motor/sensory deficits	0
Cognitive/behavioral changes	7
Incidental finding (no symptoms)	2

Table 3: Surgical outcome and follow up data

Post-operative outcome	
Simpson Grading (Resection)	
Grade I	10
Grade II	3
Grade III-IV	2
Intraoperative complications	
Venous injury	1
Neurological injuries	0
Pathological findings	
Meningothelial	12
Transitional	3
Postoperative KPS	
Mean	86 (+/-2.1)
Postoperative MMSE	
Mean	24.9
Visual function	
Improvement	0
Stabilization	2
Olfactory function	
Postoperative deterioration	1
Preservation	5
Minutes	
Mean	230.8
Range	215-255
Blood transfusion	7 patients
Complications	
Hematomas	2 (frontal hematoma, managed conservatively)
Infection	1 (managed with antibiotics and debridement)
CSF Leak	2 (managed conservatively)

*KPS: Karnofsky Performance Status scores.
**MMSE: Mini-Mental State Examination.
***CSF: Cerebrospinal fluid.

DISCUSSION

OGMs are slow-growing midline frontobasal lesions,[11,16] that commonly outstretch to large size at time of presentation, compressing unilaterally or bilaterally. Underestimated presenting manifestations and even situations of misinterpreted manifestations, particularly mental changes, resulted in an even more delayed diagnosis. These lesions are more challenging in low socioeconomic level communities, crowned by cultural disbelieves and lack of medical awareness. Such factors render the surgical option more intense owing to the enormous lesion size growing in such a confined area.

Reviewing the literature, we observed only a few comparative studies reporting outcomes of varied approaches for OGM particularly. Several studies tried comparing various approaches and their competence of total resections and complications following surgery. However, no approach had shown a great superiority over others.[18,19] Since Durante's first report on surgical management of an OGM, a wide range of surgical options got introduced.[20] The main approaches were the bifrontal approach, IHA, unilateral skull base approaches (as pterional, or supraorbital approach), or the more technically demanding endoscopic transnasal approach.[2,21-26]

Proper approach selection was always critical for a successful outcome for management. Tumor size, involvement of neurovascular structures, condition of smell sensation, spreading beyond the frontal floor base and dural extension are important approach modifiers if aiming for optimal outcome.[27,28] Older studies described the IHA for frontal pathology management; primarily ACom aneurysms and craniopharyngiomas.[12,13,29,30] It was further adjusted and integrated into the frontobasal approach.[12,31] This enabled a direct wide view of the entire anterior skull base with a full sweep of the midline from the Crista Galli anteriorly up to tuberculum, direct view of both olfactory nerves (for olfaction preservation) and laterally (towards the sphenoid wings) besides the possibility of exposing extensions to the ethmoid (when required) **(Fig. 1).**

In our series, we favored using the FBIA for large OGMs, especially those with an extension over the related orbital confinements and anterior extension of the frontal sinus inner border. In most cases, the large lesion which anatomically retracts the frontal lobe as it grows **(Fig. 1)** created a large surgical corridor. Such finding facilitates safer excision by almost avoiding additive frontal retractions and resultant hematomas encountered with the more familiar subfrontal approach. Advantages noticed with other experiences suggesting the superiority of frontobasal approaches also sustained this.[9,13,32-35] This also adds to the similarity of the approach to our previously used bifrontal approach and its congruence with our surgical experience, wish we always aim to ameliorate.

FBIA allowed early control of the lesions blood supply, commonly ethmoidal arteries, emerging from below upwards in the frontal base. Although such a scheme facilitates almost bloodless excision, yet 7 patients (46.6%) still required blood transfusions, comparable to our previous experience with the subfrontal approach.

Based on previously outlined technical nuisances, FBIA allowed gross total excision in 86.7% of the cases (Simpson grades I-II). We attributed this to our previous experience with the more conventional bifrontal approach. Although it is considered an evolution of the bifrontal approach, we saw better patient functional outcomes using it. Besides this, it has reduced operative timing (mean: 230.8 minutes) when compared to utilizing the conventional approach.

Cognitive/behavioral changes were the most challenging manifestations reported in our patients. The decline in patients' ability to care for themselves had a major impact on their families. This is mostly the driving force to seek medical attention, although was mostly in the wrong direction. This ensued a lot of misdiagnoses and more delayed presentation to properly service. We used MMSE[36] (pre-operative mean: 23.4) and KPS[37] (pre-operative mean: 81.6+/-2.4) to evaluate and follow patients. They achieved improvement in both aspects with a mean global MMSE and KPS average of 24.9 and 86 (+/-2.1) respectively. This reflects accountable better patient functional outcome backed by less frontal manipulation, granting a better chance for frontal lobe recuperation and salvaging **(Fig. 2)**. Interestingly, there is a report suggesting patients with lower KPS at the time of presentation have higher odds for total lesion excision.[18]

We could not thoroughly examine olfaction pre/postoperatively; however, we intended to apply simple assessment for olfaction. Preoperative hyposmia/anosmia was present in 9 patients (60%) and normal olfaction was found in 6 patients (40%). Only one patient had deterioration of his olfaction following surgery. This supports the favorable outcome reported by many authors using the FBIA regarding olfactory nerve preservation.[4,6,38,39] We did not appreciate any visual improvement in both our patients with preoperative visual impairments, which is probably owing to optic apparatus vulnerability and the long- standing pressure effect.

An advocated drawback of the approach is the increased possibility of the ACom injury when encountered by the meningioma. Putting that in mind, we took a lot of caution in dissecting the lateral and posterior aspects of the lesion. Others also reported that using the transbasal approach has a better chance for vascular bleeds tackling and management compared to less invasive approaches.[39] Another potential risk is higher infection possibilities, as in most cases, we deliberately open the frontal sinus. We countered this by carefully cranializing and obliterating the sinus after removing the entire mucosa and leaving betadine-soaked gel foam/muscle tissue in the sinus. This has aided lower infection rates, which were only seen in one immunocompromised patient. Compared with the other approaches, the frequency of infection-related complications with basal approaches was relatively low.[39-43]

Post-operative complications **(table 3)** occurred globally in 3 patients. The most important complication was the frontal hematomas in 2 patients seen on postoperative CT. We did not appreciate neurological deterioration related to this but were responsible for temporary postoperative headaches and behavioral changes. Overall, the approach is relatively safe. A recent study comparing the outcome of different approaches powers this concept. The results of the transbasal group had the lowest rate of complications and the best surgical outcomes. There were no CSF leaks, no vascular injuries, nor recurrences emphasizing a low morbidity risk.[39]

CONCLUSION

We could consider the frontobasal interhemispheric approach (FBIA) as a safe and workable approach, regarding its familiarity, for managing large olfactory groove meningiomas. Most encouraging is the satisfactory functional outcome improvement which we appreciated in the managed group of patients. One must always be open to change when the target is to secure

patient outcomes. We could emphasize that the approach is a safeguard for the frontal lobe and olfactory nerve functioning.

List of abbreviations

ACom: Anterior communicating artery.
CSF: Cerebrospinal fluid.
CT: Computerized tomography.
FBIA: Frontal basal interhemispheric approach.
IHA: Interhemispheric approach.
KPS: Karnofsky Performance Status scores.
MMSE: Mini-Mental State Examination.
MRI: Magnetic resonance imaging.
OGM: Olfactory groove meningiomas.
SPSS: Statistical Packages for the Social Sciences.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

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