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Original Article

Microsurgical Excision of Olfactory Groove Meningiomas, Comparative Studies of Different Surgical Approaches

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Abstract:

Introduction: To review the surgical approaches, techniques, outcomes and recurrence rates in a series of 11 olfactory groove meningioma (OGM) patients operated from January 2010 to April 2019. Methods: Eleven patients underwent craniotomy and micro-neurosurgical removal of olfactory groove meningioma. Tumor diameter varied from 5 to 8.5 cm among 11 cases, 2 cases underwent Transglabellar/ Subcranial approach, 3 cases by bifrontal approach, 1 case unifrontal approach, 2 extended endonasal and 3 cases fronto-lateral approach. Result: Total removal was possible in all cases except 2 cases. Histopathology revealed typical meningioma (WHO grade 1). There was 1 operative mortality and no permanent focal neurological deficit except anosmia. 3 patients developed CSF leak and two cases meningitis which were resolved by lumber drain and antibiotic therapy. Conclusion: Extended endonasal approach or transglabellar/ subcranial approach were sufficient for gross total removal of OGM which is associated with bony hyperostosis, paranasal extension and optic canal.

Keyword: *Olfactory groove meningiomas, extended endonasal, Transglabellar.*

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Introduction:

Olfactory groove meningiomas (OGMs) account for 4.5 to 13% of all intracranial meningiomas[1]. They commonly occur in the fourth through sixth decades of life. They are more common in females and are rare in children. Olfactory groove meningiomas arise in the mid line over the cribriform plate and fronto sphenoidal suture[1,2]. It is well known that most of these tumors occupy the floor of the anterior cranial fossa, extending all the way from the crista galli to the tuberculum sellae[1,2,3]. The blood supply to these lesions most commonly derives from the anterior and posterior ethmoidal arteries, anterior branches of the middle meningeal artery, and the meningeal branches of the ophthalmic artery. As the tumors become larger, vascular supply from small branches of the ACA and ACoA is not uncommon[11]. The main distinguishing feature is the location of the optic apparatus in relation to the tumor. OGMs push the optic nerves and the chiasm downward and posteriorly as they grow. Tuberculum sellae meningiomas elevate the chiasm and displace the optic nerve superolaterally; thus, the tumor occupies a subchiasmal position[4,5]. Neurological findings, apart from anosmia, are usually limited to visual acuity changes and/or visual field loss, with true motor paresis being rare. Because the optic nerves and chiasm are compressed superiorly by the tumor, an inferior visual field defect is most common (TSMs present with a bitemporal visual field defect). The Foster–Kennedy syndrome of unilateral optic

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atrophy and contra lateral papilledema, although originally described in OGMs, occurs in only a small number of patients[11]. These benign, slow-growing tumors frequently achieve large size before detection diagnosed at a late stage, they usually have already reached a large size[2] and are highly vascularized and covered by stretched and swollen brain parenchyma[5,6]. The tumor is very large and/or infiltrates or involves surrounding structures, making its removal challenging. Several surgical approaches can be applied for tumor removal[6]. Traditionally, bifrontal craniotomy has been used with subfrontal approach to the tumor. More recently, some surgeons have used a pterional approach. More aggressive approaches have been proposed for resection of OGMs expanding into the paranasal sinuses and orbits, including transbasal, extended transphenoidal, and fronto-orbital approaches, bifrontal craniotomy combined with orbital or nasal osteotomies, and craniofacial resection[6,7]. Therefore, various approaches have been used for surgical removal of these lesions. Olivecrona and Urban in 1954 and Cushing and Eisenhardt in 1985 described a unilateral frontal craniotomy followed by partial resection of the frontal lobe in order to expose the tumor. Dandy[6] used an even larger approach by performing a bifrontal craniotomy plus partial bifrontal lobectomy[7,8].

Materials and Methods:

From January 2010 through April 2019, our neurosurgical team operated on 11 patients with OGM tumors in Bangabandhu Sheikh Mujib Medical University Hospital, and some private hospitals. Demographic data are presented in Table 1. There was a significant female predominance (7 patients out of 11). Patient age ranged from 30 to 65years.

Headache was the most common symptom to these patients. Anosmia and mental and personality changes were the next common manifestation. Visual impairment were found only in two cases associated with papilledema (Table-2). All patient underwent preoperative and postoperative CT scan and or MRI of brain.

Table-I

Demographic data of 11 patients operated for olfactory groove meningioma:

Characteristics		Patient Detail
Sex	Male	4
	Female	7
Age(yr)	Median	35
	Range	20-65

Table-II

Demographic study of age, symptoms, CT/MRI findings and size of the tumor

Sl NO.	Age/ Sex	Presenting symptoms of tumor	CT/MRI finding of tumor	Max diameter
1.	35/ F	1. Headache 2. Vomiting 3. Anosmia	Olfactory groove meningioma	5 cm
2.	55/M	1. Headache 2. Vomiting 3. Anosmia 4. Visual blurring 5. Irrelevant talking	Olfactory groove meningioma	6.5cm
3.	65 /F	1. Headache 2. Vomiting 3. Anosmia 4. Irrelevant talking	Olfactory groove meningioma	8.5 cm
4.	35/ F	1. Headache 2. Vomiting 3.	Olfactory groove meningioma	6 cm
5.	30/ F	1. Headache 2. Vomiting 3. Visual blurring	Olfactory groove meningioma	8 cm
6.	55/M	1. Headache 2. Vomiting 3. Anosmia	Olfactory groove meningioma	8 cm
7.	25/M	1. Headache 2. Vomiting 3. Anosmia 4. Visual dimness	Olfactory groove meningioma	6 cm
8.	35/M	1. Headache 2. Vomiting 3. Anosmia	Olfactory groove meningioma	5 cm
9.	50/ F	1. Headache 2. Vomiting 3. Anosmia 4. Visual dimness	Olfactory groove meningioma	4 cm
10.	45/ F	1. Headache 2. Vomiting 3. Bilateral blind	Huge Olfactory groove meningioma	8.5 cm
11.	20/F	1. Headache 2. Anosmia	Olfactory groove meningioma	2.5 cm

Radiological Features

Patients were divided into 3 groups according to the largest diameter of the tumor; small (d”3cm), medium (3-6 cm) and large (≥6cm) OGMs. There was one patient of small category. Maximum tumor diameter was 8.5 cm intracranial tumor with extension to ethmoidal sinuses were found in two cases. Hyperostosis of the ethmoid sinus planum sphenoidale was found in two case.

Surgical Techniques

In all the cases surgery was performed with the help of an operating microscope and microsurgical instrumentation. Tumors were operated on through

Table-III

Outcome according to surgical approach.

SINO.	Approach	Extent of tumor removal	Complication	Outcome
1.	Transglabellar/Subcranial approach	Gross total	Meningitis	GOS 5
2.	Transglabellar/Subcranial approach	Gross total	Impaired conciseness for three days	GOS 5
3.	Bifrontal craniotomy	Gross total	NIL	GOS 5
4.	Fronto lateralcraniotomy	Gross total	NIL	GOS 5
5.	Bifrontalcraniotomy	Gross total	Meningitis	GOS 5
6.	Fronto lateral craniotomy	Gross total	NIL	GOS 5
7.	Extended Endonasal Approach	Gross total	CSF leak	GOS 5
8.	Extended Endonasal Approach	Gross total	CSF leak	GOS 5
9.	Unifrontal craniotomy	Sub total	CSF leak	GOS 5
10.	Extended bi-frontal basal craniotomy	Sub total	Absent	GOS 1
11.	Fronto lateral craniotomy	Gross total	Nil	GOS 5

the Transglabellar/ Subcranial approach (2 cases), Extended Endonasal (2 cases), Frontolateral (3 cases) and Bifrontal approaches (3 cases). Bifrontal approach was chosen for larger diameter of the tumor.

Follow-up

All the eleven patients were followed-up with early postoperative CT scan and neurological evaluation. The follow up period were ranged from one to twelve months. Visual acuity was assessed both pre and post operatively. No recurrence of tumor found within this short period of follow up.

Result:

Total tumor removal (Simpsons Grade 1 or 2) was achieved in most of the cases, 8 patients. CSF leak was found in 3 cases. There is one mortality in eleven cases because of diffuse brain edema and post operative tumor bed hematoma (Table-3). Two patients developed meningitis and one case developed C.S.F. rhinorrhea along with meningitis. This patient was treated by antibiotic therapy and lumber drain for C.S.F. leak. Small subdural hygroma was developed in one case. Small amount of tumor bed hematoma in one case. Steven Johnson syndrome was developed in one case following phenytoin therapy.

Discussion:

The bifrontal approach, proposed earlier by Tonnis is recommended for removal of large frontobasal tumors, and so it is advocated for large olfactory groove meningiomas[9] (Figure-1). For many years, bifrontal craniotomy followed by subfrontal access to the tumor have been considered standard approaches for OGM resection. Mortality rates in the literature vary from 0% to 17% and even 22.7% in the old literature. Complications include postoperative epilepsy, postoperative hematoma, hemiparesis, visual and mental deterioration, bone flap infection, and CSF leak. Surgical approaches have continued to evolve overtime[10].

Bifrontal Craniotomy

The advantage of the bifrontal craniotomy is wide symmetrical anterior cranial fossa exposure. This approach provides excellent opportunity for radical tumor resection, drilling of hyperostosis in the cribriform plate area, planum sphenoidale and tuberculum sellae, and unroofing of optic nerves when necessary (Fig-2,3). Disadvantages are CSF leak and possibilities of meningitis. The most important structures-the optic apparatus, carotids, and the anterior communicating complex-come into view after the end of surgical removal. The superior sagittal sinus should be divided, compromising venous drainage from the frontal lobes and thus contributing to diffuse bifrontal cerebral edema. Preservation of the both olfactory tracts are not possible.

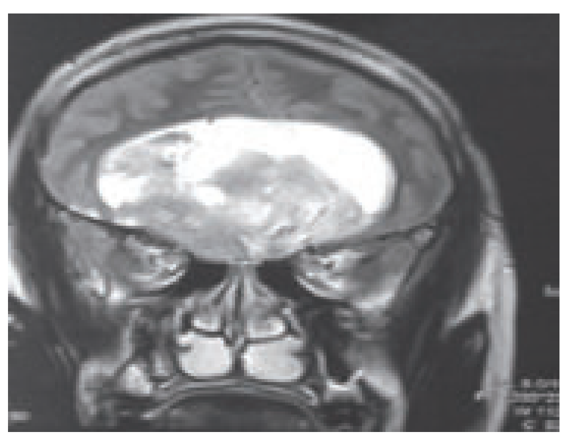

Fig.-1: *MRI shows huge of factory groove meningioma*

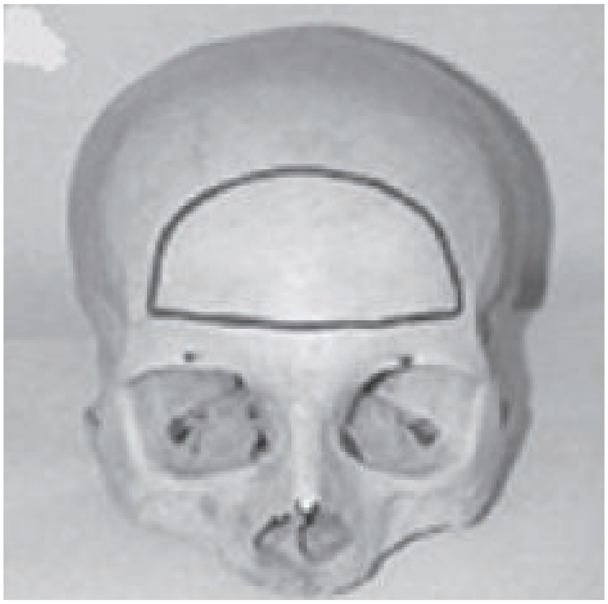

Fig.-2: *Shows extent of bifrontal craniotomy*

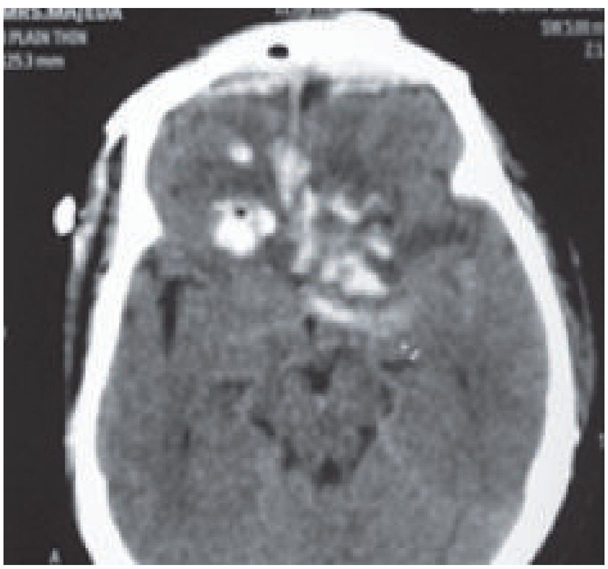

Fig.-3: *Postoperative evidence tumor bed hemorrhagic contusion*

Recently small Extended bi-frontal craniotomy is commonly chosen by some keyhole neurosurgeon for Olfactory groove meningioma where there is no hyperostosis or optic canal invasion or paranasal sinus involvement[21]. (Fig-4)

Extended bifrontal basal approach where superior orbital rim were also removed to gain access to the tumor with no, less retraction to the frontal lobe. (fig-5,6,7,8,9,10,11)

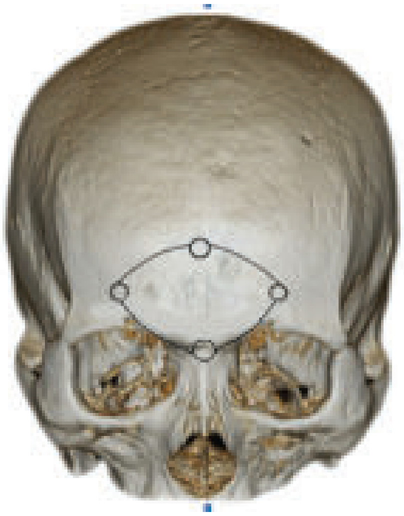

Fig.-4: *Small extended bi-frontal craniotomy*

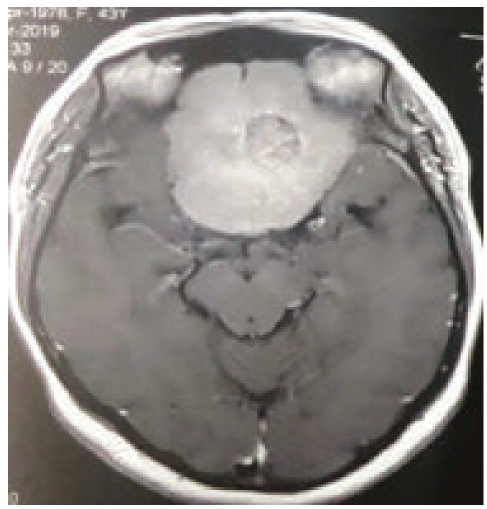

Fig.-5: *Preoperative axial picture shows contrast enhancing olfactory groove meningioma*

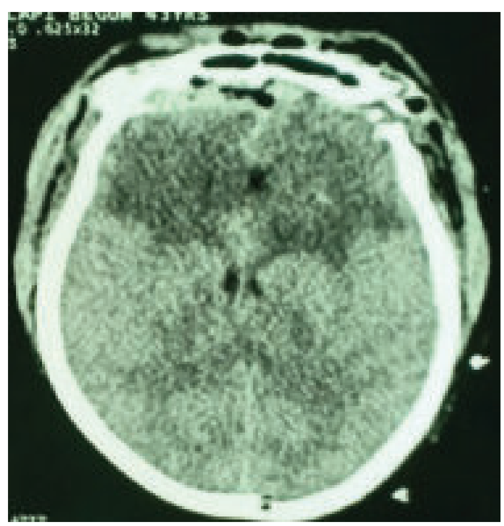

Fig.-6: *Postoperative picture shows sub total resection of meningioma*

Fig.-7: *Preoperative sagittal picture shows contrast enhancing olfactory groove meningioma*

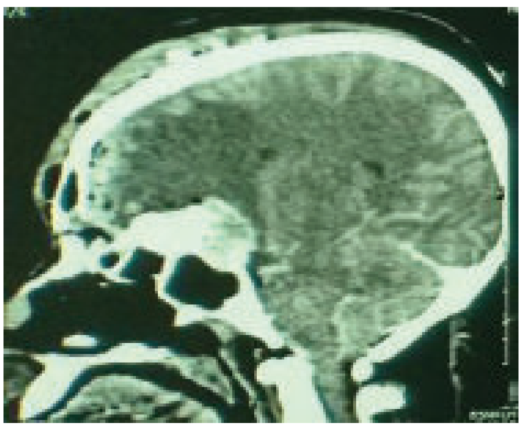

Fig.-8: *Postoperative picture shows sub total resection of meningioma*

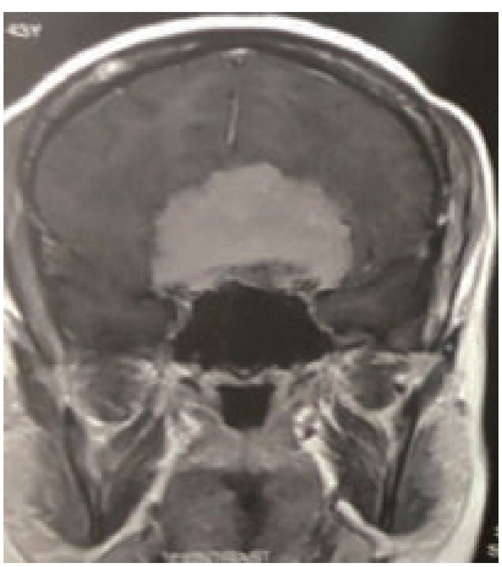

Fig.-9: *Preoperative coronal picture shows contrast enhancing olfactory groove* meningioma

Fig.-10: *Postoperative picture show sub total resection of meningioma*

Fig 11: *Bi-frontal basal craniotomy Including the orbital roof and nasal bone*

Here we can fast attack or coagulate the anterior and posterior ethmoidal arteries to devascularize the OGM.

Frontolateral Craniotomy

This approach has the advantage of sparing the contralateral frontal lobe and the ligation superior sagittal sinus. The disadvantages includes small opening with a very narrow view. Bi-coronal skin flap followed by ipsilateral, unifrontal craniotomy close to the orbital rim done in one case. We have selected this approach where tumor lies in unilateral side and did not cross the midline. (Fig-12,13,14,15,16).

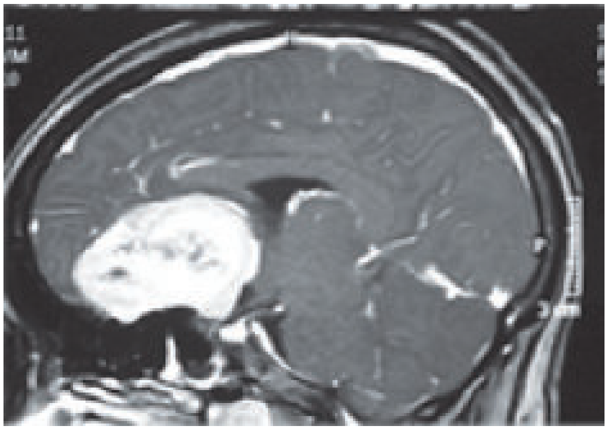

Fig.-12: *MRI shows huge olfactory groove meningioma in sagittal image*

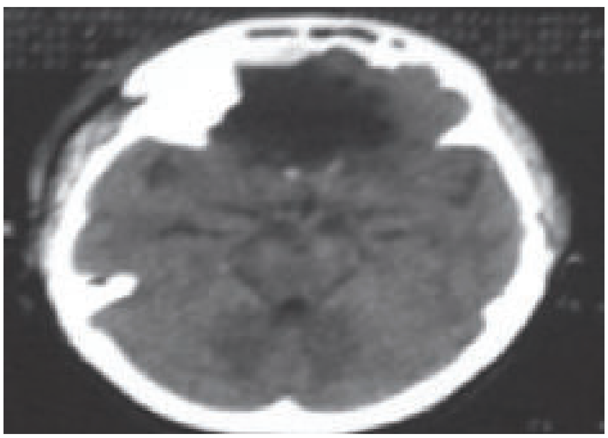

Fig.-13: *Postoperative evidence of complete tumor removal.*

Fig.-14: *Scar for frontolateral approach*

Fig.-15: *Extent of bone removal in frontolateral approach*

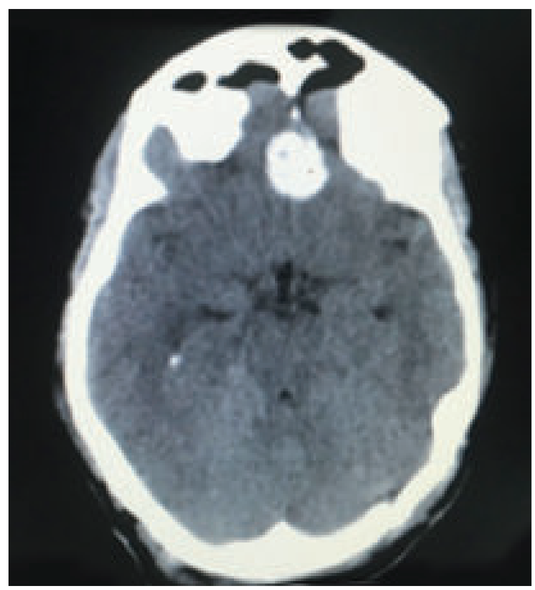

Fig.-16: *CTscan with contrast shows small olfactory groove meningioma which was remove by frontolateral approach*

Transglabellar/ Subcranial Approach

This is a modified approach for anterior skull base where both the frontal sinuses are exposed through a linear incision connecting the two eyebrows over the nasion. It provides excellent exposure of basal cavity, medial orbital wall, ethmoids and sphenoid sinus while allowing wide access to the anterior fossa with a minimum amount of frontal lobe retraction. Again the disadvantages are CSF leak, meningitis. Superior sagittal sinus is incised hence chance of brain swelling may take place (Fig- 17,18,19,20). V-shaped incision in the interorbital region, osteoplastic trephination near to the glabella sized 3x4 cm, with resection of the nasal bone[13]. This is indicated in Small OGM in midline in location, intracranial and extracranial growth with or without bony hyperostosis. Advantage of this approach is minimal brain traction, direct approach to the anterior cranial fossa, nose and ethmoidal sinuses[11].

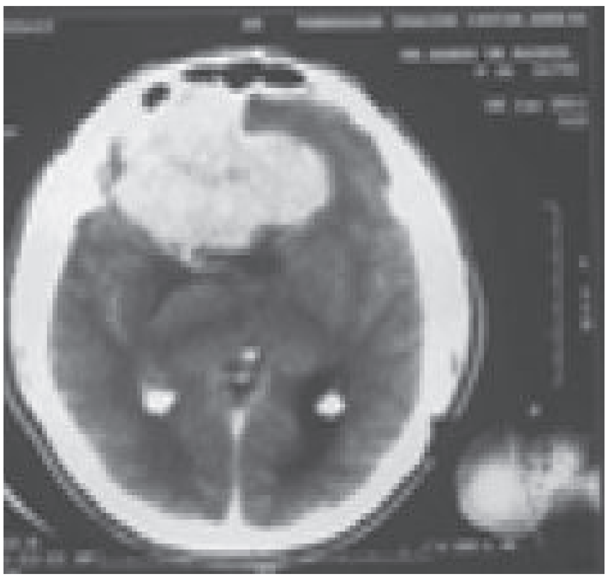

Fig.-17: *CT shows brilliant contrast enhancing olfactory groove meningioma*

Fig.-18: *Scar following glabellar mini craniotomy*

Fig.-19: *postoperative evidence of no residual tumor and small*

Fig.-20: *Figure of a subcranial approach showing extent of bone resection*

Extended Endoscopic Endonasal Approach

After the advancement of neuro-endoscopy in skullbase surgery neurosurgeons who are competent with endoscopic trans sphenoidal surgery, they often choose extended endonasal approach to remove the olfactory groove meningioma. There are two major disadvantages:

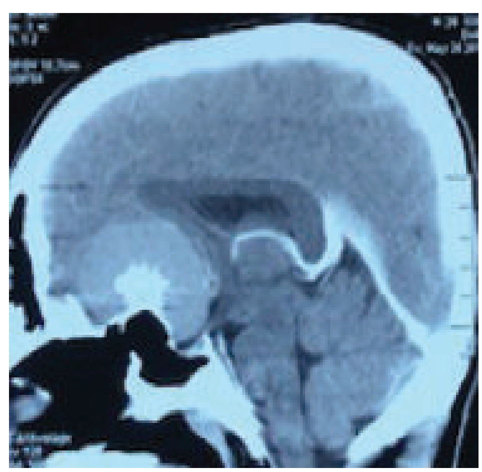

Fig.-21: *Preoperative sagittal picture shows contrast enhancing olfactory groove meningioma*

1. Preoperative and postoperative C.S.F leak.
2. Vascular encasement often makes dissection difficult.

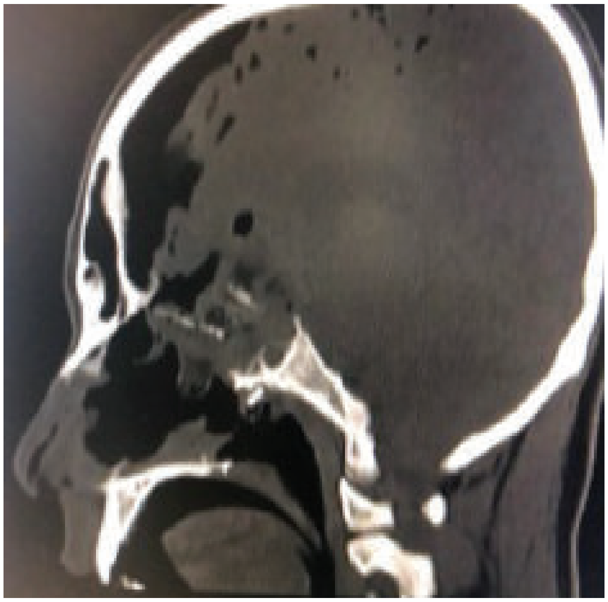

Fig.-22: *Postoperative picture shows gross total resection of meningioma*

Fig.-23: *Preoperative coronal picture shows contrast enhancing olfactory groove meningioma*

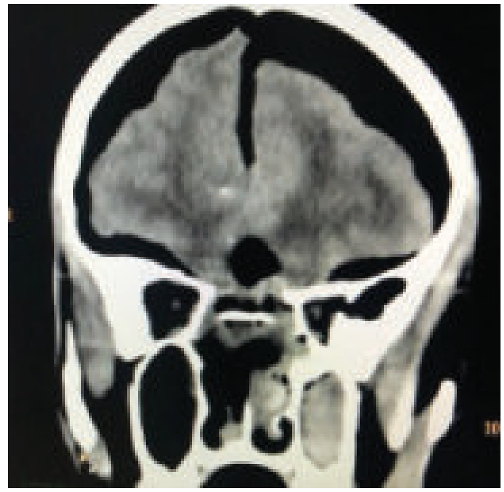

Fig.-24: *Postoperative picture show gross total resection of meningioma*

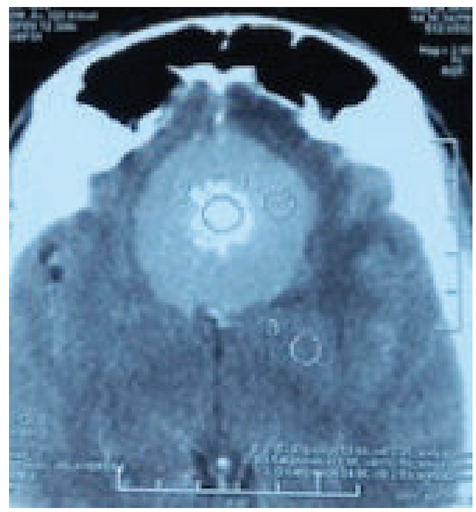

Fig.-25: *Preoperative axial picture shows contrast enhancing olfactory groove meningioma*

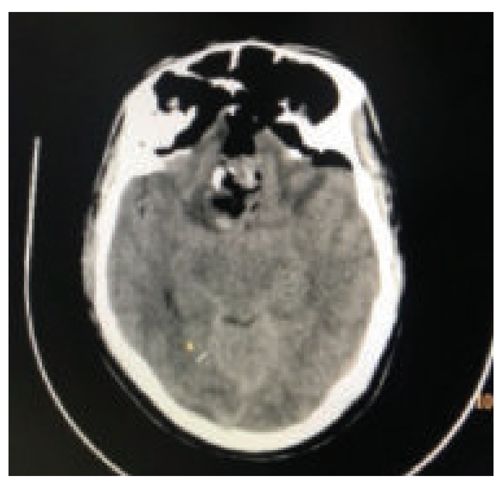

Fig.-26: *Postoperative picture show gross total resection of meningioma*

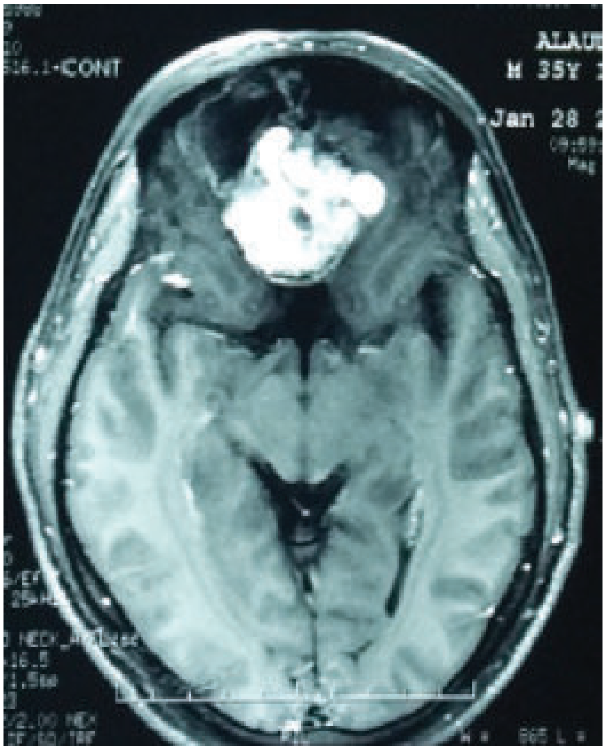

Fig 27: *Preoperative axial picture shows contrast enhancing olfactory groove meningioma*

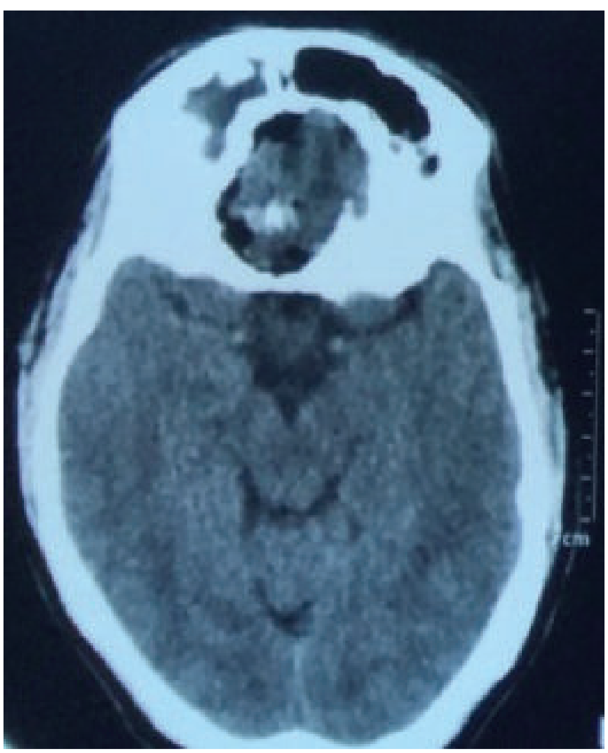

Fig.-28: *Postoperative picture shows gross total resection of meningioma*

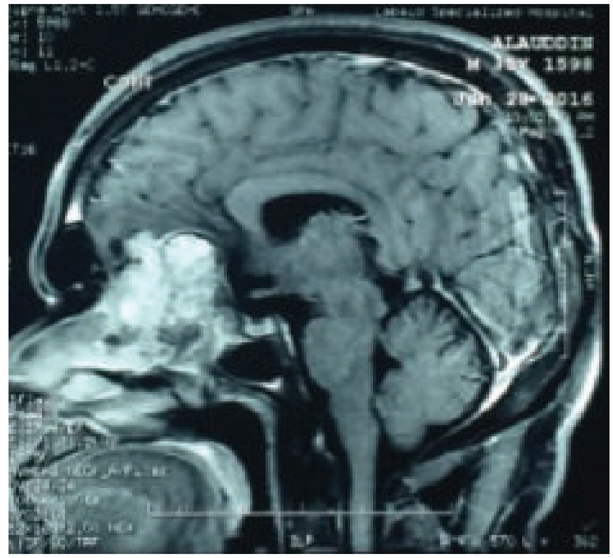

Fig.-29: *Preoperative sagittal picture shows contrast enhancing olfactory groove meningioma*

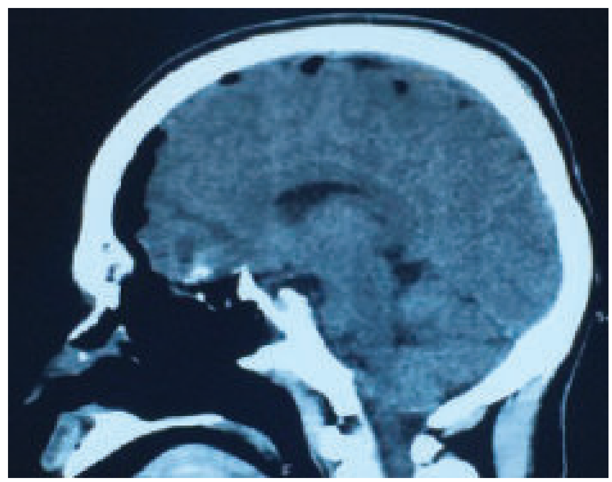

Fig.-30: *Postoperative picture shows gross total resection of meningioma*

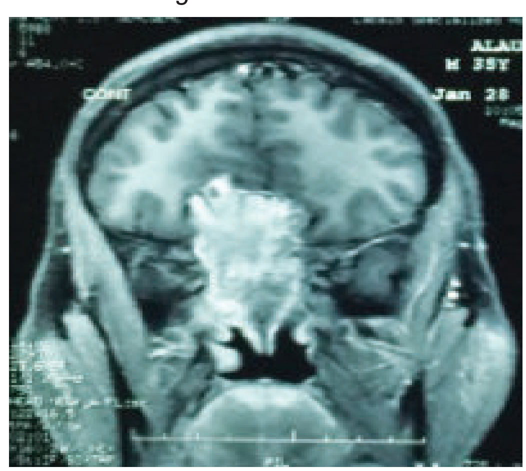

Fig 31: *Preoperative coronal picture shows contrast enhancing olfactory groove meningioma*

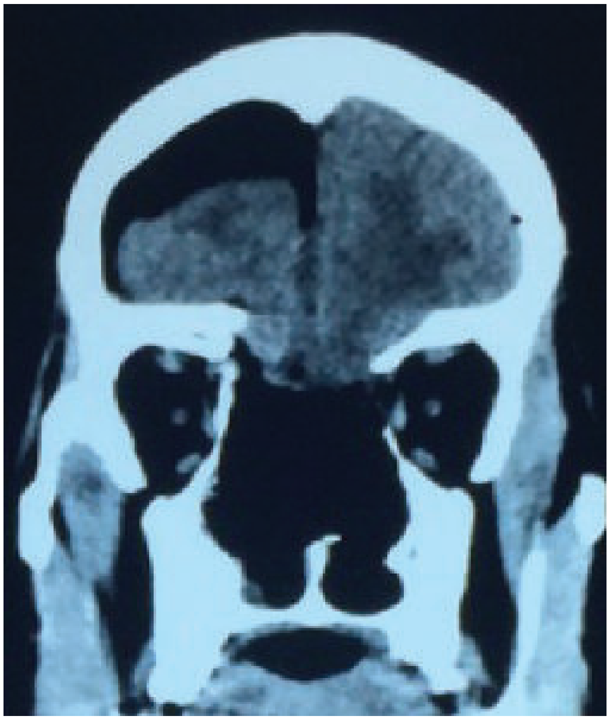

Fig.-32: *Postoperative picture show gross total resection of meningioma*

In this approach extension commonly required from frontal sinus to sphenoid sinus through cribriform plate, ethmoid and sphenoid sinus (Fig- 21,22,23,24,25,26). Removal of the cribriform plate and roof of the ethmoidal labyrinths at the area anteriorly bounded by the frontal sinus cavity, laterally eye-sockets, posterior chiasm and anterior circle of Willis (Fig- 27,28,29,30,31,32) [12].

Advantages of endoscopic approach are absence of brain traction, direct midline approach, no external incisions, tumor devascularization at early stages of the operation by coagulation of the anterior and posterior ethmoidal arteries, minimal traumatization of the optic nerves and other critical structures, generally lower incidence of complications than with other approaches, in some cases, shorter duration of surgery, shorter hospital stay, and higher quality of life of patients[13,14,15,16].

Disadvantages are higher incidence of CSF rhinorrhea, two dimensional image, narrow surgical corridor, limiting the maneuvering capabilities of instruments. The need for long-term training of surgeons and specialized equipment and tools. Intracranial arteries and nerves are located over the tumor, and they are visible only when the bulk of the tumor has been removed, and therefore they cannot be controlled at the initial stages of resection[20].

CSF leakage now a days can effectively managed by gasket seal technique of closure and post operative continuous lumber drain.

The frontolateral approach permitted, even in large meningioma's, high rates of total tumor resection with low recurrence rates and less brain exposure. The use of microsurgical techniques allowed total removal of the large OGMs. With low rates of mortality and mobility. We consider the frontolateral approach as an alternative, if not superior, to standard bifrontal approaches. This is backed by our experience with a series of some 11 patients and the following advantages:

* Unilateral approach
* Preservation of the frontal sinus
* Unilateral brain retracting spatula
* Preservation of superior sagittal sinus
* Early exposure and decompression of the neurovascular complex
* Possible preservation of the contralateral olfactory nerve in certain cases.

Patel et al. reported a bicoronal frontobasal approach involving a limited midline orbital bar osteotomy for resection of OGMs[22]. Safaee et al. described a 2-piece bifrontal craniotomy and added a tailored supraorbital osteotomy for resection of TSMs[23]. Ming Xu et al. agreed with Patel et al. that a small separate fronto-orbital bone flap may have more chance of resorption or infection when adjuvant radiotherapy is applied to nonbenign meningiomas (WHO grades II and III) [24,25]. Therefore, such a modification is better in a 1-piece fashion.

Conclusion:

OGMs were removed using the Bifrontal approach, Unifrontal, Extended Endoscopic approach, Transglabellar/subcranial approach. All surgical procedures proved to be safe and effective overall. Based on our limited experience bi-frontal basal approach or small extended bi-frontal basal approach achieved gross total ressection of most of the olfactory groove meningioma where there is no hyperostosis, optic canal invasion or paranasal extension. Extended endonasal approach or transglabellar/subcranial approach was sufficient for gross total removal of tumor where OGM is associated with bony hyperostosis, paranasal extension and optic canal invasion. Extended endonasal approach or subcranial approach was sufficient for gross total dissection of tumor. In extended endoscopic approach there were significant reduction of postoperative CSF leak by proper or standard surgical closure of skull base. Here we did gasket seal technique and postoperative use of continuous lumber drain for 4-5 days.

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