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RESEARCH ARTICLE

Olfactory groove meningioma: an analysis based on 24 cases

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Abstract

Background: Olfactory groove meningioma (OGM) is one of the most common tumors located in the fronto-basal region. This study was performed to evaluate the clinical features and surgical outcome of these tumors.
Material and method: The study was performed by retrospective review of the medical records of the patients of OGM operated in our department.
Results: Twenty four (Male 7, female 17; age range 17-74 years; mean age 42.25 years) patients of OGM were managed in our department from 2003 to 2013. Mean duration of presentation was 24.37 months. Most common presentation was features of raised ICP (n=21) followed by mental changes (n=15). Anosmia and hyposmia was present in 9 and 10 cases respectively. Visual disturbances was seen in 16 cases. Radiological bone changes in form of hyperostosis and bone erosion was seen in 14 cases. All patients were operated by unilateral or bilateral subfrontal approach depending on the extension of tumor. Total tumor excision was achieved in 15 cases. All patients were relived in raised ICP following surgery. Post-operative complications included CSF rhinorrhea (n=4), local CSF collection (n=6) and infection (n=2). There was no mortality. Histopathology was suggestive of WHO grade I (n=20) and grade II (n=4) meningioma.
Conclusions: OGM predominantly occur in females. The most common presentation is raised ICP. Surgical excision offers good outcome.

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INTRODUCTION

Meningiomas are the second most common tumor involving the central nervous system. OGMs are one of the most common tumors located in the fronto-basal midline and constitute 8-13% of all intracranial meningiomas. These tumors arise over the cribriform plate and fronto-sphenoid suture. The presence of these tumors is detected very late due to their location at potential site where these can grow to large size before causings ymptoms. They demand surgical expertise due to their intricate relationship with vital neurovascular structures.In this paper, the authors have described the clinical features, radiological findings and surgical outcome of 24 cases of OGMs.

Material and methods:

Patient population:

We retrospectively reviewed the clinical presentations, operative findings and functional outcome of 24 patients of OGM operated at our center from 2009 to 2013. Medical records were reviewed, noting the preoperative symptoms and sign with imaging details, operative findings of microsurgical treatment of theses tumors with

postoperative neurological status of patients. In case of large tumors where site of origin was difficult to define, however the anterior midline tumors with sign of bony changes over cribriform plate radiologically and tumor extension into nasal cavity or ethmoidal sinus through anterior skull base; were included. Tumors with attachment at other surrounding site like planum sphenoidal or tuberculum sellae were excluded.

Surgical strategies:

Surgical strategies were based on preoperative radiological characteristics of tumor with its extension. All surgeries were performed under general anesthesia. Advanced microsurgical techniques were used in all patients and none were preoperatively embolized or received radiation treatment. Approaches used were unilateral or bilateral subfrontal which is described in literatures. Often extradural bony work was done before tumor is handled. Tumor extending into nasal cavity and ethmoidal sinus were dissected out after drilling but tumor firmly attached to olfactory tract or anterior cerebral arteries or optic apparatus was left. Extent of surgical resections was graded according to Simpson's grading.

Results:

Patient characteristics:

During the study period, 210 meningiomas were treated at our institute, out of these, 64 (64/210; 30%) were located in the anterior cranial fossa; of these, 24 (24/210, 11.5% of total meningioma or 24/64, 37.5% of anterior cranial fossa meningioma) were OGM. Our series was predominated by females (M: F =17:7, 70.8%). The mean age of presentation was 42.25 years (Range: 17-74 years). Mean duration of presentation was 24.37 months (Range: 6-132 months) with 19 (79.2%) patients presenting with symptoms duration one year or more, meaning some symptoms appear even early which are ignored.

Clinical presentations:

In our series, most common presenting symptoms was of raised intracranial pressure (n=21, 87.5%), followed by mental status changes like apathy (n=15, 62.5%) which was noticed many times by family or friends. Anosmia was present in 9(37.5%) patients and hyposmia in 10(41.7%) patients, which was often not primarily complained by patient. Only 3(12.5%) patients presented with seizures. Decreasing vision was noted in 13(54.2%) cases, while vision loss was seen in 3(12.5%) patients. Papilloedema (n=14, 58.3%) with secondary optic atrophy (n=4, 16.7%) due to long standing intracranial hypertension was there on fundus examination in 14 (58.3%) patients owing to compression of optic nerve. The typically described Foster-Kennedy syndrome of unilateral anosmia with ipsilateral optic atrophy with contralateral papilloedema was not seen in any of our patients. Weakness of limbs was present in five patients (20.8%). The clinical features of our cases are summarized in Table-1.

Radiological features:

The CT and MRI characteristics of OGM are same as of meningioma elsewhere. However these tumors are large at the time of presentation, with 14(58.3%) patients having tumor of maximum diameter larger than 6 cm. Rest 10(41.7%) patients have that of between 3-6cm. Largest tumor in our series had volume of 600 cm^3, while the smallest volume was 20 cm^3, with mean tumor volume was 88.92 cm^3. Tumor extension was bilateral symmetrical in 50% of the patients and there were cases with tumor volume localized to one side (25%), and remaining patients in grey zone in between two. Severe perilesional edema involving bilateral frontal lobe was noted in 14 (58.3%) patients. All tumors were contrast enhancing with heterogeneous pattern in 13(54.2%) patients and remaining 11(45.8%) cases had radial spike wheel pattern of enhancement. Necrosis and cystic areas were seen in 12(50%) patients. Bony changes in form of hyperostosis or erosion on cribriform plate and rest of the ethmoid bone was present in 14(58.3%) patients, while dural tail was visible in only 11(45.8%) patients. In 14(58.3%) patients tumor was going into ethmoidal and other paranasal sinuses through floor of anterior cranial fossa.

Treatment:

All patients underwent surgical management for OGM. In all subfrontal approach was used, unilateral or bilateral. In all cases tumor was devascularized from base coagulating the ethmoidal vessel thus interrupting the majority of blood supply to meningioma. Tumor was then centrally debulked using an ultrasonic aspirator (CUSA). Tumor capsule was then gently dissected off from the arachnoid and brain parenchyma all around. In 5(20.8%) patients, there was intraoperative evidence of brain invasion. In rest of cases, brain, anterior cerebral vessels with its major branches, and optic apparatus were well protected by arachnoidal membranes. Tumor extension into paranasal sinus was removed and floor of anterior cranial fossa was repaired using thick and well vascularized pericranial flap. Goal of surgical resection was gross total excision. Extent of tumor excision achieved was Simpson grade I (n=1; 4.2%), grade II (n=16; 66.7%) and grade III (n=9; 37.5%). Extent of resection was decided based on the intraoperative impression of operating surgeon along with postoperative contrast radiology. Mean duration of postoperative hospital stay was 10 days with range from 7 to 24 days.

Postoperative outcome:

There was no perioperative mortality (during the first 30 postoperative days); however one patient needed prolonged postoperative ventilatory support and ICU care, but was eventually discharged. Olfactory function was lost in all patients, despite the facts that in unilateral approach other olfactory tract was not handled. It might would have been due to stretching of the normal olfactory tract during the surgery. Headache and frontal lobar signs were improved in all and there was no postoperative seizure. Surgical site CSF collection was seen in 6(25%) patients requiring repeated aspiration and compression dressing. Local surgical site infection occurred in 2(8.3%) patients, which was managed with conservative management.Postoperative fever requiring investigations and changes in antibiotics as per culture occurred in 9(37.5%) patients. Post-operative CSF rhinorrhea occurred in 4(16.7%) patients which was managed conservatively with decongestant and lumbar drainage of CSF. Four (16.7%) patients had frontal lobe edema with significant mass effect requiring prolonged decongestant. The complications of our cases are summarized in Table-2.

Histopathology:

Regarding the histopathological outcome, 20(83.3%) patients had WHO grade I meningioma, with predominant variety being meningothelial type (n=10, 41.7%), and rest four (16.7%) patients had WHO grade II meningioma. Of these, 3(12.5%) patients had atypical type and 1(4%) had clear cell type meningioma.

Follow up details:

In our series, follow up was available in only 12 (50%) cases. The range of follow up was 3-55 months with mean follow up of 16.9 months. None of our patients develop recurrence till the last follow up.

Legends:

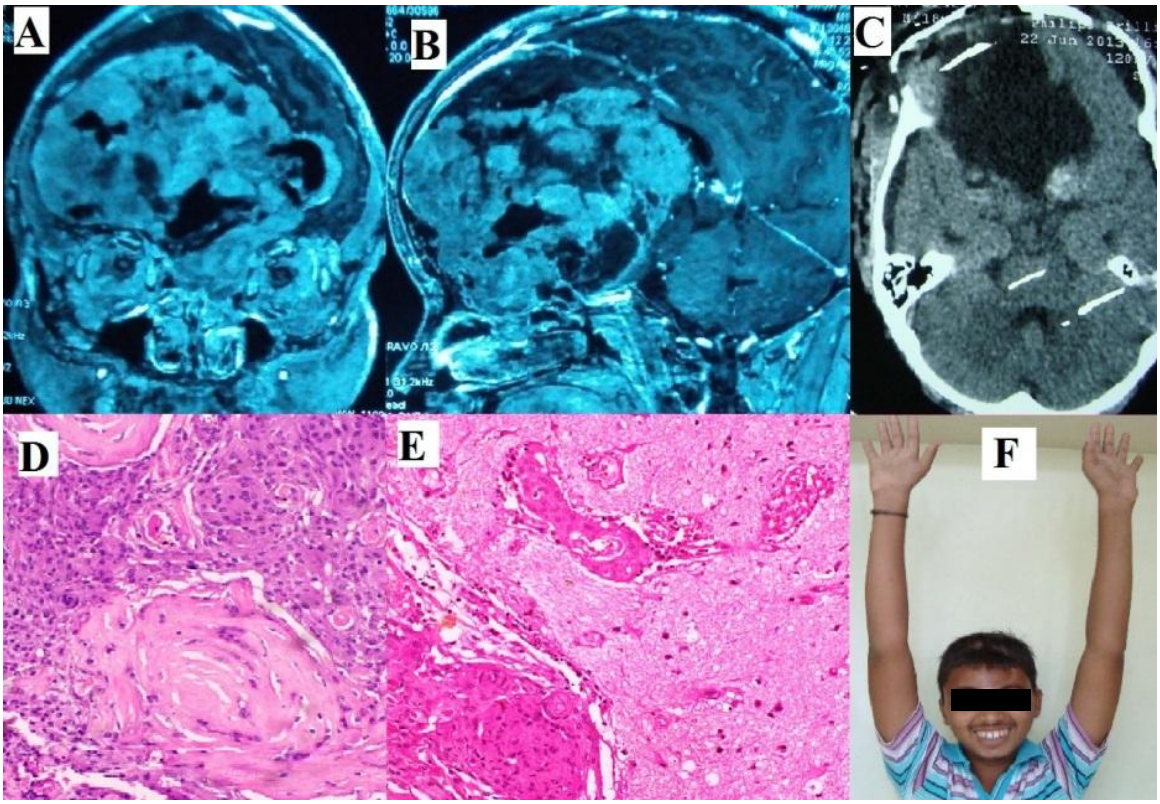

Figure-1: Contrast MRI Sagittal (A) and Coronal (B) images showing patchy contrast enhancing lesion almost filling the whole anterior cranial fossa, with extension into nasal cavity through ethmoid sinus and cribriform plate erosion. Postoperative contrast CT scan axial image (C) showing complete excision of the lesion. H and E stained sections showing tumour disposed in whorls and sheets with tumour cells displaying indistinct cellular boundaries, round to oval nuclei, finely stippled chromatin (D). There was focal invasion of adjacent brain parenchyma seen (E).Patient had no deficit and was doing well during follow up (F).

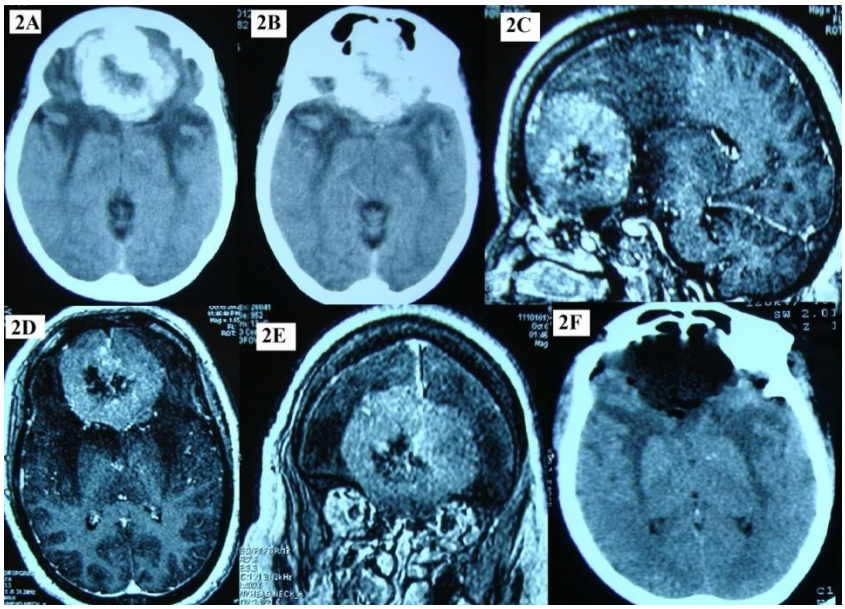

Figure-2: Plain (A) and contrast enhanced (B) CT head axial images showing the hyperdense lesion with heterogeneous contrast enhancement with bilateral frontal edema. Post-contrast MRI sagittal (C), axial (D) and coronal (E) images showing extent of lesion and shifting of bilateral frontal lobe superiorly and laterally with erosion of cribriform plate and tumor extension into nasal cavity. Postoperative CT head axial image (F) show total tumor excision with surgical cavity, however bifrontal edema is persisting.

Tables:

Table-1: Clinical features of our patients with olfactory groove meningioma	
Sign and Symptoms	Number of patients (%)
Impaired olfaction	19 (79.2)
Mental state changes	15 (62.5)
Decreased vision	16 (66.7)
Papilloedema	14 (58.3)
Optic atrophy	4 (16.7)
Headache	21 (87.5)
Seizures	3 (12.5)
Motor deficit	3 (12.5)
Memory impairment	6 (25)

Table-2: Complications associated with tumor size in our series, n (%)			
Complications	Tumor size 3 - 6 cm	Tumor size > 6 cm	Tumor size Total (%)
Loss of olfaction	1 (4.2)	4 (16.7)	5 (20.8)
CSF rhinorrhea	2 (8.3)	2 (8.3)	4 (16.7)
Persisted altered mental status	5 (20.8)	3 (12.5)	8 (33.3)
Seizures	0	0	0
Wound bulge	3 (12.5)	3 (12.5)	6 (25)
Meningitis	0	1 (4.2)	1 (4.2)
Other complication	1 (4.2)	1 (4.2)	2 (8.3)

Table-3: Details of surgical approaches used in various reported studies					
Authors, year	No.	Avg Tumor size (cm)	Approach	GTR, n (%)	Mortality
Schaller et al, 1994	28	3.5 to 6	Pterional	27 (96.4)	1
Yasargil et al, 1995	14	NA	Pterional	12 (85.7)	0
Tsikoudas et al, 1999	13	8 > 6	Bifrontal	NA	2
Zevgandis et al, 2001	5	6.7	Frontal	5 (100)	0
Hentschel et al, 2003	13	5.6	Bifrontal	11 (84.6)	NA
Bitter et al, 2013	61	54 > 4	Multiple	60 (98.3)	0
Nakamura et al,	46	NA	Bifrontal	46 (100)	4
Mirimanoff et al,	22	NA	Bifrontal	17 (77.3)	NA
Ashish et al, 2015	24	14 > 6	Frontal	17 (70.8)	0

Discussion:

OGMs are notorious to grow to a large size undetected, owing to their slow growth, anatomically non eloquent region and potential surrounding spaces. Even their intimate relation with olfactory apparatus, patients often does not complain of anosmia. In a series of 17 OGM by Colli et al[6], there was female preponderance up to rate 16:1. Headache followed by anosmia and seizure was the most common presenting complaints in their series. Hentschel et al[7] analyzed the reported series of OGMs making total 106 patients of OGM and they concluded that female to male ratio was 74:32 (1.47:1). Similarly they also analyzed the most common presenting complaints was mental changes (68%) followed by anosmia (65%), headache (50%) and vision loss (41%). The fallacy of this conclusion was that some authors of included series have not given their actual number of some presenting symptoms, so the most common presenting symptom of large series dominated the list. Most common complaint in our series was raised intracranial pressure (87.5%) followed by visual problem (66.7) and mental status changes

(62.5%). There was female preponderance in our series (17:7, 2.43:1). The average presenting age in our series was 42.25 years with range from 17 to 74 years. Combined series of Hentschel et al[7] the mean age was 55 years, but the range was very wide, from very young patient of age years (Paterniti et al[12]) to oldest patient of 75 years of age (Mayfrank & Gilsbach[9]).

In our series 14(58.3%) patients had tumor more than 6 cm, while the other authors (Table - 3), Tsikoudas et al [18] (8 out of 13) and Zevgaridis et al[21] in their series also had tumor larger than 6 cm. Large series of Bitter et al had 54 patients out of total 61 patients having tumor size more than 4 cm. In combined series of Hentschel et al[7], the mean size was 6.0 cm in total 106 patients of six studies with range from 3.5 cm to 8 cm. This makes their resection, great neurosurgical challenge due to their large size and extension into paranasal sinuses and intimate relationship with neurovascular structures. This also dictates satisfaction in its resection; total resection is possible most of the times due to preserved arachnoidal separation from surrounding brain, no vital eloquent cortical area nearby, and drastic improvement in patient symptomatology and mental status postoperatively. There is constant improvement in the outcome of these patients due to improvement in the microsurgical technique and skills with time, with new fine instruments and neuronavigation to assist in these surgeries.

Radiologically tumor involvements of optic nerve, nasal cavity, paranasal sinuses including ethmoidal, frontal, sphenoidal sinuses are seen. In our series these extensions were noted in 14(58.3%) patients, while in other series of Spektor et al[17], 52.5% of patients had these extensions. They also divided these extensions to various combinations and found that 26.2% had involvement of optic nerve only while rest 26.3% had variable involvement of paranasal sinus.

Surgical techniques have undergone huge changes starting from the use of bifrontal craniotomy with frontal lobe resection to minimal retraction by multiple osteotomies and craniofacial approaches to mini keyhole craniotomies to newer endoscopic assisted techniques. There are many surgical approaches to tackle these tumors, most commonly used are unilateral or bilateral subfrontal approaches, which are time tested and still are most common approaches to resect OGM. These procedures also have their own indication, advantages and disadvantages. The surgical approaches in various reported series are summarized in Table-3.

The classic bifrontal craniotomy with subfrontal approach was first described by Seeger, still most commonly used [14]. It gives wide view bilaterally with symmetrical exposure of anterior cranial fossa, gives direct access to bilateral ethmoidal arteries and thus helps in early devascularization of tumor and total tumor excision [14]. This also facilitates removal of hyperostotic bone of cribriform plate and drilling when needed, also the tumor extended into nasal cavity and paranasal sinus can be easily dealt with. This approach also makes repair of anterior cranial base defect easier after total tumor removal with bony drilling, due to wide exposure of base and availability of vascularized pedicled pericranial flap. The patient positioning is very important and this is one of the key factor which makes easier frontal lobe separation from tumor and non-traumatic gravity assisted auto retraction. There are also associated disadvantages; at times bilateral frontal lobe retraction is needed, critical neurovascular structures (anterior cerebral artery, optic apparatus and carotid artery) are shifted posteriorly by the tumor and hence they are seen at the last of the procedure, frontal sinuses are opened and it has to be managed meticulously, there is need for division of anterior part of superior sagittal sinus during the initial part which may rarely lead to increased venous edema [2, 3]. In our series, 19(79.2%) patients were operated by this approach. Three patients have postoperative CSF rhinorrhea which was managed conservatively and none had meningitis. Three patients had wound bulge which was managed with local aspiration and compression dressing.

Unilateral frontal approach has limited field of view but the main advantages are sparing of superior sagittal sinus and no chances of retraction injury to other frontal lobe. Brain retraction is dangerous in this situation because parenchyma is chronically edematous due to tumor and there is less space for retraction and it causes more postoperative edema along with chances of developing infarctions and hematoma. It has been described in literature that minimizing the brain retraction and preservation of cortical veins leads to decreased chances of postoperative worsening of mental status [1]. However for giant tumors or tumors having bilateral extension cannot be dealt with this approach. Five (20.8%) patients in our series were operated by this approach. Three patients had wound bulge while one had CSF rhinorrhea which was managed conservatively.

To prevent brain retraction, multiple basal osteotomies are described in literatures, orbital rim osteotomy in bifrontal craniotomy by Al-Mefty, orbital osteotomy in frontotemporal or unilateral frontal craniotomy by Sekhar [1, 15]. We performed orbital osteotomy in two of our patients to gain access to superior part of large meningioma. It also brings tumor base into view to deal with its attachment. Later Kempe described lateral approach with view for early identification of neurovascular structures; it protects the contralateral olfactory tract and it also gives shortest distance to tumor but when the tumor is in midline, then is poses difficulty is reaching out for tumor extending to opposite side which lies at very long distance[8]. This also restricts tumor removal from the nasal cavity and

paranasal sinuses, for which often a second approach is needed. This approach also restricts view to the superior extent of tumor and thus there is greater need for brain retraction.

In our study, the extent of tumor excision achieved was Simpson grade[16] I (n=1; 4.2%), grade II (n=16; 66.7%) and grade III (9, 37.5%). Both bifrontal (n=19) and unifrontal approaches (n=5) were utilized to excise the OGMs. Schaller et al and Yasargil et al achieved 96.4% and 85.7% gross total excision in their series via Pterional approach, while Zevgandis et al and Hentschel et al achieved gross total excision in 100% and 84.6% cases using frontal approach[7, 13, 20 and 21]. Nakamura et al achieved 100% total excision while Mirimanoff et al had 77.3%, both using bifrontal approach [10, 11]. Bitter et al had 98.3% gross total excision using multiple approaches[4]. There was single mortality in series of Schaller et al, four in Nakamura et al and two in Tsikoudas et al, while there was no mortality in other series as mentioned in Table-3, including our series[11, 13 and 18].

Morbidity after OGM has decreased significantly with the evolution of microsurgical techniques. There have always been trends toward completer excision of OGM with removal of involved hyperostotic bone. Earlier due to high morbidity associated, some advocated that there is no need for generous drilling of involved bone and only wise decision regarding this should be taken to decrease CSF Leak[3]. The fact put to back this concept was that the mortality from meningitis was much higher than recurrence. Now others views are that with the better technique of dural repair, the rate of CSF leak has decreased and with availability of better antimicrobial agents the mortality due to meningitis has decreased. Al-Mefty et al and Hentschel et al are in favors of total excision with removal of involved bone[1, 7]. The authors also favor this concept, also because with meticulous repair of skull base with vascularized pericranium has decreased the CSF leak rates. This requires total demucosalization of frontal sinus, resection of posterior wall of frontal sinus and cranialization, packing it with autologous tissue like muscle and then exteriorizing it with pedicled pericranium sutured to drilled skull base. Mortality rates have improved from earlier 10-67% to nearly 0% now. There was no mortality in our series also. Morbidity has also reduced including postoperative seizures, motor-sensory deficits, vision loss, mental status changes, CSF leak rates, meningitis with its complications, local surgical site infection. Morbidity in our study included CSF leak in 16.7%, persisted altered mental status in 33.3%, local wound bulge in 25%, while meningitis was seen only in one patient (4.2%) (Table-2). Other complications are seen in 2 (8.3%) patients which included pulmonary embolism secondary to deep venous thrombosis and urinary tract infection due to prolonged ICU stay which was managed conservatively. In studies by Paterniti, et al and Turazzi, et al there were no postoperative complications at all[12, 19].

Prognosis of OGM depends upon the histopathological grade of tumor and Simpson grade of excision[16]. Twenty (83.3%) patients in our series were of WHO grade I meningioma with meningothelial being the most common type. Rest four (16.7%) patients were of WHO grade II, atypical variety being the most common type. Factors implicated in the recurrences of these meningiomas are WHO grade, age and extent of resection. In our series mean follow up period was 16.9 months with range of follow up from 3 to 55 months. There were no recurrences during the follow up period in our cases. Tsikoudas et al had recurrence of four cases during follow up, earliest in 3 year and late up to 11 years[18].Chan et al in their series of meningioma had 20 cases of OGM and they found recurrence rate of 15% in 9 years of follow up[5]. While Mirimanoff et al found in his study that even after 77% GTR in OGM, there was recurrence rate of 41%[10]. These data point to the fact that recurrence of meningiomas are multifactorial and continuous watch during follow up must be kept, with radiological evaluation on slight suspicion to early detect and plan management.

Conclusion:

OGM forms 11% of all meningioma and 37.5% of all anterior cranial fossa meningioma. They predominantly occur in females and often extend to nasal cavity and/or ethmoid sinuses. The most common presentation is raised ICP followed by mental changes. Surgical excision by bifrontal or unifrontal approach depending on the extension of tumor bears good outcome.

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