Large olfactory groove meningiomas: clinical outcome considering different surgical approaches

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Abstract

Olfactory groove meningiomas (OGMs) account for 4.5 to 13% of all intracranial meningiomas (1,2). They arise in the anterior cranial fossa at the cribriform plate of the ethmoid bone and the area of the suture adjoining the planum sphenoidale.

We performed a large retrospective study of 98 patients (59 females and 39 males) evaluated and operated in the Neurosurgical Department of the National Institute of Neurology and Neurovascular Diseases between 1979 – 2009. This represented 7.93% of all intracranial meningiomas operated in our department (1235 cases). These operations were done by or under the supervision of the senior neurosurgeon (LD). For the surgical removal of the OGMs we used both frontolateral (67 cases) or bifrontal approaches (31 cases). We achieved total removal of the meningioma in most of the cases (93.9%), meaning in 66 patients operated through unilateral frontolateral craniotomy (98.5%), and in 26 patients operated through bifrontal craniotomy (83.9%). As postoperative complications, were encountered: subdural hygroma, postoperative hemorrhage, cerebrospinal fluid (CSF) leak, postoperative seizures, diffuse cerebral edema and local infection. Postoperative mortality was 7.14% (7 patients). Frontolateral approach allowed, even in large OGMs, very good postoperative results, with high rates of total tumor resection and low rates of morbidity and mortality.

Keywords: bifrontal approach, frontolateral approach, meningioma, olfactory groove, recurrence.

Introduction

Olfactory groove meningiomas arise in the anterior cranial fossa at the cribriform plate of the ethmoid bone and the area of the suture adjoining the planum sphenoidale. OGMs account for 4.5 to 13% of all intracranial meningiomas (1,2). The tumor, which covers the entire crista gali to the posterior part of the planum sphenoidale, could grow simetrically to the anterior sagittal sinus and falx or mainly to one side.

In case of large OGMs surgery represents a special challenge, because of their proximity to the arteries of the anterior circulation and the optic nerves. The authors reported on the clinical outcome after surgical treatment of the OGMs using unilateral frontolateral or bifrontal approaches.

Material and methods

We conducted a retrospective study of 98 patients with OGMs, representing 7.93% of all intracranial meningiomas operated in our department (1235 cases), which were evaluated and operated in the Neurosurgical Department of the National Institute of Neurology and Neurovascular Diseases between 1979 – 2009. There were 59 females and 39 males with an average age of 55.6 years. The mean diameter of the tumor was 4.75 cm (range 2.4-10 cm.)

Clinical features

Mental disturbances were the most common symptoms, which were present in 74 (75.5%) out of 98 patients. In most of the patients, mental disturbances were classified in fronto-orbitary syndrome, which encompassed immature personality, euphoric state and desinhibition, inappropriate social behavior and impulsivity.

Forty-one patients complaint of headache (41.8%). Visual disturbances were present in 28 patients (28.6%), and 21.4% (21 patients) had a history of seizures. On questioning, 69 patients (76.4%) reported a loss of sense of smell. The time from the first symptoms to the moment of surgical tumor removal ranged from 4 to 96 month (mean, 65 months).

Radiological features

Preoperative computed tomographic (CT) scans were performed in all patients. Magnetic resonance imaging (MRI) scans were performed in 58 cases since 1992, when this technique became available in our country (figure 1).

Bony hyperostosis was noted in 38 (38.8%) out of 98 patients. On MRI scans, compression of the optic nerve was observed in 27 patients (46.5%) out of 58. Extension of the tumor into paranasal sinuses was noted in 13 patients. Peritumoral edema on CT or MRI scans was noticed in 45 patients (46%). The maximum tumor diameter ranged from 2 to 10 cm, with a mean diameter of 4.75 cm.

Differential diagnosis

The differential diagnosis was made with falx meningiomas (figure 2), parasagittal meningiomas, convexity meningiomas and tubercullum sella meningiomas.

Surgery

In all cases, surgery was performed with the help of an operating microscope and microsurgical instrumentation. Tumors were operated on through the frontolateral (67 patients) and bifrontal approaches (31 patients).The frontolateral approach was performed on the right side in the majority (51 patients), except the cases in which the tumor extended predominantly onto the left side. Despite the fact that frontolateral approach is most often utilized for the removal of small or medium-size olfactory groove meningiomas, we used successfully this approach for the removal of large OGMs.

The mean diameter of the tumor was 4.27 cm. (range 2.4-8 cm) in patients operated through the frontolateral approach. In patients, in whom the bifrontal approach was used, the mean diameter of the meningioma was 5.2 cm. (range 6-10 cm.). Paranasal tumor extension was present in 9 tumors (29%), among 31 patients who were operated through the bifrontal approach, whereas, in the frontolateral group, the rate of paranasal tumor extension was 5.9% (4 out of 67 patients).

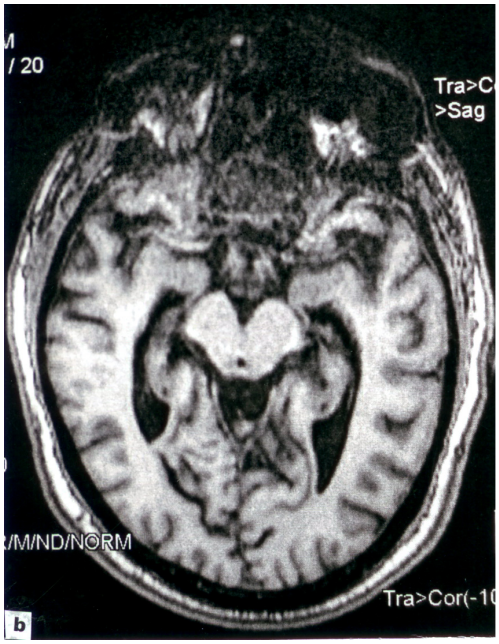
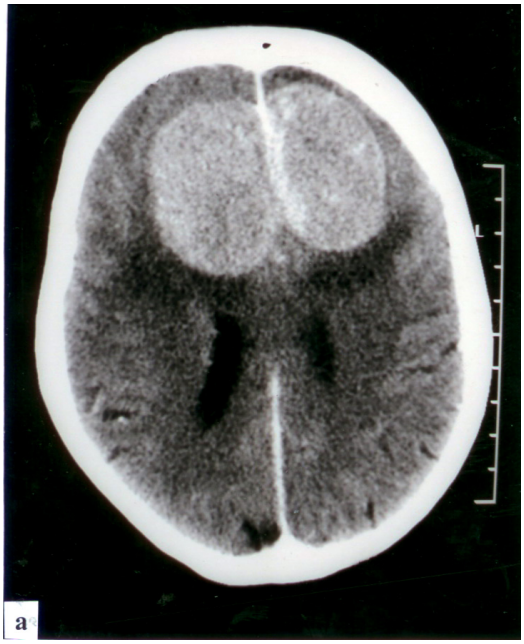


Figure 1 a) Preoperative T1-weighted axial MRI scan with gadolinium enhancement showing a large olfactory groove meningioma in a 52 years patient with mental disturbances, concentration difficulties, inappropriate social behavior and desinhibition; **b)** Postoperative T1-weighted axial MRI scan with gadolinium enhancement after tumor removal through a right frontolateral approach; the preoperative frontal lobe syndrome improved after surgery



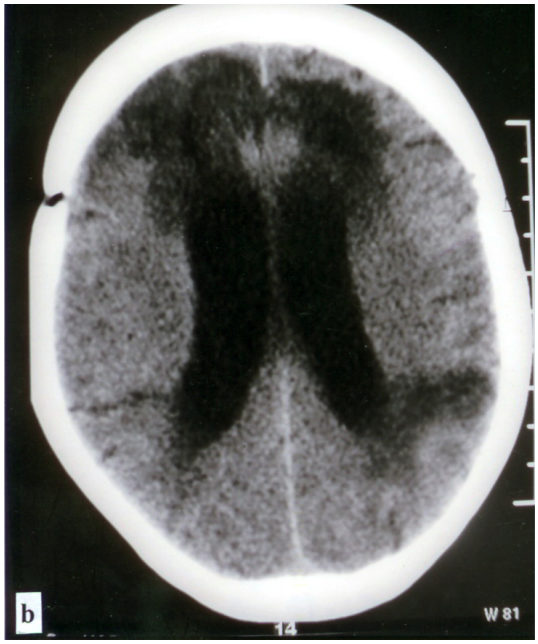


Figure 2 a) Preoperative axial CT scan showing a falx meningioma; **b)** Postoperative contrast axial CT scan showing complete resection of the tumor

When we reached tumor's attachment at the skull base, we had to decide whether complete removal of the meningioma could be achieved, and whether the tumor

invading the skull base could be removed. In case of hyperostosis or bony tumor involvement, we removed this site with a diamond drill. Despite the fact that these areas of hyperostosis may serve as a nidus for recurrence, we considered, as many other authors (10, 13) that the risk of entering the underlying ethmoid sinuses was greater than the risk of recurrence. A general tenet, practiced by the present authors, was to achieve complete tumor removal in all cases in an effort to decrease the risk of recurrence. When we approached the tumor through the frontolateral craniotomy, we mobilized it and detached from the siuns after the coagulation of its attachment at the skull base.

The extent of the tumor resection was classified according to the Simpson classification (19, 26).

Follow-up

All the 98 patients were followed-up with annual CT or MRI scans and neurologically evaluated in our clinic. The follow-up period ranged widely from 4 to 324 months (mean, 98 months; aprox. 8.2 years). We did not use standardized tests to assess the pre- and postoperative mental and psychiatric state of the patients. Those with previous mental changes, or their families, were asked whether these symptoms resolved, improved or were unchanged after surgery. Visual acuity and visual field assessment were performed pre- and postoperatively in 44 patients. Twenty-five patients presented with visual disturbances before surgery. The sense of smell was documented only on questioning. The handicap of anosmia was not assessed in a test.

Tumor recurrence occurred in 8 patients (8%). The mean follow-up period for recurrence was 86.5 months (range 51-140 months).

Results

Total tumor removal (Simpson Grade 1 or 2) was achieved in most of the cases, 92 patients (93.9%).). OGMs operated through the bifrontal approach were entirely resected in 26 (83.9%) out of 31 cases (figure 3). In patients operated through the frontolateral approach (67 patients), total tumor removal was achieved in 66 cases (98.5%) (figure 4). The difference was not significant.

Morbidity and mortality

After the frontolateral approach for the resection of the OGMs, the most common postoperative complication was subdural hygroma, which occurred in 6 patients (8.95%). None of them required surgical treatment. Postoperative subdural hygroma was observed in tumors larger than 4 cm. in diameter. Minimal postoperative hemorrhage and brain edema were noticed in 2 patients (3%), both with a tumor size larger than 5 cm, but did not require surgery. Generalized seizures were observed postoperatively in 8 patients (11.9%), with tumors size between 3 and 5 cm., with no seizure prior to surgery. These were controlled with proper antiepileptic drugs. Local wound infection was noticed in 3 patients (4.4%).

After tumor resection through the bifrontal approach, the most common postoperative complication was brain edema. It was observed in 4 patients (12.9%), 3 of them having tumors larger than 5 cm. Postoperative hemorrhage occurred in 3 patients (9.7%), all of them requiring a second surgical intervention.

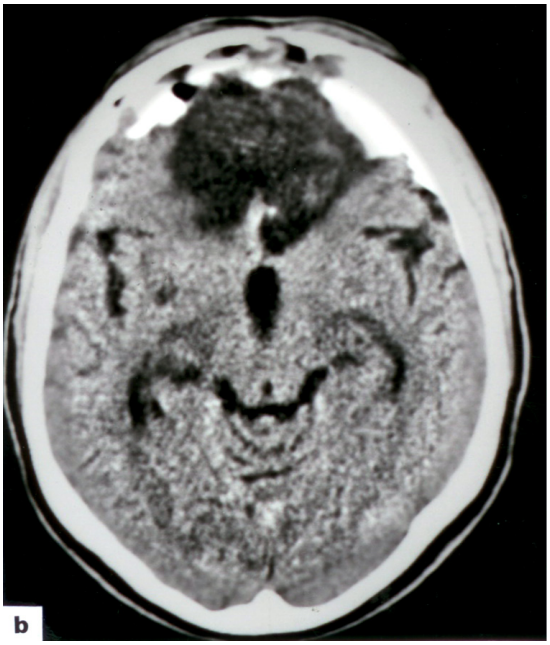


Figure 3 a) Preoperative axial CT scan with contrast enhancement showing a large olfactory groove meningioma in a 56 years old male, **b)** Postoperative contrast axial CT scan after tumor removal through the bifrontal approach

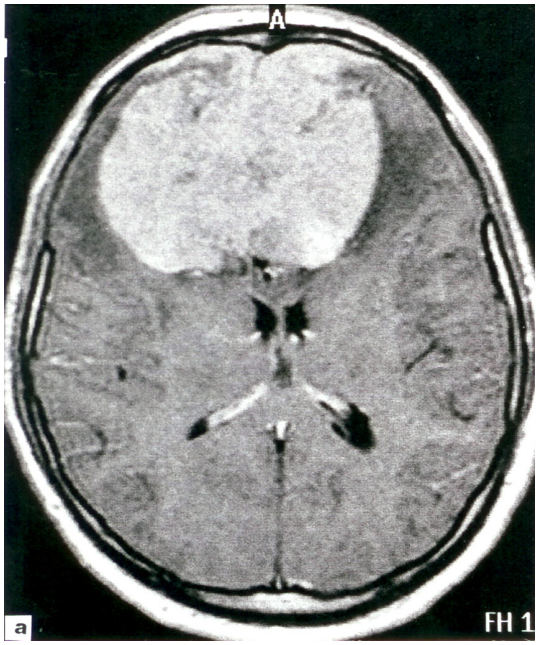


Figure 4 a) Preoperative T1-weighted axial MRI scan with gadolinium enhancement showing a large olfactory groove meningioma in a 26 years old female, **b)** Postoperative T1-weighted axial MRI scan with gadolinium enhancement after tumor removal through a right frontolateral approach

Hydrocephalus was observed in 2 patients (6.45%), and a subdural hygroma was noticed in 1 patient (3.2%). Postoperative seizures occurred in 2 patients (6.45%). A cerebrospinal fluid (CSF) fistula occurred in 1 patient (3.2%) and required repeated lumbar punctures for CSF drainage. Local wound infection was noticed in 2 patients (6.45%).

The total postoperative mortality was 7.14%, meaning that 7 patients had died: 4 because of extensive postoperative brain edema, one died because of pulmonary embolism started from a deep vein thrombosis of the lower extremities and 2 died because postoperative hemorrhage. In the group of patients who died because of postoperative brain edema, the tumor diameter was between 6-10 cm. The mortality rate was 16% (5 patients) in the bifrontal group and 3% in the frontolateral group (2 patients).

During the postoperative follow-up period, we noticed that the fronto-orbitary syndrome resolved in 21 patients and improved in 41 others. After surgery, preoperative visual disturbance improved in 16 (57%) out of 28 patients (figure 5). In 17 (81%) of the 21 patients who had a history of seizure before surgery, the symptom completely resolved after surgery, but new postoperative seizures occurred in 8 patients, who needed antiepileptic medication. Regarding the patients who reported a loss of sense of smell before surgery, olfaction did not return to normal postoperatively in any of them.

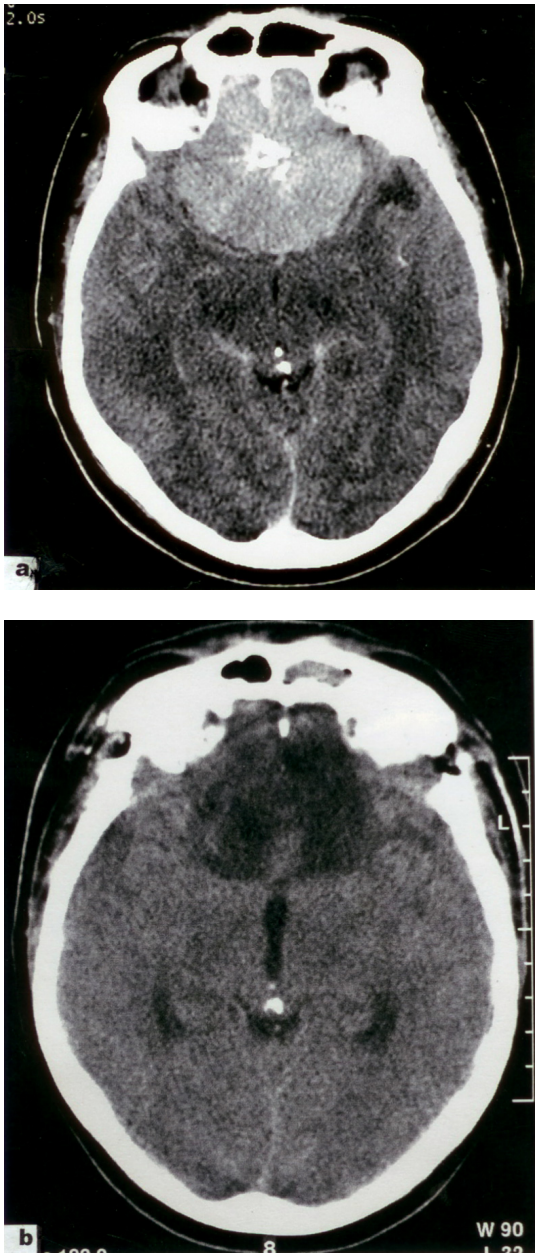


Figure 5 a) Preoperative axial CT scan with contrast enhancement showing a large olfactory groove meningioma in a 49 years old male, with mental and visual disturbances **b)** Postoperative contrast axial CT scan after tumor removal through the bifrontal approach, with disappearance of the memory disturbances and depression and improval of visual disturbances

TABLE 1

Postoperative complications in frontolateral approach for olfactory groove meningiomas

Frontolateral approach complications	No. of patients	%
Subdural hygroma	6	8.95%
Postoperative hemorrhage	2	3.0%
Postoperative brain edema	2	3.0%
Postoperative seizures	8	11.90%
Local wound infection	3	4.4%

TABLE 2

Postoperative complications in bifrontal approach for olfactory groove meningiomas

Bifrontal approach complications	No. of patients	%
Subdural hygroma	1	3.20%
Postoperative hemorrhage	3	9.70%
Postoperative brain edema	4	12.90%
Postoperative seizures	2	6.45%
Hydrocephalus	2	6.45%
CSF fistula	1	3.20%
Local wound infection	2	6.45%

Tumor recurrence

The tumor recurrence rate depends of the extent of tumor resection and the duration of the follow-up period (1,19,26). In our series, tumor recurrence occurred in 8 patients (8%). All of them required surgery. The recurrence rate was higher in patients with tumors having paranasal extension and which were mainly operated through bifrontal approach. Four of the patients with recurrences had tumors with paranasal extension and were operated through bifrontal approach. In their case, tumor recurrence developed at 51, 60, 92 and respectively 96 months after the first operation.

Among those patients with tumor recurrence, the recurrence rate for the bifrontal group was 16.12% (5 patients), which was higher, compared with the frontolateral group, in which the recurrence rate was 4.47% (3 patients).

In our series, none of the patient underwent postoperative radiation or radiosurgery. In the case of clinical recurrence, for small residual or recurrent tumors, especially when the recurrent tumor was in intimate relation to the optic nerve and chiasm, we decided for surgical treatment instead of radiosurgery.

Discussions

The bifrontal approach, proposed earlier by Tonnis (31), is recommended for removal of large frontobasal tumors, and so it is advocated for large olfactory groove meningiomas (17,21,22,23,29). This approach allows the least amount of retraction on the frontal lobes and offers direct access to almost all sides of the tumor.

For small OGMs, a unilateral subfrontal approach was preferred by some authors (7,21,27,29). Others stressed the disadvantages associated with the subfrontal approaches and advocated the pterional approach for removal of olfactory groove meningiomas (14,15,32). They claimed that the latter approach, which is closer to the posterior surface of the tumor, provide direct visualization of the vessels that are to be dissected.

Cranial base approaches, which are more aggressive, have recently been proposed for the removal of OGMs. These approaches include a combination of bifrontal craniotomy with unilateral orbital rim osteotomy (2), a frontotemporal craniotomy with orbital osteotomy (24,28), or frontal craniotomy with orbital osteotomy (3). Orbital osteotomy enables

the surgeon to attack the tumor with the shortest working distance and eliminate the need of brain retraction, because the tumor insertion at the frontal base can be reached immediately with early detachment of the tumor (19,28). Disadvantages of approaches combining craniotomy with orbital osteotomies include the higher risk of CSF fistula caused by wide opening of the frontal sinus and the time-consuming surgical approach compared with the standard frontolateral or pterional approach (7,8,19).

For tumors with significant or predominant extension to paranasal sinuses, a subcranial approach or combined craniofacial resection was developed, both of which are performed mainly by otolaryngology surgeons alone or in cooperation (6,7,19,25,28). In our series of OGMs, because the tumors did not show predominant invasion of the paranasal sinuses, a combined otolaryngology approach was not performed.

In our surgical series, in the majority of patients, the choice of surgical approach for resecting large OGMs (frontolateral or bifrontal), using microsurgical techniques, were not influenced by the tumor size.

The mortality rates for surgery of OGMs ranged from 0 to 33% in earlier surgical series (4,9,16,18,19,21,27,32). With the advent of microsurgical techniques, the morbidity and mortality rates after surgery of OGMs have declined (14, 19, 22, 23, 29, 32). Major potential surgical complications include CSF leak, meningitis, postoperative hemorrhage, subdural hygroma, worsening vision, motor deficits, and postoperative seizures (4,12,18,27). In our series, the morbidity was low and was comparable to recent surgical series of OGMs (12,14,21,22,27,30,32). It is worth to be noticed that most of the patients who died perioperatively (one of whom died from other medical complications), were operated on through the bifrontal approach (5 out of 7 patient who died). After Nakamura et al. (19), these complications are more related to the choice of surgical approach itself than to the size of the tumor and may be ascribed to the routine sectioning of the superior sagittal sinus and draining midline veins when performing the bifrontal approach. We subscribe to their opinion.

The extent of OGMs resection has improved with the advent of modern microsurgery, with a gross total resection rate of 70 to 100% in microsurgical series (19,23). Although it has been stressed that complete tumor resection should not be attempted risking higher morbidity rates, recent microsurgical series (including our series) showed that high rates of complete tumor resection can be performed without increasing morbidity (19,21,22,29,32). In our series, the rate of total tumor resection (Simpson Grade 1 or 2) did not differ significantly among the two approaches. Total tumor removal was achieved in most of the cases, 92 patients (93.9%). OGMs operated through the bifrontal approach were totally resected in 26 (83.9%) out of 31 cases. In patients operated through the frontolateral approach (67 patients), total OGMs removal was achieved in 66 cases (98.5%). Frontolateral approach does not allow removing the tumor from various angels compared with the bifrontal approach, but, in experienced hands, very high rates of total tumor removal could be achieved.

The recurrence rate for OGMs reported in the literature ranged from 0 to 41% in macro- and microsurgical series, with a

follow-up period raging widely from 3.7 to 25 years (5,9,11,13). In our series, with wide follow-up period, the recurrence rate was 8% (8 out of 98 patients). Five patients were initially operated through the bifrontal and 3 patients through the frontolateral approach, meaning that the recurrence rate for the bifrontal group (16.12%) was higher compared with the frontolateral group (4.47%). In our series, OGMs with paranasal extension, which were mainly operated through the bifrontal approach, revealed a higher recurrence rate.

Conclusions

For the removal of large olfactory groove meningiomas we used two different surgical approaches: unilateral frontolateral approach and bifrontal approach. The frontolateral approach permitted, even in large meningiomas, high rates of total tumor resection with low recurrence rates and less brain exposure (17,18). The use of microsurgical techniques allowed total removal of the large OGMs, with low rates of mortality and mortality. The conservation of the involved frontobasal bone prevented the CSF rhinorrhea, and that is why, we preferred, in most of the cases, to performe the coagulation of the basal dura and superficial removal of the hyperostosis. Considering the operative morbidity and mortality encountered in the resection of large olfactory groove meningiomas, we could conclude that, the frontolateral approach provided an important improvement compared with the bifrontal one.

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