Olfactory groove meningioma

Meningiomas of the olfactory groove arise from the region of the frontosphenoidal suture and may involve any part of the area from the crista galli to the planum sphenoidale.

Classification

The classification includes:
- Small (0–2 cm in diameter)
- Medium (2–4 cm diameter)
- Large (4–6 cm diameter)
- Giant Olfactory Groove Meningioma (>6 cm in diameter).

Epidemiology

The incidence of olfactory groove meningioma is approximately 8%–14% of all intracranial meningiomas.

Clinical features

Olfactory groove meningiomas most commonly present with symptoms of headaches, anosmia, or even possibly personality changes. The anatomic location of the olfactory groove meningioma may cause prolonged psychiatric symptoms before the onset of more overt neurologic deficits.

Due to these subtle symptoms prior to clinical presentation, olfactory groove meningiomas can grow insidiously large and present as one of the largest intracranial tumors.

Visual symptoms

They may produce progressive compression of the frontal lobes and project backward towards the sella, and if large enough, they can affect vision by compressing the optic nerve and chiasm.

Visual symptoms occur usually after an olfactory groove meningioma has reached a considerable size but can depend on their exact origin. Because olfactory groove meningiomas extend posteriorly, this extension can cause compression on one or both of the optic nerves or the chiasm, and may occur earlier in smaller tumors arising from the posterior half of the cribiform plate.

Diagnosis
MRI studies

Fine-cut CT or CT angiography (CTA)

The studied parameters are maximum tumor diameter; tumor volume, using the modified ellipsoid formula \((A*B*C)/2\); the presence of hyperostotic bone and calcified tumor (on CT/CTA studies, when available); tumor shape (rounded vs lobular); vascular encasement (on CTA and T2-weighted MRI); optic canal invasion (on fine-cut axial T1-weighted, postcontrast MRI/CT); and the presence of cortical cuff between the tumor and anterior cerebral vasculature.

Identification of SMO and AKT1 mutations in meningiomas has raised the hope for targeted therapies. It would be useful to know the precise frequency of these mutations in anatomical subgroups and clarify their prognostic value.

Molecular diagnosis of SMO L412F/W535L and AKT1 E17K mutations improves prognostic evaluation in olfactory groove meningiomas and opens new therapeutic perspectives with SMO or AKT inhibitors for recurrent cases.

Strickland et al., performed targeted sequencing in a large cohort of patients with anterior skull base meningiomas (n = 62) to better define the frequency of SMO and AKT1 mutations in these tumors. The authors found SMO mutations in 7 of 62 (11%) and AKT1 mutations in 12 of 62 (19%) of their cohort. Of the 7 meningiomas with SMO mutations, 6 (86%) occurred in the olfactory groove. Meningiomas with an SMO mutation presented with significantly larger tumor volume (70.6 ± 36.3 cm³) compared with AKT1-mutated (18.2 ± 26.8 cm³) and wild-type (22.7 ± 23.9 cm³) meningiomas, respectively.

Combined, these data demonstrate clinically actionable mutations in 30% of anterior skull base meningiomas and suggest an association between SMO mutation status and tumor volume. Genotyping of SMO and AKT1 is likely to be high yield in anterior skull base meningiomas with available surgical tissue.

Approaches

Surgical removal is often performed through the bifrontal, unilateral subfrontal (frontolateral), or pterional approach.

Olfactory groove meningiomas remain surgically challenging. The common microsurgical approaches suffer from late exposure of the neurovascular structures. Conversely, the pterional approach has the advantage of early dissection of the posterior neurovascular complex.

Adappa et al. discusses the surgical approaches for resection, especially the transnasal endoscopic approach. Alternative treatment options are primarily used where patients are not surgical candidates or location of recurrence precludes additional surgery. These options include radiotherapy, stereotactic radiosurgery, and chemotherapy. In addition, they discuss the current on going research in molecular targeting agents for meningioma treatment.
Frontolateral approach

In recent years, Nakamura et al., have preferred to use the frontolateral approach, which provides quick access to the tumor with less brain exposure while still enabling total tumor removal with a low morbidity rate and no mortality\(^\text{11}\).

Pterional approach

A total of 61 patients underwent removal of olfactory groove meningiomas via the pterional approach. These included 58 primary and 3 recurrent tumors. Mean overall follow-up time was 122 months.

Early exposure and dissection of the internal carotid artery, middle cerebral artery, anterior cerebral artery, and optic nerve was feasible in all cases. Complete tumor removal was achieved in 60 patients. Morbidity and mortality rates were 26% and 1.6% respectively. Postoperative complications included epileptic seizures (five patients) and cerebrospinal fluid (CSF) leak (two patients). During follow-up, three tumor recurrences.

The pterional approach appears to be an excellent solution for the treatment of olfactory groove meningiomas. Its foremost advantage is early visualization of the posterior neurovascular complex. Moreover, it allows frontal sinus preservation and timely tumor devascularization and avoids excessive brain retraction. The pterional view is familiar to most neurosurgeons and therefore the transition to this technique is fairly straightforward\(^\text{12}\).

Anterior interhemispheric approach

Endoscopic Endonasal Approach for Olfactory Groove Meningioma

see Endoscopic Endonasal Approach for Olfactory Groove Meningioma

Supraorbital eyebrow approach

The supraorbital eyebrow approach, with endoscopic assistance, leads to a higher extent of resection and lower rate of complications than the purely endonasal endoscopic approach. The endonasal endoscopic approach by itself may be suitable for a small percentage of cases. The combined above-and-below approaches are useful for large tumors with invasion of the ethmoid sinuses\(^\text{13}\).

Complications

Higher complication risk is associated with larger tumours and greater perilesional oedema. Preoperative dexamethasone for 3-5 days versus shorter periods may reduce the risk of complications.
Mukherjee et al. describe a characteristic pattern of perilesional oedema termed 'sabre-tooth' sign, whose presence is associated with a higher complication rate and may represent an important radiological prognostic sign. Elective post-operative ventilation for patients with high-risk tumours may reduce the risk of complications. 14).

**Case series**

2015

Ninety-nine patients who underwent 113 craniotomies at the Institute of Neurosurgery, Università Cattolica del Sacro Cuore, Rome, Italy between 1984 and 2010 were entered this study. The relationship between surgical approach (bifrontal, fronto-orbito-basal, and pterional) and either tumor diameter, extent of tumor resection, complication rate, need of reoperation, and Karnofsky Performance Status (KPS) was analyzed. The impact of age (≤ 70 vs. > 70 years), sex, tumor diameter (< 6 vs. ≥ 6 cm), pre- and postoperative KPS (< 80 vs. ≥ 80), Simpson grade (I-II vs. III-IV), and World Health Organization (WHO) histologic grade (I vs. II-III) on survival was assessed. Kaplan-Meier survival curves were plotted and differences in survival between groups of patients were compared. A multivariate analysis adjusted for age, pre- and postoperative KPS, Simpson grade, tumor diameter, and WHO histologic grade also was performed.

The fronto-orbito-basal approach (n = 22) allowed a significantly greater percentage of Simpson I-II removals than the bifrontal (n = 70) and pterional approach (n = 21) (P = 0.0354 and P = 0.0485, respectively). The risk of life-threatening complications trended to be lower in patients operated upon either via the fronto-orbito-basal and via the pterional approach than in those treated via the bifrontal approach. Retraction-related brain swelling did not occur in any case after the fronto-orbito-basal approach (P = 0.0384); however, this approach was associated with a greater rate of cerebrospinal fluid leak (P = 0.0011). Among prognostic factors, age ≤ 70 years (P = 0.0044), tumor diameter <6 cm (P = 0.0455), pre- and postoperative KPS ≥ 80 (both P < 0.0001), Simpson grade I-II (P = 0.0096), and WHO histologic grade I (P = 0.0112) were significantly associated with longer overall survival. Age (P = 0.0393) and WHO histologic grade (P = 0.0418) emerged as independent prognostic factors for overall survival on multivariate analysis.

In the largest series of OGMs published to date, the bifrontal approach was associated with a greater risk of life-threatening complications compared with the lateral pterional and fronto-orbito-basal approaches. The fronto-orbito-basal approach provided greater chances of total tumor removal than the bifrontal and pterional approaches. Two independent factors for overall survival of patients with OGM were identified, namely age and WHO grade 15).

**Case reports**

A 42-yr-old female presented with an olfactory groove meningioma causing progressive vision loss and anosmia. Given the size of the tumor, we opted for a 2-stage surgery: endoscopic endonasal approach (EEA) followed by a craniotomy. Stage I surgery was a transcricriiform transplanum EEA using a binosstril 4-hand/2 surgeons (ENT and neuro) technique, with the patient positioned supine with the head slightly turned to the right side and tilted to the left, fixed in a 3-pin head clamp, under imaging guidance, in which we drilled out all the affected skull base bone, devascularized and debulked the tumor. Stage II surgery was done through a right frontotemporal craniotomy 2 mo later.
The surgery and postoperative period was uneventful with no complications and no need for further reconstruction of the skull base. The patient’s vision was normalized. Postoperative magnetic resonance imaging (MRI) confirmed a Simpson Grade 1 resection. The rationale behind this staged approach is that we have found when using a transcranial 1-stage approach the brain edema and necessary retraction required for resection leads to brain injury, oftentimes readily identified in the diffusion-weighted imaging MRI which are associated with different degrees of cognitive impairment. The skull base bone involved is usually not removed via transcranial approaches. Despite requiring a second surgery, this staged approach allows a true total resection (including the affected bone) and in the transcranial stage the brain is more relaxed, with less edema, reducing the need for retraction, which may lead to a better outcome.\(^{16}\)

Patrikelis et al., present the case of a patient who lost the ability to enjoy humour after the surgical removal of a olfactory groove meningioma, although he was still able to detect it, while at the same time was diagnosed with organic alexithymia. The results indicate that problems in the affective appreciation of humour and in emotionalizing (alexithymic symptoms) may be the result of damage to the ventral-rostral portions of the ACG/mPFC, which prevent the patient from assessing the salience of emotion and motivational information, and generating emotional reactions; as a result he has trouble experiencing emotions, knowing how he and others feel, and enjoy humour.\(^{17}\)


