



## OLFACTORY MENINGIOMA: THE GODFATHER OF COGNITIVE IMPAIRMENT AND BEHAVIORAL CHANGES- EPIDEMIOLOGICAL FEATURES SCRUTINIZED ...

### Neurosurgery

<b>Alqroom Rami</b>	Neurosurgery Department, King Hussein Medical Center, Amman, Jordan.
<b>Alshurbaji Duaa</b>	Pathology Department at Princess Iman Research and Laboratory Sciences Center, Amman, Jordan.
<b>Makhamreh Basel</b>	Anasthesia Department, King Hussein Medical Center, Amman, Jordan.
<b>Alshurbaji Faisal</b>	Neurosurgery Department, King Hussein Medical Center, Amman, Jordan.
<b>Al manaseer Noor uddeen</b>	Neurosurgery Department, Mafraq Hospital, Abu Dhabi, UAE
<b>Al Shurbaji Amer</b>	Neurosurgery Department, King Hussein Medical Center, Amman, Jordan.

### ABSTRACT

**Impetus:** Cognitive impairment and behavioral changes are suggestive of a frontal lobe pathology; this congregated with visual symptoms and anosmia should raise suspicion of olfactory meningioma. After surgical resection, recovery of the behavioral changes can be expected.

**Objectives:** In this review, we scrutinize the epidemiological features of olfactory meningioma diagnosed at a single referral center. Special emphasis has been dedicated to demographic features, clinical magnitudes, and risk factors related to the tumor treatment itself.

**Patients and Methods:** This retrospective review was carried out by reviewing medical records of patients diagnosed to have olfactory meningioma and treated at King Hussein Medical Center. Patients were retrieved from the electronic hospital database during a 12-year period (2004 to 2015). Demographic features; sex, age, size of tumor, resection extent, and post-operative history of radiation therapy, and recurrence were documented.

Preoperative radiological reports were used to confirm tumor location and size based on largest single dimension. Extent of resection was based on surgical operative notes and post-operative imaging.

**Results:** Sixty-seven patients developed olfactory meningioma. Female patients were 44-cases, with a median age of 49.61 years (range, 30-75years) at presentation. Clinically, the most frequent complaint was headache (62.68%) followed by mental changes (52.23%). visual impairment (31.34%), anosmia/hyposmia (26.86%).

Subtotal resection in 3-cases, recurrence noted in 4-patients, 1 mortality in early post-operative stage.

**Conclusion:** Olfactory groove meningioma is rare benign, slow-growing tumor, constituting only 2% of all primary intracranial tumors and 4-13% of all intracranial meningiomas. Clinical presentation is insidious and diagnosis often occur in the late stage. Cognitive impairment and behavioral changes is the cardinal presenting picture. The archetypical demographics of these tumors; female predominance, young age group 20-50 years. Olfactory meningiomas are treatable. After surgical resection, reversal of the changes in thought processes can be expected. Gross total resection is crucial for recurrence, adjuvant radiotherapy is still controversial.

### KEYWORDS

Olfactory meningioma; Extent of resection; Meningioma; Frontolateral approach

#### Introduction

Meningiomas are the most commonly described intracranial tumors, 36% of all primary brain neoplasms in adults [1, 2]. However, olfactory groove meningiomas represent 4-13% of all intracranial meningiomas [3-5]. Olfactory groove meningiomas arise from the dura of the anterior cranial fossa over the cribriform plate [4, 5]. They are slowly growing lesions, usually remain clinically latent during the early phases of tumor growth leading to large tumor sizes at the time of diagnosis [6, 7].

Due to the fact that olfactory groove meningiomas arise from the weakest part of the skull base, the cribriform plate, making them prone to infiltrate the underlying bone and extend into the paranasal sinuses and nasal cavity [3]. The cardinal clinical feature observed usually are mental changes and headache as a result of olfactory or optic nerve and frontal lobe compression. hypo/anosmia, visual deterioration, seizures are also common in these patients [8]. Numerous surgical approaches have been recommended to tackle olfactory groove meningiomas, with the fronto-lateral, pterional and subfrontal (unifrontal or bifrontal) and their variations being the most common open transcranial procedures, but describing the ideal surgical approach is still controversial [9-13].

Histologically, meningiomas based on the World Health Organization (WHO) classification system categorized into three histological grades (1-2-3) and 15 subtypes [14-19]. Histologic grade has a noteworthy influence on prognosis, risk of recurrence, and the need for adjuvant radiation or chemotherapy [16].

In the current analysis, we analyzed outcomes of olfactory groove meningiomas diagnosed at a single institute. Special emphasis has been devoted to demographic features, clinical picture, histological alterations, and risk factors related to the tumor treatment itself and surgical techniques.

#### Patients and Methods:

This study was conducted by reviewing retrospectively the clinical data, radiological findings, surgical treatment and clinical outcomes of the patients, clinical information documented. Six hundreds sixty-five patients with meningioma were treated at King Hussein Medical Center, between January 2004 and January 2015. Sixty-seven patients showed olfactory groove meningiomas. Demographic features; sex, age, size of tumor, resection extent, surgical technique, histological alterations and post-operative treatment received were documented. Preoperative radiology reports were used to confirm tumor location and size based on largest single dimension. Extent of resection was based on surgical operative notes and post-operative imaging. Gross total resection (GTR) was defined as Simpson 1-2 and subtotal resection (STR) as Simpson 3-4.

#### Surgical details

Resection of the anterior skull base region lesions has been a challenge for neurosurgeons, several approaches had been advocated: pterional, unifrontal, bifrontal, frontolateral [17-21]. We tailor the surgical procedure to each patient according to the specific anatomic location of tumor invasion. The most commonly used approach in our hands is the frontolateral craniotomy, as it has both features and exposure benefits of subfrontal and pterional craniotomy. Other less

used in our department approaches are: the unifrontal and the bifrontal for large and invading tumors. In details; after induction and general anesthesia, the patient is positioned supine with the head elevated above the cardiac level to minimize bleeding. The head was also fixed with three pins in the head frame (Mayfield) and was rotated 15-45 degrees towards the opposite side and tilted slightly depending on the precise location of the lesion. Minimal hair shaving was performed and the skin incision was short and behind the hairline. The skin incision is curvilinear, the upper side of the incision was behind the hairline 2–3 cm across the frontal middle line, while the lower side of the skin incision was 1 cm anterior to the ear screen on the upper rim of the zygomatic arch. The temporal muscle was stripped from its bony insertion and retracted laterally. (Fig. 1A,B). The one layer skin-galea-muscle flap was dissected after its detachment from the bone by diathermy, thereby avoiding any possible injury of the branches of the facial nerve. The spring hooks were used to retract the flap anteriorly until the superior orbital rim was exposed (Fig. 1C). The temporal muscle was split only in its superior and anterior part (Fig. 1C,D). A bur hole was subsequently drilled on the key point (frontozygomatic process) (Fig. 1D). The bone flap was detached mainly by side-cutting craniotomy. The mean bone flap size was 4×3 cm (Fig. 1E,F). After the dura mater was opened in a curvilinear incision pointing antero-laterally. Only one retractor was used for the brain retraction. Our strategy is to debulk the lesion methodically, starting from the right side of the tumor, then we detach the falx anteriorly, after that we debulk the left side of the tumor, then we dissect the posterior and the superior parts of the tumor .Dealing with the basal part and tumor origin at last. In closure, the bone flap was fixated with a skull fixator (Fig. 1J). Brain relaxation and control of intracranial pressure maintained using dehydrating agents and moderate hyperventilation prior to and during surgery (Fig. 1H). The opened frontal sinus was sealed, and the supraorbital nerve was preserved as possible. If no tumor in the bone flap, we keep it for replacement, if involved we send it for biopsy and we perform cranioplasty. The dura beneath the flap if not involved opened in flap fashion and then re-sutured. The abnormal dura around the tumor usually resected and if need a dural patch is placed. Our strategy is always to aim for gross total resection (Simpson 1-2).



**Fig.1A-H: Preoperative and intra-operative steps of frontolateral approach.**

**Results:**

In this cohort of 67 treated patients, female to male ratio was 1.9:1, with a median age of 49.61 years (range, 30-75years) at presentation. The mean follow up was 78.3-months (34-172months) (table.1).

Tumor size was not available in 5 patients because of incomplete medical records or lost pre-operative images; these patients were excluded from analysis of size. A cut-off of 4cm was used as this was the average greatest single dimension in our patient base. Tumor size was >4cm in 64.3%, <4 cm in 28.2%, and unknown in 7.5%.

Clinically, majority of patients presented most frequent complaint was headache (62.68%) followed by mental changes (52.23%). visual impairment (31.34%),anosmia/hyposmia (26.86%).

All patients were clinically monitored with an average follow-up of 6.2 years. Contrasted MRI performed for follow up every 6-months in those with histologically verified grade II meningioma, or if any change in clinical picture developed. In this study we achieved gross total resection in 83.6% of cases, subtotal resection in 8.8%, and 7.5% had unknown extent of surgical resection. All evolved favorably with neurological examination. Four-cases developed recurrence. One-case of mortality due to pulmonary embolism after massive deep venous infarct.

Parameter	Number
Gender	
Male	23
female	44
Age	
>50	32
<50	35
Clinical Presentation	
Headache	42
Mental status alteration	34
visual impairment	21
anosmia/hyposmia	18

**Table.1: Demographic features and leading signs and symptoms of atypical meningioma diagnosed in our department**

**Discussion:**

Olfactory groove meningiomas are rare benign, slow-growing tumors, constituting only 2% of all primary intracranial tumors and 4-13% of all intracranial meningiomas [3,4,5,22,23]. Displacement of the olfactory tracts and optic chiasm occur when the meningioma extends into the paranasal sinuses and nasal cavity.

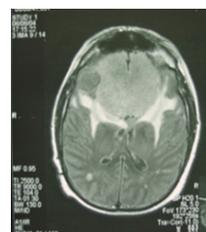
Clinical presentation is insidious and diagnosis often occur in the late stage, as many patients are asymptomatic before the meningioma reaches a sufficient size to compress the frontal lobe and optic nerve or optic chiasm [24]. The patient usually presents with severe headache, visual symptoms, cognitive impairment and profound changes in personality. Anosmia is a common finding on physical examination [25]. This analysis revealed some demographic features regarding this category; there was female predominance, 1.9:1, mean age at presentation was 49.61-year. The signs and symptoms found more frequently in our study were headache, followed by mental status alteration, seizures, and headache. Notably, a considerable part was serendipitously diagnosed [Table.1].

This study clinical results were in accordance with the literature. Patients younger than 65 who present with clinical features typical of dementia should be evaluated thoroughly for reversible causes, as dementia has serious life-altering consequences for patients and their family members.

Radiological imaging is crucial in both pre-operative evaluation of tumor size and post-operative tumor resection extant and recurrence, magnetic resonance imaging is the diagnostic tool of choice for meningiomas. The conventional characteristic evident on CT and MRI images of dural tail, peri-tumoral edema, and calcification are all important features [2,4,6]. Substantial connection has been found between the atypia/ higher grade tumor and the; the large tumor size (>40mm), shape, localization (base of skull), presence of brain invasion, and the severity of peritumoral edema [25-30]. The concomitant factors in this review indicating atypia were the massive peri-tumoral edema, the large tumor size and classification.



**Figure.2: Coronal and axial MRI images showing the extensive size of olfactory meningioma**



### Figure.3: Axial MRI images showing the extensive peri-tumoral edema surrounding the olfactory meningioma

In management of cranial meningiomas, the presence of clinical symptoms and the tumor progressive growth are the main determining factors, which lead the clinical management decision-making strategy. The first line treatment of meningiomas is surgery, but the extent and types of approaches advised for olfactory groove meningiomas are diverse, from aggressive skull base approaches to standard or minimally invasive craniotomies and endoscopic approaches [9-14]. Complete resection of tumor is the aim of the surgical procedure (if reasonable) to achieve the best quality of life for the patient and to reduce the risk of recurrence. The extent of resection is graded according to Simpson scale [30]. There is controversy regarding the role of adjuvant radiotherapy for completely resected grade II tumors, the optimal timing and approach for radiation therapy in various clinical settings [31, 32].

In our series we achieved gross total resection in 88.05% of cases, subtotal resection in 4.47%, and 7.46% had unknown extent of surgical resection [Figure. 4]. Although, some authors advocate that observation alone after GTR of high grade meningiomas was not associated with increased risk of tumor recurrence or mortality [18].

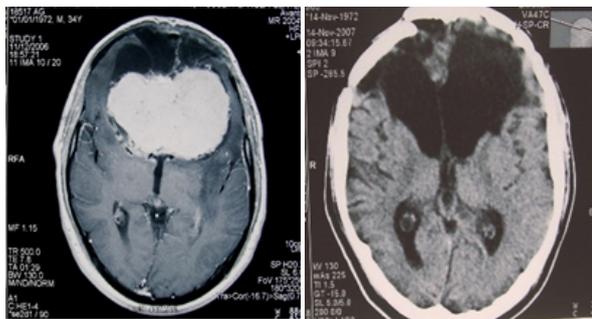


Figure.4: Preoperative and postoperative images showing the gross total resection.

Our strategy was till 2013, adjuvant radiotherapy based on empiric experience in high grade meningiomas. Nowadays, in case we achieve GTR and on regular 6-month follow-up radiological images, there no recurrence, we observe. Otherwise, patients receive adjuvant radiotherapy. Our review revealed 3-cases developed recurrence, which had previous STR and 4-cases reported histologically as high grade, 87.4% of our cases were grade 1 of all subtypes.

Postoperatively patients developed complications include CSF leak in 2-cases, hematoma in 3-cases, wound infection/ empyema 1-case. The single mortality observed in our series was due to massive deep venous thrombosis led to massive pulmonary embolism.

**Conclusion:** Olfactory meningiomas although are rare but treatable. Symptoms and signs of cognitive impairment and behaviour changes are suggestive of a frontal lobe lesion; this together with visual symptoms and anosmia should raise suspicion of olfactory meningioma. Patients presenting with features suggestive of early-onset dementia should be evaluated thoroughly for reversible causes. Magnetic resonance imaging is the criterion standard method for detecting meningiomas. After surgical resection, reversal of the changes in thought processes can be expected.

**Conflict of interest statement:** Authors state no conflict of interest.

### REFERENCES

- Ostrom QT, Gittleman H, Liao P, et al. CBTRUS statistical report: Primary brain and central nervous system tumors diagnosed in the united states in 2007-2011. *Neuro Oncol.* 2014;16(Suppl4): 1-63.
- Uduma U.F., Emejulu J.C. Intracranial meningiomas in the present era of modern neuroimaging: diagnostic and management options, with radiological illustrations. *Orient J. Med.*, 2013, 25, 67-74.
- Guduk M, Yener U, Sun HI, Hacihanefioglu M, Ozduman K, Pamir MN. Pterional and Unifrontal Approaches for the Microsurgical Resection of Olfactory Groove Meningiomas: Experience with 61 Consecutive Patients. *Turkish neurosurgery.* 2017;27(5):707-15.
- Ciurea AV, Ileanca SM, Rizea RE, Brehar FM: Olfactory groove meningiomas: A retrospective study on 59 surgical cases. *Neurosurg Rev* 2012; 35:195–202.
- Colli BO, Carlotti CG, Assirati JA, Santos MBM, Neder L, Santos AC, Batagini NC: Olfactory groove meningiomas: Surgical technique and follow-up review. *Arq*

- Neuropsychiatr 2007; 65:795–799.
- Welge-Luessen A, Temmel A, Quint C, Moll B, Wolf S, Hummel T: Olfactory function in patients with olfactory groove meningioma. *J Neurol Neurosurg Psychiatry* 2001; 70:218–221.
- Romani R, Lehecka M, Gaal E, Toninelli S, Celik O, Niemela M, Porras M, Jaaskelainen J, Hernesniemi J: Lateral supraorbital approach applied to olfactory groove meningiomas: Experience with 66 consecutive patients. *Neurosurgery* 2009; 65:39–5
- Bitter AD, Stavrinou LC, Ntoulas G, Petridis AK, Dukagjin M, Scholz M, Hassler W: The role of the pterional approach in the surgical treatment of olfactory groove meningiomas: A 20-year experience. *J Neurol Surg B Skull Base.* 2013; 74:97–102.
- Rachinger W, Grau S, Tonn JC: Different microsurgical approaches to meningiomas of the anterior cranial base. *Acta Neurochir (Wien)* 2010. 152:931–939.
- Romani R, Lehecka M, Gaal E, Toninelli S, Celik O, Niemela M, Porras M, Jaaskelainen J, Hernesniemi J: Lateral supraorbital approach applied to olfactory groove meningiomas: Experience with 66 consecutive patients. *Neurosurgery* 2009. 65:39–52.
- Schaller C, Rohde V, Hassler W: Microsurgical removal of olfactory groove meningiomas via the pterional approach. *Skull Base Surg* 1994.4:189–192.
- Spektor S, Valarezo J, Fliss DM, Gil Z, Cohen J, Goldman J, Umansky F: Olfactory groove meningiomas from neurosurgical and ear, nose, and throat perspectives: Approaches, techniques, and outcomes. *Neurosurgery* 2005. 57:268–280.
- Telera S, Carapella CM, Caroli F, Crispo F, Cristalli G, Raus L, Sperduti I, Pompili A: Supraorbital keyhole approach for removal of midline anterior cranial fossa meningiomas: A series of 20 consecutive cases. *Neurosurg Rev* 2012. 35:67–83.
- Kessler RA, Garzon-Muvdi T, Yang W, Weingart J, Olivi A, Huang J, et al. Metastatic Atypical and Anaplastic Meningioma: A Case Series and Review of the Literature. *World neurosurgery.* 2017;101:47-56.
- Louis DN, Perry A, Reifenberger G, von Deimling A, Figarella-Branger D, Cavenee WK, et al. The 2016 World Health Organization Classification of Tumors of the Central Nervous System: a summary. *Acta neuropathologica.* 2016;131(6):803-20.
- Hortobagyi T, Bencze J, Varkoly G, Kouhsari MC, Klekner A. Meningioma recurrence. *Open medicine (Warsaw, Poland).* 2016;11(1):168-73.
- Samii M. *Surgery of the Skull Base: Meningiomas.* 1st ed. Berlin: Springer; 1992.
- Pernecky A, MI-FW van Lindert E, Fries G. *Keyhole Concept in Neurosurgery.* 1st ed. Stuttgart: Thieme Medical Publishers; 1999.
- Samii M, Gerganov VM. Surgery of extra-axial tumors of the cerebral base. *Neurosurgery.* 2008;62(6 Suppl 3):1153–66. doi: 10.1227/01.neu.0000333782.
- Czirják S, Szeifert GT. Surgical experience with frontolateral keyhole craniotomy through a superciliary skin incision. *Neurosurgery.* 2001;48:145–9
- Jia W, Liu L, Jiang Z, Guo E, He X, Zong Z, et al. Tuberculum sellar operation by frontolateral approach (32 cases report) (in Chinese) *Chin J Neurosurg.* 2010;5:448–50.
- Chiang GS, Goh LG. Olfactory groove and planum sphenoidale meningioma: Dementia masquerade. *Canadian family physician Medecin de famille canadien.* 2017;63(4):288-91.
- Ojemann RG. Olfactory groove meningiomas. In: Al-Mefty O, editor. *Meningiomas.* New York, NY: Raven; 1991. pp. 383–93.
- Bakay L, Cares HL. Olfactory meningiomas. Report on a series of twenty-five cases. *Acta Neurochir (Wien)* 1972;26(1):1–12.
- McCarthy B.J., Davis F.G., Freels S., Surawicz T.S., Damek D.M., Grutsch J., et al. Factors associated with survival in patients with meningioma. *J. Neurosurg.*, 1998, 88, 831-839.
- Boeker D.K., Meurer H., Gullotta F. Recurring intracranial meningiomas. Evaluation of some factors predisposing for tumor recurrence. *J. Neurosurg. Sci.*, 1985, 29, 11-17.
- Nakasu S., Nakasu Y., Nakajima M., Matsuda M., Handa J. Preoperative identification of meningiomas that are highly likely to recur. *J. Neurosurg.*, 1999, 90, 455-462.
- Maïllo A., Orfao A., Espinosa A.B., Sayagués J.M., Merino M., Sousa P., et al. Early recurrences in histologically benign/ grade I meningiomas are associated with large tumors and coexistence of monosomy 14 and del(1p36) in the ancestral tumor cell clone. *Neuro. Oncol.*, 2007, 9, 438-446.
- Ildan F., Erman T., Göçer A.I., Tuna M., Bag datog lu H., C etinalp E., et al. Predicting the probability of meningioma recurrence in the preoperative and early postoperative period: a multivariate analysis in the midterm follow-up. *Skull Base.* 2007, 17, 157-171.
- Oya S., Kawai K., Nakatomi H., Saito N. Significance of Simpson grading system in modern meningioma surgery: integration of the grade with MIB-1 labeling index as a key to predict the recurrence of WHO Grade I meningiomas. *Journal of neurosurgery.* 2012;117(1):121-8
- Kim D, Niemiierko A, Hwang WL, Stemmer-Rachamimov AO, Curry WT, Barker FG, 2nd, et al. Histopathological prognostic factors of recurrence following definitive therapy for atypical and malignant meningiomas. *Journal of neurosurgery.* 2017:1-10.
- McDermott MW, Wilson CB. *Meningiomas.* In: Winn HR, Youmans JR, editors. *Youmans neurological surgery.* 4th ed. Vol. 1. Philadelphia, PA: WB Saunders Company; 1996. pp. 2782–825.