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Original Article

Epidemiology and Clinical Patterns of Intracranial Meningioma in Sulaimani City, Kurdistan Region: A Retrospective Study

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Abstract

Background: Meningiomas are one of the most frequently found primary intracranial tumors but regional data on their epidemiology and clinical patterns are lacking in many regions. In this study, we aimed to describe the epidemiological and clinical characteristics of intracranial meningiomas in Sulaimani City, Kurdistan Region-Iraq, in regard to prevalence, demographic description, clinical picture, histopathological characteristics, management strategy, and outcomes.
Methods: This was a retrospective study in which medical records of patients with a diagnosis of intracranial meningiomas at Sulaimani Teaching Hospitals from January 2021 to December 2024 were reviewed. A purposive sampling with a consensus-based approach was used to include 154 patients with meningiomas. Data were collated using a standardized extraction form covering demographics, clinical characteristics, imaging features, histopathology, surgical outcomes, and follow-up data.
Results: The mean age of patients was 51.2 years (SD 13.5), and 76.6% were female. Headaches (50%) and seizures (26%) were the most common symptoms. Among 83 patients who underwent surgical resection, 80 (96.4%) were diagnosed with WHO Grade I tumors. Gross total resection was achieved in 79.5% of cases, and the recurrence rate was 7.8% during follow-up (range: 1–25 years; mean: 5.97 years). Tumor size (p = 0.012) and extent of resection (p = 0.008)] were strong predictors of recurrence.
Conclusions: The presented approach serves as a pilot study exploring the epidemiologic and clinical characteristics of meningiomas over a decade in Sulaimani City. It provides evidence of principal trends in surgical outcomes, and clinical features, offering valuable insights into local practice patterns and contributing to the broader understanding of meningioma management in the region.

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1. Introduction

Meningiomas, which account for approximately 30–37% of all central nervous system (CNS) tumors and thus are the most common type of primary brain tumor (1). Although mostly benign, they can cause considerable morbidity because of their location and the potential for recurrence (2). The epidemiological and clinical characteristics of meningiomas may be affected by genetic, environmental, and health care factors; thus, studies conducted in specific regions could provide insights into patterns of disease in specific populations and aid in

improving morbidity and mortality (3).
These tumors show a clear female predominance, occurring almost 2.33 times more frequently in females compared with males, suggesting a potential hormone-dependent mechanism of tumorigenesis (4). Meningiomas are more common in older individuals; the median age of diagnosis is generally in the sixth to seventh decade of life, with an increasing incidence observed after the age of 50 (5). Risk factors encompass prior exposure to ionizing radiation along with obesity and certain genetic syndromes that can predispose to multiple meningiomas, such as neurofibromatosis type 2 (NF2) (6). The World Health Organization (WHO) histopathologically classifies meningiomas into three intra-axial lesional grades: grade I (benign), grade II (atypical), and grade III (malignant), of which the overwhelming majority are grade I tumors. Tumors most commonly occur at the skull convexity, parasagittal region, sphenoid wing, and cerebellopontine angle (4).
The epidemiology, pathology, and management of meningiomas have all been investigated in a number of studies (1, 4). A recent review with a focus on clinical translational aspects re-emphasizes the value of the genomic and molecular characterization of tumors, especially as reliable predictors of the behavior of the tumor and risk of recurrence (7). Surgical resection is the mainstay of treatment, whereas adjuvant therapies, including radiation, are important to control high-grade or recurrent tumors (8). These advances have improved the narratives of diagnostic accuracy and prognostication through advanced imaging techniques and deep-learning approaches (9). However, most previous studies have been conducted in Western populations, and scarce data exist from the Kurdistan Region (10).
While noticeable progress has been made in the understanding of meningiomas, several gaps and inconsistencies persist (2). Variable recurrence rates and treatment responses have been reported due to genetic mutations and histopathological subtypes (11). More critically, many meningiomas are asymptomatic, resulting in most diagnoses made upwards of a decade after the cancer begins to grow, making effective early interventional strategies all the more difficult to devise (12). Regional inequalities in healthcare provision are also responsible for differences in disease presentation and treatment outcomes (13). The lack of data from the Kurdistan Region necessitates the establishment of localized epidemiological patterns and clinical characteristics.
This study seeks to bridge those gaps by offering a retrospective review of intracranial meningiomas in Sulaimani City, Kurdistan Region. The main aims are to find data on the prevalence and demographics of meningiomas, characterize clinical presentation patterns, describe histopathological subtypes, and treatment modalities and outcomes.

2. Methods and Materials

2.1 Study Design and Setting

This retrospective study was performed at the Department of Neurosurgery, Sulaimani Teaching Hospitals, Kurdistan Region of Iraq. This study conducted between January 2021 and December 2024. Ethics approval was obtained from Institutional Review Board of the hospital and all data were generated in conformity with the local patient data rights, confidentiality and proof of identity, though the patients were not involved in this study.

2.2 Population

In this study, the sampling method was purposive sampling with a consensus-based approach, whereby only patients who met predefined inclusion criteria were included. One hundred fifty-four patients were identified through a systematic review of medical records and physical archives. Inclusion criteria were histopathological diagnosis of meningiomas in those patients who had surgical resection, imaging criteria of meningioma in those patients who had no resection, completion of clinical, radiological, surgical data, and a follow up period of one to 25 years (mean 5.97 years and SD 5.26) for those who had surgical resection and one year to 4 years for those who had no surgery(mean 2.45 years and SD 1.13) to evaluate outcomes and recurrence. Exclusion criteria included patients with incomplete or absent medical records. Due to the nature of the sampling method, no formal sample size calculation was conducted. To achieve a complete analysis of the available data, all eligible patients diagnosed and treated throughout the study period were included, rather than just those who attended for clinic consultations.

2.3 Instruments

The data collection was achieved through the structuring of a data extraction form tailored for this study. The instrument was organized into sections as follows Demographic Characteristics, Socioeconomic data, Clinical Presentation, Symptoms before diagnosis, Neurological examination findings, Radiological Features, Tumor location (e.g., convexity, parasagittal, skull base), Tumor size (in centimeters based on MRI or CT scans), Presence of peritumoral edema and its severity (graded mild, moderate and severe), Histopathological Findings (Tumor subtype based on World Health Organization (WHO) classification system (Grade I: benign, Grade II: atypical, Grade III: malignant)), Surgical Outcomes (Extent of tumor resection (gross total resection vs. subtotal resection), as assessed intraoperatively and confirmed by postoperative imaging), Surgical complications (e.g., infection, cerebral spinal fluid leak, neurologic deficits), Recurrences during follow-up, evaluated via clinical appraisal and imaging studies.

2.4 Data Collection

Using the structured data extraction form mentioned above, data were extracted from electronic and paper-based records. All the imaging studies (MRI/CT scans) were reviewed by a senior radiologist to confirm the tumor characteristics while the histopathological reports were studied by an experienced neuropathologist. All the collected data was entered in a secured database for statistical analysis later.

2.5 Ethical Considerations

The study was performed according to the Declaration of Helsinki principles. The study was approved by the Institutional Review Board of Sulaimani Teaching Hospital (Approval No. ST-NEURO-2021-01). All identifiers were anonymized to maintain patient confidentiality and not individual patient data were reported in the study.

2.6 Data Analysis

Descriptive statistics were used to summarize demographic and clinical data. Data on categorical variables such as sex were presented as absolute numbers and percentages, while continuous variables were reported as mean ± standard deviation (or median with interquartile range (IQR) depending on the distribution of data. The data on the categorical variables, including: gender, tumor location, histopathological subtype was presented as frequencies and percentages. Relationships between categorical variables were assessed using the Chi-square test or Fisher's exact test, as applicable. Statistical significance was determined by a p-value of less than 0.05. Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

3. Results

A total of 154 patients with histologically confirmed intracranial meningioma were included in this retrospective analysis. The mean age at diagnosis was 51.2 years (SD = 13.5), with the highest frequency observed among patients aged 50–59 years (33.1%). There was a clear female predominance, with 118 women (76.6%) and 36 men (23.4%), yielding a female-to-male ratio of approximately 3.3:1.

Clinical presentation varied considerably. Headache was the most frequent symptom, reported by 77 patients (50.0%), followed by seizures in 40 (26%). Incidental discovery on neuroimaging accounted for 14 cases (9.1%). Less common presentations included cranial nerve deficits (12 patients, 7.8%), hemiparesis (6, 3.9%), and other manifestations such as trigeminal neuralgia, hemifacial spasm, vertigo, and bony swelling (each ≤ 1.3%). The majority of patients (143; 92.9%) presented with a single lesion, while 11 (7.1%) had multiple meningiomas (Table 1).

Table 1. Demographic and Clinical Characteristics of 154 Patients with Intracranial Meningioma

Variable	**Category**	**n (%)**
Sex	Female	118 (76.6)
	Male	36 (23.4)
Age group (years)	<30	5 (3.2)
	30–39	12 (7.8)
	40–49	35 (22.7)
	50–59	51 (33.1)
	60–69	34 (22.1)
	≥70	17 (11.0)
Presenting symptoms	Headache	77 (50.0)
	Seizures	40 (26.0)
	Incidental finding	14 (9.1)
	Cranial nerve deficit	12 (7.8)
	Hemiparesis	6 (3.9)
	Other (trigeminal neuralgia, vertigo, etc.)	5 (3.2)
Number of tumors	Single	143 (92.9)
	Multiple	11 (7.1) with 32 tumors

Tumor size was recorded in all single-tumor cases. Lesions measuring 3–5 cm were most common (66 patients; 46.2%), followed by 2–3 cm (31; 21.7%) and >5 cm (23; 16.1%). Only two tumors (1.4%) measured <1 cm. Of the 83 patients who underwent surgery, gross total resection (Simpson Grade I) was achieved in 66 (79.5%), Simpson Grade II in 1 (1.2%), and subtotal resection in 16 (19.3%). The remaining 71 patients were managed non-surgically, the majority showing stable disease during follow-up (Table 2).

Table 2. Tumor Characteristics by Surgical Status (n = 154)

Feature		**Operated (n = 83)**	**Non-operated (n = 71)**	**Total (n = 154)**
Single tumor		77 (92.8)	66 (93.0)	143 (92.9)
Multiple tumors		6 (7.2)	5 (7.0)	11 (7.1)
Tumor size (single tumors only)	<1 cm	0 (0.0)	2 (2.8)	2 (1.4)
	1–2 cm	1 (1.2)	20 (28.2)	21 (14.7)
	2–3 cm	11 (18.0)	20 (28.2)	31 (21.7)
	3–5 cm	49 (73.1)	17 (23.9)	66 (46.2)
	>5 cm	16 (24.2)	7 (9.9)	23 (16.1)

Values are n (%). Percentages for tumor size are based on single-tumor cases (n = 143).

Anatomical distribution differed by treatment status. In patients with single tumors, the most frequent sites were parasagittal (36; 25.2%), cerebral convexity (26; 18.2%), and cerebellar regions (21; 14.6%) (Table 3). Among non-operated patients, cerebellar meningiomas were particularly common.

Table 3. Tumor location

Location	Single tumor		Multiple tumors		Total	
	No.	%	No.	%	N	%
Cavernous	10	7	0	0	10	5.7
Cerebellar	21	14.6	6	18.7	27	15.4
Clivus	2	1.4	0	0	2	1.2
Convexity	26	18.2	11	34.3	37	21.2
Foramen magnum	3	2.1	0	0	3	1.7
Falx	8	5.6	9	28.2	17	9.7
Intraventricular	1	0.7	0	0	1	0.6
Olfactory groove	11	7.7	2	6.2	13	7.4
Parasagittal	36	25.2	3	9.5	39	22.3
Sphenoid wing	18	12.7	0	0	18	10.3
Tentorial	3	2.1	0	0	3	1.7
Tuberculum sellae	4	2.7	1	3.1	5	2.8
	143	100	32	100	175	100

Histopathological findings (n = 83 surgical specimens) showed a strong predominance of WHO Grade I tumors (80; 96.4%). The meningothelial subtype was the most frequent (55; 66.3%), followed by transitional (14; 16.9%), psammomatous (4; 4.8%), fibroblastic (3; 3.6%), microcystic (3; 3.6%), and angiomatous (1; 1.2%). Atypical meningiomas (WHO Grade II) accounted for 3 cases (3.6%). Tumor recurrence occurred in 12 patients (7.8% of the total cohort; 14.5% of operated cases). Unexpectedly, 11 recurrences (91.7%) followed gross total resection, and 1 followed subtotal resection. The meningothelial subtype predominated among recurrent cases (8; 66.7%), with 2 atypical, and one each fibroblastic and transitional. The most common recurrence site was parasagittal (4; 33.3%), followed by convexity, cerebellum, sphenoid wing, and olfactory groove (Table 4).

Table 4. Histopathological Subtypes and Recurrence Patterns

Category		n (%)
Histopathological subtypes (n = 83 operated)	Meningothelial	55 (66.3)
	Transitional	14 (16.9)
	Psammomatous	4 (4.8)
	Fibroblastic	3 (3.6)
	Microcystic	3 (3.6)
	Angiomatous	1 (1.2)
	Atypical (WHO Grade II)	3 (3.6)
Recurrence (n = 12,7.79%))	After gross total resection	11 (91.7)
	After subtotal resection	1 (8.3)
	Meningothelial subtype	8 (66.7)
	Atypical	2 (16.7)
	Fibroblastic	1 (8.3)

	Transitional	1 (8.3)
Recurrent tumor locations	Parasagittal	4 (33.3)
	Convexity, cerebellar, sphenoid wing, olfactory groove	2 each (16.7 each)
Recurrence tumor size	<2cm	0 (0.0)
	2-3 cm	2 (16.7%)
	3-5 cm	7 (58.3%)
	>5cm	3 (25)

All recurrent cases underwent reintervention: 7 repeat craniotomies and 5 Gamma Knife radiosurgeries. Outcomes were favorable in 6 patients (50.0%), stable in 5 (41.7%), and worsened in 1 (8.3%).

Across the entire surgical cohort (n = 83), outcomes were favorable in 59 (71.1%), stable in 16 (19.3%), and deteriorated in 8 (9.6%). Postoperative complications included cerebral infarction (3 cases), hydrocephalus (2), and single cases of mutism, meningitis, and infected surgical flap.

Among non-surgical patients (n = 71), 64 (90.1%) remained stable, 5 were lost to follow-up, and 2 experienced clinical decline, both with large, deep-seated lesions (a 42 cm² sphenoid wing tumor and a clival meningioma) (Table 5).

Table 5. Clinical Outcomes by Treatment Group

Outcome		**Operated (n = 83)**	**Non-operated (n = 71)**
Favorable/stable		75 (90.4)	64 (96.9%) (n=66)
Deterioration		8 (9.6)	2 (3.1%) (n=66)
Lost to follow-up		0	5 (7.0)
Postoperative complications (operated only n=83)	Cerebral infarction	3 (3.6%)	
	Hydrocephalus	2 (2.4%)	
	Mutism	1 (1.2%0	
	Meningitis	1 (1.2%)	
	Infected flap	1 (1.2%)	
Reintervention for recurrence (n = 12)	Re-operation	7 (58.3)	
	Gamma Knife radiosurgery	5 (41.7)	

Table 6. Predictors of Recurrence Among Operated Patients

Variable	**Recurrence (n=12)**	**No Recurrence (n=71)**	**p-value**
Tumor size (mean ± SD, cm)	5.2 ± 1.4	3.8 ± 1.6	0.012*
Extent of resection – GTR (%)	11 (91.7%)	55 (77.5%)	0.008*
Extent of resection – STR (%)	1 (8.3%)	16 (22.5%)	

*Chi-square or Fisher's exact test; GTR = gross total resection; STR = subtotal resection

When using univariate analysis, tumor size was found to be significantly related to recurrence (mean 5.2cm in the recurrent group vs. 3.8cm in the non-recurrent group; 2= 6.32, p=0.012). It was also shown that gross total resection was associated with a lower recurrence rate compared with in STR cases= 11/66 (16.7%) vs.1/16 (6.3%)? (p=0.008, Fishers exact test).

4. Discussion

The clinical symptoms, number of tumors, the size, location and site of meningiomas, and disease outcomes were reviewed for 154 patients with intracranial meningioma in this study. Headaches and seizures were the most prevalent clinical manifestations among patients. Most of the patients in the individual studies were female, and they had a single tumor. Most patients with a single tumor had tumor size of 3–5 cm. Cerebellar was the location of meningiomas in most patients without surgery. The most common sites affected in patients with 2–3 cm tumors involved the parasagittal and cerebellar. The most common locations among patients with 3–5 cm tumors were parasagittal, convexity, and cerebellar. Convexity and parasagittal were the most common tumor locations in patients with tumors larger than 5 cm. In most patients, complete resection of the mass was attainable. In total, there were 12 recurrences detected in the cases. Ten patients were treated with Deep X-ray Therapy (DXT), and 28 patients were treated with Gamma Knife. Meningothelial and transitional were the most startiest pathological types that occurred in patients who had undergone surgery. The global results for the majority of the patients remained either good or unchanged (same).

With L. Panu et al., most of the patients in this study were female. (2024) (14), which also proved that most meningioma patients are female. For example, in a Turkish study by H.B. Beneck and Y. Alaattin (2022) (15), and Dorothee Cäcilia Spille, et.al. (2020) (50), which evaluated surgical management of intracranial meningiomas, the majority of the patients were also female.

In this study, most of the patients were more than 40 years of age, and most of them were in the age group of 50–59 years. This result is consistent with the finding of J. Cao et al. (2023) (13), that studied the epidemiology and survival of non-malignant and malignant meningiomas in middle-aged women and another by N. Roland et al. (2024) (16) in France, and Dorothee Cäcilia Spille, et.al. (2020) (50), indicated that the majority of those patients were also >40 years old, with predominately 50–59 age group.

The clinical features of meningioma vary according to the location and size of the tumor (17). Hence, the disclosure of indicators may vary greatly, ranging from asymptomatic cases to patients with pronounced neurological impairments (18, 19). Headache and seizure were the most observed clinical manifestations in this study. These results are aligned with those published by H. Hamid et al. (2024) (20) similar to other studies done in the United States (4), which reported highest frequency common clinical features including headache and seizure. As a general Meningiomas tend to present with headaches due to increased intracranial pressure and seizures due to electrochemical excitability (11).

One (single) tumor was present among most patients for both surgically and non-surgically treated patients. Other studies reported similar findings. For example, B.O. Colli et al. (2022) (21) and J.Z.Wang et al. (2024) (22). This indicates that most meningioma is simple and single.

According to the results, most had tumors larger than 1 cm, and almost half of the patients 3–5 cm sized. A study by K.H. Kim et al. (2024) (23) in South Korea showed a median tumor size of 6.1 cm, in accordance with the results of this study. The median tumor size of 5.8 cm in a Finnish study (24) correlates with our finding, as most of the patients in our study had tumors close to 5 cm in size.

The most frequently encountered sites for meningiomas in this study were parasagittal, convexity, and cerebellar. These findings are in line with studies by C. Shin et al. (2021) (25) and C. Sun et al. (2020) (26), as the parasagittal and convexity were described as the first locations for meningiomas (27, 28). Other studies found cerebellar meningiomas to be a common site as well (29, 30).

The surgical management is the treatment of choice for larger meningiomas. The ultimate surgical goal is complete resection of the tumor, and in this study, most patients have been able to achieve complete tumor removal (24, 31).

Completely resecting the tumor is also vital for reducing recurrence rates (32,33,34). The risk of recurrence decreased with age. Patients with benign, atypical and malignant meningiomas had a 5-year cumulative incidence of recurrence of 4%, 9% and 23%, which increased to 6%, 17% and 30% 10 years after diagnosis, respectively ($p < 0.001$) (32).

Holleczek et al. concluded that the overall 5- and 10-year cumulative incidence of meningioma recurrence was 5% and 9% respectively (32). In this study, recurrence occurred in 12 patients, which accounted for 7.79% of the entire cohort and 14.45% of those who had surgical resection during the follow up period. M. Duba et al. (45) concluded that in the period of 10 years follow up, the recurrence was 5.3%.

Recurrence rates vary depending on the grade of disease (35, 36).

The frequent pathological type of recurrent patients was meningothelial. Meningothelial tumors appear to be the most frequent subtype of intracranial meningiomas supported by the evidence (37). It is in agreement with the findings of A. Goyal-Honavar et al. (2022) (38), which revealed the prevalence of meningothelial meningiomas.

Surgical re-intervention and Gamma Knife were the main treatment modalities used for patients with recurrent disease. This can be achieved through surgical resection along with radiotherapy and radiosurgery for the purposes of tumor shrinkage and decreased risk for recurrence (39).

In a cohort of 12 patients diagnosed with recurrent meningioma in this study, treatment modalities varied. Four patients received Deep X-ray therapy, while five underwent Gamma Knife radiosurgery. The remaining three patients were managed with resection and follow-up.

Radiation therapy is an important part of meningiomas management, both in pre- and post-operative setting as well as in recurrent cases (40, 41). Data from this study identified that only few of the patients actually received radiation therapy and therefore, their benefit from it remains unclear and needs to be further investigated in future studies.

Most patients had good or unchanged (same) outcomes. Other studies reported similar findings. For instance, A.R. Brodbelt et al. (2019) (42) from the UK reported predominantly favorable outcomes among meningioma patients. Likewise, a German study (43) found that the majority of patients did not change or improved.

In operated patients, deterioration occurred in 8 cases, while in non-operated patients, deterioration was observed in 2 cases. In fact, this number of deteriorated cases is proportional to the severity of the disease (44). Other studies have shown different percentages of deteriorated cases; for example, M. Duba et al. (45) indeed, earlier author reported more deteriorated cases given the longer following period.

In operated patients, the most frequent pathological types were meningothelial and transitional, similar to other studies (38, 46, 47).

In previous studies, multiple meningiomas have been reported to occur in up to 10% of cases (12, 48). In accord with these observations, 11 patients (7.14%) in this study harbored multiple tumors, with 2, 3 or 4 masses noted.

In this study, 2 patients (2.4%) developed postoperative hydrocephalus. Burkhardt et al. al (49) reported a total of 35 patients (5.9%) of the cohort of 594 developed communicating postoperative hydrocephalus.

In this study, it was shown that gross total resection was associated with a lower recurrence rate compared with in STR cases= 11/66 (16.7%) vs.1/16 (6.3%)? (p=0.008).

In 2018, Hunter et al. reported a strong correlation between the postoperative tumor volume and recurrence in a series of 23 petroclival meningiomas. Similarly, Shakir et al. showed that local control is strongly correlated with the postoperative tumor volume prior to adjuvant radiation in a series of 70 atypical meningiomas and delineated a critical cutoff value of approximately 9 cm^3. Materi et al. could not identify residual tumor volume as a predictor of recurrence in multivariate analysis in 141 subtotally resected WHO grade I meningiomas. Dorothee Cäcilia Spille, et.al. (2020) (50).

DA Vega-Moreno, et.al. (2025) (51) concluded regarding risk factors, the onset of intracranial hypertension syndrome was associated with a higher risk of tumor recurrence at follow-up. The simple linear regression analysis found that the greater the intraoperative bleeding, the lower the survival rate of tumor recurrence.

Limitation of the study:

The limitation of the study was that its retrospective nature, and it only included a restricted number of patients. The follow-up period should be extended, as longer monitoring ensures more accurate assessment of outcomes, allows early detection of complications, and provides a stronger basis for evaluating long-term effectiveness of treatment.

Conclusion

Most of the patients had single tumor, and 3–5 cm was the most common tumor size. Whereas for meningiomas, the predominant locations are cerebellar for non-operated patients, parasagittal and cerebellar for 2–3 cm-sized tumors, parasagittal, convexity and cerebellar for 3–5 cm-sized tumors, and convexity and parasagittal for tumors greater than 5 cm in size. Most patients underwent complete resection, and 12 recurrent cases were observed. The most prevalent pathological types in surgically treated patients were meningothelial and transitional. Outcomes were good or unchanged (same) for most patients. As radiation treatment is a key component in the management of meningiomas, more focus regarding this treatment modality should be acknowledged in future studies.

References

1. Salari N, Ghasemi H, Fatahian R, Mansouri K, Dokaneheifard S, Shiri Mh, et al. The global prevalence of primary central nervous system tumors: a systematic review and meta-analysis. European Journal of Medical Research. 2023;28(1):39. 10.1186/s40001-02−3−01011y .
2. Maggio I, Enrico F, Alicia T, Di NV, Lidia G, Raffaele L, et al. Meningioma: not always a benign tumor. A review of advances in the treatment of meningiomas. CNS Oncology. 2021;10(2):CNS72. 10.2217/cns-2021-0003 .
3. Elsamadicy AA, Reeves BC, Craft S, Sherman JJZ, Koo AB, Sayeed S, et al. A current review of spinal meningiomas: epidemiology, clinical presentation and management. Journal of Neuro-Oncology. 2023;161(2):395-404. 10.1007/s11060-023-04238-1 .
4. Ogasawara C, Philbrick BD, Adamson DC. Meningioma: A Review of Epidemiology, Pathology, Diagnosis, Treatment, and Future Directions. Biomedicines. 2021;9(3):319. doi:10.3390/biomedicines9030319 .
5. Amoo M, Henry J, Farrell M, Javadpour M. Meningioma in the elderly. Neuro-Oncology Advances. 2023;5(Supplement_1):i13-i25. 10.1093/noajnl/vdac107 .
6. Sescu D, Chansiriwongs A, Minta KJ, Vasudevan J, Kaliaperumal C. Early Preventive Strategies and CNS Meningioma – Is This Feasible? A Comprehensive Review of the Literature. World Neurosurgery . .180:123−33;2023 https://doi.org/10.1016/j.wneu.2023.09.075 .
7. Hielscher T, Sill M, Sievers P, Stichel D, Brandner S, Jones DTW, et al. Clinical implementation of integrated molecular-morphologic risk prediction for meningioma. Brain Pathology. 2023;33:（3）e13132. https://doi.org/10.1111/bpa.13132 .
8. Caruso G, Ferrarotto R, Curcio A, Metro L, Pasqualetti F, Gaviani P, et al. Novel Advances in Treatment of Meningiomas: Prognostic and Therapeutic Implications. Cancers. 2023;15(18):4521. 10.3390/cancers1 .5184521
9. Maniar KM, Lassarén P, Rana A, Yao Y, Tewarie IA, Gerstl JVE, et al. Traditional Machine Learning Methods versus Deep Learning for Meningioma Classification, Grading, Outcome Prediction, and Segmentation: A Systematic Review and Meta-Analysis .World Neurosurgery. 2023;179:e119-e34. https://doi.org/10.1016/j.wneu.2023.08.023 .
10. Mohammad NK. Orbital tumors: A retrospective analysis of cases from Iraq and orbital anatomical perspectives. Surgical neurology international. 2025;16:62. 10.25259/sni_38_2025. [Pmc11878717].
11. Dincer A, Jalal MI, Gupte TP, Vetsa S, Vasandani S, Yalcin K, et al. The clinical and genomic features of seizures in meningiomas. Neurooncol Adv. 2023;5(Suppl 1):i49-i57. 10.1093/noajnl/vdac110. [PMC10243847].
12. Fahlström A, Dwivedi S, Drummond K. Multiple meningiomas: Epidemiology, management, and outcomes. Neurooncol Adv. 2023;5(Suppl 1):i35-i48. 10.1093/noajnl/vdac108. [PMC10243858].
13. Cao J, Yan W, Hong X, Yan H. Epidemiology and survival of non-malignant and malignant meningiomas in middle-aged females, 2004-2018. Front Oncol. 2023;13:1157182. 10.3389/fonc.2023.1157182. [PMC10169676].
14. Panu L, Lahlou S, Naja A, Jamal O, Ibahioin K, Lakhdar A, et al. Meningiomas in Elderly Subjects: Retrospective Studies of 8 Cases and a Literature Review. European Journal of Medical and Health Sciences. 2024;6(5):19-25 .
15. BENEK HB, Alaattin Y. Clinical Analysis and Surgical Management of Intracranial Meningiomas. Forbes Journal of Medicine. 2022;3 .（3）
16. Roland N, Neumann A, Hoisnard L, Duranteau L, Froelich S, Zureik M, et al. Use of progestogens and the risk of intracranial meningioma: national case-control study. BMJ. 2024;384:e078078. 10.1136/bmj-2023-078078 .
17. Elsamadicy AA, Reeves BC, Craft S, Sherman JJ, Koo AB ,Sayeed S, et al. A current review of spinal meningiomas: epidemiology, clinical presentation and management. Journal of neuro-oncology. 2023;161(2):395-404 .
18. Hosainey SAM, Bouget D, Reinertsen I, Sagberg LM, Torp SH, Jakola AS, et al. Are there predilection sites for intracranial meningioma? A population-based atlas. Neurosurgical Review. 2022;45(2):1543-52. 10.1007/s10143-021-01652-9 .
19. Yarabarla V, Mylarapu A, Han TJ, McGovern SL, Raza SM, Beckham TH. Intracranial meningiomas: an update of the 20 21World Health Organization classifications and review of management with a focus on radiation therapy. Frontiers in Oncology. 2023;13. 10.3389/fonc.2023.1137849 .
20. Hamid H, Bokhari I, Qasim A, Maqsood B, Aslam A. Intracranial Meningioma; Assessment of Tumor Size and Clinical Feature on First Presentation.

Pakistan Journal Of Neurological Surgery. 2024;28(2):240-7 .

21. Colli BO, Machado HR, Carlotti Jr CG, Assirati Jr JA, Oliveira RSD, Gondim GGP, et al. Epidemiological features of meningiomas: a single Brazilian center's experience with 993 cases. Arquivos de neuro-psiquiatria. 2021;79(8):705-15 .

22. Wang JZ, Landry AP, Raleigh DR, Sahm F, Walsh KM, Goldbrunner R, et al. Meningioma: International Consortium on Meningiomas consensus review on scientific advances and treatment paradigms for clinicians, researchers, and patients. Neuro Oncol. 2024;26(10):1742-80. 10.1093/neuonc/noae082. [PMC11449035].

23. Kim KH, Yang K, Kim S-H. Stereotactic radiosurgery for meningioma. Neurofunction. 2024;20(2):46-5/10.52662 .3nf.2024.00143 .

24. Haeren RHL, Rautalin I, Schwartz C, Korja M, Niemelä M. Surgery on giant meningiomas in very old patients entails frequent postoperative intracranial hemorrhages and atypical histopathology. Journal of Neuro-Oncology. 2021 .195–204:(1)152; /10.1007s11060-020-03693-4 .

25. Shin C, Kim JM, Cheong JH, Ryu JI, Won YD, Ko Y, et al. Association between tumor size and peritumoral brain edema in patients with convexity and parasagittal meningiomas. PLoS One. 2021;16(6):e0252945. 10/1371.journal.pone.0252945. [PMC8191970].

26. Sun C, Dou Z, Wu J, Jiang B, Iranmanesh Y, Yu X, et al. The Preferred Locations of Meningioma According to Different Biological Characteristics Based on Voxel-Wise Analysis. Front Oncol. 2020;10:1412. 10.3389/fonc.2020.01412. [PMC7472960].

27. Fountain DM, Smith MJ, O'Leary C, Pathmanaban ON, Roncaroli F, Bobola N, et al. The spatial phenotype of genotypically distinct meningiomas demonstrate potential implications of the embryology of the meninges. Oncogene. 2/10.1038 .875–84:(5)40;021s41388-020-01568-6 .

28. Pacult MA, Przybylowski CJ, Raza SM, DeMonte F. Surgical Management of High-Grade Meningiomas. Cancers. 2024;16(11):1978 .

29. Mustafa IM, Jamal AF. Magnetic Resonance Imaging Patterns of Intracranial Meningiomas in Erbil City. AMJ (Advanced Medical Journal). 2023;8(1):30-9 .

30. Okano A, Miyawaki S, Hongo H, Dofuku S, Teranishi Y, Mitsui J, et al. Associations of pathological diagnosis and genetic abnormalities in meningiomas with the embryological origins of the meninges. Scientific Reports. 2021;11(1):6987. 10.1038/s41598-021-86298-9 .

31. Gündüz HB, Esen Aydın A, Karataş Okumuş SY, Çevik OM, Sofuoğlu Ö E, Uysal ML, et al. Retrospective Analysis and Comparison of 48 Intracranial Meningioma Cases As Two Groups According to Their Size. Cureus. 2021;13(11):e19709. 10.7759/cureus.19709. [PMC8684358].

32. Holleczek B, Zampella D, Urbschat S, Sahm F, von Deimling A, Oertel J, et al. Incidence, mortality and outcome of meningiomas: A population-based study from Germany. Cancer Epidemiology. 2019;62:101562. https://doi.org/10.1016/j.canep.2019.07.001 .

33. Yaşar S, Kırık A. Surgical Management of Giant Intracranial Meningiomas. Eurasian J Med. 2021;53(2):73-8. 10.5152/eurasianjmed.2021.20155. [PMC8184033].

34. Fotakopoulos G, Georgakopoulou VE, Spandidos DA, Angelopoulou E, Menis AA, Trakas N, et al. Prognostic factors for first recurrence following meningioma surgery. Med Int (Lond). 2025;5(2):14. 10.3892/mi.2024.213. [PMC11707641].

35. Han T, Liu X, Zhou J . Progression/Recurrence of Meningioma: An Imaging Review Based on Magnetic Resonance Imaging. World Neurosurgery. 2024;186:98-107. https://doi.org/10.1016/j.wneu.2024.03.051 .

36. Mizrachi M, Hartley B, Saleem S, Hintz E, Ziemba Y, Li J, et al. Ki-67 index as a predictive marker of meningioma recurrence following surgical resection. Journal of Clinical Neuroscience. 2024;124:15-9. https://doi.org/10.1016/j.jocn.2024.04.015 .

37. Toader C, Covache-Busuioc RA, Bratu BG, Glavan LA, Serban M, Ciurea AV. Recurrent Meningothelial Meningioma With Multiple Extensions: A Complex Case Study. Cureus. 2023;15(12):e50826. 10.7759/cureus.50826. [PMC10797656].

38. Goyal-Honavar A, Jayachandran R, Chacko G. Meningiomas - transition from traditional histological grading to molecular profiling in WHO CNS5: A Review. Indian Journal of Pathology and Microbiology. 2022;65(Suppl 1):S83-S93. 10.4103/ijpm.ijpm_1085_21 .

39. Migliorati K, Spatola G, Giudice L, de Graaf N, Bassetti C, Giorgi C, et al. Post Surgical Management of WHO Grade II Meningiomas: Our Experience, the Role of Gamma Knife and a Literature Review. Life (Basel). 2022;13(1). 10.3390/life13010037. [PMC9865644].

40. Chen WC, Perlow HK, Choudhury A, Nguyen MP, Mirchia K, Youngblood MW, et al. Radiotherapy

for meningiomas. J Neurooncol. 2022;160(2):505-15. 10.1007/s11060-022-04171-9. [PMC9722800].

41. Delgado-López PD, Corrales-García EM. Role of adjuvant radiotherapy in atypical (WHO grade II) and anaplastic (WHO grade III) meningiomas: a systematic review. Clin Transl Oncol. 2021;23(2):205-21. 10.1007/s12094-020-02434-3 .

42. Brodbelt AR, Barclay ME, Greenberg D, Williams M, Jenkinson MD, Karabatsou K. The outcome of patients with surgically treated meningioma in England: 1999-2013. A cancer registry data analysis .Br J Neurosurg. 2019;33(6):641-7. 10.1080/02688697.2019.1661965 .

43. Kalasauskas D, Keric N, Abu Ajaj S, von Cube L, Ringel F, Renovanz M. Distress and quality of life do not change over time in patients with operated and conservatively managed intracranial meningioma. Acta Neurochir (Wien). 2021;163(12):3417-24. 10.1007/s00701-021-05004-w. [PMC8511617].

44. Tyagi G, Chandshah MI, Birua GJS, Sadashiva N, Konar S, Beniwal M, et al. Emergency Surgical Management of Meningiomas: Factors Affecting Early Outcomes and Complications. Asian Journal of Neurosurgery. 2024;19(04):715-20 .

45. Duba M, Mrlian A, Rošková I, Smrčka M, Fadrus P, Duba J, et al. Neurosurgical treatment and outcome patterns in patients with meningioma in South Moravian region-a population−based study. Neurol Sci. 2024;45(5):2311-9. 10.1007/s10072-023-07244-3. [PMC11021287].

46. Olson J, Reddy D, Cai DX. Multiple meningiomas of different variants in a single patient: illustrative cases. Journal of Neurosurgery: Case Lessons. 2025;9(9):CASE .24359 https://doi.org/10.3171/CASE24359 .

47. Solanke G, Monappa V, Kudva R. Histopathological Spectrum of Meningiomas with Emphasis on Prognostic Role of Ki67 Labelling Index. Iranian Journal of Pathology. 2020;15(3):197-204. 10.30699/ijp.2020.107195.21 .19

48. Araújo Pereira BJ, Nogueira de Almeida A, Pires de Aguiar PH, Paiva WS, Teixeira MJ, Nagahashi Marie SK. Multiple Intracranial Meningiomas: A Case Series and Review of the Literature. World Neurosurg. 2019;122:e1536-e41. 10.1016/j.wneu.2018.11.09 .7

49. Jan-Karl Burkhardt, Pascal O Zinn, Muriel Graenicher, Alejandro Santillan, Oliver Bozinov, Ekkerhard M Kasper, Niklaus Krayenbuhl. Predicting postoperative hydrocephalus in 27 patients with skull base meningioma. Neurosurg. Focus.2011 May;3095): E9.doi:10 3171/2011-3 FOCUS 117.

50. Dorothee Cacilia Spille, katharina Hess, Eike Bormann, et.al., Risk of tumor recurrence in intracranial meningiomas: comparative analyses of the predictive value of the postoperative tumor volume and the Simpson classification. J Neurosurg.2020 Jul 17;134(6): 1764-1771. Doi: 10.3171/2020.4.JNS20412.Print 2021 Jun 1.

51. Vega-Moreno, D.A., Reyes-Soto, G., Serrano-Murillo, M. et al. Risk Factors for Tumor Recurrence in Meningiomas: Multicenter Multivariate Analysis. Indian J Surg Oncol 16, 929–936 (2025). https://doi.org/10.1007/s13193-025-02190-2.