Original article

Ukrainian Neurosurgical Journal. 2026;32(1):52-59
doi: 10.25305/unj.338724

Factors contributing to surgical complexity in giant parasagittal and falcine meningiomas: a case-based review

Tommy A. Nazwar [1], Nasim Amar [2], Farhad Bal'afif [1], Donny W. Wardhana [1], Fachriy Bal'afif [1]

[1] Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Brawijaya University-Saiful Anwar General Hospital, Malang, East Java, Indonesia
[2] Faculty of Medicine, Brawijaya University-Saiful Anwar General Hospital, Indonesia

Received: 07 September 2025
Accepted: 16 October 2025

Address for correspondence: *Tommy A. Nazwar, Division of Neurosurgery, Department of Surgery, Brawijaya University/ Saiful Anwar General Hospital, GPT II Building, 2nd Floor, Malang, East Java, 65112, Indonesia, email: tommy@ub.ac.id*

Introduction: Giant parasagittal and falcine meningiomas are surgically challenging due to their frequent involvement of the superior sagittal sinus (SSS), proximity to eloquent cortex, and complex venous anatomy. Although these tumors carry a high operative risk, detailed analyses of surgical difficulty remain limited in the literature.

Objective: This narrative review of published case reports and series aims to delineate the key determinants of surgical complexity in giant parasagittal and falcine meningiomas, including tumor size, sinus involvement, anatomical constraints, and intraoperative decision-making while emphasizing the balance between surgical radicality and patient safety.

Methods: A narrative review and multicase synthesis were performed, analyzing 22 published reports (19 case reports and 3 case series) describing the microsurgical management of giant parasagittal and falcine meningiomas. Studies were included based on the PICOS framework, focusing on tumors ≥5 cm with original surgical and outcome data. Extracted variables included demographics, tumor size, location, SSS involvement, histology, surgical technique, and clinical outcomes**.**

Results: A total of 36 patients were identified. Most tumors were parasagittal (52.8%), involved the middle third of the SSS (38.9%), and demonstrated SSS invasion (78.6%), with complete occlusion in 64.3% of cases. Gross total resection was achieved in 75.7% of cases. Pediatric patients (11.1%) were more frequently associated with high-grade histology and intraoperative complications. Tumors involving the middle third of the SSS and those with parasagittal location were consistently associated with increased technical difficulty, venous bleeding, and postoperative deficits. Overall, 72.2% of patients experienced favorable recovery, while 11.1% had poor outcomes, including tumor recurrence or death.

Conclusion: Surgical management of giant parasagittal and falcine meningiomas is technically demanding, particularly in pediatric cases and when tumors involve the parasagittal region or the middle third of the SSS. Careful preoperative venous evaluation and individualized strategies are crucial for optimizing the resection while minimizing complications.

Keywords: *parasagittal meningioma; falcine meningioma; giant meningioma; surgical complexity*

Introduction

Parasagittal and falcine meningiomas are among the most frequently encountered intracranial tumors, ranking second only to convexity meningiomas in terms of location [1, 2]. Arising from the arachnoid cap cells, often near the arachnoid villi along the falx cerebri or superior sagittal sinus (SSS), these tumors are associated with significant surgical morbidity and account for approximately 2.6–6.7% of meningioma-related deaths [3]. Although they are generally histologically benign, their proximity to essential venous structures and cortical regions poses considerable surgical challenges [4].

Parasagittal meningiomas, which are defined by their involvement with the wall or lumen of the SSS, represent approximately 20-30% of all intracranial meningiomas [5]. Surgical complexity is amplified in giant tumors, commonly defined as those measuring more than 5 cm in diameter [6]. These large tumors often compress or invade the SSS, impair venous drainage, and distort adjacent brain tissue, elevating the risks of venous infarction, cerebral edema, and neurological deficits [4, 7, 8]. The challenges are particularly pronounced when the lesion involves the middle or posterior thirds of the sinus or is situated near eloquent brain areas, such as the sensorimotor

or supplementary motor cortex [1, 9, 10]. Similarly, parafalcine meningiomas, typically located parafalcine meningiomas, typically located deep within the interhemispheric fissure, pose challenges due to limited surgical exposure and proximity to critical structures [5, 11].

While gross total resection (GTR) offers the best chance of minimizing recurrence, its feasibility is often constrained by the need to preserve vital venous and cortical anatomy [11, 12]. Despite the growing awareness of the complexities associated with parasagittal and falcine meningiomas, giant variants remain underrepresented in the literature, particularly in terms of detailed, case-level surgical evaluations [8, 13]. Additionally, there remains limited consensus on optimal strategies for managing tumors with partial or complete SSS occlusion [6]. These gaps underscore the need for a focused synthesis of case-level data on surgical complexity, venous sinus management, and outcomes in giant parasagittal and falcine meningiomas.

Objective

This narrative review of published case reports and series aims to delineate key determinants of surgical complexity in giant parasagittal and falcine meningiomas including tumor size, degree of sinus invasion or occlusion, venous and cortical anatomical constraints, and intraoperative decision making. The review also aims to relate these factors to the extent of resection, perioperative complications, and overall clinical outcomes, while emphasizing the need to balance surgical radicality with patient safety.

Methods

This narrative review was conducted to systematically identify clinical and anatomical factors contributing to surgical complexity in giant parasagittal and falcine meningiomas, based on published case reports and case series.

Eligibility criteria

The study followed the PICOS framework:

Population: Patients of any age diagnosed with parasagittal or falcine meningiomas ≥5 cm, with or without SSS invasion.

Intervention: Microsurgical resection, including GTR, near total, or subtotal resection (STR) approaches, with or without adjunctive measures such as sinus reconstruction, preoperative embolization, or radiotherapy.

Comparison: Cases were analyzed based on degree of sinus invasion (none, partial, complete), tumor location (anterior, middle, posterior third), patient age (pediatric vs. adult), histological grade (WHO I–III), and extent of resection.

Outcomes:

- Primary: Identification of factors associated with increased surgical difficulty, including sinus invasion, tumor location, patient age, etc.

- Secondary: Neurological recovery, extent of resection, recurrence, and surgical complications.

Study Design: Case reports and series with original surgical and outcome data.

Only full-text articles published in English were included.

Studies were excluded if tumors were <5 cm, located outside the parasagittal or falcine region, or lacked surgical or outcome details.

Search strategy

A structured search of PubMed, ScienceDirect, SpringerLink, and the Cochrane Library was conducted for articles published up to May 2025, using the following terms: "Falcine meningioma" OR "parasagittal meningioma") AND ("surgical resection" OR "Simpson grade") AND ("superior sagittal sinus" OR "SSS invasion") AND ("case report" OR "case series"). Relevant references from selected studies were also reviewed.

Data extraction and analysis

Two reviewers independently extracted data using a standardized form, collecting patient demographics, tumor features (size, location, SSS involvement, histology), surgical strategy, and clinical outcomes. Descriptive statistics were applied, and a structured comparison was used to explore associations between specific factors (e.g., venous anatomy, pediatric status, tumor site) and surgical complexity or outcomes.

Results

Study selection and identification

A total of 548 records were identified through a systematic literature search of four databases: PubMed (n=127), ScienceDirect (n=173), SpringerLink (n=130), and the Cochrane Library (n=148). After removing duplicates, the remaining articles were screened based on title, abstract, relevance to the predefined inclusion criteria, language (English), and full-text accessibility. Following full-text assessment, 22 studies, comprising 19 case reports [5, 7, 13–29] and 3 case series [6, 9, 30], met all eligibility criteria and were included in the final analysis.

Summary of findings

A total of 36 patients were included in the analysis (***Table 1***), comprising 19 males (52.8%) and 17 females

(47.2%). The majority were adults (n=32, 88.9%), with a mean age of 52.5±12.5 years, while four patients (11.1%) were children (mean age 5.75±3.8 years). The most common presenting symptoms were motor or sensory deficits, reported in 14 patients (38.9%), including weakness, hemiparesis, foot drop, and gait disturbances. Symptoms of raised intracranial pressure were present in 10 patients (27.8%), while seizures occurred in 9 cases (25%), including generalized, focal, and complex partial types. Cognitive or behavioral changes were reported in 4 patients (11.1%), such as memory impairment, aggression, or glossolalia.

The average tumor size was 7.69 × 5.80 × 5.56 cm, indicating a large lesion volume, primarily parasagittal (n=19, 52.8%) and falcine (n=16, 44.4%), with one patient (2.8%) exhibiting combined falcine–parasagittal involvement. Regarding tumor site within the SSS, the middle third was the most commonly affected region (n=14, 38.9%), followed by the anterior third (n=12, 33.3%). Multiple adjacent segments were also involved (anterior–middle: n=3, 8.3%; middle–posterior: n=1, 2.8%). Posterior third involvement was noted in 2 cases (5.6%). Overall, SSS invasion occurred in 22 patients (78.6%), with complete invasion in 18 (64.3%) and partial invasion in 4 (14.3%).

Gross total resection (GTR) was achieved in 28 patients (75.7%), including two cases who underwent simultaneous sinus reconstruction. Incomplete resection was reported in 4 cases (10.8%). Histopathologically, meningothelial meningioma was the most common subtype (n=12, 33.3%), followed by atypical (n=9, 25%), transitional (n=7, 19.4%), and malignant variants, including anaplastic and malignant meningiomas (n=2, 5.6%). Most tumors were WHO Grade I (n=19, 52.8%), with Grade II in 9 cases (25%) and Grade III in 2 (5.6%).

Postoperatively, 26 patients (72.2%) had favourable recovery, while 6 (16.7%) experienced residual neurological deficits (mild hemiparesis, seizures well controlled with anticonvulsants, apraxia, intermittent headaches, and sixth nerve palsy). Four patients (11.1%) who experienced tumor recurrence had poor outcomes (worsening of symptoms, metastases, progressive tumor enlargement, multiple tumors detected, and death). The median follow-up duration was 17.5 months (range 2–180 months), and the mean length of hospital stay was 10.77±8.36 days.

Table 1. Descriptive Analysis

Variable	Descriptive Data (n=36)
Gender	
Male	19 (51.4%)
Female	17 (45.9%)
Age Group	
Adults	32 (88.9%), 52.5±12.5
Children	4 (11.1%), 5.75±3.8
Presenting Symptoms	
Seizures	9 (25%)
ICP-related symptoms	10 (27.8%)
Motor/sensory deficits	14 (38.9%)
Cognitive/behavioral changes	4 (11.1%)
Tumor size (mean)	7.69 × 5.80 × 5.56
Tumor Location	
Falcine	16 (44.4%)
Parasagittal	19 (52.8%)
Falcine–Parasagittal	1 (2.8%)
Tumor Site (SSS thirds)	
Anterior third	12 (33.3%)
Middle third	14 (38.9%)
Posterior third	2 (5.6%)
Anterior-Middle	3 (8.3%)
Middle-Posterior	1 (2.8%)
SSS Invasion	
Complete	18 (64.3%)
Partial	4 (14.3%)
None	6 (21.4%)
Extent of Resection	
Gross Total Resection (GTR)	28 (75.7%)
Incomplete Resection	4 (10.8%)
GTR with sinus reconstruction	2 (5.4%)
Histopathological Subtype	
Meningothelial meningioma	12 (33.3%)
Transitional meningioma	7 (19.4%)
Atypical meningioma	9 (25%)
Anaplastic meningioma	1 (2.8%)
Malignant meningioma	1 (2.8%)
WHO Grade	
Grade I	19 (52.8%)
Grade II	9 (25%)
Grade III	2 (5.6%)
Postoperative Outcomes	
Good recovery	26 (72.2%)
Recovery with deficits	6 (26.7%)
Poor outcome / Recurrence	4 (11.1%)
Follow-up Duration (months)	17.50 (IQR 2-180)
Length of Hospital Stay (days)	10.77±8.36

Factors Contributing to Surgical Difficulty

Pediatric meningioma

The surgical management of giant parasagittal and falcine meningiomas is frequently complicated by a combination of factors, including patient age, vascular involvement, tumor location, and anatomical

subtype (***See Table 2 at the link https://theunj.org/article/view/338724/331688***). Pediatric patients, for instance, present unique challenges due to more aggressive tumor behaviour and a higher risk of intraoperative complications [5, 7, 21, 22]. In our review, four children (11.1%) were identified, with a mean age of 5.75±3.8 years; three had atypical and one had anaplastic meningioma. Li *et al*. reported a 2-year-old child with a 14.2 × 13.5 × 11.1 cm occipito-temporo-parietal tumor featuring necrosis, vascularity, and bone erosion. The patient underwent staged resection but experienced two episodes of hemorrhagic shock, including one with unrecordable intraoperative blood pressure; nonetheless, gross total resection was achieved, and the child remained recurrence-free at 5 years [5]. Similarly, Savateev *et al*. described a 10-year-old with an 11 × 8.5 cm parasagittal tumor extending intra- and extracranially with SSS invasion; initial surgery was aborted due to hemorrhage, and the tumor was removed during a second-stage operation, followed by complete recovery and adjuvant stereotactic radiotherapy [18]. Other cases, such as those reported by Honda and Doxtader, involved high-grade meningiomas with recurrence or metastasis despite surgical resection [21, 22]. These pediatric cases highlight the need for cautious, individualized, and often staged approaches as well as long-term postoperative surveillance.

Vascular complexity and middle third SSS involvement

Vascular factors, particularly SSS invasion, high tumor vascularity, and dependence on collateral venous pathways, pose significant challenges in resecting giant parasagittal and falcine meningiomas [7, 9, 26]. These challenges are especially pronounced when the tumor involves the middle third of the SSS, a region closely associated with the eloquent cortex and prominent bridging veins such as the rolandic and precentral veins [5]. In our review, nine cases (37.5%) demonstrated involvement of the middle third segment, resulting in SSS occlusion. Otani *et al*. (2018) utilized 3D computed tomography (CT) venography to visualize multiple rolandic veins near a 6 cm falcine tumor, enabling a gravity-assisted interhemispheric approach [9]. Similarly, Wang *et al*. (2022) described a large parasagittal meningioma infiltrating the middle third of the SSS, with CT venography revealing complete sinus occlusion and displacement of the right precentral vein [7]. Consequently, surgical strategies should prioritize the preservation of collateral venous pathways and employ patient positioning techniques that enhance cerebral venous drainage, thereby minimizing the risk of postoperative neurological deficits.

Several cases further illustrate the surgical impact of venous anatomy. In Bederson's 1995 report, partial SSS occlusion in an 8 cm parasagittal tumor led to significant sinus bleeding, requiring a staged resection [15]. In Kusdiansah's 2023 case, CT venography revealed complete SSS occlusion with compensatory diploic vein bypass. This finding led the surgical team to design an "L"-shaped craniotomy that preserved venous outflow, allowing for safe resection without compromising the bypass [28]. Rajagopal (2022) described a case with complete sinus blockage and prominent bridging vein networks, which necessitated an intrinsic resection strategy to avoid venous infarction [19]. Li and Gotohda each reported highly vascular tumors that resulted in intraoperative hemorrhagic shock; in Gotohda's case, prior embolization of arterial feeders made resection safer [5, 14]. Psaras *et al*. (2009) were only able to do subtotal resection of a middle-third SSS tumor due to dense sinus adherence and bleeding; tumor recurrence and lung metastasis developed 15 years later [27].

Falcine vs parasagittal meningioma

Finally, tumor location plays a key role in determining surgical complexity. Parasagittal meningiomas are generally more challenging to resect than falcine tumors due to higher rates of SSS invasion, peritumoral edema, and hyperostotic bone changes [16, 20, 22]. In this review, 18 cases (64.3%) of parasagittal meningiomas invaded the SSS, compared to just 3 cases (10.7%) of falcine tumors. Parasagittal tumors more frequently exhibited vasogenic edema, which complicates resection and recovery. For example, Walker *et al*. (2023) described a parasagittal tumor with extensive edema and intraoperative evidence of pial invasion [16]. Similarly, Bederson (1995) and Okunlola (2024) reported neurological decline associated with peritumoral edema and cystic changes [15, 20]. Hyperostosis further complicates surgery in parasagittal lesions. Rajagopal (2022) described hypervascular bone overlying a parasagittal tumor requiring a sinus-sparing approach [19]. Moreover, Savateev (2016) and Wang *et al*. (2016) noted cases where bony hyperostosis contributed to increased intracranial pressure, prompting decompressive craniectomy [6, 18]. Overall, these findings highlight parasagittal meningiomas are often more invasive and technically demanding than their falcine counterparts.

Discussion

Gross total resection (GTR) remains the primary surgical goal in the management of meningiomas due to its consistently superior outcomes in progression-free survival (PFS) and overall survival (OS), as demonstrated across multiple studies [31–34]. In our review, GTR was

achieved in 75.7% of patients, while STR was performed in 10.8%. Soyuer *et al*. (2004), reported significantly higher 5-year PFS rates in patients undergoing GTR compared to STR (77% vs. 52%, p=0.02) [35]. Similarly, Aizer *et al*. (2014) reported improved 5-year OS in patients with atypical and malignant meningiomas who underwent GTR [36]. Sun *et al*. (2015) also demonstrated superior PFS rates in favor of GTR [37]. In pediatric populations, Wach *et al*. (2025) reported significantly longer PFS and OS for GTR over STR based on pooled data from 20 studies (PFS: 113.8 vs. 40.1 months; OS: 602.9 vs. 173.8 months; both p<0.001) [31].

In this review, the extent of resection was recorded as described by the original authors. Most studies defined GTR as Simpson Grade I–III removal, consistent with evidence showing no significant difference in recurrence between these grades when modern microsurgical techniques are used [38]. In cases with SSS invasion or occlusion, GTR often referred to complete macroscopic removal of the extraluminal component with preservation or reconstruction of venous outflow. For example, Aguiar *et al*. (2022) achieved favorable outcomes following Simpson Grade II resection and sinus preservation, while Alzughaibi *et al*. (2024) and Aboud *et al*. (2021) reported complete excision of tumors invading occluded sinus segments, the latter with venous graft reconstruction. Consistent with this strategy, Sirko *et al*. (2022) and Kvasha & Spiridonov (2024) showed that tailoring the extent of resection to preoperative assessment of SSS patency and collateral venous outflow can increase completeness (Simpson Grade I–II) while lowering complications and subsequent tumor regrowth [40] [41].

Conversely, when safe sinus resection was not feasible, subtotal removal followed by observation or adjuvant radiotherapy was employed, as illustrated by Psaras *et al*. (2009) and Kusdiansah *et al*. (2023) [27,28]. Thus, the 28 cases labeled as GTR in this review should be interpreted within this context of "functional total resection," emphasizing maximal tumor removal while maintaining venous integrity. This approach reflects the current surgical philosophy that achieving a balance between radicality and preservation of venous drainage is crucial in the management of giant parasagittal and falcine meningiomas.

Despite its benefits, GTR is not always feasible, particularly in giant parasagittal or falcine meningiomas with high vascularity, SSS invasion, or proximity to eloquent cortex. For example, Savateev (2016) reported the need for staged resection due to intraoperative hemorrhage risk, resulting in a Simpson Grade IV resection [18]. Similarly, Li *et al*. (2016) described a successful two-stage GTR in a highly vascular pediatric tumor with bone erosion and mass effect [5]. These cases highlight that STR followed by delayed resection may be a safe and pragmatic alternative. In elderly patients, since the risk of recurrence may be unlikely within the patient's lifetime, and if the tumors are adjacent to critical structures, STR may be preferable. GTR may not confer significant survival benefits [42]. Studies by Psaras *et al*. (2009), Kusdiansah *et al*. (2023), and Karthigeyan *et al*. (2018) support STR with adjuvant radiotherapy or delayed GTR as effective strategies for long-term symptom control and favorable outcomes [27, 28, 30]. Therefore, while GTR should be pursued when safely achievable, STR remains a valid option to balance oncological control with surgical safety in selected cases.

Although tumor size often contributes to surgical complexity, our analysis suggests that biological behavior and tumor aggressiveness are more critical determinants. In our review, 72.2% of patients had favorable postoperative outcomes despite large tumor size, indicating that size alone is not a reliable predictor of surgical difficulty or outcome. Aggressive features —such as high vascularity, sinus invasion, and intraosseous extension—were more strongly associated with intraoperative challenges [5, 18, 26]. Pediatric patients, in particular, frequently presented with WHO grade II or III tumors requiring complex or staged resections. For instance, Savateev *et al*. (2016) described a 10-year-old with a large parasagittal meningioma invading both the SSS and the skull; although initially suspected to be grade I, the tumor was confirmed as atypical (grade II) during surgery [18]. The operation was halted due to life-threatening hemorrhage. Arivazhagan *et al*. (2008) and Tufan *et al*. also reported increased surgical risks and the need for staged operations in pediatric patients, primarily due to excessive bleeding [43, 44]. Lakhdar *et al*. (2010) identified radiographic signs—such as hyperostosis and intracranial hypertension that indicated aggressive tumor behavior, regardless of tumor size [45]. These findings underscore the need for further large-scale studies to clarify the association between tumor behavior and surgical complexity, particularly in high-risk populations.

Management of meningiomas involving the SSS, especially those affecting the middle third, remains controversial due to the complexity of venous anatomy and functional implications. Some authors including Aboud *et al*. (2021) and Sindou *et al*. (1997) advocate sinus reconstruction. They recommend resecting the invaded segment and restoring venous flow using autologous grafts when collateral drainage is insufficient [13, 46]. Sindou emphasized that reconstruction may help maintain venous circulation and prevent delayed complications even in completely occluded sinuses [15, 46]. Conversely, other studies challenge this approach. Wang *et al*. (2016) found that in cases of complete sinus

occlusion with adequate collateral flow, reconstruction may be unnecessary and it is associated with increased risks such as infection, prolonged operative time, and graft thrombosis. Similarly, Al-Mefty *et al*. also warned that reconstruction in well-collateralized sinuses could compromise critical cortical veins with limited benefit [6, 15]. In our review, SSS invasion was observed in 78.6% of cases, with complete occlusion in 64.3%, predominantly involving the middle third. While favorable outcomes following sinus reconstruction have been reported by Bederson (1995) and Aboud (2021), the decision to reconstruct should be individualized based on sinus patency, collateral circulation, anatomical location, and patient-specific factors [13, 15]. Reconstruction may be beneficial in select cases but is not universally required.

Surgical outcomes for giant parasagittal and falcine meningiomas are generally favorable, though complications and recurrences remain possible, especially in tumors with aggressive features or critical anatomical involvement. In our series, 72.2% of patients had favorable outcomes, while 16.7% experienced mild neurological deficits including hemiparesis, seizures, or cranial nerve palsies. Poor outcomes (11.1%) were mainly due to recurrence, progressive disease, or metastasis. Özsoy *et al*. highlighted the role of tumor location: among parasagittal meningiomas, GTR was achieved in seven patients, with six experiencing good recovery, two remaining unchanged, and two showing poor outcomes, including one fatality due to cerebral edema. In contrast, falcine meningiomas had more favorable results: seven out of eight underwent total resection, five experienced good recovery, and only one death occurred due to postoperative meningitis, with no recurrence reported [47].

Kalfas *et al*. reported that 87% of patients with parasagittal and falcine meningiomas experienced no complications postoperatively, with brain edema being the most common complication, although none required surgical intervention [32]. Similarly, Narayan *et al*. reported a 5% operative mortality rate in patients with large meningiomas (≥5 cm), while Yaşar *et al*. observed no deaths among patients with giant tumors who underwent Simpson grade I or II resections [4, 8].

This study presents a focused exploratory analysis of the surgical challenges associated with giant parasagittal and falcine meningiomas, emphasizing key factors such as sinus invasion, vascular complexity, and anatomical constraints. Synthesizing detailed case-level data offers practical insights that may inform surgical planning and guide future research. However, limitations include the heterogeneity and incompleteness of available reports, variability in surgical techniques, and short-term follow-up, all of which restrict the generalizability of the findings. Further large-scale studies are warranted to validate these observations and develop standardized management protocols.

Conclusion

Giant parasagittal and falcine meningiomas pose significant surgical challenges, primarily due to SSS invasion, vascular complexity, and high-grade pathology in pediatric cases. Parasagittal tumors, particularly with middle-third SSS involvement, are associated with greater technical difficulty and surgical risk. Despite these factors, gross total resection and favorable outcomes can be achieved in most cases. Optimal results depend on careful preoperative venous assessment and individualized surgical strategies that balance maximal tumor resection with preservation of critical venous structures.

Disclosure

Clinical trial number

Not applicable.

Competing interests

The authors declare that there is no conflict of interest regarding publication of this paper.

Funding

No funding is available

Authors' contributions

TAN and NA conceptualized the study, designed the protocol and methodology, conducted the literature search and article screening, and contributed to drafting the manuscript. FB, DWW, and FB2 assisted in drafting the manuscript, supervised the overall process, and validated the findings. All authors read and approved the final version of the manuscript.

Acknowledgments

We thank all contributors for their work in creating the paper.

Consent to Publish declaration

Not applicable.

References

1. Byard RW, Bourne AJ, Clark B, Hanieh A. Clinicopathological and radiological features of two cases of intraventricular meningioma in childhood. Pediatr Neurosci. 1989;15(5):260-4. doi: 10.1159/000120478
2. Casali C, Del Bene M, DiMeco F. Falcine meningiomas. Handb Clin Neurol. 2020;170:101-106. doi: 10.1016/B978-0-12-822198-3.00032-X
3. Black P, Kathiresan S, Chung W. Meningioma surgery in the elderly: a case-control study assessing morbidity and mortality. Acta Neurochir (Wien). 1998;140(10):1013-6; discussion 1016-7. doi: 10.1007/s007010050209
4. Narayan V, Bir SC, Mohammed N, Savardekar AR, Patra DP, Nanda A. Surgical Management of Giant Intracranial Meningioma: Operative Nuances, Challenges, and Outcome. World Neurosurg. 2018 Feb;110:e32-e41. doi: 10.1016/j.wneu.2017.09.184
5. Li J, Mzimbiri JM, Zhao J, Zhang Z, Liao X, Liu J. Surviving the Largest Atypical Parasagittal Meningioma in a 2-Year-

Old Child: A Case Report and a Brief Review of the Literature. World Neurosurg. 2016 Mar;87:662.e1-6. doi: 10.1016/j.wneu.2015.10.078
6. Wang X, Wu R, Zhang P, Zhang C, Song G, Gao Z. Superior Sagittal Sinus Obstruction by Giant Meningiomas: Is Total Removal Feasible? World Neurosurg. 2016 Oct;94:111-119. doi: 10.1016/j.wneu.2016.06.113
7. Wang H, Yang Z, You H, Song J. How I do it: the surgical resection of a middle third parasagittal meningioma with venous preservation strategy. Acta Neurochir (Wien). 2022 May;164(5):1385-1389. doi: 10.1007/s00701-022-05129-6
8. Yaşar S, Kırık A. Surgical Management of Giant Intracranial Meningiomas. Eurasian J Med. 2021 Jun;53(2):73-78. doi: 10.5152/eurasianjmed.2021.20155
9. Otani N, Wada K, Toyooka T, Mori K. Occipital Interhemispheric Approach for Surgical Removal of the Middle Third Falx Meningioma: Two Case Reports. Asian J Neurosurg. 2018 Jul-Sep;13(3):789-791. doi: 10.4103/ajns.AJNS_158_16
10. Bansal C, Shah H, Bora SK, Suri A. Middle third falcine meningiomas-surgical nuances for cortical venous preservation. Acta Neurochir (Wien). 2024 May 18;166(1):220. doi: 10.1007/s00701-024-06088-w
11. Luther E, Ramsay I, Berke C, Makhoul V, Lu V, Elarjani T, Burks J, Berry K, Eichberg DG, Di L, Mansour S, Echeverry N, Morell A, Ivan M, Komotar R. Widening the Operative Corridor-Evaluating the Transcortical Approach to Giant Falcine Meningiomas. World Neurosurg. 2024 May;185:e442-e450. doi: 10.1016/j.wneu.2024.02.046
12. Dudley RWR, Torok MR, Randall S, Béland B, Handler MH, Mulcahy-Levy JM, Liu AK, Hankinson TC. Pediatric versus adult meningioma: comparison of epidemiology, treatments, and outcomes using the Surveillance, Epidemiology, and End Results database. J Neurooncol. 2018 May;137(3):621-629. doi: 10.1007/s11060-018-2756-1
13. Aboud E, Tamer WA, Ibn Essayed W, Al-Mefty O. Resection of Giant Invasive Parasagittal Atypical Meningioma With a Venous Graft Reconstruction of the Sagittal Sinus: 2-Dimensional Operative Video. Oper Neurosurg. 2021 Sep 15;21(4):E332-E333. doi: 10.1093/ons/opab232
14. Gotohda K, Uchino A, Suzuki T, Mishima K, Homma T, Miyama Y, Baba Y. Acute subdural hematoma caused by hemorrhagic falx meningioma: A case report and review of the literature. Radiol Case Rep. 2024 Apr 24;19(7):2804-2811. doi: 10.1016/j.radcr.2024.03.056
15. Bederson JB, Eisenberg MB. Resection and replacement of the superior sagittal sinus for treatment of a parasagittal meningioma: technical case report. Neurosurgery. 1995 Nov;37(5):1015-8; discussion 1018-9. doi: 10.1227/00006123-199511000-00026
16. Walker SE, Kaoutzani L, Vale FL. Supplementary Motor Area Syndrome After Resection of a Dominant Hemisphere Parasagittal Meningioma: A Case Report. Neurosurg Pract. 2023 Oct 13;4(4):e00067. doi: 10.1227/neuprac.0000000000000067
17. Dimou S, Nehoff HL, Jackson S. Falcine meningioma masquerading as biliary colic - Case report and literature review. J Clin Neurosci. 2021 May;87:66-68. doi: 10.1016/j.jocn.2021.02.004
18. Savateev AN, Konovalov AN, Gorelyshev SK, Satanin LA, Khukhlaeva EA, Shishkina LV, Ozerova VI, Valiakhmetova EF, Medvedeva OA. A giant hyperostotic parasagittal meningioma in a child with neurofibromatosis type II (a case report and literature review). Zh Vopr Neirokhir Im N N Burdenko. 2016;80(6):66-73. English, Russian. doi: 10.17116/neiro201680666-73
19. Rajagopal M, Toms J, Graham RS. Meningioma with holo-sagittal sinus involvement treated successfully with intrinsic sinus surgery: illustrative case. J Neurosurg Case Lessons. 2022 Apr 18;3(16):CASE21710. doi: 10.3171/CASE21710
20. Okunlola AI, Ibijola AA, Babalola OF, Okunlola CK, Erinomo OO. Parasagittal cystic meningioma mimicking hemangioblastoma: A case report. Surg Neurol Int. 2021 Jul 27;12:368. doi: 10.25259/SNI_507_2021
21. Honda Y, Shirayama R, Morita H, Kusuhara K. Pulmonary and pleural metastasis of intracranial anaplastic meningioma in a 3-year-old boy: A case report. Mol Clin Oncol. 2017 Oct;7(4):633-636. doi: 10.3892/mco.2017.1375
22. Doxtader EE, Butts SC, Holsapple JW, Fuller CE. Aggressive pediatric meningioma with soft tissue and lymph node metastases: a case report. Pediatr Dev Pathol. 2009 May-Jun;12(3):244-8. doi: 10.2350/08-07-0501.1
23. Alzughaibi RA, Almuhammadi GA, Alasmari SS, Khoja MM, Almashni AA. Challenging Resection of Bilateral Parasagittal and Falcine Meningioma Involving Both Anterior Third and Middle Third of the Superior Sagittal Sinus: A Case Report and Literature Review. Cureus. 2024 Jul 18;16(7):e64865. doi: 10.7759/cureus.64865
24. Hassan M, Salman I, Salman A, Tofan S, Salman I. Massive cystic falcine meningioma presented with slight symptoms: a case report. Ann Med Surg (Lond). 2024 Apr 29;86(6):3766-3769. doi: 10.1097/MS9.0000000000002108
25. Sim SK, Khairul Aizad A, Lim SS, Wong A. Large falcine meningioma presented as treatment-resistant depression: A case report. Med J Malaysia. 2019 Feb;74(1):87-89.
26. Papadimitriou K, Rocca A, Dunet V, Daniel RT. Feeding artery aneurysms associated with large meningiomas: case report and review of the literature. Heliyon. 2020 May 28;6(5):e04071. doi: 10.1016/j.heliyon.2020.e04071
27. Psaras T, Pantazis G, Steger V, Meyermann R, Honegger J, Beschorner R. Benign meningioma developing late lung metastases: case report and review of the literature. Clin Neuropathol. 2009 Nov-Dec;28(6):453-9. doi: 10.5414/npp28453
28. Kusdiansah M, Benet A, Ota N. Adaptative Diploic Vein Bypass of the Superior Sagittal Sinus in a Large Falcine Meningioma. World Neurosurg. 2023 Jul;175:45-46. doi: 10.1016/j.wneu.2023.04.023
29. Mathuriya SN, Vasishta RK, Khandelwal N, Pathak A, Sharma BS, Khosla VK. Calcified falx meningioma. Neurol India. 2000 Sep;48(3):285-7.
30. Karthigeyan M, Rajasekhar R, Salunke P, Singh A. Modified unilateral approach for mid-third giant bifalcine meningiomas: resection using an oblique surgical trajectory and falx window. Acta Neurochir (Wien). 2019 Feb;161(2):327-332. doi: 10.1007/s00701-018-3770-y
31. Wach J, Vychopen M, Basaran AE, Tatagiba M, Goldbrunner R, Güresir E. Overall survival and progression-free survival in pediatric meningiomas: a systematic review and individual patient-level meta-analysis. J Neurooncol. 2025 Apr;172(2):289-305. doi: 10.1007/s11060-024-04917-7
32. Kalfas F, Scudieri C. Neurosurgical Management of Parasagittal and Falcine Meningiomas: Judicious Modern Optimization of the Results in a 100-Case Study. Asian J Neurosurg. 2019 Nov 25;14(4):1138-1143. doi: 10.4103/ajns.AJNS_245_18
33. Armocida D, Catapano A, Palmieri M, Arcidiacono UA, Pesce A, Cofano F, Picotti V, Salvati M, Garbossa D, D'Andrea G, Santoro A, Frati A. The Surgical Risk Factors of Giant Intracranial Meningiomas: A Multi-Centric Retrospective Analysis of Large Case Serie. Brain Sci. 2022 Jun 22;12(7):817. doi: 10.3390/brainsci12070817
34. Hua L, Wang D, Zhu H, Deng J, Luan S, Chen H, Sun S, Tang H, Xie Q, Wakimoto H, Gong Y. Long-term outcomes of multimodality management for parasagittal meningiomas. J Neurooncol. 2020 Apr;147(2):441-450. doi: 10.1007/s11060-020-03440-9
35. Soyuer S, Chang EL, Selek U, Shi W, Maor MH, DeMonte F. Radiotherapy after surgery for benign cerebral

meningioma. Radiother Oncol. 2004 Apr;71(1):85-90. doi: 10.1016/j.radonc.2004.01.006
36. Aizer AA, Arvold ND, Catalano P, Claus EB, Golby AJ, Johnson MD, Al-Mefty O, Wen PY, Reardon DA, Lee EQ, Nayak L, Rinne ML, Beroukhim R, Weiss SE, Ramkissoon SH, Abedalthagafi M, Santagata S, Dunn IF, Alexander BM. Adjuvant radiation therapy, local recurrence, and the need for salvage therapy in atypical meningioma. Neuro Oncol. 2014 Nov;16(11):1547-53. doi: 10.1093/neuonc/nou098
37. Sun SQ, Hawasli AH, Huang J, Chicoine MR, Kim AH. An evidence-based treatment algorithm for the management of WHO Grade II and III meningiomas. Neurosurg Focus. 2015 Mar;38(3):E3. doi: 10.3171/2015.1.FOCUS14757
38. Chotai S, Schwartz TH. The Simpson Grading: Is It Still Valid? Cancers (Basel). 2022 Apr 15;14(8):2007. doi: 10.3390/cancers14082007
39. Aguiar PHP, Dos Santos RRP, Marson FAL, Dezena RA, Rampazzo ACMR. What is the ideal grade of resection for parasagittal meningiomas with the invasion of superior sagittal sinus? Simpson I or Simpson II resection? A retrospective observational study. Surg Neurol Int. 2022 Sep 16;13:423. doi: 10.25259/SNI_436_2022
40. Sirko AH, Perepelytsia VA. Parasagittal meningiomas: surgical treatment outcomes. Ukr Neurosurg J. 2022Sep.29;28(3):33-42. doi: 10.25305/unj.259324
41. Kvasha MS, Spiridonov AV. Surgical treatment of meningiomas invading the superior sagittal sinus. Ukr Neurosurg J. 2024Dec.30;30(4):51-6. doi: 10.25305/unj.312398
42. Amoo M, Henry J, Farrell M, Javadpour M. Meningioma in the elderly. Neurooncol Adv. 2023 Jun 3;5(Suppl 1):i13-i25. doi: 10.1093/noajnl/vdac107
43. Arivazhagan A, Devi BI, Kolluri SV, Abraham RG, Sampath S, Chandramouli BA. Pediatric intracranial meningiomas--do they differ from their counterparts in adults? Pediatr Neurosurg. 2008;44(1):43-8. doi: 10.1159/000110661
44. Tufan K, Dogulu F, Kurt G, Emmez H, Ceviker N, Baykaner MK. Intracranial meningiomas of childhood and adolescence. Pediatr Neurosurg. 2005 Jan-Feb;41(1):1-7. doi: 10.1159/000084858
45. Lakhdar F, Arkha Y, El Ouahabi A, Melhaoui A, Rifi L, Derraz S, El Khamlichi A. Intracranial meningioma in children: different from adult forms? A series of 21 cases. Neurochirurgie. 2010 Aug;56(4):309-14. doi: 10.1016/j.neuchi.2010.05.008
46. Sindou M. Meningiomas invading the sagittal or transverse sinuses, resection with venous reconstruction. J Clin Neurosci. 2001 May;8 Suppl 1:8-11. doi: 10.1054/jocn.2001.0868
47. Özsoy KM, Ökten Aİ, Ateş T, Arslan A, Menekşe G, Çikili M, Güzel A. Intracranial benign giant meningiomas: a clinical analysis of 56 cases. Neurosurgery Quarterly. 2013 Feb 1;23(1):27-32. doi: 10.1097/WNQ.0b013e318266c501