

Surgical Decision-Making in a Parasagittal Meningioma with Chronic Anterior Superior Sagittal Sinus Occlusion: An Illustrative Case Report

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Case Report

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Abstract

Background: Parasagittal meningiomas involving the superior sagittal sinus (SSS) remain surgically challenging because operative strategy is determined not only by the anatomical extent of sinus involvement but also by the functional significance of the affected venous segment. The need for sinus reconstruction remains controversial. ^[1-5]

Case Presentation: A 50-year-old woman presented with a right frontal parasagittal meningioma. Contrast-enhanced magnetic resonance imaging (MRI) demonstrated a dural-based lesion adjacent to the anterior third of the SSS (Fig.1). Magnetic resonance venography (MRV) showed complete absence of a flow-related signal within the involved sinus segment and prominent collateral cortical venous channels (Fig.2). Computed tomography (CT) demonstrated adjacent focal hyperostosis (Fig. 3). A right parasagittal craniotomy was performed. Intraoperatively, the involved sinus segment was fibrotic, collapsed, and devoid of a functional lumen. Multiple collateral cortical venous pathways were identified and preserved. Progressive surgical assessment confirmed that the occluded sinus segment was no longer participating in cerebral venous drainage. Gross total tumor resection (Simpson grade II) was achieved without sinus reconstruction. Postoperative imaging showed no hemorrhage, venous infarction, or residual tumor (Figs.4 and Figs.5). Histopathology confirmed transitional meningioma, CNS WHO grade 2 (Fig.6).

Conclusions: Chronic occlusion of the anterior SSS may evolve into functional exclusion through collateral venous adaptation. In such cases, preoperative imaging, intraoperative functional assessment, and preservation of collateral venous drainage together may permit safe gross total resection without routine sinus reconstruction.

BACKGROUND

Parasagittal meningiomas account for approximately 20%–30% of intracranial meningiomas and frequently involve the superior sagittal sinus (SSS). ^[1–5, 7] Surgical management is challenging because these tumors may compress, narrow, or invade the sinus and its bridging veins, thereby placing cerebral venous outflow at risk. The aim of surgery is therefore not only tumor removal, but also maximal safe resection while preserving venous drainage.

The extent of resection remains a major determinant of recurrence risk in meningioma, and the Simpson grade continues to provide a practical framework for operative decision-making. In parasagittal lesions, a higher degree of sinus invasion has been associated with increased perioperative complications and recurrence risk. ^[8, 9] At the same time, overly aggressive sinus manipulation can increase venous morbidity. This persistent tension between radicality and safety is why the management of parasagittal meningiomas with SSS involvement remains one of the most debated problems in cranial tumor surgery. ^[1–5]

Although some surgeons advocate radical resection with venous reconstruction, others favor individualized preservation of the sinus or venous outflow when mature collateral drainage is present. [2–5] Modern consensus documents emphasize integrated diagnosis and tailored treatment planning for meningiomas, but they do not eliminate the need for intraoperative judgment in sinus-involved disease. [6, 7] Importantly, radiographic narrowing or absence of flow on MRV does not always prove complete physiological exclusion of the sinus. [2–5] We report a case of parasagittal meningioma involving the anterior third of the SSS in which preoperative imaging suggested chronic venous adaptation and intraoperative findings confirmed functional exclusion of the involved sinus segment.

CASE PRESENTATION

Clinical Presentation

A 50-year-old woman was diagnosed with a right frontal parasagittal lesion. Neurological examination was unremarkable.

Imaging Findings

Contrast-enhanced MRI demonstrated a right frontal parasagittal extra-axial mass with broad dural attachment, consistent with a meningioma (Fig. 1).

MRV demonstrated complete absence of a flow-related signal within the anterior third of the SSS, together with prominent collateral cortical venous channels, suggesting chronic alteration of venous drainage (Fig. 2).

CT bone-window imaging demonstrated focal hyperostosis adjacent to the parasagittal attachment site (Fig. 3).

Surgical Findings

A right parasagittal craniotomy was performed. The tumor was firmly attached to the SSS. Intraoperatively, the involved sinus segment appeared fibrotic and collapsed, with no identifiable functional lumen.

Multiple collateral cortical venous channels were identified and meticulously preserved. Progressive intraoperative assessment demonstrated that the affected sinus segment was not participating in active cerebral venous outflow.

Gross total tumor resection (Simpson grade II) was achieved without sinus reconstruction.

Histopathology

Histopathological examination confirmed transitional meningioma, CNS WHO grade 2 (Fig. 6).

Immunohistochemistry demonstrated progesterone receptor positivity, SSTR2 positivity, and a low proliferative index (Ki-67 approximately 2%–5%).

Postoperative Course

Postoperative CT obtained within 24 hours demonstrated no intracranial hemorrhage, venous infarction, or cerebral edema (Fig. 4).

Follow-up MRI at 6 weeks confirmed gross total tumor resection without residual disease (Fig. 5).

The patient remained neurologically intact and subsequently received adjuvant radiotherapy.

DISCUSSION

The principal challenge in the present case was determining whether the involved anterior SSS retained functional significance and therefore required reconstruction after tumor removal. Preoperative MRV demonstrated absence of a flow-related signal within the involved sinus segment together with well-developed collateral cortical venous channels. However, imaging alone cannot always determine whether a sinus segment is truly functionally excluded. [2–5]

Anatomical versus Functional Sinus Involvement

A central lesson from this case is the distinction between anatomical sinus involvement and functional venous participation. MRV may show narrowing, absent flow, or non-visualization of the sinus segment, but these findings do not automatically prove complete loss of venous function. Conversely, an anatomically invaded segment may already have been bypassed by collateral pathways and may contribute little to cerebral drainage. This distinction is clinically important because operative strategy should be based on function, not anatomy alone. [2–5]

In the present patient, the absence of flow-related signal in the anterior third of the SSS, combined with prominent collateral cortical venous channels, suggested long-standing adaptation rather than acute obstruction. Intraoperatively, the sinus was fibrotic, collapsed, and devoid of a functional lumen, confirming complete functional exclusion from active venous outflow. Thus, the definitive functional status of the sinus was established only during surgery.

Significance of Collateral Venous Adaptation

The most important biological feature of this case was the mature collateral venous adaptation. Chronic occlusion of the SSS by a parasagittal tumor can induce venous remodeling over time, allowing cortical,

diploic, and intersinus pathways to enlarge and compensate for loss of the primary sinus channel. This process is gradual and fundamentally different from acute venous sacrifice, which may precipitate venous congestion, infarction or edema.

Recent angiographic studies have shown that collateral venous routes in tumors invading the SSS are common and clinically relevant, often traversing cortical and diploic channels. In our patient, these collateral cortical veins were not incidental findings; they represented the dominant venous outflow route and therefore had to be preserved. Recognition of these established pathways allowed the operation to proceed safely without sinus reconstruction.

Reconstruction Strategy in Anterior-Third SSS Lesions

The question of whether to reconstruct an invaded sinus remains controversial. Classic surgical series have supported both radical resection with venous repair and more conservative strategies that preserve venous outflow when possible. ^[1–5] Bonnal and Brotchi described early operative experience with the SSS in parasagittal meningiomas, while Sindou and colleagues emphasized venous reconstruction in selected cases. ^[1, 2, 4] DiMeco et al. and Caroli et al. further showed that surgical management must balance radicality with venous risk. ^[3, 5]

The anterior third of the SSS has particular surgical significance. Compared with more posterior segments, it generally receives less critical cortical venous inflow and may better tolerate chronic occlusion when robust collateral circulation has already developed. This does not mean that reconstruction is never needed; rather, it means that anterior-third lesions require individualized assessment because the physiological reserve of the sinus segment differs substantially between patients.

More recent series have continued to support the value of venous preservation or simplified strategies when the sinus is already chronically occluded. A simplified surgical strategy has been proposed for selected parasagittal meningiomas, and recurrence and complications have been associated with higher invasion classes, again highlighting the importance of careful sinus assessment and venous risk stratification. ^[8, 9] Taken together, these data support individualized decision-making rather than a one-size-fits-all reconstruction policy.

Implications for Surgical Decision-Making

The present case illustrates why parasagittal meningioma surgery should be planned as a venous problem as much as a tumor problem. The operative goal is not simply to remove the tumor at any cost, but to remove it while maintaining the venous drainage network that the brain is actually using. In this patient, imaging, intraoperative inspection, and collateral preservation all converged on the same conclusion: the involved SSS segment was functionally excluded and the collateral channels were physiologically essential. That recognition made a reconstruction-free strategy both logical and safe.

This case also aligns with modern guideline thinking. The EANO guideline emphasizes individualized management of meningiomas, while the WHO CNS5 framework reinforces integrated diagnosis using histology and immunohistochemistry.^[6, 7] Although these documents do not prescribe a single operative algorithm for SSS-involved meningiomas, they support the broader principle that treatment should be tailored to tumor biology, anatomy, and patient-specific risk.

CONCLUSIONS

Chronic occlusion of the anterior superior sagittal sinus may become physiologically compensated through mature collateral cortical venous adaptation. In the present case, imaging, intraoperative functional assessment, and recognition of collateral venous drainage together determined the surgical strategy. Gross total resection was achieved without sinus reconstruction because the involved sinus segment was functionally excluded from cerebral venous outflow. This case emphasizes that surgical strategy in parasagittal meningioma should be guided by anatomical imaging, intraoperative venous function, and collateral circulation, rather than by anatomy alone.

Abbreviations

CT
Computed tomography
MRI
Magnetic resonance imaging
MRV
Magnetic resonance venography
PR
Progesterone receptor
SSS
Superior sagittal sinus
WHO
World Health Organization

Declarations

Ethics approval and consent to participate:

Formal ethics committee approval was waived because this study reports a single clinical case without experimental intervention.

Consent for publication:

Written informed consent for publication was obtained from the patient.

Competing interests:

The authors declare that they have no competing interests.

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Author Contribution

Doctor Junfeng Jiao and Jianhua Xiong performed the surgery. Doctor Junfeng Jiao wrote the main manuscript text. Professor Shufang Zhao performed the pathological diagnosis. Doctor Chao Gao and Nannan Gao conducted the literature review. Doctor Hongzhao Wang performed manuscript proofreading and revision. Doctor Derang Jiao contributed to the overall study design and supervision, critically revised the manuscript. All authors reviewed the manuscript.

Availability of data and materials:

All relevant data supporting the findings of this study are included within the article.

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Figures

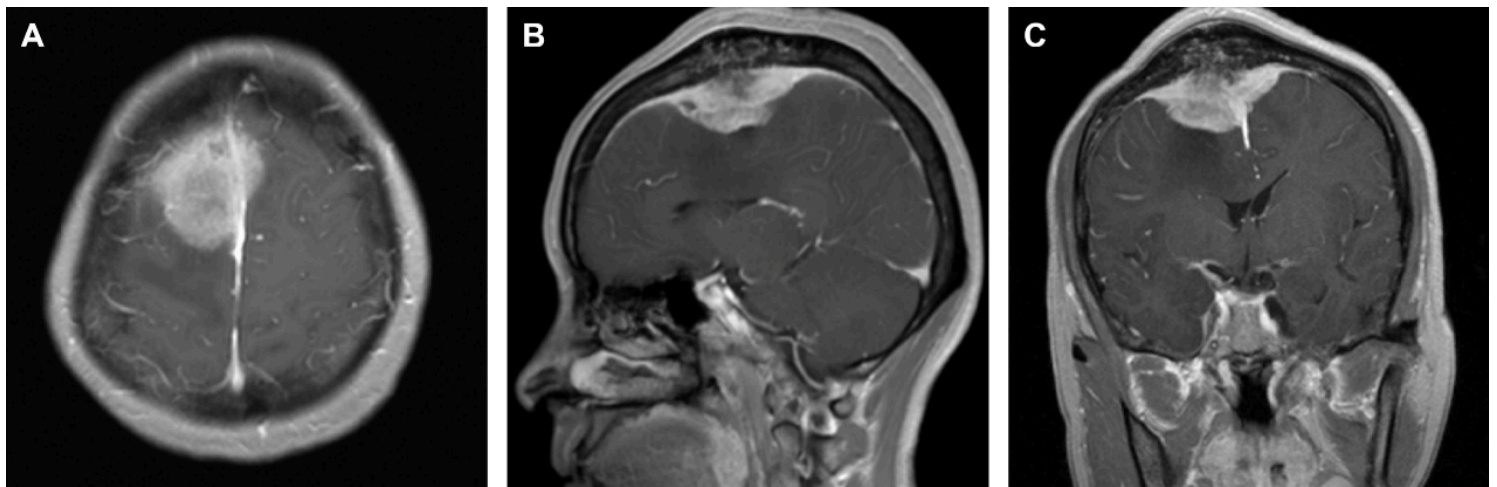


Figure 1

Preoperative contrast-enhanced MRI. (A) Axial, (B) sagittal, and (C) coronal contrast-enhanced MRI demonstrating a right frontal parasagittal extra-axial mass with broad dural attachment, consistent with a parasagittal meningioma.

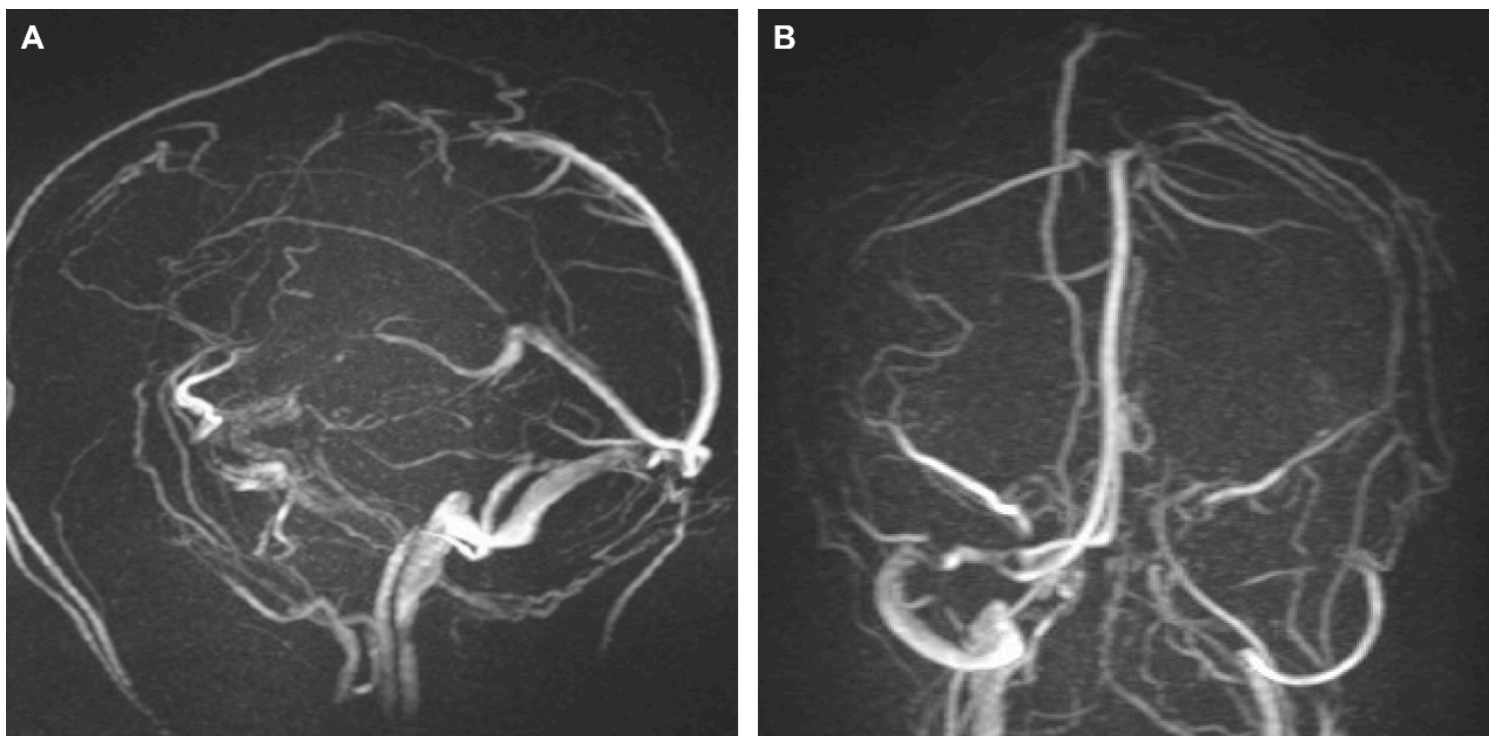


Figure 2

Preoperative MRV. (A) Global venous view and (B) detailed view of the anterior third of the superior sagittal sinus (SSS) showing an absence of flow-related signal with prominent, well-developed collateral cortical venous channels.

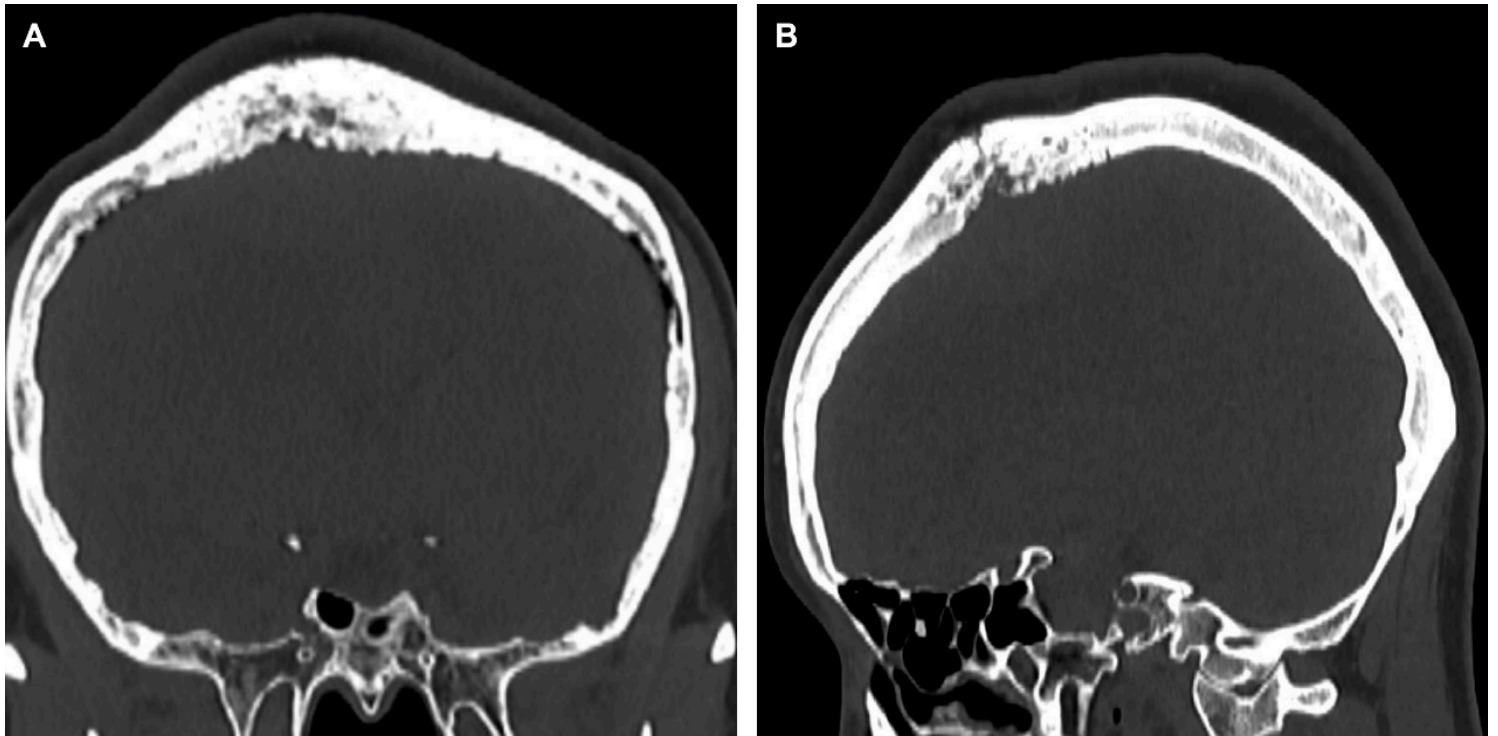


Figure 3

Preoperative CT bone window. Axial bone-window imaging demonstrates focal hyperostosis adjacent to the tumor attachment site.

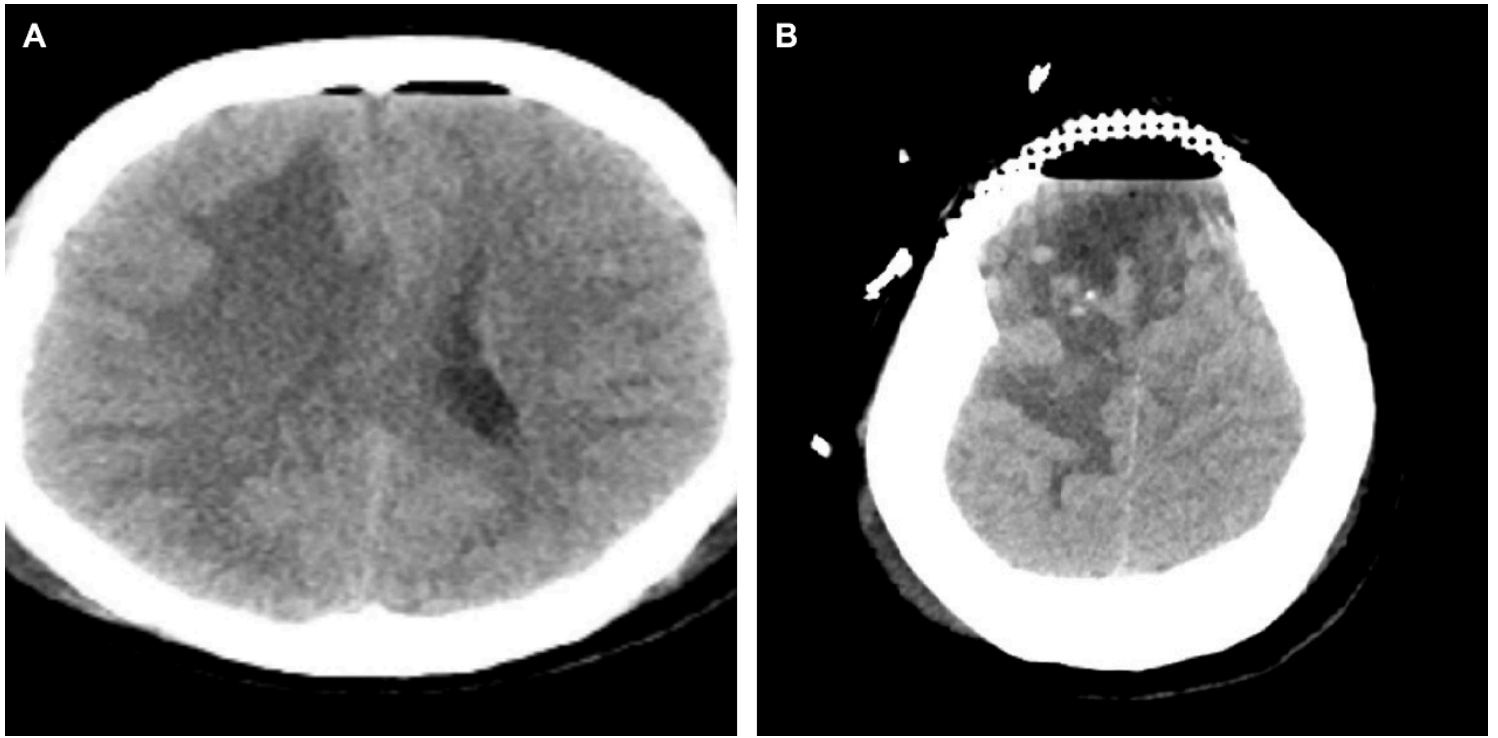


Figure 4

Postoperative CT obtained 24 hours after surgery. Axial imaging confirms satisfactory tumor removal without postoperative intracranial hemorrhage or venous infarction.

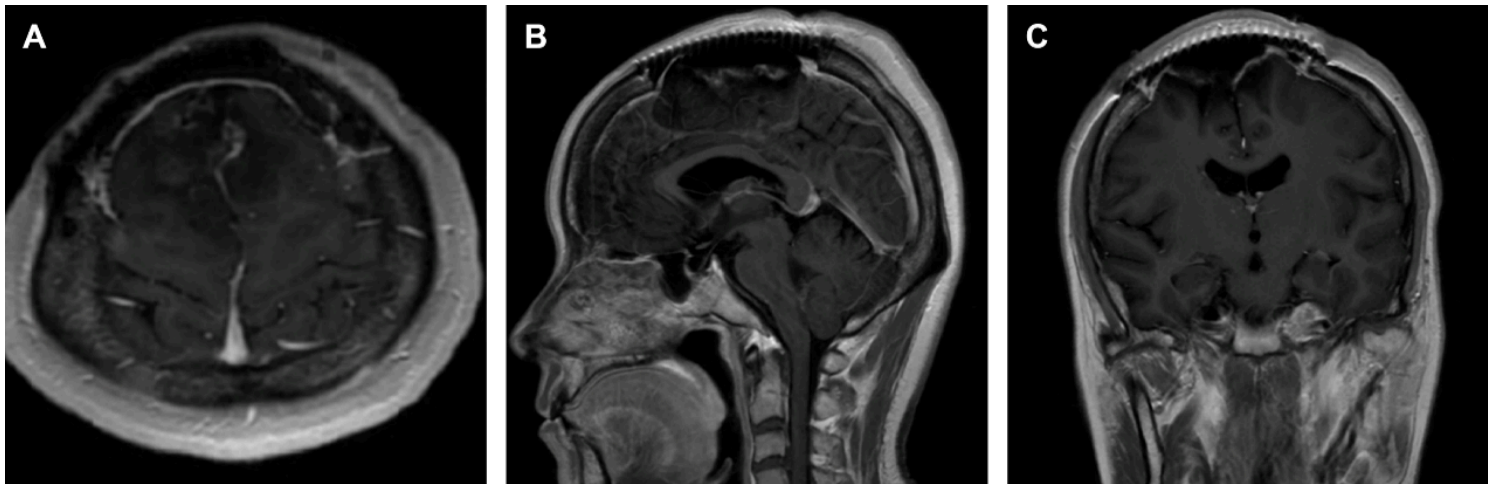


Figure 5

Follow-up MRI obtained 6 weeks postoperatively. (A) Axial, (B) sagittal, and (C) coronal contrast-enhanced MRI demonstrate gross total resection (Simpson grade II) without residual tumor.

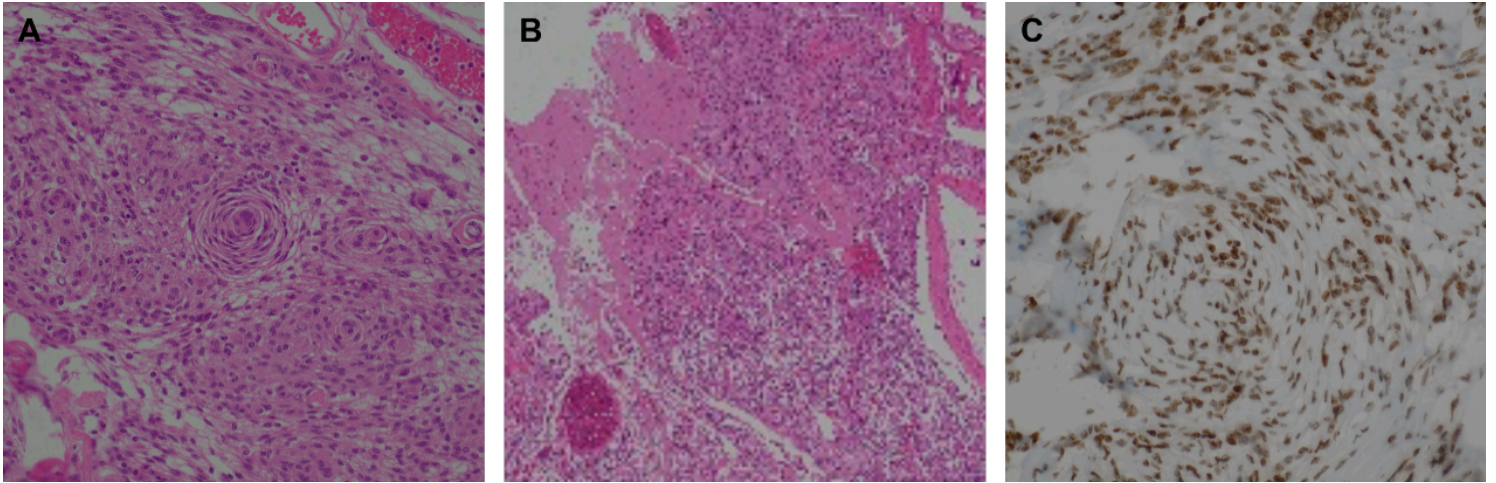


Figure 6

Histopathology. (A) H&E staining (×100) shows typical transitional meningioma features, (B) H&E staining (×200) highlights focal brain invasion supporting CNS WHO grade 2, and (C) Ki-67 immunohistochemistry demonstrates a low proliferative index of approximately 2%–5%.