Perioperative and Long-term Outcomes From the Management of Parasagittal Meningiomas Invading the Superior Sagittal Sinus

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BACKGROUND: Parasagittal meningiomas invading the superior sagittal sinus (SSS) pose formidable obstacles to surgical management. Invasion is often considered a contraindication to surgery because of associated morbidity, such as cerebral venous thrombosis.

OBJECTIVE: We report our most recent experience with the resection of parasagittal meningiomas invading the SSS.

METHODS: Between 1992 and 2004, 110 patients with parasagittal meningiomas underwent surgery at the Johns Hopkins Medical Institutions. Clinical charts, radiological studies, pathological features, and operative notes were retrospectively analyzed; only those patients with minimum 24 months follow-up (n = 61) were further studied.

RESULTS: Tumor distribution by location along the SSS was: 21% anterior, 62% middle, and 17% posterior. All patients were managed with initial surgical resection with radiosurgery for residual/recurrent disease if indicated (19.6%). Pathological examination revealed 80% grade I meningiomas, 13% grade II meningiomas, and 7% grade III meningiomas. Simpson grade I/II resection was achieved in 81% of patients. Major complications included venous thrombosis/infarction (7%), intraoperative air embolism (1.5%), and death (1.5%); long-term outcomes assessed included recurrence (11%) and improvement in Karnofsky Performance Score (85%).

CONCLUSION: On the basis of our study, the incidence of postoperative venous sinus thrombosis is 7% in the setting of a recurrence rate of 11% with a mean follow-up of 41 months. In comparison with the published literature, the data corroborate the rationale for our treatment paradigm; lesions invading the sinus can initially be resected to the greatest extent possible without excessive manipulation of vascular structures, whereas residual/recurrent disease can be observed and managed with radiosurgery.

KEY WORDS: Parasagittal meningioma, Superior sagittal sinus, Thrombosis

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Although slow-growing and macroscopically well-circumscribed, meningiomas often pose significant surgical obstacles based on their location.[1-4] Defined as those tumors arising from the parasagittal angle without intervening brain parenchyma between the tumor and the sagittal sinus, parasagittal meningiomas attached to and invading the superior sagittal sinus present a unique set of challenges. The treatment of these tumors poses the risk for catastrophic complications because of the intimate relationship between these tumors and the venous sinus with critical tributary bridging veins. Radical resection of meningiomas involving major dural sinuses or bridging veins may be limited, in particular, when these venous channels are patent.[2,5] As occasionally reported, some authors consider invasion of the sinus a contraindication to complete resection, in particular, with tumor involvement posterior to the coronal suture. This is why this cohort of lesions has the highest postoperative recurrence rates (8%-24%) among all meningiomas.[6,7] Although the consequence of such conservative management is

ABBREVIATIONS: **SSS**, superior sagittal sinus; **WHO**, World Health Organization

increased recurrence, the subsequent results of aggressive resection could include severe morbidity and mortality due to injury to critical venous structures with consequent venous infarction.[8] As a result, it then becomes important to balance the ultimate goal of surgical resection with possible complications and the mechanisms by which they occur. The goal of this study was to retrospectively review the morbidity/mortality and long-term outcomes in our experience with parasagittal meningiomas invading the superior sagittal sinus.

METHODS

Between 1992 and 2004, 110 patients with parasagittal meningiomas underwent surgical resection at The Johns Hopkins Medical Institutions by the senior authors (H.B, J.D.W, D.M.L, A.O). For this study, the clinical entity was defined as tumors arising from the parasagittal angle with involvement of the superior sagittal sinus per radiological and/or intraoperative assessments. Clinical data were obtained by retrospective review of patient charts and imaging; only those patients with documented follow-up of 2 years were included for study. Information was collected regarding demographic characteristics, and intraoperative and postoperative complications. Operative reports were reviewed to confirm invasion of the sagittal sinus in addition to intraoperative complications; postoperative complications were ascertained from discharge summaries and postoperative imaging.

Preoperative Workup

Preoperatively, all patients underwent magnetic resonance imaging. Tumors were preoperatively assessed on magnetic resonance imaging (MRI) based on the extent of sinus involvement. Retrospectively for this project, sinus involvement was graded according to the scheme proposed by Sindou[30] (type I, tumor attached to the outer sinus wall; type II, lateral recess invaded by tumor; type III, lateral wall of sinus invaded; type IV, entire lateral wall and roof of sinus invaded, Type V/VI, entire sinus occluded).

In an effort to assess venous collateralization/circulation for tumors with Sindou grades IV and higher, patients typically underwent 4-vessel angiography. With improvements in MRI, some surgeons utilized magnetic resonance venography for lower grades of sinus involvement.

Surgical Technique

Utilizing intraoperative MRI/CT-based neuronavigation, all craniotomies were centered over the tumor and occasionally spanned the contralateral aspect of the superior sagittal sinus. Bone was subsequently separated from the underlying dura; a curvilinear horseshoe-shaped dural flap was created based on the sagittal sinus and the edges of the tumor mapped with surgical neuronavigation. After dural opening, tumor exposure and resection were performed using standard surgical techniques at the anterior, lateral, posterior, and inferior edges. In this process, all attempts were made at preserving bridging veins (even when operating in the anterior third of the sinus). Next, the crucial part of the procedure was directed at the neoplastic component involving the superior sagittal sinus. All attempts were made at Simpson grade I/II resection. Management of the sinus depended on the extent of sinus involvement. For type II tumors, the sinus was not entered and the remaining residual tumor was observed for growth and irradiated. For type III to IV tumors with demonstrated sinus flow, the sinus was entered with the goal of tumor resection and the sinus was reconstructed. For type V/VI tumors with no demonstrated patency, the sinus was ligated and resected with tumor; however, for type V tumors with demonstrated patency, the tumor within the sinus was left and observed.

Decision to Irradiate

All patients underwent serial postoperative imaging. Patients with known residual tumor underwent MRI at 3-month intervals to follow-up the extent of residual tumor. Any patients with documented growth were then sent for stereotactic radiosurgery for tumor control.

ILLUSTRATIVE CASES

Case 1

This 65-year-old man presented with a left homonymous hemianopsia. Preoperative MRI demonstrated a homogenously enhancing lobulated 6.5 × 4.8 × 6.0 cm torcular mass extending to the right of midline into the parietal and occipital lobes (Figure 1). Further angiographic evaluation demonstrated an occluded right transverse sinus and venous drainage via the left transverse sinus and retrograde flow through the superior sagittal sinus, in turn, draining into cortical and diploic veins (Figure 2). The patient subsequently underwent preoperative embolization via a feeding right occipital artery and a Simpson grade I resection via a combined parieto-occipital craniotomy/suboccipital craniectomy (Figures 3 and 4). Postoperatively, the patient experienced persistent left-sided homonymous hemianopsia with no evidence of venous thrombosis on imaging. Postoperative MRI/CT imaging revealed a resection cavity without any evidence of venous thrombosis.

Case 2

This 50-year-old male presented with headaches, visual decline, and left lower extremity paresthesias. Preoperative imaging with MRI revealed a homogeneously enhancing dural-based mass measuring 3.5 × 2.5 × 2.5 cm in the parasagittal angle invading and obstructing the middle-posterior thirds of the sagittal sinus (Figure 5).

Angiographic evaluation demonstrated segmental obstruction of the middle-posterior thirds of the sagittal sinus; cortical venous drainage was also accompanied by convexity venous drainage to the transverse sinuses, transcalvarial venous drainage, and retrograde drainage through the cavernous/paracavernous sinuses. A Simpson grade I resection was achieved and the sinus was entered for tumor resection with subsequent primary repair (Figures 6 and 7). No intraoperative or postoperative complications were encountered. Final pathology indicated a World Health Organization (WHO) grade I meningioma.

Case 3

This 50-year-old female presented with grand mal seizures and preoperative imaging demonstrating multiple meningiomas. A right-sided enhancing parasagittal mass invading the anterior sagittal sinus was noted (Figure 8). The patient underwent a Simpson grade I resection of the parasagittal mass and Simpson grade I resection of the left-sided convexity masses (Figures 9 and 10). Intraoperatively, the parasagittal mass was found to involve several

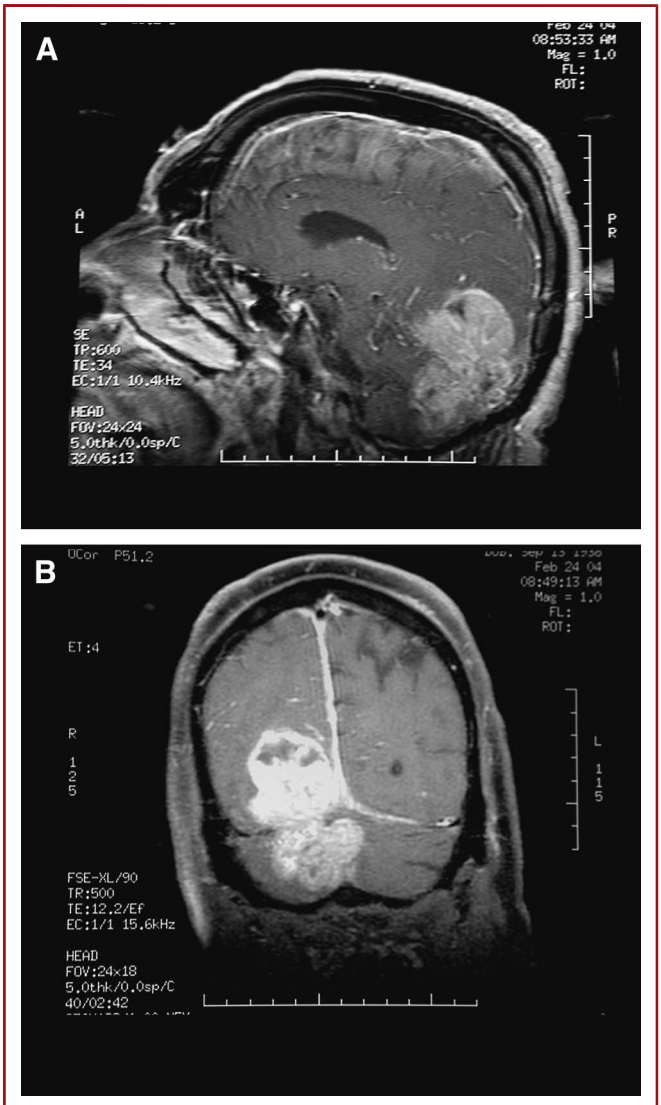

FIGURE 1. *Preoperative T1 weighted magnetic resonance images with gadolinium for case 1.*

draining veins and to invade the lateral wall of the sinus. The consistency of the parasagittal meningioma was very soft and the sinus was entered during tumor resection and subsequently reconstructed with 5-0 prolene. Immediately postoperatively, the patient awoke with an unremarkable neurological examination; however, 12 hours later, she deteriorated with clinical findings of acute brain herniation. Emergent CT imaging revealed venous infarction; consequently, the patient experienced brain death.

RESULTS

Cohort Characteristics

A total of 110 patients with parasagittal meningiomas received surgical treatment at the Johns Hopkins Medical Institutions between 1992 and 2004. Only those patients with a minimum of 24 months documented follow-up were included for analysis; 61 patients from the study period met the criteria. The remaining patients were not included for study because of either a) a follow-up of less than 24 months or b) inadequate documentation (ie, lack of follow-up imaging or clinic note) of clinical follow-up. Table 1 lists the clinical features of the 61 patients retrospectively studied. The patients' mean age at presentation was 58 years and the female to male ratio was 4:1. As indicated in Table 2, most tumors were WHO grade I meningiomas. By location (Table 3), 62% of the tumors involved the middle third of the superior sagittal sinus. Most patients (55%) underwent Simpson grade II resection (Table 4). The mean follow-up in patients studied was 53 months.

Operative Outcomes and Complications

Intraoperative and immediate perioperative complications for all studied patients are shown in Table 5. Complications (over the first 30 days postoperatively) included cerebral venous thrombosis/venous infarction (7%), intraoperative air embolism (1.5%), and death (1.5%); however, when complications for all 110 patients (regardless of extent of follow-up) are noted, the incidences of venous thrombosis, air embolism, and death are 3.6%, 0.9%, and 0.9%, respectively.

With regard to long-term outcomes, recurrence was noted in 11% of patients at a mean postoperative time of 45 months; no statistically significant differences were found between recurrent and nonrecurrent tumors with regard to factors such as histology, location along the sinus, extent of sinus involvement, and extent of resection.

When the results (Table 6) are stratified according to sinus involvement (anterior, middle, or posterior third), it is notable that a larger fraction of the lesions involving the middle third underwent less aggressive surgical resection and required postoperative radiation. No delayed complications were seen in patients requiring radiation. In addition, the middle third of the sinus was less forgiving to venous manipulation because 2 of the 3 incidences of venous thrombosis occurred at this location.

DISCUSSION

In the management of parasagittal meningiomas, invasion and involvement of the superior sagittal sinus and tributary bridging veins present significant challenges; hence, anatomic considerations define surgical paradigms. Although these tumors are benign, in general, the concern for recurrence underscores the importance of achieving Simpson grade I/II resection. Yet, the avoidance of serious complications secondary to damage to critical venous structures places emphasis on preservation of draining structures but can increase subsequent recurrence rates. In light of these considerations, our management paradigm has been to achieve Simpson grade I/II resection but with the goal of preservation of venous structures; hence, utilizing postoperative radiation for control of residual disease when necessary. Support

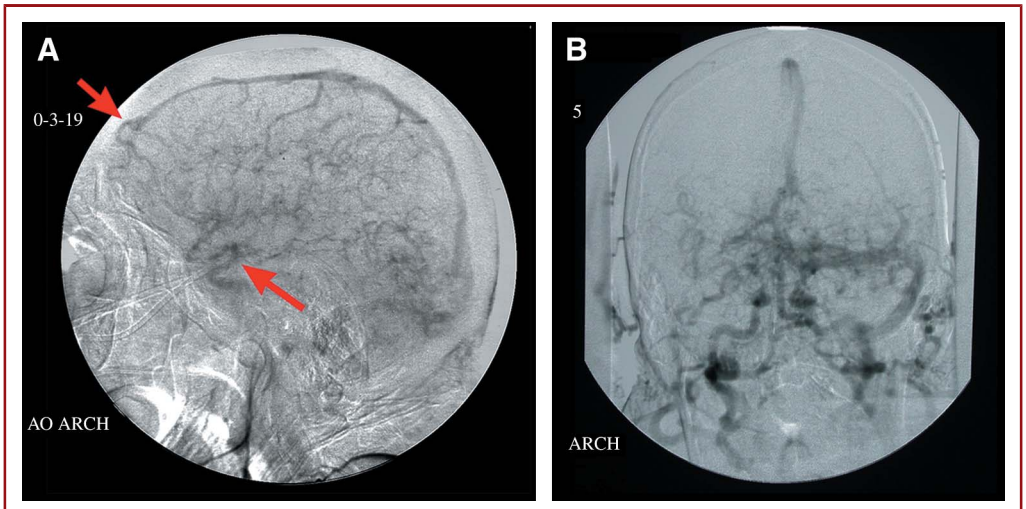

FIGURE 2. *Preoperative angiographic images for case 1 demonstrating retrograde collateral venous outflow.*

for this paradigm is highlighted by the lower morbidity and comparable recurrence rate in our series in comparison with the literature highlighted by previously published data indicating recurrence even in the face of Simpson grade I resection. Our retrospective study demonstrated that the most significant and prevalent complication is cerebral venous thrombosis/infarction (3.6%) in the setting of a long-term recurrence rate of 11%. These results raise the importance of understanding risk factors for operative complications in addition to factors influencing recurrence and underlying treatment paradigms.

As one interprets the data, particular limitations must be kept in mind: the inhomogeneous nature of the series due to the inclusion of four different surgeons—reflecting differences in technique and surgical philosophy. In addition, the study is further limited by the poorly documented follow-up of a large fraction of patients initially operated on—unfortunately, a phenomenon seen with a lot of the benign tumors operated on at a tertiary care center. As a result of these shortcomings, it becomes hard to truly draw any definitive treatment paradigms.

Short-term Considerations: Mechanisms and Prevention of Venous Thrombosis

In evaluating the pathogenesis of venous thrombosis, consideration should include the inherent biology of meningiomas. Although these tumors are benign with regard to clinical outcome, they are biologically active with local and systemic

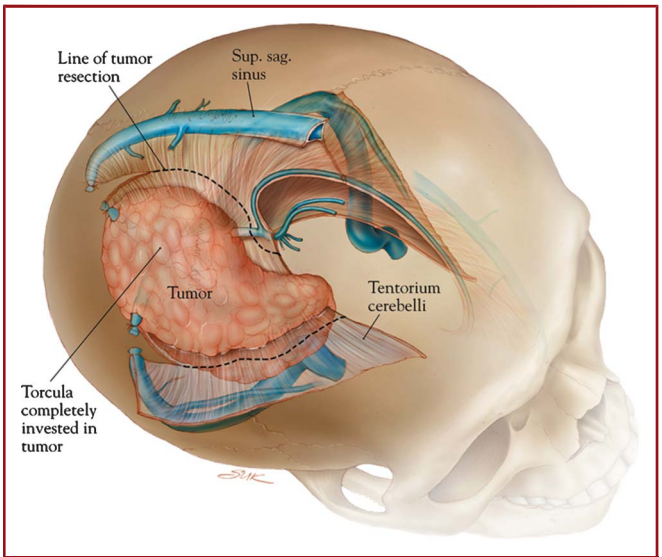

FIGURE 3. *Artist's depiction of tumor resection for case 1.*

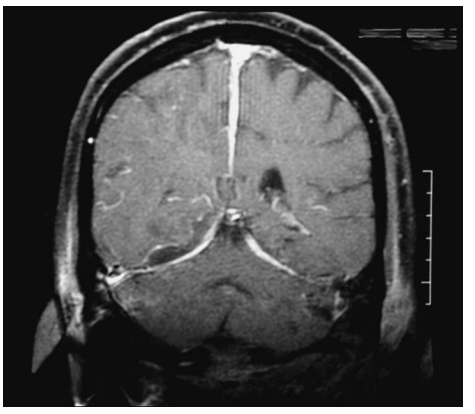

FIGURE 4. *Postoperative T1 weighted magnetic resonance images with gadolinium for case 1.*

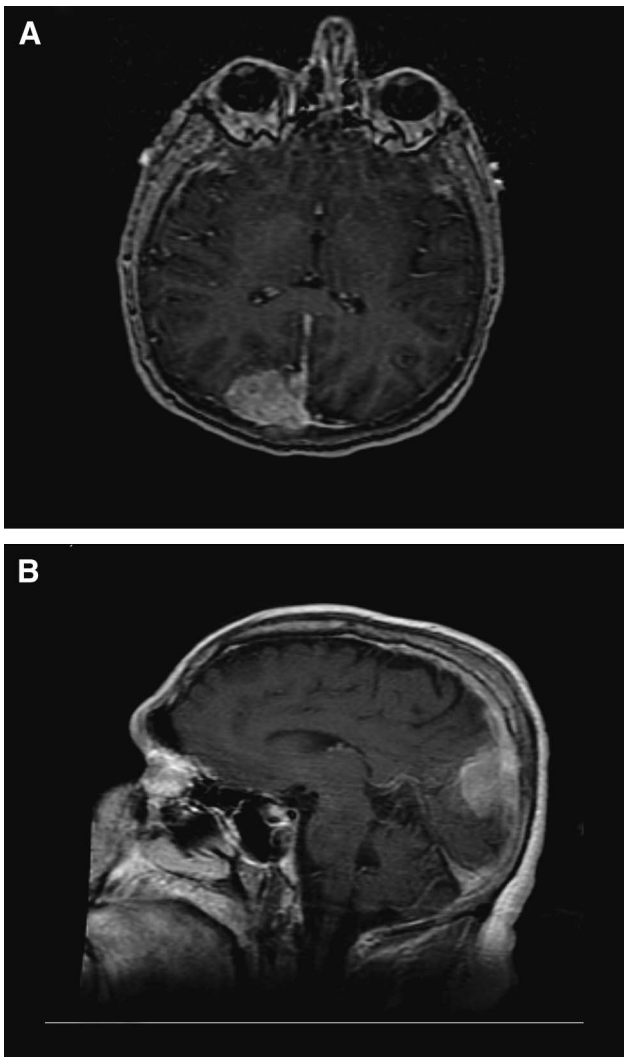

FIGURE 5. *Preoperative T1 weighted magnetic resonance images with gadolinium for case 2.*

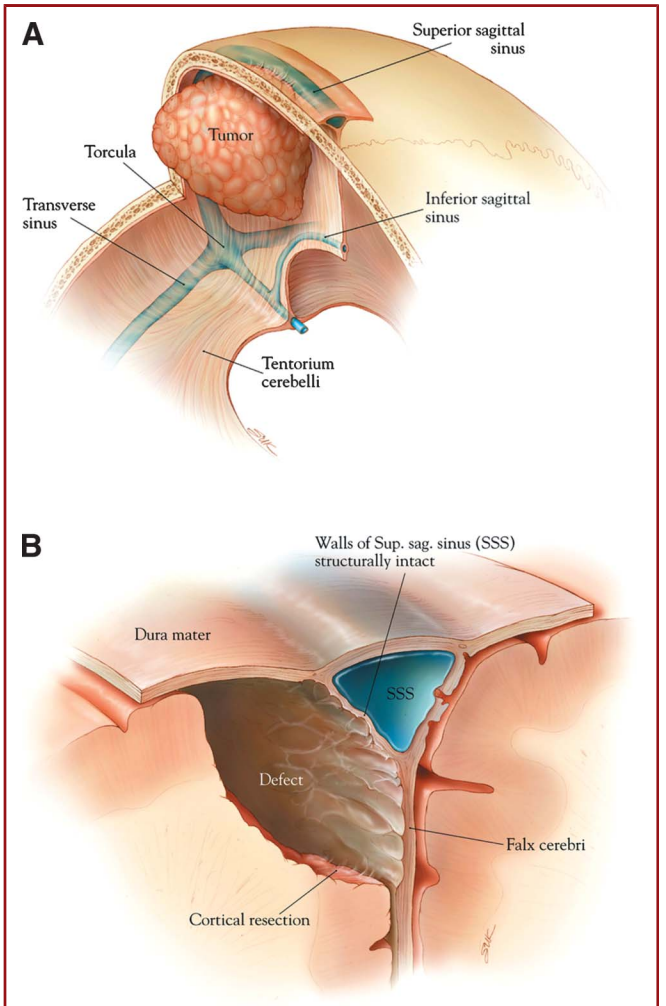

FIGURE 6. *Artist's depiction of tumor pre- and postoperatively for case 2. SSS, superior sagittal sinus.*

hormonal and hematological effects. Brain tumors, and meningiomas, in particular, have been linked with a systemically elevated thromboembolic state.[9-11] Parasagittal meningiomas could certainly promote local thrombosis because of the intricate association with vascular structures as opposed to convexity meningiomas.

An important consideration is the intraoperative sacrifice of bridging veins. These structures can be intimately associated with the tumor mass, even enveloped within neoplastic tissue. Sacrifice of a bridging vein promotes thrombosis within the injured vessel by causing focal venous engorgement and decreased vascular flow that encourages venous stasis and resultant thrombosis.[12,13] However, single or multiple bridging vein injury could also promote venous sinus thrombosis. The laminar flow within vessels (including the superior sagittal sinus) can be described by the equation Q = Delta P/R (Q = flow, Delta P = pressure difference between the start and end of a vessel, R = resistance within a vessel). With sacrifice, the contribution of flow from the bridging vein to the sagittal sinus is eliminated. Consequently, a decrease in pressure at the ostium of the vein into the sinus results in diminished flow within the sinus. With a sufficient drop in velocity to a critical point, the deposition of clotting factors on the endothelial wall of the sinus acts in synergy with increased frictional forces between platelets and the sinus to promote clotting. The traditional paradigm has been that the sacrifice of bridging veins anterior to the Vein of Trolard is acceptable. However, the contribution of bridging veins is relative to the flow within the sinus. With relatively decreased flow in the anterior third of the sinus in relation to the posterior two-thirds in

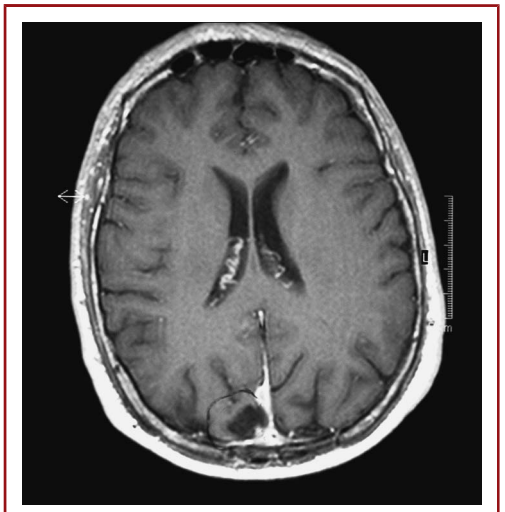

FIGURE 7. *Postoperative T1 weighted magnetic resonance images with gadolinium for case 2.*

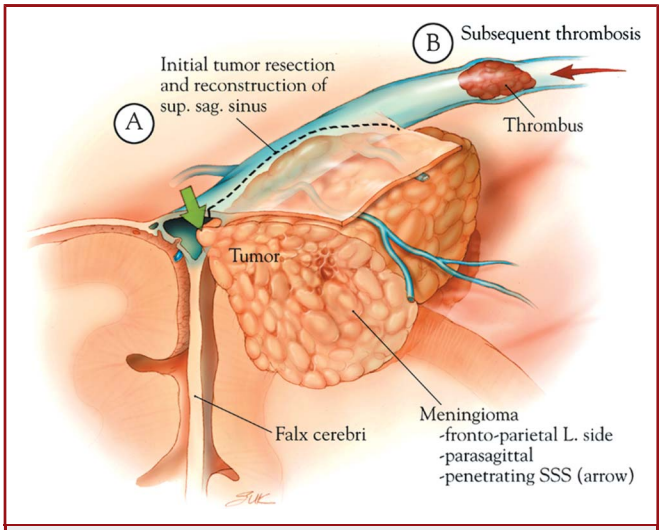

FIGURE 9. *Artist's rendering of tumor preoperatively for case 3. SSS, superior sagittal sinus.*

nondiseased states, sacrifice of particular bridging veins can still result in catastrophic complications, as seen in case 3.

Timing of Surgery and Role of Collateral Venous Pathways

In addition to surgical technique, preoperative decision making and evaluation may also be critical in the minimization of venous thrombosis. Few reports have emphasized the importance of collateral venous pathways in patients with occlusion of the superior sagittal sinus due to lesions such as parasagittal meningiomas and dural arteriovenous fistulas.[14] Lesions that partially obstruct the sinus without collateral pathways are at particular risk for complications. The presence of nonnative collateral pathways particularly dictates the extent of resection. As opposed to sudden intraoperative occlusion, which can result in venous infarcts, gradual sinus obliteration secondary to tumor growth results in the rerouting of cortical venous flow channels. Hence, it is important, especially for partially obstructive lesions, to preoperatively evaluate collateral venous pathways. While MRI can be used to assess relevant anatomy, venous flow studies (ie, conventional angiography or magnetic resonance venography) are often helpful. Marc and Schechter have noted a constellation of angiographic findings indicating the presence of venous flow rerouting linked with partial or complete occlusion of the superior sagittal sinus: (a) nonvisualization of a segment of the SSS, (b) failure of cortical veins to reach the SSS, (c) delayed emptying of veins in the region of obstruction, and (d) reversal of normal

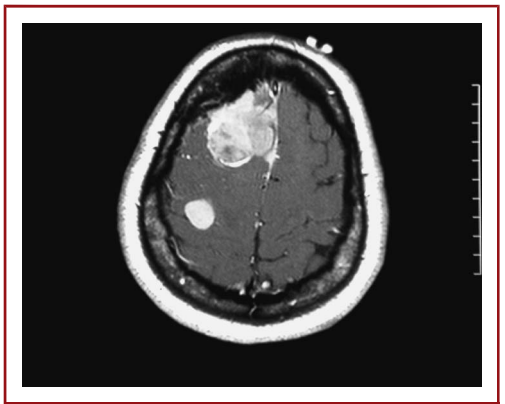

FIGURE 8. *Preoperative T1 weighted magnetic resonance images with gadolinium for case 3.*

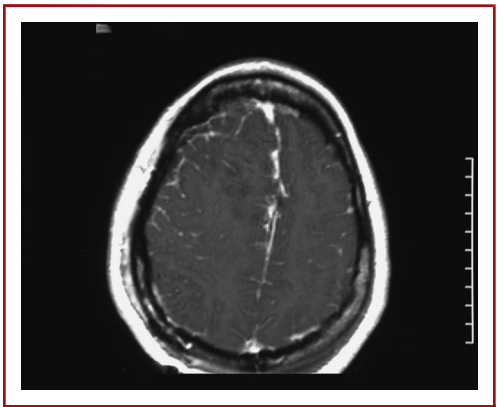

FIGURE 10. *Postoperative T1 weighted magnetic resonance image with gadolinium for case 3.*

TABLE 1. Patient Demographics

Age, y	58
Sex	Male 20%; Female 80%
Time to Operation	11.3
Time to follow-up	41

TABLE 3. Location of Tumors Along Sinus

Location	n	%
Anterior	13	21
Middle	38	62
Posterior	10	17

venous flow with collateral venous channels connecting the SSS with other channels.[15] In assessing the presence of collateral flow, it is important to be cognizant of common locations for venous rerouting, which include (a) anastomoses between cortical veins and deep ventricular and cisternal veins, (b) end-to-end anastomoses of superficial cortical veins, (c) anastomoses with meningeal veins allowing for drainage through other dural sinuses and venous lacunae, and (d) anastomoses with scalp veins.[16,17] Because of the presence of such nonnative flow, care must be taken in incising scalp and dura in addition to sacrificing veins during cortical entry and tumor resection.

Because of the importance of collateral flow in the minimization of surgical serious complications, such circumstances determine the timing of surgery. There potentially may be a role to delay initial surgical debulking in an effort to promote the gradual development of collateral venous drainage. In particular, for tumors presenting with near-complete occlusion of the sinus, such a strategy would permit radical resection without a need for venous bypass, as shown in case 1. Alternatively, early surgery before any occlusion occurs may minimize these risks even if the tumor is asymptomatic.

Long-term Considerations: Initial Management and Treatment of Recurrent/Residual Disease

The ultimate goal of therapy is the control of tumor growth and prevention of further neurological deterioration. Varying management paradigms have been described in the paucity of large case series in the literature. One operative strategy includes an attempt at total meningioma removal with restoration of venous outflow by techniques of repair and vein grafting of sagittal sinus.[2,18,19] A second strategy, as described by Hartmann and Klug,[20] consists of partial resection while awaiting for sinus occlusion by residual tumor with the hope of promoting the development of collateral venous outflow. DiMeco et al[21] support sinus entry and exploration without bypass with partial invasion while the sinus can be resected entirely with complete occlusion; a similar paradigm is reported by Caroli et al.[22] Kondziolka et al[23] described in their case series patients treated with stereotactic radiosurgery, either alone or in combination with surgery; the authors subsequently proposed a role for radiosurgery alone as a first-line treatment for tumors smaller than 3 cm.

In assessing modalities, the risk for morbidity and mortality must be balanced with long-term outcomes. Sindou[2] supports aggressive resection of tumors with sinus reconstruction or venous bypass in his series of meningiomas invading the dural sinuses. Because the data reported are not correlated to surgical procedure, it is hard to assess the morbidity and mortality in his series. In addition, owing to the lack of presentation of factors such as histopathological findings, median follow-up, and recurrence-free survival, it is difficult to interpret the 2.5% recurrence rate. However, DiMeco et al[21] report a recurrence rate of 13.9% with a morbidity/mortality of 8.3% in the setting of a mean follow-up of 79.5 months.

Our management strategy primarily consists of attempts at Simpson grade I resection without sacrifice of critical vascular structures, with residual or recurrent disease treated with stereotactic radiosurgery. Our perioperative complication rate is 7% with an 11% recurrence rate. The rationale for our approach is to minimize immediate morbidity and mortality through initial judicious surgical resection. Increasing amounts of evidence support the use of radiation therapy/radiosurgery in treating residual disease after initial surgical debulking.

It is interesting that the timing of such irradiation in treating residual/recurrent disease has not been studied. Although Kondziolka et al,[23] in their series of 203 parasagittal meningiomas, advocate the use radiosurgery in the management of initial disease, their data certainly support a role for radiosurgery in the treatment of subtotally resected tumors. In their multi-institutional case series of 203 parasagittal meningiomas, radiation

TABLE 2. Tumor Histology[a]

Histology	n	%
Meningioma, WHO Grade I	49	80
Meningioma, WHO Grade II	8	13
Meningioma, WHO Grade III	4	7

[a]WHO, World Health Organization.

TABLE 4. Breakdown of Tumors by Simpson Extent of Resection

Simpson Extent of Resection	Treatment Cohort
Grade I	26%
Grade II	55%
Grade III	17%
Grade IV	2%

TABLE 5. Incidence of Operative Complications

Complications	Treatment Cohort
Cerebral venous thrombosis/infarct	7%
Intraoperative air embolism	1.5%
Mortality	1.5%

as an option for initial presentation was only shown to be effective for tumors less than 3 cm in diameter; because most tumors present symptomatically at a larger size, it is evident that radiation is not a practical initial step for treatment in most patients. However, several previous groups have addressed recurrence (including nonparasagittal meningiomas) with radiation therapy[24–28]; Wara et al[24] reported a 22% recurrence rate after subtotal resection in combination with radiation in comparison with 74% recurrence after subtotal resection alone.

Our management strategy is further corroborated by studies demonstrating recurrence despite Simpson grade I resection. Chan and Thompson[21] reported 13% recurrence despite Simpson grade I resection. Recurrence of meningiomas have been shown outside the limits of dural resection; this phenomenon is hypothesized to be due to the presence of neoplastic elements in the dura outside of the insertion site of meningiomas.[29,30] Similar findings are suggested by our data with recurrence despite Simpson grade I resection. Therefore, although complete extent of resection should be the desired goal, it is acceptable to attain grade II resection to preserve anatomic structures and neurological function.

CONCLUSIONS

We present a review of our long-term experience with parasagittal meningiomas invading the superior sagittal sinus. A perioperative complication rate of 7% (3.6%, if all patients are included despite extent of follow-up) with a recurrence rate of 11% where 19.6% of patients with residual/recurrent disease received radiosurgery is comparable if not lower than reported series in the literature. Based on these data, we conclude that lesions partially invading the sinus should be resected to the greatest extent possible where residual/recurrent disease is subsequently observed and treated with radiosurgery.

TABLE 6. Treatment Characteristics by Location

	Anterior	Middle	Posterior
Sinus invasion			
Partial	84.6% (11)	71% (27)	80% (8)
Complete	15.4% (2)	29% (11)	20% (2)
Simpson grade of resection			
I	15.4% (2)	26.3% (10)	40% (4)
II	76.9% (10)	50% (19)	50% (5)
III	7.7% (1)	21.1% (8)	10% (1)
IV	0% (0)	2.6% (1)	0% (0)
Postoperative radiation	7.7% (1)	26.3% (10)	10% (1)
Venous sinus thrombosis	8% (1)	5.3% (2)	0% (0)

Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENTS

In this article, the authors have discussed the management of parasagittal meningiomas in 1 institution, with a 24-month follow-up. They followed a policy of removing what could be safely removed. There are some problems with the data in that only somewhat better than a half of the patients had adequate follow-up, raising questions about what happened to the remainder of the patients. Additionally, because multiple surgeons were involved, there does not appear to have been a prospective protocol of treatment. Therefore, it is difficult to say that the authors' approach is any better than worse than that of any other.

When treating parasagittal meningiomas, I make decisions based not only on the location and degree of sinus involvement, but also the collateral circulation. This is best assessed on cerebral angiography, which allows a careful evaluation of the cortical veins, as well as the inferior sagittal sinus, and the superior sagittal sinus. I do not open the superior sagittal sinus unless there is a good chance of repairing it with a patch graft. Interposition grafts have been used, but the rate of thrombosis is high (approximately 50%). In addition, it is very important to preserve the cortical veins or the inferior sagittal sinus, if they are part of the collateral circulation, or if they are large. I use radiosurgery for any residual tumor, except in patients older than 65 years of age, in whom one can wait to see whether the tumor is growing.

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In this study the authors retrospectively analyzed a series of parasagittal meningiomas invading the superior sagittal sinus (SSS) operated on at a single institution from 1992 to 2004. Important issues such as the timing of surgery, the role of radiosurgery, and foremost the management of the sagittal sinus have been discussed extensively.

We agree with the authors' attitude advocating attempts at Simpson grade I resection of lesions partially invading the sinus to the extent possible without sacrifice of critical vascular structures and extensive SSS reconstruction. Residual lesions can then be followed and treated with radiosurgery in case of relapse. In our experience, we considered sinus patency and collateral veins drainage as the paradigm on which planning our surgery.

Our series now comprises 181 cases and we performed marginal resection of the tumor along the sinus when preoperative imaging demonstrated patency of the SSS. The violated sinus wall was then closed primarily or reconstructed with a lyophilized cadaveric graft. In patients with complete SSS obliteration, the SSS was ligated at the proximal and distal ends of the involved sinus and then resected, allowing en bloc tumor removal. Extreme care of collateral venous drainage was taken and in some cases residual tumor was left behind to avoid a postoperative venous stroke. Using this paradigm we have achieved excellent outcomes with a tumor recurrence rate for grade I meningiomas of 3.5%.

The article is well written, contains excellent art illustrations, and clarifies its clinical relevance. Therefore, we feel that can be a great contribution to a field that still lacks of general consensus.

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Raza et al report a series of 61 patients harboring parasagittal meningiomas and surgically treated at their institution by 4 different neurosurgeons. Only patients with a minimum follow-up of 24 months were included in this retrospective analysis. A total excision, defined as Simpson grade I or II, was achieved in 81% of patients and 11% experienced tumor recurrence. 1.5 % of patients died, 1.5% had intraoperative air embolism, and 7% had cerebral venous thrombosis/infarction.

Parasagittal meningiomas represent a surgical challenge for their intimate relationships with the sagittal sinus and bridging veins. The neurosurgeon should balance aggressive surgery to achieve radical resection with preservation of venous flow that is the major cause of postoperative morbidity.

Different strategies have been proposed in the recent literature. Some authors advocate aggressive tumor removal with dural sinus exploration and even venous reconstruction in case of partial invasion of the lumen, whereas others suggest a more conservative treatment aimed at resecting only the extrasinusal portion of the meningioma. Residual or recurrent tumor may be just followed up and treated in case of progression or primarily treated with radiosurgery. The most important message of the article is expressed in one sentence at the end of the discussion section when the authors state that they attempt Simpson grade I resection avoiding any sacrifice of bridging veins. Residual tumor is treated with radiosurgery. This message is basically reinforced by their experience suggesting no direct relationship between extent of resection and recurrence rate.

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