The article in this issue by Drs. Sindou and Alvernia is an important contribution to the neurosurgical literature. They summarize Dr. Sindou’s personal experience with a remarkable 100 cases of meningiomas involving a major dural sinus—the superior sagittal sinus in 92 cases, the transverse sinus in five, and the confluence of sinuses in three—and treated with radical excision over a 20-year period. The article reveals the senior author’s well-known bias and extensive experience with reconstruction of the sinus in these cases. It is important to note that the authors have carefully avoided dilution of this patient series by excluding cases in which the surgical removal was relatively straightforward, such as in patients with meningiomas involving the most anterior aspect of the superior sagittal sinus in front of the precentral veins as well as in cases in which the tumor was adjacent to the sinus but could easily be separated from it (for example, cases of meningiomas arising from the falx that were adjacent to, but not involving, the sinus). The authors classify the tumors according to the degree of sinus involvement by using a classification scheme that they have previously described; the scheme can be used to classify tumors ranging from those removed simply by peeling the outer layer of the lateral wall of the sinus (Type I) to those that completely occlude the sinus and involve all three walls (Type VI).

Overall, the authors achieved excellent results with a grossly complete removal in 93% of the patients (Simpson Grade I or II removal) and very radical excision combined with coagulation of a small amount of residual tumor (Simpson Grade III removal) in the other 7%. The permanent neurological morbidity rate was 8%, and the mortality rate was 3%. The authors quote a recurrence rate of 4% over a mean 8-year follow-up period (3–23 years). Note, however, that the follow up was limited to clinical study; routine imaging was performed only once at 3 years postsurgery. Patients underwent subsequent imaging studies only if symptoms developed. Therefore, we do not know how many tumors recurred asymptomatically after the 3-year imaging follow up.

Given Dr. Sindou’s extensive experience and well-recognized surgical mastery, it seems worthwhile to summarize some of the technical concepts and refinements that he has developed over the years and describes well in the paper. The patients underwent surgery in the semi-sitting position when the sagittal sinus was involved and in the sitting position when the confluence of sinuses or the transverse sinus were involved. The latter position was used to facilitate good venous return, and it is interesting to note that only one patient suffered from a significant air embolism. We are told that “particular care was taken to preserve the venous anastomotic pathways that had developed throughout the scalp, the pericranium, and the diploic venous channels;” however, I must confess that I am not sure exactly what this means. Importantly, the authors recommend exploring the inside of the sinus through a small incision in all cases, including those in which the sinus appears to be completely patent preoperatively and the tumor could be removed by peeling the outer layer of the lateral wall. They achieve control of the sinus and the afferent veins by using small pledgets of Surgicel to plug the lumen rather than balloons or vascular clamps. When the sinus needed to be reconstructed, they used patches of dura mater, pericranium, fascia lata, or fascia temporalis if at least one of the walls of the sinus was intact, and they used either a vein graft or a Gore-Tex tube when the entire sinus needed to be replaced. Interestingly, they excised the tumor in two stages in 31 patients. Importantly, they heparinized the patients starting the morning after surgery and continuing for 3 weeks, and thereafter they used Coumadin for 3 months. Remarkably, there was no major permanent morbidity related to hemorrhage as a result of this aggressive anticoagulation regimen. Note, however, that an epidural hematoma developed in two patients and a subdural hematoma in one patient; in all cases the lesion was evacuated without consequence.

Data in this study offer strong confirmation of some important concepts, lend support to some, but fail to resolve others. I will try to summarize my interpretations under these different categories.

The study data offer substantial confirmatory evidence of the following points. Radical excision of meningiomas in the middle third portion of the superior sagittal sinus (the central region) carries a substantial risk of morbidity even when a most experienced surgeon performs the procedure. Seven of the eight patients with a permanent neurological
morbidity harbored meningiomas in this location. Moreover, although not clearly stated, we are led to assume that the three patients who died also harbored tumors in this location. This assumption would indicate a combined permanent morbidity and mortality rate of 20.8% for meningiomas located in this region. Additionally, the four confirmed recurrences involved tumors in this location, which suggests that complete removal of such lesions may have been more difficult to achieve. I have personally been impressed with my own less-than-satisfactory results with radical excision of parasagittal meningiomas involving the middle third of the superior sagittal sinus regardless of whether the sinus was completely occluded. In fact, I have been so disturbed by the associated morbidity in some of these patients that my colleagues and I are currently studying our own data to try to quantify this impression.

There is also very interesting data from other centers supporting the concept that morbidity can be expected frequently from radical surgery of tumors in this location. The inevitable conclusion is that one must strongly consider the use, whenever possible, of more conservative approaches, such as primary radiosurgery if the tumor is small enough, or more conservative removal with preservation of all veins even when the sinus is occluded, followed by observation or radiosurgery. Additionally and somewhat paradoxically, the relatively high morbidity associated with surgical removal of these central parasagittal meningiomas once the sinus becomes involved may justify the more aggressive attitude, at least in younger patients, of recommending treatment (excision or radiosurgery) rather than observation in cases of small tumors that are adjacent to, but not yet involving, the sinus.

It is also clear from the authors’ results that radical resection together with removal of the sinus is not necessarily safe even when the sinus is already completely occluded before surgery, particularly with meningiomas of the middle third of the superior sagittal sinus. This point is important because there is a tendency to think, as I personally have thought, that once the sinus is occluded, the tumor together with the sinus can be safely removed. However, the three deaths in their study and most of the morbidity occurred precisely in this context of radical excision including the sinus in cases in which the sinus was already occluded.

Nonetheless, radical resection of meningiomas involving the major dural sinuses, particularly when the tumor does not involve the middle third of the superior sagittal sinus, can be performed by an expert such as Dr. Sindou with considerable safety and a very low rate of clinical recurrence (remembering the aforementioned caveat concerning the lack of long-term imaging follow-up).

In expert hands, intraluminal sinus exploration and/or reconstruction can be performed with low morbidity. Even completely replacing or bypassing the sinus with vein grafts (not with Gore-Tex tubes) can be performed, with minimal morbidity related to the bypass per se and with a reasonably early patency rate (70% at the 2-week angiographic follow-up in patients in whom the sinus had been replaced with a venous graft). Clearly, Gore-Tex grafts should not be used to reconstruct the sinus. All six of the grafts used by the authors were found to be thrombosed at the early angiographic follow-up evaluation. Interestingly, only one of these patients became symptomatic.

The authors’ paper also contains evidence in support of the following points. When the sinus is partially involved and not completely occluded by tumor, it may be advisable to explore the sinus, remove the intraluminal tumor, and reconstruct the sinus by patching. This process was routinely followed in the authors’ study with low morbidity, and it may have led to the relatively low rate of clinical recurrence in these patients.

Replacement or bypass of the sagittal sinus by using a vein graft may be useful and result in reduced morbidity and mortality, as compared with radical excision including the occluded sinus without venous reconstruction. The authors performed a bypass in 13 of 32 cases in which the tumor completely involved the sinus (Type VI) and treated 15 of these patients with global resection of both the tumor and the invaded sinus without any reconstruction. Three patients in the latter group died, and six had a permanent neurological morbidity: only one of the patients who had undergone a venous reconstruction suffered permanent neurological morbidity. It is conceptually difficult to understand why reconstruction of the sinus could be useful when the sinus is already completely occluded. The authors allude to this issue, although they offer no clear explanation. Presumably, there are veins, perhaps running within the tumor or on its capsule, that provide some degree of continual flow between the proximal and distal aspects of the occluded sinus. Because these veins are usually damaged or occluded on radical excision of the tumor, it may be useful to bypass the sinus to allow substitution for the continual flow offered by those veins.

The high morbidity and mortality rates associated with radical resection of meningiomas involving the middle third of the superior sagittal sinus is likely related to venous occlusion of important central veins that run within the tumor or its capsule. Drs. Sindou and Alvernia strongly believe this hypothesis, and I certainly agree, although one cannot rule out the fact that the morbidity encountered in their study may have been partially or mostly related to surgical trauma to the underlying eloquent brain. Such injury certainly could lead to edema, which at times can be difficult to differentiate from the edema and swelling resulting from venous occlusion.

Issues not resolved by this article are as follows. The true tumor recurrence rate in this study of radical excision of meningiomas involving a major dural sinus is not known. As discussed earlier, the authors’ protocol called for an imaging study 3 years postsurgery (and clearly the recurrence rate at that time was a low 4%), but further imaging was thereafter performed only when clinical symptoms developed. It is possible, and I would say perhaps likely, that several of these patients had an asymptomatic tumor recurrence over the subsequent follow-up period.

The important question of whether a policy of radical resection for these tumors, as advocated by Drs. Sindou and Alvernia, is superior to a more conservative policy remains unanswered. Clearly, at least the bulk of the tumor should be removed whenever possible when the patient is progressively symptomatic. It is not clear how many patients in this study were in this category. Should asymptomatic tumors be surgically treated, monitored, or treated primarily with radiosurgery when they are small enough? Even when symptomatic, should the tumors be radically resected as in the present study? Should more conservative lesion removal with an attempt to preserve all important veins, followed by