Radiosurgery for arteriovenous malformations after hemorrhage

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Arteriovenous malformations (AVMs) of the brain are a considerable source of morbidity and mortality for patients. Our understanding of AVM anatomy and physiology continues to be refined but much more needs to be learned. For patients who present with symptomatic hemorrhage, there is some urgency to prevent further bleeding. Nevertheless, management decisions can remain difficult, depending on AVM size, location, and patient condition. Today, at our own conference, we discussed the case of a large (Grade V) motor cortex region AVM in a patient who sustained a devasting bleed, was hemiplegic, and is now recovering. Numerous surgeons have been consulted. Some neurosurgeons are recommending resection and others staged radiosurgery. Resection may reverse any neurological recovery. Radiosurgery is associated with a delayed response. There are no comparative data to guide decision making for such a patient.

As Ding and colleagues show, there is a large collective experience indicating that radiosurgery, as a minimally invasive technique, can produce excellent results with a modest risk profile.1 The primary risks to a patient after stereotactic radiosurgery (SRS), as opposed to microsurgical resection, are twofold. They relate, firstly, to the latency period prior to obliteration during which the lesion remains at risk for hemorrhage and, secondly, to the chance for an adverse radiation effect as part of the vascular response. The latter is usually transient. In the series described by Ding et al., only 3% of the patients had permanent radiation-associated changes. Successful obliteration after SRS depends directly on the amount of radiation delivered and accurate identification of the AVM shunt, but the morbidity of SRS is a function of the radiation dose and the total volume targeted.

Ding and colleagues provide additional evidence that embolization prior to radiosurgery is associated with reduced obliteration rates.1,2 This may be due to difficulties in AVM nidus identification. Most of the data are from the pre-Onyx era, and more information is needed to see if this observation holds true today. We are now exploring the use of radiosurgery as the initial therapy followed by targeted embolization for any hemorrhagic risk factors. Early reduction in flow following radiosurgery may increase obliteration rates and decrease the length of the period in which the patient is at risk of hemorrhage. Of course, postradiosurgical endovascular repair of an associated aneurysm seems important. In this series, only 6% of patients had associated aneurysms,3 a number less than that reported by some other authors who have noted associated aneurysms in up to 50% of patients. I think that our understanding of why an AVM ruptures is far from complete. We need to better understand how flow dynamics, blood pressure, and venous drainage affect hemorrhage. We need to know whether there are changes in adjacent brain parenchyma that weaken the vessel wall, whether some of these changes are genetic, how they might be identified, and how we might mitigate risk. These are the avenues for new research. Until we begin to look at AVM pathophysiology in a different light, I fear we may have maximized our outcomes with current approaches.

Disclosure

The author reports no conflict of interest.

References


Response

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While the fund of knowledge regarding AVMs has increased over the past decade, we agree with Dr. Kondziolka that there remains much to be learned and meaningful advances to be made in our management of pa-
patients harboring these lesions. Resection, radiosurgery, and embolization individually as well as in combination afford more options than ever before for effective AVM treatment. While some AVMs may be best left alone, few would advocate for such an approach after a patient has suffered the devastating effects of an intracranial hemorrhage.

Grading systems, including surgical and radiosurgical ones, help neurosurgeons to predict the likelihood of a successful outcome when using a particular treatment modality. These grading systems generally work well for straightforward cases treated with a single approach. While the systems have been applied to patients undergoing combinations of treatments as either staged or salvage approaches, they may fall short of capturing the complexities of contemporary, multidisciplinary AVM management.

Computational modeling and fluid dynamics may provide better guidance in the neurosurgical management of AVM patients. Most of the modeling parameters can be derived from current standard neuroimaging data sets being routinely acquired for patients. Such modeling may provide a more scientific approach to combining embolization with radiosurgery. To guide management, patient-specific AVM models could be devised, which is analogous to personalized oncological care based on the genetic mutations of a patient’s cancer. One AVM might benefit from radiosurgery before embolization whereas another might benefit from radiosurgery after embolization.

Finally, other approaches lie on the horizon for the treatment of cerebrovascular disorders. In particular, the use of MR-guided focused ultrasound may have therapeutic potential for patients with cerebrovascular disorders. This modality could represent another approach for ablation of vascular malformations or radiosensitization during radiosurgery. Unlike other aspects of neurosurgery, substantial room for improvement exists for the outcomes of AVM patients. Therefore, it is imperative that neurosurgeons lead the scientific studies necessary to shed better light on AVM management.

References

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