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Indications for Surgical Treatment of Arteriovenous Malformations

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The indications for surgical treatment of arteriovenous malformations (AVMs) of the brain are evolving. In general, any AVM whose natural history and anatomic characteristics make it more likely to cause morbidity or mortality than the treatment itself should be treated. Given the relatively high rate of hemorrhage associated with AVMs without treatment, their obliteration is usually desirable. Microsurgical removal remains the mainstay of definitive treatment, but the management of AVMs fundamentally requires a team approach. Advances in endovascular therapy and radiosurgery offer options that must be considered when formulating any treatment plan. Most patients' plans incorporate a combination of modalities. As we critically evaluate treatment outcomes, it has become clear that microsurgical removal is only one branch in a decision tree that may include the option of no treatment for some patients. This article reviews the indications for treatment of AVMs in general and then focuses on the selection of surgery as a treatment modality, alone and in combination with embolization and radiosurgery.

The decision about whether and how to treat an AVM depends on a number of factors, the most important elements of which are the patient's age, symptoms, and medical condition; the size of the AVM; its location; the type of venous drainage; the history of the AVM; and the natural history of AVMs in general. The known natural history of AVMs suggests that the rate of hemorrhage from an AVM is approximately 3% per year [1,2]. Each episode of bleeding is associated with a mean mortality rate of 10% and a mean rate of neurologic morbidity of 20%. Examining these numbers actuarially leads to the conclusion that the younger a patient is and the lower the surgical risk, the more likely the patient is to benefit from treatment. In children and younger patients, we are aggressive about surgical removal, especially because it avoids complications related to applying radiation to the young brain. Symptomatic patients are more likely to benefit, because surgery often eliminates the risks of rebleeding and vascular steal and can improve headache and, in some cases, seizures. As for the characteristics of the AVM itself, a higher risk of bleeding is associated with small AVMs; the presence of a feeding artery, nidus, or venous aneurysm; or impaired venous drainage [3]. For this reason, we favor treating most small lesions because they are easier to remove and more likely to bleed than larger aneurysms. Conversely, some evidence suggests that larger lesions are less likely to bleed than smaller ones. Because they are more formidable to remove, conservative management is a more reasonable option in such cases. Similarly, AVMs located in eloquent brain and with deep venous drainage are technically more difficult to remove without morbidity, relatively favoring their nonsurgical management. If a given AVM has already hemorrhaged and caused a fixed deficit or if recurrent hemorrhages, steal, or venous hypertension is producing a stepwise decline, we favor surgical removal.

Improvements in endovascular therapy and radiosurgery have resulted in welcome additions

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to the armamentarium of therapeutic modalities available for this disease. Endovascular embolization has rendered many previously difficult AVMs much easier to remove surgically. In general, endovascular embolization is most useful for grade III AVMs, although we also often use it for AVMs of lesser grades. Although there are anecdotal reports of permanent occlusion of AVMs through endovascular embolization alone, endovascular obliteration is not considered definitive treatment as a stand-alone therapy. The rate of complete occlusion associated with endovascular therapy alone is estimated at 10% [4]. The durability of the occlusion in this setting is unknown. In contrast, stereotactic radiosurgery produces an angiographic and clinical cure for many lesions. Optimally, the lesion should be small (<10 mL in total volume). The efficacy of radiosurgical treatment of lesions less than 2.5 cm in diameter ranges from 74% to 80% and is approximately 50% for lesions between 2.5 and 3 cm in diameter [5,6]. Two years or more may be required for the full protective effect of radiotherapy to be seen. We prefer surgery for accessible lesions and recommend radiosurgery for lesions when the associated approach-related morbidity is high (eg, AVMs in basal ganglia or thalamus). Endovascular embolization has been used to reduce the size of the nidus of a difficult AVM so that it can be treated with radiosurgery. The benefit of this strategy has not been substantiated, however. For large lesions (>4 cm in diameter), surgery typically offers the most realistic hope of cure.

There has been an increasing trend toward conservative management of high-grade AVMs (Spetzler-Martin grades IV and V), although some surgeons still advocate an aggressive approach [7,8]. The microsurgical removal of these lesions involves substantial risk. The possibility of achieving surgical cure is attractive, particularly when it can be achieved without morbidity in some cases. In our opinion, however, critical analysis of the risk-benefit ratio for a large number of patients does not support the routine treatment of grade IV and V lesions. Expectant care, even with the attendant rates of hemorrhage that the natural history of AVMs inevitably incurs, is still likely to produce an outcome as good as or better than that which can be achieved surgically. Incomplete treatment of an AVM seems to increase rather than decrease the risk of hemorrhage. This does not mean that surgery on high-grade AVMs is never justified. Each AVM needs to be evaluated individually. In equivocal cases, the patient's preference may drive the decision to pursue or forgo excision.

In summary, the best candidates for surgical treatment are patients in good medical condition, with a good life expectancy, who harbor small to medium-sized AVMs located in anatomically accessible parts of the brain. Indications further favoring surgery include significant symptoms, AVMs with a higher bleeding risk (eg, those associated with aneurysms or venous outflow obstruction), and AVMs that have failed treatment with radiotherapy or endovascular embolization. Any residual AVM should be considered to have at least the same risk of bleeding as a native lesion and should be treated. Once the decision to treat has been made, for many AVMs, the choice between radiosurgery and microsurgery depends on the patient's attitude about surgery and radiation and on the patient's willingness to wait for the protective effect of radiotherapy to be realized.

If surgery is chosen, multimodality therapy with combined endovascular embolization and surgery typically is preferred. Both therapies should be staged when appropriate.

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