Editorial

Embolization of arteriovenous malformations

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This paper is an important contribution by the neurovascular group at Southwestern Medical Center. Over the last several years, this group has carefully analyzed and candidly reported not only their results, which in general have been excellent, but also the complications they have witnessed in the multidisciplinary management of complex vascular problems, particularly aneurysms and arteriovenous malformations (AVMs). This particular contribution emphasizes what previously has been reported by other excellent neurointerventional groups, that is, that the risk of embolization of parenchymal cerebral AVMs is substantial. An understanding of this risk is important to clinicians involved in therapeutic decisions about patients with cerebral AVMs. I personally think, although I have no way to substantiate this belief, that embolization of AVMs is a relatively overused procedure in this country. Having said this, I agree completely with the authors that there is an extremely important role for embolization, particularly preoperative embolization, in an attempt to make excision safer and sometimes even possible. I will make some comments specifically about this paper and then discuss some personal opinions relevant to this issue.

As the authors readily admit, the relative paucity of available details such as the grade of the AVMs, their locations, the number of vascular pedicles that were embolized, and so forth, is a weakness of the study. It would have been pertinent to know whether this relatively high rate of complications occurred, as I presume, because the authors were dealing with complex high-grade AVMs, frequently located in or near critical areas of the brain in which multiple vascular pedicles were embolized. I suspect that the authors proceed with excision without preoperative embolization in the treatment of simpler AVMs, as do most experienced neurovascular surgeons. Certainly, this rate of complication would have been unacceptable if a significant proportion of the patients who underwent the embolization procedure had harbored simpler Grade I and Grade II AVMs. Although the authors could not retrieve this important data for their retrospective review, they state that they are currently entering such information prospectively into their database.

I found interesting the authors’ statement, “No patient at our institution underwent the embolization procedure as the only form of treatment.” Coming from this very experienced group, this is a significant and important statement because palliative embolization performed as the only treatment for complex AVMs that cannot be excised completely or are too large to be treated by radiosurgery is practiced with considerable frequency by many important interventional groups in this country and in Europe. Along the same lines, it is important to note that during a 7.5-year time period, when the authors treated 230 patients with cerebral AVMs, only one patient underwent embolization followed by radiosurgery, whereas 31 patients were treated by radiotherapy alone. I will comment on these two topics later on.

Finally, two issues related to the manner in which the authors perform embolization may have a bearing on the rate of complications. First, the majority of their patients were treated with polyvinyl alcohol particles and only 13% with N-butyl cyanoacrylate. As the authors suggest, it is not clear whether one of these forms of embolization is associated with a higher rate of complications. A second issue is the timing between sessions of embolization; apparently, there usually was a 2-day waiting period between different sessions in those patients who required multiple sessions of embolization. Would the rate of complications have been lower if longer intervals between each session had been mandated?

I will proceed to discuss my personal bias about some of the topics mentioned earlier in this editorial. First I will address the issue of performing preoperative embolization when complete excision is planned. This is obviously the central theme of the paper by Taylor, et al., and I want to confirm their impression that preoperative embolization is a most important adjunct in the treatment of patients with complex AVMs. Clearly, this procedure makes it possible to treat with relative safety many complex lesions that would be too formidable for safe excision without preembolization. Also without any doubt, as stated by the authors, preoperative embolization makes excision much less formidable for the surgeon in terms of operative time, blood loss, and so forth. Furthermore, although this issue continues to be controversial, there is no question in my mind that problems related to hyperperfusion, whether one calls them “normal perfusion breakthrough” or otherwise, can be minimized or prevented by first performing preoperative embolization. Clearly, we do not see this problem frequently nowadays, but I believe that the reason for this is that we perform preoperative embolization in patients with complex high-flow AVMs, in whom these problems are likely to arise.
If we accept that preoperative embolization is useful, the issue is when, how, and how much to use it. As I stated earlier, I believe that in general, we overuse this procedure. As I review my earlier experience, when most patients underwent surgery without preoperative embolization, I have the feeling that the results were not worse than they are now when I perform this procedure much more liberally. CLEARLY, I rarely find myself struggling with bleeding from an "angry" AVM at midnight, as I frequently did during my earlier experience. I believe that to a large extent, this difference is a result of the use of preoperative embolization, although to a certain extent, it can be explained by the fact that most of us simply do not perform surgery on the most complex Grade IV and V AVMs nowadays. The bottom line is that preoperative embolization should only be used when, in the estimation of the neurovascular team, the combined risk of preoperative embolization and surgery is lower than the risk of excision alone. I firmly believe—although I am still guilty of this not infrequently—that to perform preoperative embolization with its significant risk to the patient (2% rate of mortality and 9% rate of permanent neurological deficit in this paper) simply to make surgery easier and shorter for the surgeon is inappropriate. Even the issue of minimizing blood loss, which nowadays can be safely managed with blood transfusions, hardly merits the significant risk of preoperative embolization.

How and how much embolization is performed is also important. My opinion is that there is no need to embolize superficial feeding vessels that are readily accessible during surgical exposure. I prefer to restrict embolization to those deep vascular pedicles that are inaccessible to the surgeon during the early stages of the operation or that can be accessed only through significant retraction of the brain, with stretching and possible injury to arterialized draining veins. As to how much embolization, I have also developed the opinion, through bad experience, that too much embolization can be dangerous. Clearly, it is wonderful for the surgeon to operate on an AVM that is almost completely embolized, if the patient is lucky enough to make it to surgery without a preoperative complication from the embolization. Nevertheless, I have learned to worry and sleep poorly when my endovascular colleagues call me with great pride to tell me that they have "almost completely" obliterated the AVM. This is the usual setting in which a catastrophic postembolization hemorrhage tends to occur, probably from obliteration of some of the venous outflow.

The issue of palliative embolization (embolization to reduce flow when there is no reasonable hope of excising the AVM completely or when the AVM is too large to be treated by radiosurgery), is also controversial. My colleagues and I have diligently searched for evidence that palliative embolization reduces the risk of hemorrhage and improves the natural history of the lesion over no treatment at all; we have failed to find such evidence. In fact, there is some evidence that palliative embolization increases the risk of future hemorrhage; therefore, like the Southwestern group, we do not use embolization as the only treatment for cerebral AVMs. The theoretical exception would be those patients whose AVMs can be obliterated completely with embolization, but generally these happen to be the patients in whom excision is feasible and, in our opinion, almost always safer than embolization. Related to this issue is the frequent practice throughout the country of performing embolization either to reduce flow to the AVM or to "make it smaller" so that it can be treated with radiosurgery. This is a controversial topic with considerable published material in favor of or opposed to it. Our bias is similar to that of the Southwestern group (they used this treatment paradigm in only one patient in 7.5 years) and we do not as a rule use preoperative embolization in preparation for radiosurgery; this policy is based on our personal experience as well as on reports in the literature of frequent recanalization of areas of the AVM that appear to be obliterated immediately after embolization.

The issue of what material to use for embolization remains controversial and I do not have a strong opinion on this matter. Nevertheless, it has been my feeling that we have seen a greater number of complications since our endovascular colleagues began to use glue instead of particles. It is possible, however, that this perceived increase in complication rates is due to a more thorough embolization with possible occlusion of some venous outflow, which is more common with glue than with particles.

The timing of embolization, alluded to earlier, may also be of relevance. The authors generally waited only a couple of days between sessions of embolization in those patients who required more than one session. It is my impression that our incidence of major complications, mostly intracerebral hemorrhages, was higher when our policy was similar to that of the authors, that is, when we offered the entire treatment package within the same hospitalization. This policy was convenient because many of our patients, as I am sure is the case at Southwestern, come from elsewhere, frequently from abroad. Because of the unacceptable incidence of postembolization hemorrhage, whenever possible, we have switched to a policy of embolizing "little by little," in several sessions if necessary. When practical, these sessions are separated by approximately 4 to 6 weeks. As stated, although I have the impression that this policy has reduced the incidence of major hemorrhagic complications, more time will be required to obtain sufficient data to make a positive statement to this effect.

To conclude, the article from the neurovascular group at Southwestern Medical Center is important because it confirms previous reports from other cerebrovascular centers of excellence that embolization of cerebral AVMs, even in the best hands, carries a significant toll of mortality and morbidity. This should encourage all of us to use preoperative embolization thoughtfully and critically, only when in our estimation the combined risk of preoperative embolization and excision is less than the risk of excision alone. Additionally, these data should raise our level of skepticism about the indiscriminate use of embolization either as palliative treatment or in preparation for radiosurgery in AVMs that because of their size, location, or both are not amenable to complete excision.

References
2. Frizzel RT, Fisher WS: Cure, morbidity and mortality associated with embolization of brain arteriovenous malformations: a review


RESPONSE: We appreciate the thoughtful and detailed editorial by Dr. Heros.

In 1993 the average number of embolizations performed per patient was 1.2. In 2002 that ratio had risen to 2.2. The trend toward more embolization sessions per patient at our institution is primarily due to two factors. One is our belief that a more gradual reduction of flow to the AVM is less likely to be complicated by a preoperative hemorrhage or postoperative hyperperfusion. Another is improvement in endovascular microcatheters and guidewires, which allow us to perform more selective embolizations at the expense of more time spent on each lesion. For these reasons and because our ultimate goal is improvement in the duration and quality of life for each of our patients, we emphasize the risk of preoperative AVM embolization per patient and not simply by procedure.

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