AJNR

Preoperative intracranial meningioma embolization: technical considerations affecting the risk-to-benefit ratio.

R E Latchaw

AJNR Am J Neuroradiol 1993, 14 (3) 583-586
http://www.ajnr.org/content/14/3/583.citation

Commentary

Preoperative Intracranial Meningioma Embolization: Technical Considerations Affecting the Risk-to-Benefit Ratio

Richard E. Latchaw[1]

The most common rationale given for the preoperative embolization of an intracranial meningioma is the reduction of surgical blood loss (1). According to some surgeons, large or critically placed meningiomas may be easier to remove after embolization. However, objective data to validate these impressions are not readily available. The degree of surgical blood loss may be as or more dependent upon the type of meningioma and its inherent degree of vascularity, the surgical technique, and the position of the meningioma relative to other vascular structures, than upon whether the tumor was preoperatively embolized. The neurosurgeons with whom I have worked over the years have not believed it necessary to embolize every meningioma. A convexity meningioma of small to moderate size may be easily controlled by the surgeon, without the risk and expense of preoperative embolization. However, there certainly are meningiomas that represent more formidable challenges and in which preoperative embolization may play a significant role, including the following:

1) Meningioma of the skull base, where it may be difficult to control the vascular supply. Although it may be impossible to embolize the entire meningioma because of supply from critical vascular structures such as the internal carotid or middle cerebral arteries, some embolization in this difficult tumor may be better than none, and may reduce surgical blood loss.

2) A large meningioma with abundant edema in which retraction and definition of surgical planes may be difficult.

3) Tumorous involvement of a persistently patent dural sinus, from which there may be significant hemorrhage if complete resection is attempted.

4) Tumorous involvement of the scalp and calvarium, because of significant bleeding just getting to the tumor.

5) Predominant vascular supply from the external carotid artery is preferred; however, there may be benefit to embolization even with a moderate to large pial supply to the meningioma if embolization allows better separation of tumor from eloquent portions of brain tissue.

If the goal of embolization is to decrease intraoperative bleeding, the embolic material must pass deep into the vasculature of the tumor. More proximal vascular occlusion is inadequate; the surgeon can do that. Superselective catheterization of vessels supplying the tumor must be performed. Then come the questions: What type and size of embolic agent must be used? How do we document the efficacy of the embolization procedure? How do we document the effect of embolization on the surgical procedure and on patient outcome? In sum, how do we get around purely subjective statements by the neurosurgeon that embolization helps, and "prove" that the procedure is really worth the risk and the expense?

We must also examine the risk side of the equation. If tiny particles or a liquid are used, agents that could pass through anastomotic channels to normal tissues, do we increase the risk to the patient? In other words, by producing a more efficacious result of embolization, do we also increase the inherent risk of the procedure?

This issue of the *American Journal of Neuroradiology* contains two articles that attempt to measure the efficacy of preoperative meningioma embolization. In the paper by Grand et al (2), the authors discuss their study of 15 patients undergoing preoperative meningioma emboliza-

[1] Margaret and H.O. Peterson Chair of Neuroradiology, Professor of Radiology and Neurosurgery, Department of Radiology, University of Minnesota, Box 292, 420 Delaware Street SE, Minneapolis, MN 55455.

Index terms: Meninges, neoplasms; Interventional neuroradiology; Commentaries

AJNR 14:583–586, May/Jun 1993 0195-6108/93/1403–0583

tion. The efficacy of the embolization procedure was evaluated using a number of techniques, including: a pre-embolization complete angiogram consisting of selective internal and external injections to determine the percentage of possible devascularization of the meningioma from an external carotid embolization procedure; the comparison of the pre- and postembolization angiograms to determine the degree of devascularization; the performance of gadolinium-enhanced magnetic resonance (MR) imaging a number of days after the procedure to demonstrate decreased tumor perfusion; a statement from the surgeon regarding estimated blood loss; and the degree of necrosis seen histologically following tumor removal. The technique of embolization included the superselective catheterization of external carotid branches supplying the tumor using a microcatheter. Free-hand cut pieces of Gelfoam were embolized in six cases, with polyvinyl alcohol particles measuring 150 to 300 microns in size used in nine cases. These particles were significantly smaller in size than recommended in a current textbook on neurointerventional procedures (3). No liquid agents were used because of their ability to pass through tiny anastomoses.

Seven of the 15 cases reported by Grand et al (2) had an external carotid supply to the meningioma accounting for 80% of the overall vascular supply to the tumor. However, only two of these seven had a significant decrease of MR imaging enhancement, and the lowest levels of estimated blood loss occurred in these two patients. Two other patients had lesser degrees of decreased enhancement, and these two cases plus one other had areas of necrosis histologically. These five cases had the lowest blood loss. In the rest of the 10 cases, there was not much difference in blood loss, but neither was there much effect from embolization. The lowest blood loss was 150 cc, for the tumor in which the degree of enhancement decrease was determined to be 88%; the highest blood loss was 800 cc, for a tumor with a 2.4% enhancement decrease. The latter case was supplied primarily by the pial vasculature, as were four other cases.

There are problems with the embolization techniques used in this study, in that the particles of 150 to 300 microns were probably too large to penetrate the tumor vasculature adequately. Certainly, five of the seven cases had 80% supply from the external carotid artery, yet had decreased MR enhancement ranging only from 2.5% to 43.7%. Undoubtedly, the particles simply blocked the vasculature more proximally.

There are some conceptual problems in the paper by Grand et al (2). First, the reason for a low efficacy rate of embolization, even in those meningiomas that had predominating external carotid artery blood supply, was thought to be spasm of the feeding arteries. I doubt that spasm plays a significant role. More than likely it was the problem of particle size, as discussed previously. This is supported by the paper by Wakhloo et al (4), which will be discussed subsequently. Second, the authors attempted to estimate the percentage of tumor embolized by comparing the postembolization external carotid angiogram with the pre-embolization study. Unfortunately, the authors did not perform a complete cerebral angiography after the embolization, so that they really had no way of knowing the status of persisting supply from the pial vasculature, or from collateral arteries to vessels supplying the tumor that had been blocked proximally. The angiographic evaluation is simply incomplete. Last, the authors state that gadolinium-enhanced MR imaging is much more indicative of the true nature of perfusion than is contrast-enhanced computed tomography (CT) scanning, even if performed several days after the angiogram. CT scanning has been found by other authors to be spurious in many cases (1). However, CT scanning is most likely equal to MR imaging for evaluating those meningiomas that have been embolized deeply into their vasculature, a finding that is supported by the Wakhloo et al (4) article. The spurious CT results are probably a function of particle size and embolization technique, rather than of the type of imaging study.

The paper by Wakhloo et al (4) is an excellent evaluation of the efficacy of embolization of intracranial meningiomas. They, too, used enhanced MR imaging, enhanced CT, estimated blood loss, and histologic studies to evaluate the efficacy of embolization. They also measured a change in tumor volume pre- and postembolization. They used polyvinyl alcohol particles of two different sizes: in 14 patients, 150 to 300 microns (similar to Grand et al (2)); in 20 patients, 50 to 150 microns diluted in a large volume of saline and administered slowly over many minutes to hours.

Only two of the 14 patients embolized with the larger particles had decreased MR enhancement. However, 12 of the 20 patients embolized with

the smaller particles had 30% to 95% devascularization by enhanced MR imaging. This decreased enhancement by MR imaging correlated with decreased enhancement as seen on CT. Histologically, particles were seen within tumor capillaries in 15 of these 20 patients.

Three of the patients in the series by Wakhloo et al (4) had significant tumor enlargement, and there was an increase in perifocal edema in one patient. However, in two of these cases the routine of 4 days of dexamethasone treatment before embolization was not undertaken, which may have made a difference. There was hemorrhage within one tumor, but it was one of those being embolized with the larger particles. Intratumoral hemorrhage is known to be a complication of embolization with small particles or liquid agents, which may lead to emergency surgery.

The only problem with the paper by Wakhloo et al (4) particularly referable to the paper by Grand et al (2), is that there is no statement regarding angiographic findings of the internal and external circulations following embolization to evaluate the remaining vascular supply. Three of the 34 patients were known to have significant pial supply pre-embolization. In addition, there is no indication that embolization of tumors with predominantly pial supply is helpful; in other words, is some necrosis helpful for surgical removal?

There are several messages from these two studies. First, evaluation of the *efficacy of embolization by angiography certainly requires that all vessels be injected before and after the procedure.* Even with this, however, the best form of evaluation is probably gadolinium-enhanced MR imaging. Contrary to what other authors believe, contrast-enhanced CT scanning may also be efficacious.

Second, in order to decrease the intratumoral vasculature significantly, and thereby decrease the surgical blood loss significantly, the *neurointerventionalist probably must use tiny particles on the order of 50 to 150 microns in size.* Larger particles simply produce proximal occlusion of feeding arteries. The larger particles have irregular surfaces which may predispose them to produce only a partial occlusion of a larger artery and enough stagnant flow so that clot forms. However, over time, the clot lyses and the tumor is revascularized. Small particles penetrate deep into the tumorous vasculature as shown histologically. The size of these particles is significantly smaller than some authors have advocated previously.

Third, *peritumoral swelling and intratumoral hemorrhage may occur with agents that are able to flow deep into the tumor vasculature.* Steroids are helpful; everyone must be prepared for urgent surgery, and, most importantly, the neuroradiologist and neurosurgeon must be experts at their trades.

Fourth, *the harmful side effects of using small particles must be assessed.* The complications of external carotid artery embolization of a tumor include devascularization of cranial nerves, swelling of the tumor and compression of neurologic structures, devascularization of normal tissues such as the skin, and passage of particles through normal anastomoses to produce ischemia of normal brain, the eye, and cranial nerves. The vasa nevorum are usually smaller than 150 microns; therefore, particles of the 50 to 150 size could devascularize a cranial nerve. The complication rate for preoperative embolization of meningiomas is reported to be 1.6% (5); this figure is almost surely for the use of larger particles. Is the risk increased by using smaller particles? While there was one patient with increased peritumoral edema in the series by Wakhloo et al (4), there were no complications of cranial nerve devascularization or ischemia of normal tissues. However, a larger series is needed. Rarely, a liquid such as alcohol has been used for a "routine" meningioma, but this agent is usually reserved for attempted necrosis of a tumor in a nonoperative candidate because of its theoretically increased risk.

There are four "bottom line" conclusions that one can draw from these studies in the context of prior controversies regarding preoperative meningioma embolization:

1) Meningioma embolization probably is efficacious, and the blood loss significantly decreased, only if the procedure is done with exquisite technique using super-superselective catheterization and tiny particles injected in dilute solutions over a long period of time. This is not a quick procedure performed with a 4 or 5 French catheter on an outpatient!

2) External carotid artery embolization procedures, if they are to be done efficaciously, need to be done by experts. Superb technique, use of small particles, knowledge of the normal anastomoses, knowledge of the vascular supply to the cranial nerves, and appreciation for all the poten-

tial complications require a high degree of expertise. Contrary to popular belief, external carotid artery embolization procedures are not for the occasional embolizer!

3) If the embolization is not performed with superb technique by an expert at the trade, it is probably not worth the risk to the patient and the expense of the procedure.

4) It is essential that neurointerventionalists conduct studies such as the two reported herein in order to determine the effect on patient outcome and to evaluate the efficacy of their procedure and the benefits of the procedure relative to the risks. Anecdotal statements regarding procedural efficacy are no longer acceptable.

References

1. Manelfe C, Lasjaunias P, Ruscalleda J. Preoperative embolization of intracranial meningiomas. *AJNR: Am J Neuroradiol* 1986;7(5):963–972
2. Grand C, Bank WO, Balériaux D, et al. Gadolinium-Enhanced MR in the evaluation of preoperative meningioma embolization. *AJNR: Am J Neuroradiol* 1993;14:563–569
3. Halbach VV, Hieshima GB, Higashida RT, David CF. Endovascular therapy of head and neck tumors. In: Viñuela F, et al. *Interventional neuroradiology: endovascular therapy of the central nervous system.* New York: Raven, 1992
4. Wakhloo AK, Juengling FD, Van Velthoven V, Schumacher M, Hennig J, Schwechheimer K. Extended preoperative polyvinyl-alcohol microembolization of intracranial meningiomas: assessment of two embolization techniques. *AJNR: Am J Neuroradiol* 1993;14:571–582
5. Lasjaunias P, Berenstein A. *Surgical neuroangiography, Vol II. Endovascular treatment of craniofacial lesions.* 1st ed. Springer-Verlag, New York: 1987:96