Editorial

Arteriovenous malformation

DOUGLAS KONDZIOŁKA, M.D., M.Sc., F.R.C.S.C.

Department of Neurosurgery, NYU Langone Medical Center, New York University, New York, New York

Ding and colleagues at the University of Virginia provide an analysis of 444 patients who had stereotactic radiosurgery for an arteriovenous malformation (AVM) without evidence of prior symptomatic hemorrhage.¹ The series included patients with a mean AVM volume of 4.2 cm³ (about 2 cm in diameter), but only 14% of the AVMs were in deep brain locations. The median radiosurgical dose was 20 Gy, which is typically associated with a high obliteration rate.

As has been found in other studies, the authors noted that a higher obliteration rate was associated with no prior embolization, a higher radiosurgery dose, a single draining vein, and imaging evidence of radiation-induced changes during the obliteration process. Clinical worsening after radiosurgery occurred in 7% of the cases, and it was more common in patients who had a hemorrhage after radiosurgery.

This is an important study on the management of unruptured AVMs. The current randomized trial that the authors describe (ARUBA) is aimed to determine outcomes with or without treatment. Whether or not that study will successfully accrue enough patients is not known. Because AVMs often occur in younger adults, the concept of simply observing an AVM is uncomfortable for many patients and their physicians.

Since these patients did not present with a hemorrhage, the outcome with respect to the presentation symptom would be interesting to readers. Forty-seven percent of the patients in this series presented with seizures, 28% with headache, and 12% with a focal neurological deficit. The patients with unruptured AVMs that I see before radiosurgery want to know what will happen to their presenting symptoms. Unfortunately, this study did not provide solid answers for all presentation types. Headache was not well studied. Seizure outcomes were easier to determine. Overall, only 7% of patients were neurologically “improved”; another 7% were “worse”; and 86% were “unchanged.” New-onset seizures developed in only 0.9% of patients.

The purpose of radiosurgery for an unruptured AVM is to obliterate the malformation and eliminate the hemorrhage risk. In this series, the cohort demonstrated an an-

nual hemorrhage rate comparable to the usual estimates that clinicians provide to their patients. The authors conclude that treatment should be offered to patients who are “younger and therefore have more at-risk years for hemorrhage,” which is logical. Because this conclusion is already believed by many clinicians, one wonders whether the ARUBA study will meet its goals.

(<http://thejns.org/doi/abs/10.3171/2013.11.JNS121812>)

Disclosure

The author reports being a consultant for Elekta AB.

Reference

1. Ding D, Yen CP, Xu Z, Starke RM, Sheehan JP: Radiosurgery for patients with unruptured intracranial arteriovenous malformations. Clinical article. **J Neurosurg** [epub ahead of print March 26, 2013. DOI: 10.3171/2013.2.JNS121239]

Response

DALE DING, M.D., CHUN-PO YEN, M.D.,
AND JASON P. SHEEHAN, M.D., PH.D.

Department of Neurological Surgery, University of Virginia Health System, Charlottesville, Virginia

We thank Dr. Kondziolka for his insightful comments regarding our paper on unruptured AVMs. Arteriovenous malformations represent a relatively rare but complicated vascular pathology for which the treatment will always involve a multidisciplinary approach.^{4,6} Our bias is to aggressively treat unruptured AVMs that present in young patients using microsurgery, radiosurgery, embolization, or a combination of these techniques.

Dr. Kondziolka mentioned that there was a high proportion of superficial AVMs (86%) in our series. In fact, some of the patients in our series had superficially located AVMs that were in eloquent areas; they were offered radiosurgery. Stapf et al.⁷ noted deep location to be an independent predictor of AVM rupture, which may explain the relatively low proportion of unruptured deep AVMs in our series. In our experience, a patient with an unruptured and asymptomatic AVM most often chooses radiosurgery over the alternatives of microsurgery or embolization. Patients perceive radiosurgery as an attractive approach conferring a reasonable chance of benefiting them while

at the same time exposing them to only rare upfront risks and generally infrequent as well as manageable long-term risks. Based on our results, radiosurgery seems warranted given its relatively favorable results, the high cumulative lifetime AVM hemorrhage risk in the absence of obliteration, and the known morbidity and mortality associated with rupture.^{1,2}

We acknowledge the significant undertaking of the ARUBA trial and hope that it can be completed.^{3,5} The results from this prospective study are highly anticipated by the cerebrovascular community and could affect the way we treat and counsel patients harboring unruptured AVMs. However, in the event that ARUBA fails to attain adequate patient accrual, the next best study may be a prospective registry such as the National Neurosurgery Quality and Outcomes Database (N²QOD). A prospective registry detailing radiosurgical treatment outcomes of unruptured AVMs would allow us to observe their behavior and risk-benefit profile over time. The ultimate goal is to settle the controversy regarding the optimal management algorithm for patients with unruptured AVMs.

References

1. Brown RD Jr, Wiebers DO, Forbes G, O'Fallon WM, Piegras DG, Marsh WR, et al: The natural history of unruptured intracranial arteriovenous malformations. **J Neurosurg** 68:352–357, 1988
2. Choi JH, Mast H, Sciacca RR, Hartmann A, Khaw AV, Mohr JP, et al: Clinical outcome after first and recurrent hemorrhage in patients with untreated brain arteriovenous malformation. **Stroke** 37:1243–1247, 2006
3. Fiehler J, Stapf C: ARUBA—beating natural history in unruptured brain AVMs by intervention. **Neuroradiology** 50:465–467, 2008
4. Lawton MT, Du R, Tran MN, Achrol AS, McCulloch CE, Johnston SC: Effect of presenting hemorrhage on outcome after microsurgical resection of brain arteriovenous malformations. **Neurosurgery** 56:485–493, 2005
5. Mohr JP, Moskowitz AJ, Stapf C, Hartmann A, Lord K, Marshall SM, et al: The ARUBA trial: current status, future hopes. **Stroke** 41:e537–e540, 2010
6. Saatci I, Geyik S, Yavuz K, Cekirge HS: Endovascular treatment of brain arteriovenous malformations with prolonged intranidal Onyx injection technique: long-term results in 350 consecutive patients with completed endovascular treatment course. Clinical article. **J Neurosurg** 115:78–88, 2011
7. Stapf C, Mast H, Sciacca RR, Choi JH, Khaw AV, Connolly ES, et al: Predictors of hemorrhage in patients with untreated brain arteriovenous malformation. **Neurology** 66:1350–1355, 2006

Please include this information when citing this paper: published online March 26, 2013; DOI: 10.3171/2012.11.JNS121812.