Radiosurgery for treating unruptured intracranial arteriovenous malformations

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Researchers at the University of Virginia (UVA) Health System recommend radiosurgery for treating unruptured arteriovenous malformations (AVMs), because the procedure has a reasonable benefit-to-risk profile. They base this recommendation on an evaluation of clinical and radiographic outcomes in 444 patients treated with radiosurgery for unruptured AVMs at their institution. Detailed findings in this single-institution patient cohort are reported and discussed in "Radiosurgery for patients with unruptured intracranial arteriovenous malformations. Clinical article" by Dale Ding, M.D., Chun-Po Yen, M.D., Zhiyuan Xu, M.D., Robert M. Starke, M.D., M.Sc., and Jason P. Sheehan, M.D., Ph.D., published today online, ahead of print, in the *Journal of Neurosurgery*.

Arteriovenous malformations are vascular anomalies in which arteries feed directly into veins, bypassing the capillary system, which provides nutrients to tissues, clears waste products, and decreases the pressure of blood as it moves from arteries to veins. Usually congenital, AVMs occur in approximately 1 in 100,000 persons and present equally in both sexes. Most people with AVMs in the brain live full lives with no knowledge of ever having the anomaly; sometimes the lesions are identified during workup for another disorder. Other patients experience symptoms such as headaches, seizures, and neurological deficits. Patients who do experience symptoms often do so by the time they are in their thirties. Occasionally, AVMs rupture due to increased blood pressure and damage to the walls of the vessels involved. Past medical studies show the annual risk of AVM hemorrhage to be 2 to 4 percent.

In the present study, the UVA researchers reviewed a database of 1204 cases of AVMs that were treated by radiosurgery with a Gamma Knife® between 1989 and 2009. The researchers focused on 444 patients whose AVMs were unruptured at the time of radiosurgery and who participated in follow-up for at least 2 years (less if there was early proof that radiosurgery had obliterated the AVM). The patients' mean age was 36.9 years; 11% of patients were younger than 18 years at the time of radiosurgery. The patient cohort was evenly split between the sexes. The authors report that the mean size of the AVM nidus was 4.2 cubic centimeters (approximately 2 centimeters in diameter). Nearly 14 percent of the AVMs were located deep within the brain. Twelve percent of patients presented with neurological deficits, 28 percent with headaches, and 47 percent with seizures.

The median dose of radiation directed to the edge of the AVM during radiosurgery was 20 Gray and the median maximum dose was 40 Gray. Sixty-four patients underwent radiosurgery as a repeat procedure. Univariate and multivariate Cox regression analyses were performed to identify the effects of various factors on AVM obliteration and determine risk factors associated with radiosurgery.

The researchers state that 62 percent of unruptured AVMs in this patient cohort were obliterated by radiosurgery. Their analyses showed that a higher prescribed radiation dose, a single draining vein, radiation-induced changes apparent on neuroimages, a lower Spetzler-Martin AVM grade, and no earlier embolization procedure performed to treat the AVM were statistically significant positive predictors of AVM obliteration. Following radiosurgery, the annual hemorrhage rate was 1.6 percent, which is equivalent to or may be slightly better than the 2 to 4 percent estimated for unruptured AVMs left untreated. Once an AVM has been obliterated, however, there is no longer a risk of hemorrhage.

In comparison with the patients' pre-radiosurgery neurological

symptoms, 7 percent of patients showed improvement, 7 percent were worse, and 86 percent were unchanged. The authors state, "the risks associated with stereotactic radiosurgery were temporary; those risks that were permanent were typically not debilitating for the patient." Statistical analysis showed that worsening of clinical conditions was significantly more common in patients who experienced hemorrhage after radiosurgery.

Patients generally present with unruptured AVMs when they are young. Without treatment, they must face many years at risk for hemorrhage, which can cause neurological impairment and even death. The authors believe that treatment of an AVM is indicated for these younger patients as well as for patients with large AVMs and those with worse radiosurgery-based AVM scores. Treatment of an AVM with the Gamma Knife® appears warranted in most patients, even if the AVM has not previously ruptured. These researchers recommend radiosurgery as the means of treatment because of its "reasonable chance of obliteration of unruptured AVMs with relatively low rates of clinical and radiological complications."

When asked for the take-home message of the study, the senior author, Dr. Jason Sheehan, said, "The essence of this study is that unruptured AVMs can rupture, and rupture has significant morbidity or even mortality. Gamma Knife® radiosurgery yielded obliteration in the majority of unruptured AVMs. Obliterated AVMs do not rupture. The overall surgical risks of Gamma Knife® radiosurgery in unruptured AVMs seem lower than those in the natural history of an AVM if left untreated, even if the AVM has not previously ruptured."

More information: Ding D, Yen C-P, Xu Z, Starke RM, Sheehan JP. Radiosurgery for patients with unruptured intracranial arteriovenous malformations. Clinical article. Journal of Neurosurgery, published online, ahead of print, March 26, 2013; DOI:

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An editorial by Dr. Douglas Kondziolka of NYU Langone Medical Center accompanies this paper:
Kondziolka, D. Editorial. Arteriovenous malformation. Journal of Neurosurgery, published online, ahead of print, March 26, 2013; DOI: 10.3171/2012.11.JNS121812.