Aneurysm geometry

GIUSEPPE LANZINO, M.D.

Department of Neurologic Surgery, Mayo Clinic, Rochester, Minnesota

Treatment of small, unruptured intracranial aneurysms is controversial, and the decision of whether to intervene is a difficult one. While a very small subset of unruptured aneurysms go on to rupture, the vast majority remain quiescent for years. Different factors (related to patient, aneurysm, and surgeon/technique) are taken into consideration to guide the decision-making process. The development of 3D imaging techniques has triggered an expanding number of reports on the predictive role of various geometric and hemodynamic measurements on the formation, growth, and rupture of intracranial aneurysms. While estimation of the putative role of these measurements is appealing and sophisticated, most of the studies suffer from a major methodological flaw: unruptured aneurysms are compared with ruptured aneurysms. As most surgeons who have operated on patients with ruptured and unruptured aneurysms are well aware, the 2 entities are often completely different.

In their article, Lin and coworkers1 analyze a relatively large cohort of middle cerebral artery (MCA) aneurysms and compare unruptured and ruptured aneurysms with respect to various geometric and hemodynamic measurements calculated on 3D CT angiography reconstructions. The authors conclude that aspect ratio, flow angle, and parent-daughter angle were more common in the ruptured rather than in the unruptured cohort. The authors of this study make an attempt to consider a homogeneous group of aneurysms by selecting only patients with MCA aneurysms. As most surgeons who have operated on patients with ruptured and unruptured aneurysms are well aware, the 2 entities are often completely different.

In their article, Lin and coworkers1 analyze a relatively large cohort of middle cerebral artery (MCA) aneurysms and compare unruptured and ruptured aneurysms with respect to various geometric and hemodynamic measurements calculated on 3D CT angiography reconstructions. The authors conclude that aspect ratio, flow angle, and parent-daughter angle were more common in the ruptured rather than in the unruptured cohort. The authors of this study make an attempt to consider a homogeneous group of aneurysms by selecting only patients with MCA aneurysms. However, the 2 groups under consideration are still quite different, and the study is not devoid of the significant methodological flaws of similar studies. I suspect that composition and strength of the aneurysm wall and time elapsed from aneurysm formation to its detection are much more important differences between ruptured and unruptured aneurysms than are geometric differences. Most aneurysms that go on to rupture most likely do so shortly after their formation at a time when the aneurysm wall is more vulnerable to hemodynamic stress.2,3 It is possible that aneurysm geometry plays a role in this early stage of vulnerability, hence the differences between ruptured and unruptured aneurysms.

While the growing body of literature on fluid dynamics and aneurysm geometry has had important repercussions in designing newer treatments for intracranial aneurysms (such as flow diverters), the ever-increasing list of complex geometric factors associated with “rupture” has done little to change our decision making in patients with unruptured aneurysms or our understanding of the formation, growth, and rupture of intracranial aneurysms. A prospective study of conservatively treated unruptured aneurysms with analysis of geometric factors associated with rupture risk may provide useful information, but even such a study could be inconclusive because of the small number of end points (that is, ruptures) and the interaction with other important variables (aneurysm size, patient age, aneurysm location, and correctable risk factors for aneurysm rupture). Despite the growing body of literature on aneurysm/parent artery geometry and computational fluid analysis, the decision making in treating unruptured intracranial aneurysms continues to be based on art rather than science.

Disclosure

The author reports no conflict of interest.

References


Response

NING LIN, M.D., AND ROSE DU, M.D., PH.D.

Department of Neurosurgery, Brigham and Women’s Hospital, Boston, Massachusetts

We thank Dr. Lanzino for his thoughtful and insightful discussion of our study, particularly the utility of geometric parameters in assessing the rupture risk of intracranial aneurysms. We agree that ruptured and un-
ruptured aneurysms are inherently different entities and that direct comparison of these 2 groups could constitute a methodological flaw. However, we believe that different morphological parameters are affected by the process of aneurysm rupture differently. Since the morphology of the aneurysm may change at the time of rupture, the relationship of certain characteristics of the aneurysm itself (for example, the undulation index) and its risk of rupture would need to be interpreted carefully. On the other hand, parameters investigated in our study, such as aspect ratio, flow angle, and parent-daughter angle, should be less affected by the mechanics of aneurysm rupture. In particular, parent-daughter angle describes the geometric relationship of the surrounding vasculature and is independent of the aneurysm itself.

We also agree that although advancement of 3D vascular imaging allows more accurate demonstration of aneurysm morphology and surrounding angioarchitecture, evaluating the rupture risk of an intracranial aneurysm remains complex. A prospective observational trial to monitor the changes of aneurysm morphology over time and to assess its relationship with rupture risk is difficult to conduct and will likely result in treatment of the aneurysm prior to rupture. In addition, such a study would be unlikely to include patients whose aneurysms rupture soon after formation. Nevertheless, recent reports have suggested that geometric parameters and fluid dynamics analyses have already entered the arena of clinical decision making. We hope that our paper adds to this growing body of literature and stimulates interest in studying not only the morphology of the aneurysm itself, but also the relationship of the surrounding vessels.

References


Please include this information when citing this paper: published online September 7, 2012; DOI: 10.3171/2012.3.JNS112260.