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proceed, but with caution.**

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MR Angiography of Intracranial Aneurysms: Proceed, but with Caution

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Intracranial aneurysms are believed to be present in up to 8% of the population. Twenty thousand aneurysms rupture each year in the United States. A noninvasive method of screening for these lesions clearly would be of significant benefit. Magnetic resonance (MR) angiography (MRA) has been repeatedly suggested as such a method. The article by Huston et al in this issue of the *AJNR* (1) presents enough data on the limitations of this technique to give the more circumspect among us pause.

Previous reports comparing MRA with conventional angiography have shown a high level of sensitivity in the detection of aneurysms with the MR methods. The first of these by Ross et al had a true-positive rate of 86% when time-of-flight MRA was combined with standard spin-echo imaging and the individual MRA partitions as well as the cine maximum intensity projections were viewed (2). However, among the 21 aneurysms, only two were smaller than 5 mm and only 1 of these was detected with MR. Significantly, the false-positive rate among a group of healthy control subjects in this study was zero.

More recent studies by Schuierer et al (3) using time of flight alone and Gouliamos et al (4) using both time-of-flight and phase-contrast MRA have shown similar or better results. Although Schuierer did not provide detailed aneurysm size data, the overall detection rate was at least 86%. Nine percent of lesions were questionably seen, and 5% (one lesion, smaller than 1 cm) were missed. Gouliamos studied 14 cases and failed to see one 2-mm aneurysm on MRA, for a detection rate of 93%. Interestingly, one 3-mm aneurysm was seen with MRA but not on conventional angiography.

In the current work by Huston et al, 16 patients with 27 aneurysms were examined along

with 19 healthy control subjects. The authors reviewed T1-weighted MR, T2-weighted MR, time-of-flight MRA, and phase-contrast MRA separately and arrived at overall sensitivities of 26%, 48%, 56%, and 44%, respectively, for each method. These numbers are considerably below those previously reported and viewed alone are cause for great concern regarding the value of MR and MRA. Nonetheless, if one scrutinizes the details underlying the broad conclusions, further important observations can be made.

To compare directly Huston's conclusions with those of Ross, one could combine the results of each of the MR and MRA tests. Using the criteria of two or more readers detecting an aneurysm, 70% of aneurysms would have been identified on one of the four imaging studies. This does not account for the overall improvement in detection sure to result from having all the images available to review together. The whole undoubtedly is greater than the sum of the parts in this analysis, although the authors' comments regarding information overload in reviewing these cases surely will be echoed by any radiologist who routinely performs these examinations.

Of the eight aneurysms not diagnosed, all but one were smaller than 5 mm. Thus, for aneurysms at least 5 mm, the overall true-positive rate is 94%, which in fact is equal to that seen by Ross for the same size range. Unfortunately, aneurysms smaller than 5 mm do rupture, making this statistic of only limited comfort. Although studies have shown no hemorrhages in patients with aneurysms smaller than 3 mm, six of the eight missed aneurysms were larger than or equal to this size, and the overall detection rate for these aneurysms was only 30%.

Three of the eight lesions not seen in this study were aneurysms of the carotid siphon, an

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area difficult to evaluate even with conventional angiography. These may be of somewhat less clinical importance in that when they rupture, they do so into the cavernous sinus and form carotocavernous fistulas. Although these lesions are symptomatic and require therapy, they are rarely, if ever, life threatening.

On a per-patient basis, the results are more encouraging. All 16 patients with aneurysms in this study had at least one of their lesions detected by an MR technique. Furthermore, the one control subject that was mistakenly identified with an aneurysm on the time-of-flight MRA clearly would have been diagnosed correctly if all the sequences had been presented together. These results are equivalent or better than those demonstrated by Ross.

The foregoing analysis has developed several conclusions: First, MR imaging and MRA are valuable techniques in the screening of patients suspected of having aneurysms. The two patient populations, those with one or more aneurysms and those without, can be reliably distinguished. Second, the use of both routine MR imaging and MRA, perhaps both time of flight and phase-contrast, is essential to achieve these results. Moreover, MRA requires evaluation of the individual partitions as well as of the "cine" loop. Reliance on a few maximum intensity projection images or a single "collapse" view from a two-dimensional phase-contrast acquisition is not sufficient. Third, small aneurysms, smaller than 5 mm, are not detected as reliably as those larger. At the least, this means that patients with one aneurysm must have conventional angiography to exclude the presence of other small lesions completely. A

more conservative interpretation would be that MR studies not be trusted to "rule out aneurysm" definitively.

In practice, this pessimistic view probably is not reasonable. MR imaging and MRA can and should be used to screen patients suspected of harboring an aneurysm and perhaps equally important, the combination of different techniques can be applied to resolve an ambiguous finding on another study, MR, or computed tomography of a patient scanned for a different indication. However, it is our obligation to understand the limitations of the MR methods as demonstrated by Huston and those before him and to educate our clinical colleagues regarding those limitations and the appropriate use of the study. Moreover, we must encourage further development, perhaps taking advantage of the new higher gradient strengths being offered by the MR manufacturers, to maximize fully MR's potential in this important area. Let us proceed, but with caution.

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