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Is Catheter Angiography Still Necessary to Evaluate Obliteration of Brain Arteriovenous Malformations Treated with Stereotactic Radiosurgery?

In this single-center prospective study, the authors investigated the accuracy of 4D arterial spin-labeling MR angiography (ASL-MRA) and contrast-enhanced time-resolved MRA (CE-MRA) sequences for determining obliteration of brain AVMs treated with stereotactic radiosurgery (SRS). Patients with SRS-treated AVMs found to have obliteration on routine follow-up MR imaging/MRA or residual nidus after 4 years of follow-up were enrolled in the study. These patients then underwent MRA with 4D ASL-MRA and CE-MRA sequences in addition to the recommended catheter DSA on the same day. Images were randomly allocated to and independently interpreted by 2 experienced neuroradiologists who were blinded to clinical data. The ability of the 4D ASL-MRA and CE-MRA sequences to distinguish AVM obliteration status was compared with that of DSA, the current the criterion standard.

Thirty consecutive patients were enrolled, but 1 was subsequently excluded because of technical error during imaging acquisition, so the final analysis included 29 patients. The mean follow-up duration was 53 months. Complete obliteration and residual AVMs, based on DSA, were found in 20 (69%) and 9 (31%) patients, respectively. Residual AVMs were accurately identified in 8 and 7 cases based on 4D ASL-MRA (sensitivity = 88%, negative predictive value [NPV] = 95%) and CE-MRA (sensitivity = 77%, NPV = 90%) sequences, respectively. The sensitivity and NPV improved to 100% when these sequences were used together. The authors also reported that 4D ASL-MRA and CE-MRA sequences were able to provide data relevant to the Spetzler-Martin grade in complete agreement with DSA with regard to nidus size and venous drainage pattern (Cohen $k = 1$, $P < .003$). The authors concluded that 4D ASL-MRA and CE-MRA sequences are promising alternatives to DSA for confirming AVM obliteration after SRS, and they may also be able to characterize the angioarchitecture of residual AVMs.

Despite improvements in catheters and its minimally invasive nature, DSA continues to harbor small risks of stroke and access site complications.[1] Advances in image resolution and dynamic imaging with MR imaging have improved contemporary noninvasive radiologic evaluation of AVMs. The role of MR imaging in determining SRS-induced AVM obliteration has evolved concurrently with technological improvements in its neuroimaging resolution and capabilities.[2,3] The goal of AVM intervention is obliteration of the nidus because any residual arteriovenous shunting represents persistent hemorrhage risk.[4] As such, sensitivity and NPV of the imaging technique under investigation for detecting residual AVM nidus are of utmost importance.[5] These factors are particularly crucial for AVMs treated with SRS because obliteration after this intervention occurs in a delayed fashion over a period of up to 5 years.[6,7] SRS-treated AVMs often require routine serial imaging follow-up during this latency period, so the accuracy of noninvasive imaging in guiding the necessity and timing of DSA is essential.

4D ASL-MRA and CE-MRA sequences each demonstrated reasonable sensitivities and NPVs for residual AVM detection after SRS, and their combined sensitivity and NPV were both 100%. The authors should be commended for putting forth a well-designed study investigating this topic, though readers should recognize the study's limitations. First, the sample included a highly selected cohort of AVMs with a high likelihood of obliteration (because of obliteration observed on MR imaging) and patent nidi 4 years after SRS. The study did not clearly define whether residual AVMs detected on 4D ASL-MRA and CE-MRA sequences derived from the obliterated or nonobliterated groups based on routine follow-up MR imaging. The utility of DSA for post-SRS follow-up lies in its ability to detect residual AVMs not otherwise identified on MR imaging. Small and poorly defined AVMs usually include residual nidi that are missed on routine follow-up MRI, and detection of these lesions on 4D ASL-MRA and CE-MRA sequences may not have been adequately assessed. Therefore, inclusion of patent AVMs on routine follow-up MR imaging may have falsely inflated the sensitivities and NPVs of these MRA sequences.

Although the overall study cohort included 29 patients, the sample size used to assess the sensitivities of 4D ASL-MRA and CE-MRA included only 9 patients. The small sample size also precluded subgroup analyses. Therefore, future studies of larger cohorts are necessary to confirm the presented findings. The

results of this study demonstrated a promising future for noninvasive imaging in accurately assessing the obliteration status of AVMs treated with SRS, thereby reducing the need for DSA in post-SRS follow-up. Although noninvasive imaging may not entirely supplant the need for DSA in future AVM imaging, a larger proportion of these patients may be spared the procedural risks associated with DSA.

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