

A novel non-contrast-enhanced MRA using silent scan for evaluation of brain arteriovenous malformation

A case report and review of literature

Jin Il Moon, MD^a, Hye Jin Baek, MD, PhD^{a,*}, Kyeong Hwa Ryu, MD^a, Hyun Park, MD^b

Abstract

Rationale: Brain arteriovenous malformations (AVMs) are congenital vascular abnormalities involving abnormal connections between arteries and veins. In clinical practice, imaging studies help evaluate feeding arteries, niduses, draining venous systems, and coexisting complications in patients with brain AVM. They also have an impact on decision-making regarding clinical management. We applied a novel non-contrast-enhanced MR angiography (MRA) technique, termed “silent MRA,” for evaluating an incidental brain AVM. Here, we describe the clinical case with radiological review and highlight the technical background and clinical usefulness of silent MRA.

Patient concerns: A 60-year-old woman underwent neuroimaging study including MRA to evaluate intracranial cause of headache.

Diagnoses: The brain AVM, including its nidus and draining veins, was conspicuously delineated on silent MRA images; these findings correlated well with conventional angiographic findings.

Interventions: The patient did not receive interventional or surgical treatment.

Outcomes: The patient is being followed up regularly at the outpatient department.

Lessons: The silent MRA can be a suitable imaging modality for repeated follow-up evaluation for not only brain AVMs but also various intracranial vascular diseases without the use of contrast materials.

Abbreviations: ASL = arterial spin labeling, AVM = arteriovenous malformation, CT = computed tomography, MRA = magnetic resonance angiography, MRI = magnetic resonance imaging, TE = echo time, TOF = time-of-flight.

Keywords: arteriovenous malformation, brain, conventional catheter angiography, MR angiography, silent scan

1. Introduction

Brain arteriovenous malformations (AVMs) are complex tangles of abnormal arteries and veins, with fistulous connections and lacking a capillary bed.^[1,2] Brain AVMs are often detected incidentally. Therefore, it is essential to carefully evaluate brain AVMs using imaging modalities to reach an accurate diagnosis

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^a Department of Radiology, ^b Department of Neurosurgery, Gyeongsang National University School of Medicine and Gyeongsang National University Changwon Hospital, Seongsan-gu, Changwon, Republic of Korea.

* Correspondence: Hye Jin Baek, Department of Radiology, Gyeongsang National University School of Medicine and Gyeongsang National University Changwon Hospital, 11 Samjeongja-ro, Seongsan-gu, Changwon 51472, Republic of Korea (e-mail: sartre81@gmail.com).

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by differentiating them from other conditions that mimic AVMs, to assess AVM-related complications, and to aid decision-making regarding clinical management. Conventional catheter angiography is the best modality for delineating the architecture of brain AVMs. However, owing to recent technical advances, magnetic resonance angiography (MRA) is being commonly used as a noninvasive alternative to conventional catheter angiography for evaluation of brain AVMs in clinical practice.^[3,4] Here, we present a case of brain AVM in the left temporal lobe, which was incidentally detected by brain magnetic resonance imaging (MRI) using a novel non-contrast-enhanced MRA technique, termed “silent MRA.” We also provide a relevant literature review on this disease and a brief summary of the technical background of silent MRA. To the best of our knowledge, this is the first report on diagnosis of brain AVM by silent MRA.

2. Case report

This was purely an observational case study. The patient’s management and outcome were unaltered. Therefore, no ethical approval was required for this case report. Written informed consent was obtained from the patient for publication of this case report and accompanying images.

A 60-year-old woman visited our hospital with a headache after a traffic accident. She had no history of any neurological or medical disorders. The findings of physical examination, plain

radiography, and laboratory tests revealed no specific abnormalities, including cervical sprain. Careful neurological examination revealed no focal sign. Therefore, the patient underwent brain computed tomography (CT) for evaluation of traumatic intracranial abnormalities such as intracranial hemorrhage. The CT findings revealed a poorly defined hyperattenuating mass-like lesion with tiny calcifications in the left anterior temporal lobe (Fig. 1A). Therefore, to characterize the left temporal lesion, brain MRI was performed using a 3T system (Signa Architect; GE Healthcare, Milwaukee, WI) with a 48-channel head coil. Silent MRA was also performed during the same scanning session, with the following scan parameters: repetition time, 1110 ms; echo time (TE), 0.016 ms; flip angle, 5°; field of view, 180 × 180 mm; matrix size, 180 × 180; section thickness, 1 mm; number of excitations, 1.0; bandwidth, ±25 kHz; and acquisition time, 4 minutes 48 seconds. There was an incidental finding of a well-circumscribed tangled vascular mass in the left anterior temporal lobe, measuring approximately 4.1 × 3.8 × 4.3 cm in size, which was suggestive of brain AVM (Fig. 1B and C). There was no hemorrhagic complication associated with AVM. Unlike time-of-flight (TOF) MRA findings, silent MRA findings clearly demonstrated the large AVM, especially the nidus of the AVM and the draining veins in the vicinity of the nidus. The AVM had multiple feeders from ipsilateral middle and posterior cerebral arteries, with the anterior temporal artery being the main feeder. The draining veins exhibited aneurysmal dilatation with significant tortuosity, and they finally drained into the vein of Galen (Fig. 1D and E). The nidus was of a typical compact-type and consisted of abnormal vessels without any interspersed normal brain tissue. There was no aneurysm within the nidus. These silent MRA findings were well correlated with the findings of conventional catheter angiography (Fig. 1F-I).

3. Discussion

Brain AVMs are complex tangles of abnormal connections between arteries that normally supply the brain tissue and veins that normally drain from the brain, resulting in arteriovenous shunting with an intervening network of vessels within the brain parenchyma and lack of a true capillary bed.^[1,2] The transition between artery and vein can occur through a nidus or a fistula without any intervening network.^[5] Brain AVMs are thought to be congenital abnormalities, which might arise from developmental vascular derangement in the embryonic stage.^[1,2] Brain AVMs account for approximately 11% of cerebrovascular malformations and are clinically less symptomatic than other malformations. However, they are an important cause of intracranial hemorrhage or seizure in young adults.^[6] They are classified into 2 subtypes on the basis of the nidus structure—glomerular or compact-type (incidence, 66%) and diffuse or proliferative-type (incidence, 34%).^[7] Compact AVMs are typical AVMs that possess niduses consisting of tightly packed abnormal vessels without any interspersed normal brain tissue; they are typically located in the cerebral hemisphere. Diffuse or proliferative AVMs, in which brain parenchyma is interspersed throughout the tangle of vessels, are rare and usually occur in the deep grey matter. Conventional catheter angiography is the best modality for depicting the architecture of abnormal vascular tangles in brain AVMs. It can help evaluate the nidus, arterial feeders, and venous drainage pattern, along with coexisting nidal aneurysms, venous varices, and venous stenoses. CT angiography is a useful noninvasive imaging modality, which also allows direct visualization of arterial and venous anatomy, including the nidus. With technical advances, TOF-MRA could serve as a noninvasive and non-contrast-enhanced alternative to conventional catheter angiography. However, it fails to demonstrate the nidus and draining veins with slow flow.^[1,3,4,8]

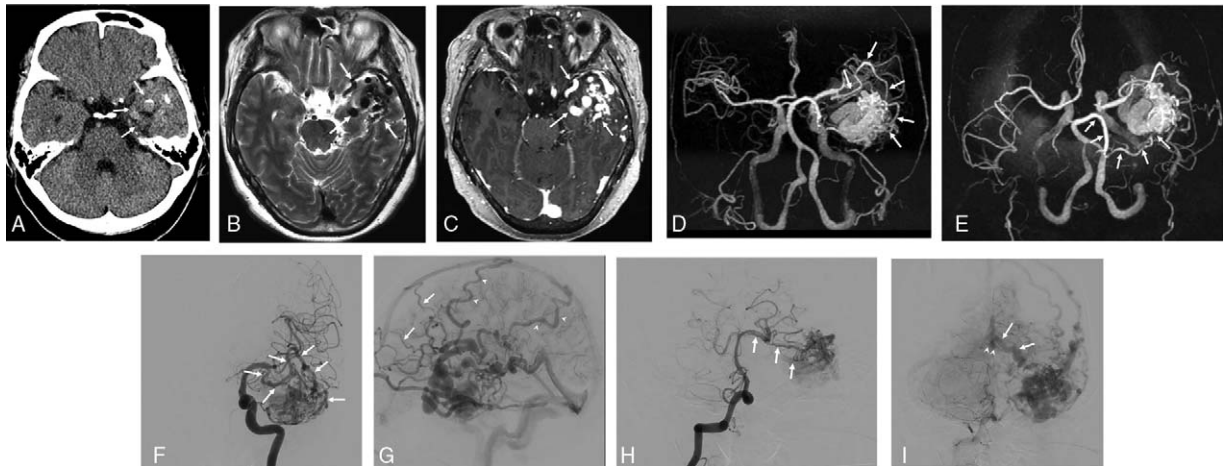


Figure 1. Incidentally detected classic brain arteriovenous malformation (AVM) in a 60-year-old woman. (A) Axial non-contrast-enhanced computed tomography image shows a poorly defined mass-like lesion with hyperattenuation and tiny calcifications in the left anterior temporal lobe (arrows). (B) On a T2-weighted image, the lesion shows a large tangled mass with multiple engorged vessels, showing flow-signal void (arrows). There is no interspersed normal brain tissue between the abnormal vessels. (C) Contrast-enhanced T1-weighted image reveals multiple enhanced tubular structures, suggesting a large vascular lesion (arrows). (D and E) Silent magnetic resonance angiography images reveal a compact-type nidus, supplied mainly by the anterior temporal branches of the left middle cerebral artery (arrows on D), and anterior and posterior temporal branches of the left posterior cerebral artery (arrows on E). The draining veins near the nidus exhibit aneurysmal dilatation, and there is no intranidal aneurysm. (F and G) Left internal carotid arteriogram (anteroposterior (F) and lateral (G) views) reveal that the nidus is supplied by cortical branches of the left middle cerebral artery with final venous drainage into the vein of Galen via the engorged left frontal and parietal cortical veins. (H and I) Left vertebral arteriogram (anteroposterior (H) and lateral (I) views) also reveal that the arterial feeders arise from the temporal branches of the left posterior cerebral artery. They also reveal early venous drainage into the left frontal and parietal cortical veins. These angiographic findings confirm the diagnosis of brain AVM.

In the present case, we applied a novel non-contrast-enhanced MRA technique by using the silent MRA technology. Silent MRA employs the silent scan algorithm (GE Healthcare, Milwaukee, WI) and an ultrashort TE (TE, 0.016ms) and arterial spin labeling (ASL). The ultrashort TE is a key factor that can help minimize the phase dispersion of the labeled blood flow signal in the voxel space and decrease magnetic susceptibility. The ASL technique is used as a preparation pulse, and it can help visualize mild flow-signal change.^[9,10] In silent MRA, a control image is first acquired before the labeling pulse, followed by a labeled image. The control and labeled images are subtracted to yield an angiographic image.^[9,10] Consequently, unlike TOF-MRA images, silent MRA images are easy to interpret, because they can demonstrate vessels with slow flow, regardless of direction. Two recent studies have demonstrated that silent MRA might be useful for follow-up imaging after stent-assisted coil embolization.^[9,10]

To the best of our knowledge, no study to date has reported the use of this novel non-contrast-enhanced MRA technique for evaluation of brain AVMs. In the present case, the brain AVM—including its nidus and draining veins—was conspicuously delineated on silent MRA images; these findings correlated well with conventional angiographic findings. Therefore, we believe that silent MRA might be a suitable imaging modality for repeated follow-up evaluation for not only brain AVMs but also various intracranial vascular diseases without the use of contrast materials.

Here, we have described the incidental detection of a brain AVM using silent MRA. Through this report, we hope to highlight the clinical usefulness of silent MRA for evaluating intracranial arteries in routine clinical practice on the basis of its technical background.

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