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Two Cases of Mechanical Thrombectomy in Patients with Fenestration of the M1 Segment of the Middle Cerebral Artery

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Abstract

M1 fenestration of the middle cerebral artery is rare. We present two patterns of acute thromboembolic conditions in M1 fenestrations treated with mechanical thrombectomy. Case 1 was a male in his 60s presenting with right hemiparesis and aphasia. Angiography showed acute left M1 proximal occlusion; the first direct aspiration revealed two parallel routes, and the second aspiration achieved complete recanalization of the left M1 fenestration. Case 2 was a male in his 70s presenting right hemiparesis and aphasia. Angiography revealed a sudden stair-like narrowing of the left M1 in the intermediate part, and a retrograde blood flow cavity was observed on the upper side of the distal part. Mechanical thrombectomy was performed to diagnose the upper limb occlusion of the left M1 fenestration, and successful recanalization was achieved through direct aspiration. Anatomical variations, such as fenestration, should be considered to reduce complication risks.

Keywords: mechanical thrombectomy, M1 fenestration

Introduction

M1 fenestration of the middle cerebral artery (MCA) is rare, only detected in 0.17%-0.43% on digital subtraction angiography (DSA) and 0.28-1% on autopsy.[1,2] Fenestration divides the parent artery into two parallel channels, whose diameters are narrower than that of the parent artery. In cases of intracranial thrombosis with M1 fenestration, the clot is captured by the fenestrated bifurcation instead of the M2 bifurcation.[3,4]

Mechanical thrombectomy (MT) is the standard treatment for acute cerebral infarctions.[5] During MT, wires or catheters may advance beyond the occluded area; however, in acute thromboembolic situations, identifying fenestrations at the occlusion site is difficult. Therefore, in situations where prompt decision-making and treatment are necessary, there is a risk of misunderstanding the situation, which can lead to the risk of vascular injury.

Here, we report two cases of M1 occlusion at the fenestration treated with MT in which we could detect the fenestration during or before treatment.

Case Report

Case 1 (Fig. 1): A male in his 60s was found crouching at home and was transferred to our hospital. Upon arrival at the hospital, he had a Glasgow Coma Scale (GCS) score of E4V1M5, blood pressure of 129/107 mmHg, heart rate of 81 bpm, and atrial fibrillation. His National Institutes of Health Stroke Scale (NIHSS) score was 22, and he had right hemiplegia and complete aphasia. Early ischemic signs were observed in the left basal ganglia and insula on a head computed tomography (CT) scan. Magnetic resonance angiography (MRA) revealed proximal occlusion of the left M1. While administering intravenous recombinant tissue-type plasminogen activator, MT was performed. First, a direct aspiration first pass technique (ADAPT) using a 9-Fr balloon-guiding catheter (Optimo; Tokai Medical Products, Aichi, Japan) and 5MAX ACE68 (Penumbra Inc., Alameda, CA, USA) led to partial recanalization with two

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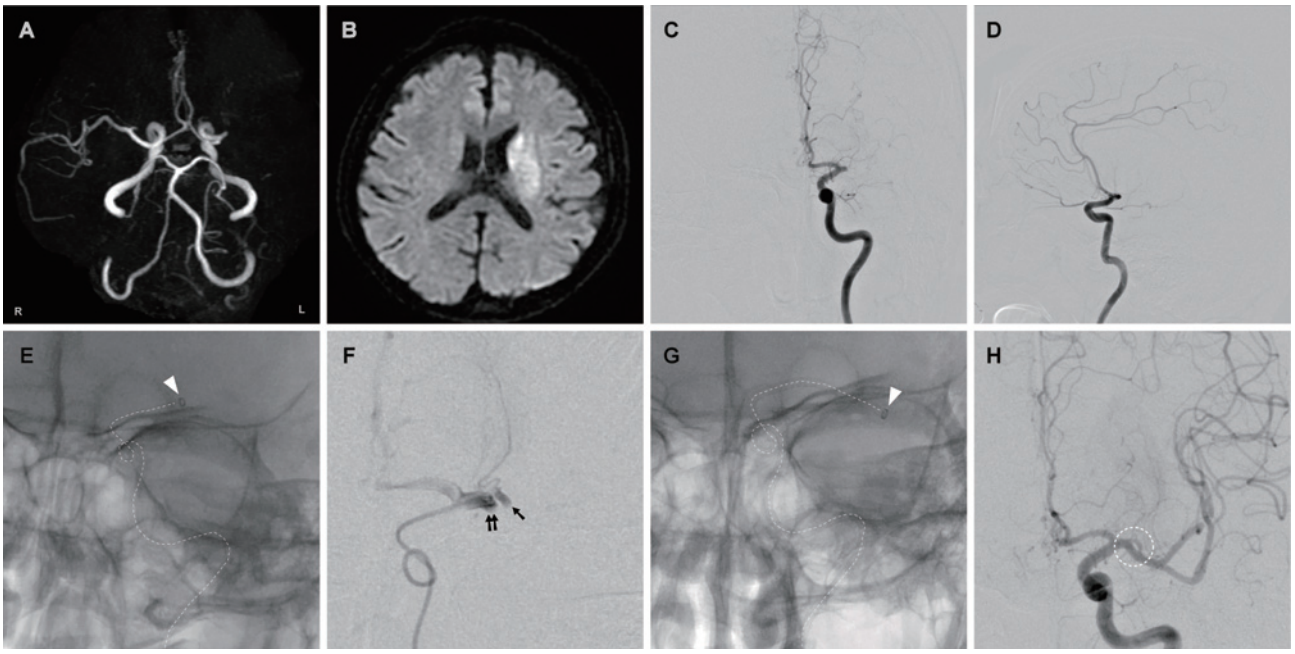

Fig. 1 Case 1. (A) MRA shows a right M1 occlusion. (B) DWI shows acute left striatal infarction. (C-D) Left ICA-DSA from the AP and lateral projections showing proximal occlusion of the left M1. (E) Direct aspiration first pass technique using ACE68. (F) Left ICA-DSA from the AP projection after the first pass shows partial recanalization of M1 and reveals two parallel limbs. The diameter of the lower limb was larger than that of the upper limb, and both limbs were occluded distally. The lateral striatal artery originates in the upper limbs. (G) The second aspiration used ACE68 through the lower limbs. (H) Left ICA-DSA from the AP projection after the second pass showing complete recanalization of the left M1 fenestration.
Abbreviations: MRA, magnetic resonance angiography; DWI, diffusion-weighted image; ICA-DSA, internal carotid artery-digital subtraction angiography; AP, anteroposterior

distinct parallel routes. At this point, the possibility of M1 fenestration occlusion was observed, and complete recanalization was achieved by performing a second thrombus aspiration from the enlarged lower leg. The left M1 fenestration became evident. Paralysis improved, and only mild aphasia persisted. The patient was discharged home on the 13th day after MT.

Case 2 (Fig. 2): A male in his 70s was transferred to our hospital because of sudden disturbances in consciousness, right hemiplegia, and aphasia. Upon arrival at the hospital, he had a GCS score of E4V1M5, blood pressure of 159/85 mmHg, and a regular pulse of 51 bpm. His NIHSS score was 26. Head CT did not reveal any intracranial hemorrhage; however, CT angiography and perfusion showed abnormal narrowing of the left M1 and reduced perfusion of the left lateral striatal artery (LSA) region. Although M1 perforating branch occlusion was suspected, given the unnatural stenosis and double lumen distal to the stenosis, cerebral angiography was performed considering the possibility of an acute neurointervention. Left internal carotid artery angiography revealed sudden stair-like narrowing of the left M1 in the intermediate part and a retrograde blood flow cavity in the upper side of the distal part. Based on these findings, we diagnosed the occlusion of the proximal part of the upper limb of the M1 fenestration and performed MT. Two-stage aspiration was performed using a 9-Fr Optimo, 5MAX ACE68, and 3MAX (Penumbra Inc., Alameda, CA, USA), and recanalization was achieved in the upper limbs of the M1 fenestration and LSA. A small thrombus was retrieved, and the remaining thrombus migrated to the temporal branch. Right hemiparesis gradually improved; however, sensory aphasia due to temporal lobe infarction persisted. The patient was transferred to a rehabilitation hospital on the 38th day after MT.

Informed consent was obtained from all the participants before submitting this case report for publication.

Discussion

M1 fenestration is rare. However, it may still be encountered during MT, the standard treatment for acute infarction.[1,3,6-9]

The mechanism of M1 fenestration development is unclear. The most reasonable explanation is that M1 fenestration is incidentally formed during the arterial network fusion of the primitive MCA at days 30-40 of embryogenesis.[10,11] Because the development of accessory MCA and MCA duplication are similar to M1 fenestration, the perforators, including the lateral striate artery, branch from the superior limb. Meanwhile, temporal arteries branch from

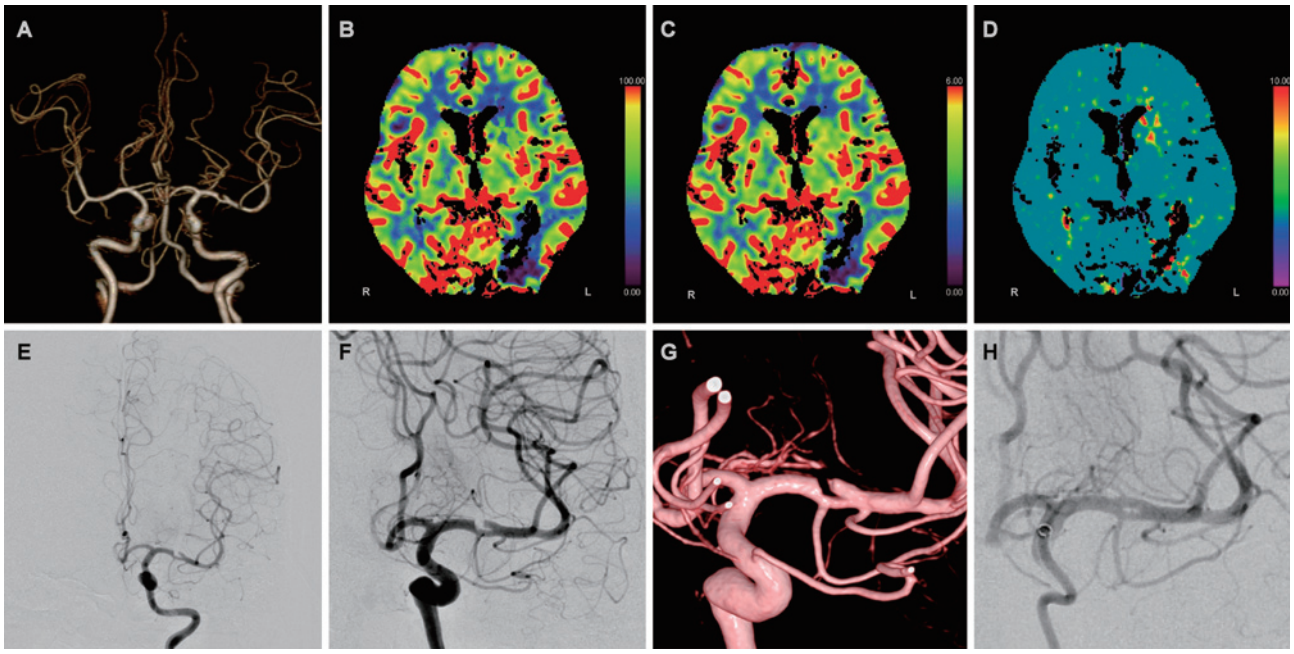

Fig. 2 Case 2. (A) CT angiography showing irregular stenosis of the left M1. (B-D) CBF, CBV, and MTT images from the CT Perfusion study show mildly decreased perfusion in the left striatum. (E) Left ICA-DSA from AP projection showing irregular and unnatural stenosis in the left M1. (F, G) 3D-DSA and magnified DSA show stair-like stenosis in the middle part of the left M1 and retrograde filling in the upper lumen at the distal part of the stenosis. Thin-slice MIP reconstruction revealed a slight lateral striatal artery at the proximal end of the upper lumen. These findings concur with fenestration rather than stenosis with atherosclerotic plaques or arterial dissection. The early branching temporal artery arises from the lower limb. (H) Left ICA-DSA from AP projection after the first pass showing recanalization of the upper limb of the left M1 fenestration.
Abbreviations: CT, computed tomography; CBF, cerebral blood flow; CBV, cerebral blood volume; MTT, mean transit time; ICA-DSA, internal carotid artery-digital subtraction angiography; AP, anteroposterior; MIP, maximum intensity projection

the inferior limb.[12] In the case of occlusion of the fenestration, reperfusion of the superior limb should be done before that of the inferior limb because infarction of the LSA territory may result in severe hemiparesis.

When encountering M1 fenestration occlusion, it is important to note that the aspiration catheter or stent retriever becomes relatively oversized, posing a risk of vascular injury because the vessel diameter at the fenestrated site is smaller than usual. In addition, similar to Case 2's partial occlusion of fenestration, there is a risk of performing percutaneous transarterial angioplasty by misdiagnosing a single-limb occlusion of the fenestration as a stenosis due to its shape; therefore, caution is needed to avoid treatment withdrawal due to the misdiagnosis as an arterial dissection. Thus, considering fenestration and selecting the appropriate device size are important.

A completely occluded area, including its distal parts, is not clearly depicted in images. However, if preoperative MRI evaluation is done, 3D turbo spin-echo sequences may reveal the anatomy of the occluded vessel.[13] Moreover, as in Case 1, because the fenestration may be exposed during treatment, performing treatment with a sufficient understanding of the anatomy can reduce the risk of complications. Therefore, although the time to reperfusion is important, the anatomy must still be evaluated to avoid complications.

Regarding the treatment strategy, the two cases were treated with ADAPT. Meanwhile, in the previous reports, one case was treated with mechanical thrombolysis using a coil,[3] four cases were treated with stent retrievers,[6-9] and one case was treated with ADAPT.[1] All cases were successfully recanalized, but mild postoperative subarachnoid hemorrhage occurred in the case treated with stent retrievers.[8] In cases of treatment with ADAPT, where contact aspiration is the fundamental method, the stress on the vessel wall seems to be less than that of the treatment with stent retrievers. Nonetheless, the distal migration of the thrombus must be monitored, as observed in Case 2.

In conclusion, considering the possibility of fenestration can help mitigate complication risks if an M1 occlusion with an atypical shape is observed before or during MT. Performing treatment with an awareness of the vascular anatomy is important.

Conflicts of Interest Disclosure

All authors have no conflicts of interest. All JNS member authors have registered self-reported COI Disclosure State-

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