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Case Report

Mechanical thrombectomy for occlusion of the fenestrated middle cerebral artery M1 segment: A case report and review of the literature☆

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ABSTRACT

It is impossible to predict underlying anomalies in acute large vessel occlusion and it could be a problem when performing mechanical thrombectomy (MT). We report a case of MT for occlusion of the fenestrated middle cerebral artery (MCA) M1 segment. A 49-year-old woman presented to our hospital with dysarthria and left hemiparesis. Acute ischemic stroke due to right occluded MCA was diagnosed. During performing emergent MT, a part of the M1 segment was revealed to be slit-shaped by digital subtraction angiography, suggesting a fenestrated MCA. The aspiration catheter could not be advanced through the narrow limb of the fenestration, and the distal thrombus was retrieved using a stent retriever, additionally. Postoperatively, the patient's symptoms improved without complications. When occlusion of the fenestrated MCA is suspected, it is necessary to consider converting the strategy from an aspiration catheter alone to the combined use of a stent retriever.

Introduction

Fenestration of the middle cerebral artery (MCA) is a rare vascular variant, with a reported angiographic incidence of 0.17%, and its diagnosis before mechanical thrombectomy (MT) poses a challenge to us [1]. Therefore, retrieval of the thrombus in the fenestrated narrow limb and the distal thrombus beyond the fenestration could be a pitfall of MT [2–5]. We report a case of successful recanalization of an occluded MCA fenestration with the combined use of a large-bore aspiration catheter and a stent retriever (SR). In addition,

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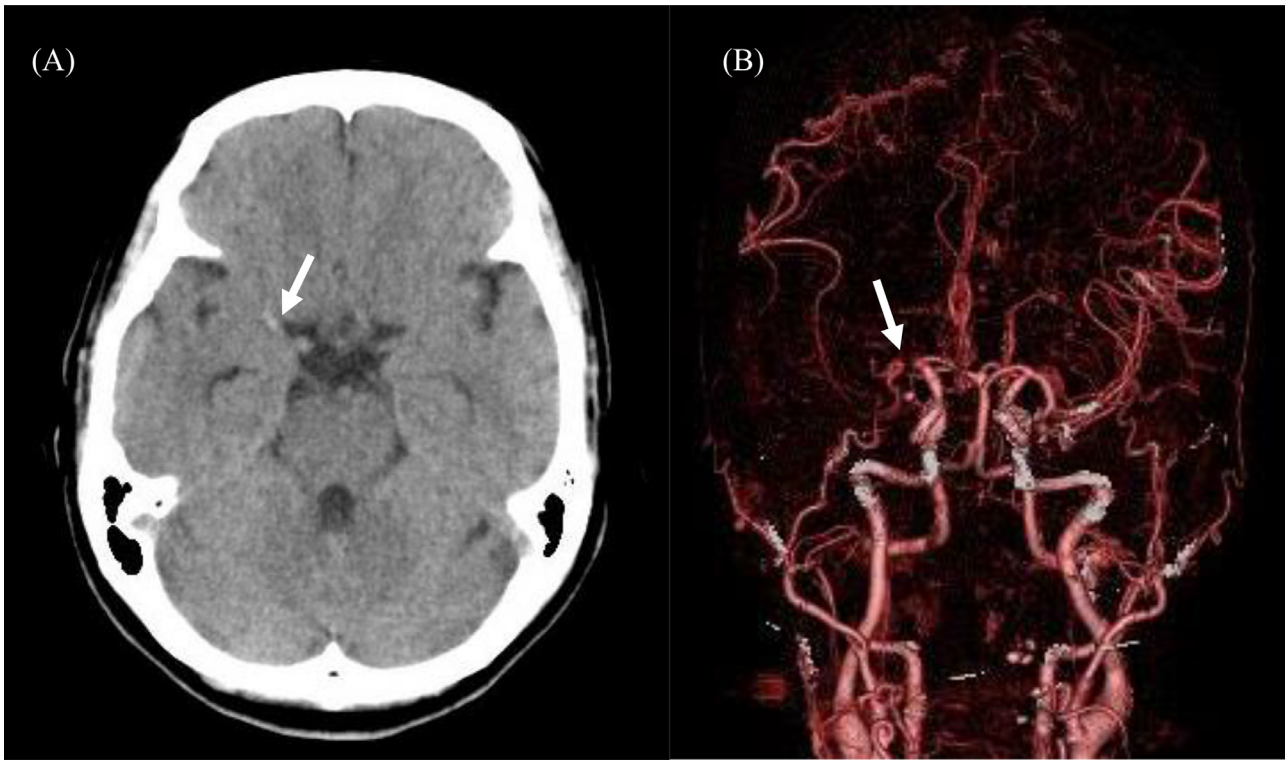

Fig. 1 – (A) Computed tomography (CT) revealed no abnormalities in the cerebral hemispheres and a right hyperdense middle cerebral artery (MCA) sign (white arrow). (B) CT angiography revealed occlusion of the M1 proximal segment of the right MCA (white arrow).

we summarized the recent reports regarding the effective use of devices for MT of fenestrated MCA.

Case report

A 49-year-old woman presented with sudden left hemiparesis and was transported to our hospital by ambulance 1 hour after the onset of symptoms. The patient had a history of depression. The patient's family history was unremarkable. On admission, she was conscious, and her blood pressure was 97/61 mmHg. She presented with dysarthria and left hemiparesis (manual muscle test score, 2/5). The National Institutes of Health Stroke Scale (NIHSS) score was 8/42. Although noncontrast computed tomography (CT) of the brain did not reveal any abnormalities in the bilateral cerebral hemispheres and brain stem, a right hyperdense MCA sign was observed (Fig. 1A). The Alberta Stroke Program early CT score was 10. Occlusion of the proximal M1 segment of the right MCA was observed on 3-dimensional CT angiography (Fig.1B). Therefore, MT was performed 50 minutes after the patient arrived at the hospital, following the administration of recombinant tissue plasminogen activator. A 9 French (Fr) sheath was inserted into the right femoral artery, and a 9 Fr balloon-guiding catheter (Branchor, Asahi Intecc, Aichi, Japan) was advanced into the right internal carotid artery. Digital subtraction angiography (DSA) revealed occlusion of the proximal M1 segment of the right MCA and leptomeningeal anastomosis from anterior cerebral artery was observed (Fig. 2A). A large-bore aspiration catheter (Salva 71, 132 cm; Goodman Co., Ltd., Nagoya, Aichi, Japan) was introduced along with a Traxcess guidewire (Terumo, Tokyo, Japan) and a Phenom 27, 160 cm long microcatheter (Medtronic, Irvine, CA). After performing contact aspiration using the direct aspiration first-pass technique (ADAPT) twice [6], internal carotid angiogram revealed partial recanalization (modified thrombolysis in cerebral infarction [mTICI] grade 1), and the recanalized part of the M1 segment appeared to be fenestrated by DSA (Fig. 2C). Owing to resistance, we could not advance Salva 71 beyond where the fenestration was suspected. The recovery was conducted with the A stent-retrieving into an aspiration catheter with proximal balloon (ASAP) technique, which is one of the combined techniques [7]. The microcatheter was smoothly guided to the M2 segment through the occluded superior limb on the outside of the curve. Solitaire 4 mm/40 mm (Medtronic) was deployed from the occluded M2 segment of the MCA to the superior limb of the fenestration site. The SR was removed from Salva 71 located just before the fenestration under continuous aspiration. The aspiration catheter was subsequently removed, and proximal balloon protection and continuous aspiration were performed to ensure aspiration of the residual thrombus. The ASAP technique was repeated twice. At this stage, only partial recanalization was achieved (mTICI grade 2b; Figs. 2E–G). Therefore, the SR was changed to Solitaire 6 mm/40 mm (Medtronic), and the ASAP technique was repeated using the

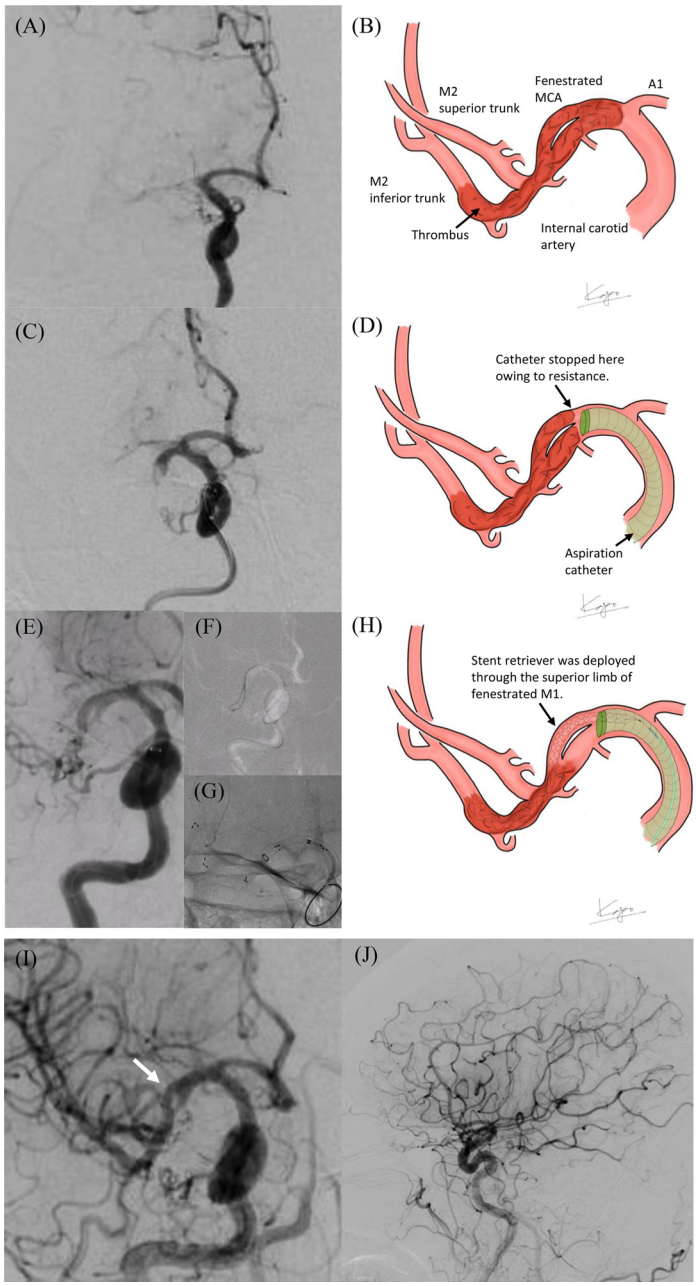

Fig. 2 – Angiographic findings of mechanical thrombectomy and its explanation with practical illustrations. (A and B) Anteroposterior (AP) view of internal carotid angiogram (ICAG) showing occlusion of right middle cerebral artery (MCA) M1 proximal segment. The illustration showed the positional relationship between the occlusion of the fenestrated M1 segment and the thrombus. (C and D) After performing the direct aspiration first-pass technique (ADAPT) with Salva 71 for right M1 occlusion, ICAG revealed partial revisualization (modified thrombolysis in cerebral infarction (mTICI) grade 1). The aspiration catheter did not advance beyond where fenestrated MCA was suspected, owing to resistance. (E–H) J-shaped microguidewire and microcatheter passed through the superior limb of the fenestrated M1 segment. A stent retriever was deployed from the MCA M2 segment to the superior limb of the fenestrated M1 segment. After performing a combined technique with Solitaire 4 mm/40 mm and Salva 71, ICAG showed partial revascularization (mTICI grade 2b). The large-bore aspiration catheter could not pass through the narrow limb of the fenestration, and a stent retriever was used to retrieve the thrombus beyond the fenestration. (I and J) After performing a combined technique with Solitaire 6 mm/40 mm and Salva 71, AP and lateral views of ICAG showed fenestrated MCA (white arrow) and complete revascularization (mTICI grade 3). *These artworks are original and created for the purpose of this publication and have not been published before nor will be published in the future.*

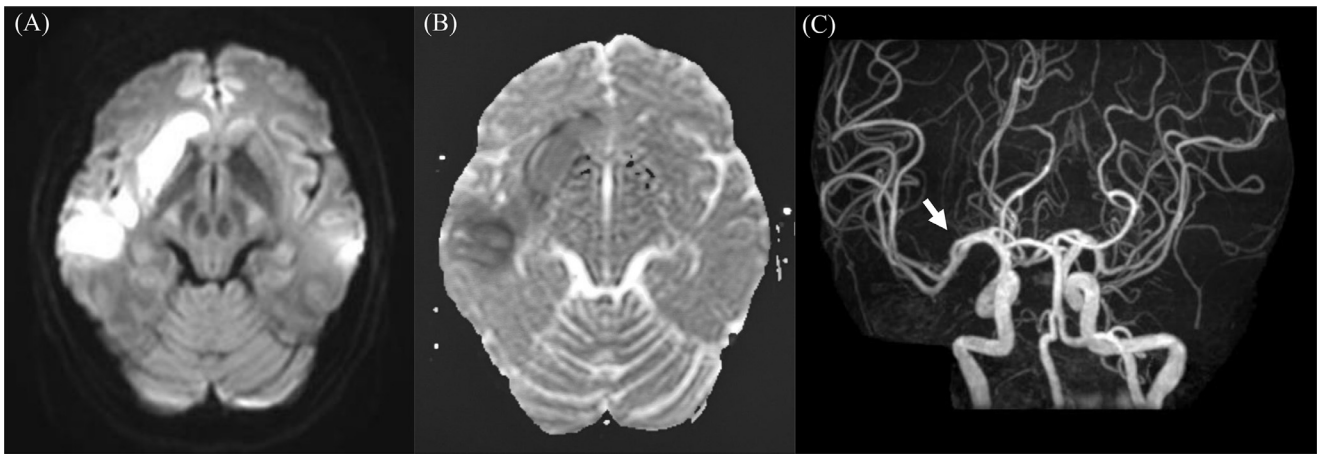

Fig. 3 – (A) Postoperative diffusion-weighted magnetic resonance imaging showed high-intensity areas in the right basal ganglia and anterior temporal lobe. (B) Apparent diffusion coefficient map revealed low-intensity areas in the right basal ganglia and anterior temporal lobe. (C) Right M1 fenestration was detected by magnetic resonance angiography (white arrow).

Table 1 – Summary of cases of mechanical thrombectomy for occlusion of the fenestrated middle cerebral artery M1 segment.

	Age/Sex	Af	EVT	TICI	Complication	Medication
1. Nishimuta Y, et al.	65/M	Yes	Solitaire 4 mm/20 mm + 5 MAX ACE (combined T, 1 pass)	2b	None	DOAC
2. Liao G, et al.	65/M	No	Navien + Solitaire 4 mm/20 mm (combined T, 1 pass)	3	None	APT
3. Miyoshi H, et al.	71/M	No	ACE 68 (ADAPT, 1 pass)	3	None	APT
4. Hosokawa M, et al.	73/M	No	Solitaire 4 mm/40 mm (SR, 1 pass)	3	None	NA
5. Present case	49/F	No	Salva 71 (ADAPT, 2 pass) →Solitaire 4 mm/40 mm + Salva 71 (combined T, 2 pass) →Solitaire 6 mm/40 mm + Salva 71 (combined T, 1 pass)	3	None	APT

ADAPT, a direct aspiration first pass technique; Af, atrial fibrillation; APT, antiplatelet therapy; combined T, combined technique; DOAC, direct oral anti coagulants; EVT, endovascular treatment; NA, not applicable; SR, stent retriever; TICI, thrombolysis in cerebral infarction.

same maneuver. ICAG showed fenestration in the right MCA M1 segment by anteroposterior view and complete recanalization by lateral view (mTICI grade 3; Figs. 2I J). The puncture to recanalization time was 77 min. The next day, the NIHSS score improved to 1. Diffusion weighted imaging of postoperative magnetic resonance imaging revealed high-intensity area in the right basal ganglia and anterior temporal lobe (Fig. 3A). Apparent diffusion coefficient value was also reduced in the same lesion (Fig. 3B). Fenestration of the M1 segment was clearly revealed by magnetic resonance angiography (Fig. 3C).

The etiology of the stroke could not be elucidated by comprehensive analysis, including hematological examination, transthoracic and transesophageal echocardiography, carotid and deep venous ultrasonography, Holter electrocardiography, and event monitoring for 10 days. Embolic stroke of an undetermined source was diagnosed, and antiplatelet therapy was initiated [8]. The patient underwent subsequent medical treatment and rehabilitation. The patient fully recovered (modified Rankin score of 0 at discharge) and was discharged on the 28th day.

Discussion

In this report, we present a case of occluded MCA fenestration, which was recanalized by MT using a combined technique, converted from simple ADAPT. Anatomical incident rate of fenestrated MCA is 0.17%, and it has been reported that the lenticulostriate artery (LSA) often branches from the superior limb, and the temporopolar artery branches from the inferior limb [1]. In particular, the occluded superior limb can impair the perfused regions of the LSA, such as the caudate nucleus, putamen, pallidum, and internal capsule, leading to aggravation of neurological symptoms [1]. Furthermore, recognizing the presence of fenestrations is challenging before perform-

ing MT, as shown in Figure 2A. The fenestrated vessels were reported to be slit-shaped by DSA [3]. In our case, after 2 passes of ADAPT, as shown in Fig. 2C, the part of the fenestration was revealed to be slit-shaped in the anteroposterior view of DSA.

We summarized previous case reports of MT concerning the fenestrated MCA in Table 1 [2–5]. Previous reports reported that the combined technique, SR alone and aspiration catheter alone were useful for occlusion of the fenestrated MCA. No complications were observed in any of the patients.

ADAPT is the first-line procedure for MT at our institution. In our case, a large-bore aspiration catheter was used for the first and second passes. The aspiration catheter could not be passed through the narrow limb of the fenestrated vessel and stopped owing to resistance, as illustrated in Fig. 2D. Miyoshi et al. reported a successful case of MT using ADAPT alone. However, the thrombus on the distal side of the fenestration could not be completely retrieved in our case. Complete recanalization was achieved by deploying the SR through the occluded limb and retrieving the thrombus distal to the fenestration site, as illustrated in Fig. 2H. When fenestration is suspected and recanalization cannot be achieved by simple ADAPT, as in this case, it is necessary to consider converting the strategy from a standard technique to a combined technique, such as the ASAP technique. Alternatively, the use of a smaller aspiration catheter may also be effective.

In the present case and previous reports, Solitaire was used as the SR with diameters of 4 and 6 mm. Although 6-mm-diameter Solitaire stent was used in the narrow fenestrated vessel, no hemorrhagic complications were observed in our case. It was considered that Solitaire was a sheet-like overlapping stent and appropriately adjusted even in the narrow fenestrated M1 segment.

Conclusion

In our case, sufficient recanalization could not be achieved by simple ADAPT, because of the fenestrated MCA. If fenestrated MCA is suspected during performing MT, it is necessary to consider converting the strategy from simple ADAPT to a combined technique using the occluded limb of the fenestration.

Patient consent

Written informed consent was obtained before endovascular surgery. Informed consent was also obtained for this research.

Ethical approval

This research was performed in accordance with the rules of the ethics committee of Fujita Health University and the principles of the Declaration of Helsinki.

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