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Case Report

Iatrogenic intracranial vessel dissection during mechanical thrombectomy rescued by emergent stenting: 2 case reports☆,☆☆

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ABSTRACT

Intracranial vessel dissection is a procedural complication associated with endovascular treatment. However, there have been few reports on its potential causes and management during mechanical thrombectomy. In approximately 250 cases of mechanical thrombectomy over the past 5 years at our institution, iatrogenic intracranial dissection occurred in 2 patients (0.8%). In this report, we described these 2 cases that were rescued through emergent stenting. Mechanical thrombectomy, using both a stent retriever and an aspiration catheter, was performed for acute middle cerebral artery M2 occlusion in Patient 1 (a 69-year-old man) and for distal M1 occlusion in Patient 2 (an 83-year-old woman). In both cases, recanalization was achieved with the procedure, but irregular stenosis developed at the initially nonoccluded, but mildly arteriosclerotic, M1, after recanalization. During the thrombectomy procedure, the aspiration catheter sifted up to the arteriosclerotic M1. In both cases, the lesions were considered vessel dissection, due to a shift of the aspiration catheter tip into the arteriosclerotic vessel wall. Repeated percu-

Abbreviations: BGC, balloon-guide catheter; CT, computed tomography; DES, drug-eluting stent; DWI, diffusion-weighted imaging; ICA, internal carotid artery; MCA, middle cerebral artery; MRA, magnetic resonance angiography; MT, mechanical thrombectomy; NIHSS, National Institutes of Health Stroke Scale; PCI, percutaneous coronary intervention; PTA, percutaneous transluminal angioplasty; SR, stent retriever; TICI, thrombolysis in cerebral infarction.

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taneous angiography with antithrombotic therapy failed to improve the lesions and to maintain the antegrade blood flow. Finally, lesions in each patient were successfully rescued through the use of emergent stenting. A drug-eluting stent for coronary use was deployed in Patient 1, and an Enterprise stent was applied in Patient 2. Inadvertent shift of the aspiration catheter into arteriosclerotic vessels can cause a serious intracranial vessel dissection. When performing mechanical thrombectomy, intracranial stents need to be available as rescue treatment devices to manage refractory iatrogenic intracranial vessel dissection.

Introduction

Mechanical thrombectomy using a stent retriever (SR) has proven to be effective for patients with acute ischemic stroke secondary to large vessel occlusions [1]. In addition to the use of a single SR, various devices and techniques for mechanical thrombectomy have emerged and are now widely used to achieve good procedural results [2-6]. Furthermore, mechanical thrombectomy is now being used to target more peripheral arteries [7-9]. However, mechanical thrombectomy can sometimes be associated with several procedural complications, including vessel injury, distal embolism, puncture site problems, and postprocedural intracranial hemorrhage [10-14].

Vessel injury is the most directly related procedural complication, usually caused by clinician error while using endovascular devices and techniques. Vessel perforation is common and requires urgent management because it can lead to critical conditions [15,16]. Vessel perforation is usually noticed as an obvious protrusion of a device from the vascular structure, or is visualized as a contrast leak at the distal site of the manipulation. Improper mechanical thrombectomy procedures can also cause vessel dissection, another type of vessel injury [17-19]. Unlike vessel perforation, vessel dissection is not always apparent on subsequent angiography and can occur at any procedural site without the obvious protrusion of a device from a vascular structure. To prevent and manage vessel dissection during mechanical thrombectomy, clinicians need to be aware of procedures causing this complication and ways to avoid them as well as rescue them.

Two patients (0.8%), out of approximately 250 cases of mechanical thrombectomy over the past 5 years at our institution, were definitively diagnosed with iatrogenic intracranial dissection caused by the thrombectomy procedure [20-23]. In this report, we provide the details of these 2 cases of refractory iatrogenic intracranial artery dissection that occurred during mechanical thrombectomy performed with the combined use of an SR and an aspiration catheter. Both occurred on a mildly arteriosclerotic vessel proximal to the occlusion, and each was rescued through emergent stenting.

Case descriptions

Case 1

A 69-year-old man with a history of hypertension and diabetes mellitus was hospitalized at our institute for myocardial infarction. He suddenly developed aphasia with a National Institutes of Health Stroke Scale score of 8. He had previously undergone percutaneous coronary intervention with drug-eluting stents (DES) and was taking 100 mg of aspirin and 3.75 mg of prasugrel daily. Magnetic resonance angiography (MRA) and diffusion-weighted imaging (DWI) showed occlusion of the M2 segment of the left middle cerebral artery (MCA) with only slight ischemic change (Fig. 1 A, B). There was mild atherosclerotic stenosis at the mid-M1 segment of the MCA proximal to the occlusion (Fig. 1A). After initiating intravenous thrombolysis with alteplase, endovascular treatment was performed. Written informed consent was obtained from a member of the patient's family before the procedure.

The endovascular procedure was performed via femoral access under local anesthesia. Heparin was not administered initially because of the ongoing administration of alteplase. A 9-French balloon-guide catheter (BGC) was placed in the left cervical internal carotid artery (ICA). Initial angiography revealed persistent occlusion of the inferior M2 segment of the left MCA with mild atherosclerotic stenosis at the mid-M1 proximal to the occlusion (Fig. 2A, B). The occlusion was crossed with a Marksman microcatheter (Medtronic, Minneapolis, MN), and a microguidewire using a Penumbra 5MAX ACE 68 catheter (Penumbra Inc., Alameda, CA) as an intermediate support catheter.

We attempted to place the Penumbra at the proximal M1 but could not advance beyond the ophthalmic artery origin because of the ledge effect at that time. A Trevo XP 3 mm × 20 mm SR (Stryker Neurovascular, Kalamazoo, MI) was placed across the occluded lesion (Fig. 2C, D). When the microcatheter was removed to increase suction force from the Penumbra, the Penumbra unintentionally shifted up to the mid-M1 which was initially nonoccluded but mildly arteriosclerotic (Fig. 2E). The placed SR was pulled back through the Penumbra under continuous aspiration, and a small clot was retrieved (Fig. 2F).

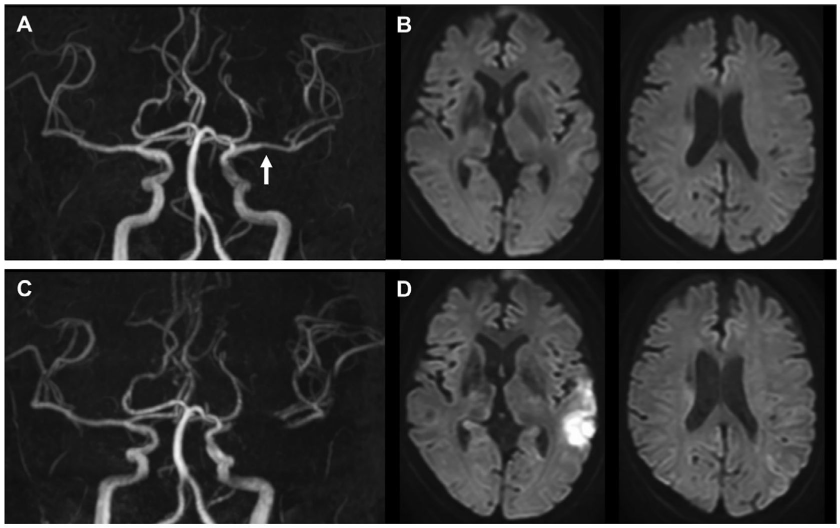

Fig. 1 – Case 1. (A, B) Magnetic resonance angiography and diffusion-weighted imaging performed upon patient admission, showing occlusion of the M2 segment of the left middle cerebral artery with only slight ischemic change. Note the mild atherosclerotic stenosis at the mid-M1 proximal to the occlusion (arrow). (C, D) Magnetic resonance angiography and diffusion-weighted imaging performed the day after the procedure, showing successful recanalization with localized ischemic change.

The Penumbra was pulled back to the C1 portion of the ICA from mid-M1, as it was wedged at the mid M1, and angiography showed the occlusion at M2 had been recanalized (Fig. 2G). The time from femoral puncture to recanalization was 35 minutes, and the time from stroke onset to recanalization was 205 minutes. However, irregular stenosis was noticed in the mid-M1, and it gradually progressed with decreasing peripheral blood flow (Fig. 2H). Based on the appearance of the irregular stenosis and the unintentional shift of the Penumbra, this lesion was considered a vessel dissection induced by the tip of the Penumbra at an initially atherosclerotic vessel. Intravenous alteplase infusion was not yet finished, but systemic heparinization was started.

Percutaneous transluminal angioplasty (PTA) was performed using a Gateway 2 mm × 9 mm balloon catheter (Stryker Neurovascular) several times over for an hour, and the stenotic lesion was dilated and then restenosed repeatedly (Fig. 2I, J, K). Because an intracranial stent was not readily available at the time of surgery, we employed a DES for coronary use that was regularly available for percutaneous coronary intervention at our institution. A Xience Sierra DES 2.25 mm × 15 mm (Abbott Vascular, Santa Clara, CA) was placed at the lesion, and the stenosis was successfully recovered with sufficient stent-wall apposition which was viewed with cone-beam computed tomography (Fig. 2L, M, N). Final angiography confirmed a score of 3 on thrombolysis in cerebral infarction recanalization (Fig. 2O).

MRA and DWI on the day after the procedure showed successful recanalization with localized ischemic change (Fig. 1C, D). Anticoagulant therapy for the prevention of cardiogenic embolism was started and continued in addition to dual antiplatelets. At the 3-month follow-up, the patient was almost independent with only mild sensory aphasia.

Case 2

An 83-year-old woman was admitted to our institute with left hemiparesis, a National Institutes of Health Stroke Scale score of 4, and an unknown time of symptom onset. She had a history of atrial fibrillation but was not taking anticoagulants. MRA and DWI showed occlusion of the M1 segment of the right MCA with subtle ischemic change (Fig. 3A, B). There was a mild atherosclerotic stenosis at the mid-M1 proximal to the occlusion (Fig. 3A). Intravenous thrombolysis was not initiated because of the time course. Written informed consent was obtained from a member of the patient's family before the procedure.

The endovascular procedure was performed via femoral access under local anesthesia after systemic heparinization. A 9-French BGC was placed in the right cervical ICA. Initial angiography revealed occlusion of the M1 of the right MCA (Fig. 4A). One pass of the simple SR technique using a Trevo XP 4 mm × 20 mm (Stryker Neurovascular) failed to recanalize the occlusion (Fig. 4B, C). Subsequently, a Penumbra 5MAX ACE 60 catheter (Penumbra Inc.), a Trevo Pro18 microcatheter (Stryker Neurovascular), and a microguidewire were advanced as a unit, with the microcatheter traversing the occlusion. A Penumbra ACE 60 was used instead of an ACE 68 because previous angiography revealed mild stenosis at the mid-M1 (Fig. 4C). However, during this manipulation, the Penumbra shifted up to the occluded site through the mildly arteriosclerotic mid-M1 (Fig. 4D). A Trevo XP 4 mm × 20 mm (Stryker Neurovascular) was placed beyond the Penumbra without reposition of the Penumbra (Fig. 4E). The SR and the Penumbra were pulled back together through the BGC under continuous aspiration, and a hard clot was retrieved (Fig. 4F). Subsequent angiography demonstrated recanalization of the occlusion (Fig. 4G).

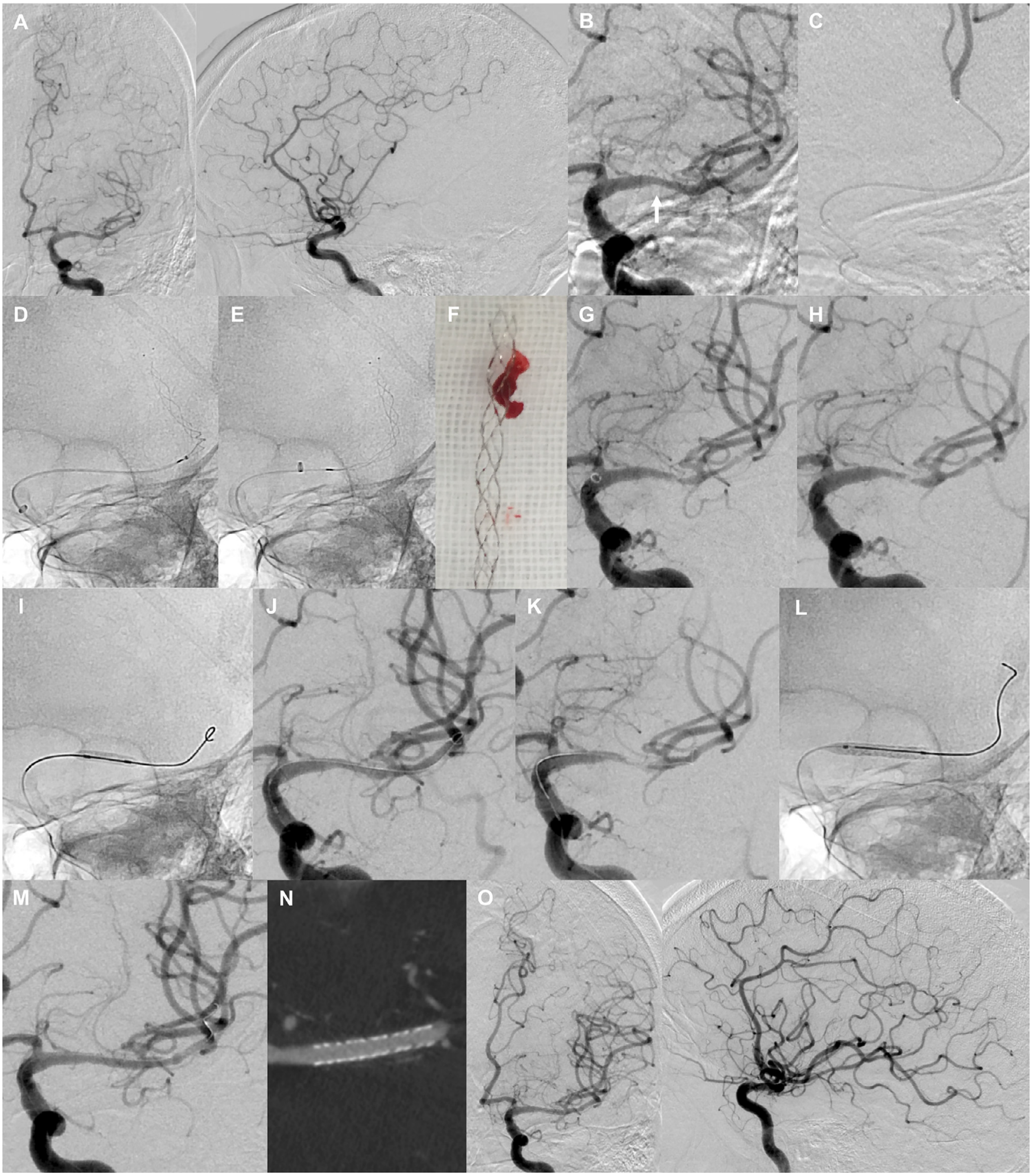

Fig. 2 – Case 1. (A, B) Initial angiography showing occlusion of the inferior M2 of the left middle cerebral artery. Note the mild atherosclerotic stenosis of the mid-M1 proximal to the occlusion (arrow). (C, D) A microcatheter navigated into the distal portion of the thrombus, and a Trevo XP 3 mm × 20 mm stent retriever placed across the occluded lesion. We attempted to place the Penumbra catheter at the proximal M1 as an intermediate support catheter, but could not advance beyond the origin of the ophthalmic artery at that time. (E) Upon removal of the microcatheter, the Penumbra sifted up to the mid-M1, which was initially nonoccluded but mildly arteriosclerotic. (F) The stent retriever pulled back, and a small clot was retrieved. (G) Upon pulling back the Penumbra proximally, after being wedged at the mid-M1, angiography demonstrated recanalization. (H) Irregular stenosis noticed at mid-M1 which gradually progressed with decreasing peripheral blood flow. (I, J, K) Despite performing percutaneous transluminal angioplasty, the lesion is dilated and then restenosed repeatedly. (L, M, N) A drug-eluting stent placed at the lesion, and cone-beam computed tomography showing the lesion successfully recovered with sufficient stent-wall apposition. (O) Final angiography confirming complete recanalization.

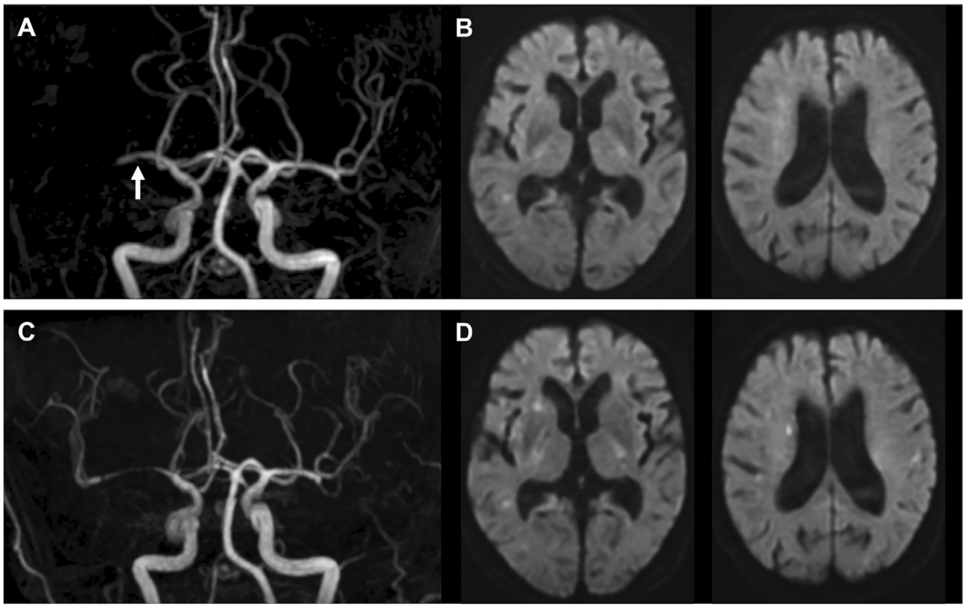

Fig. 3 – Case 2. (A, B) Magnetic resonance angiography and diffusion-weighted imaging performed upon patient admission showing occlusion of the M1 segment of the left middle cerebral artery with subtle ischemic change. Note the mild atherosclerotic stenosis at the mid-M1 proximal to the occlusion (arrow). (C, D) Magnetic resonance angiography and diffusion-weighted imaging performed the day after the procedure showing successful recanalization with small ischemic change.

The time from femoral puncture to recanalization was 38 minutes. However, irregular stenosis developed at the mid-M1 which gradually progressed, eliminating peripheral blood flow (Fig. 4H). Based on the irregular stenosis and the preceding maneuver, this lesion was considered a vessel dissection induced by the tip of the Penumbra catheter at an initially atherosclerotic vessel. Over the course of an hour, PTA was conducted several times, using a Gateway 2.5 mm × 9 mm (Stryker Neurovascular). Dosing with dual antiplatelet drugs (300 mg of aspirin and 300 mg of clopidogrel) also failed to improve the lesion or maintain the blood flow (Fig. 4I, J, K). Therefore, an Enterprise stent 4 mm × 23 mm (Cordis, Miami Lakes, FL) was placed at the lesion, and the stenosis was successfully recovered with sufficient stent-wall apposition (Fig. 4L, M, N). Final angiography confirmed a score of 2b on thrombolysis in cerebral infarction recanalization (Fig. 4O).

MRA and DWI on the day after the procedure showed successful recanalization with small ischemic change (Fig. 3C, D). Oral anticoagulant therapy was started and continued in addition to dual antiplatelets. At the 3-month follow-up, the patient was independent with no neurological symptoms.

Discussion

We report 2 cases of iatrogenic intracranial artery dissection during mechanical thrombectomy that were rescued through emergent stenting. In each case, an inadvertent shift of the aspiration catheter into mildly arteriosclerotic vessels during the procedure was the suggested cause of vessel dissection. When performing mechanical thrombectomy, it is necessary to manipulate the aspiration catheter to avoid such movement near arteriosclerotic vessels. Stenting may be necessary in cases of dissection where blood flow to the periphery is not maintained.

Iatrogenic intracranial vessel dissection is not seen frequently, but it is one of the procedural complications associated with endovascular procedures for intracranial lesions. During mechanical thrombectomy, intracranial vessel dissection can also occur and might be more likely because mechanical thrombectomy is the procedure used for occluded vessels with emergent setting. It has been reported that iatrogenic vessel dissection occurs in 0.6%-3.9% of mechanical thrombectomy cases [11-13]. Among these cases, extracranial dissection was more common, whereas intracranial vessel dissection was precisely described in only a small number [11,17]. Among approximately 250 cases of mechanical thrombectomy at our institute over the past 5 years, only these 2 patients were definitively diagnosed with iatrogenic intracranial dissection (0.8%) [20-23]. However, there is a current concern that instances of intracranial dissection may increase because more peripheral lesions are being treated with a variety of interventions other than the simple SR technique. Therefore, it is necessary to describe the procedural causes of iatrogenic intracranial vessel dissection, their implications, and strategies for managing them during mechanical thrombectomy.

Our findings from these 2 cases suggest that an inadvertent shift of the aspiration catheter into the arteriosclerotic vessels caused intracranial vessel dissection during mechanical thrombectomy. In both cases, dissection occurred at the initially nonoccluded but mildly arteriosclerotic M1, where a

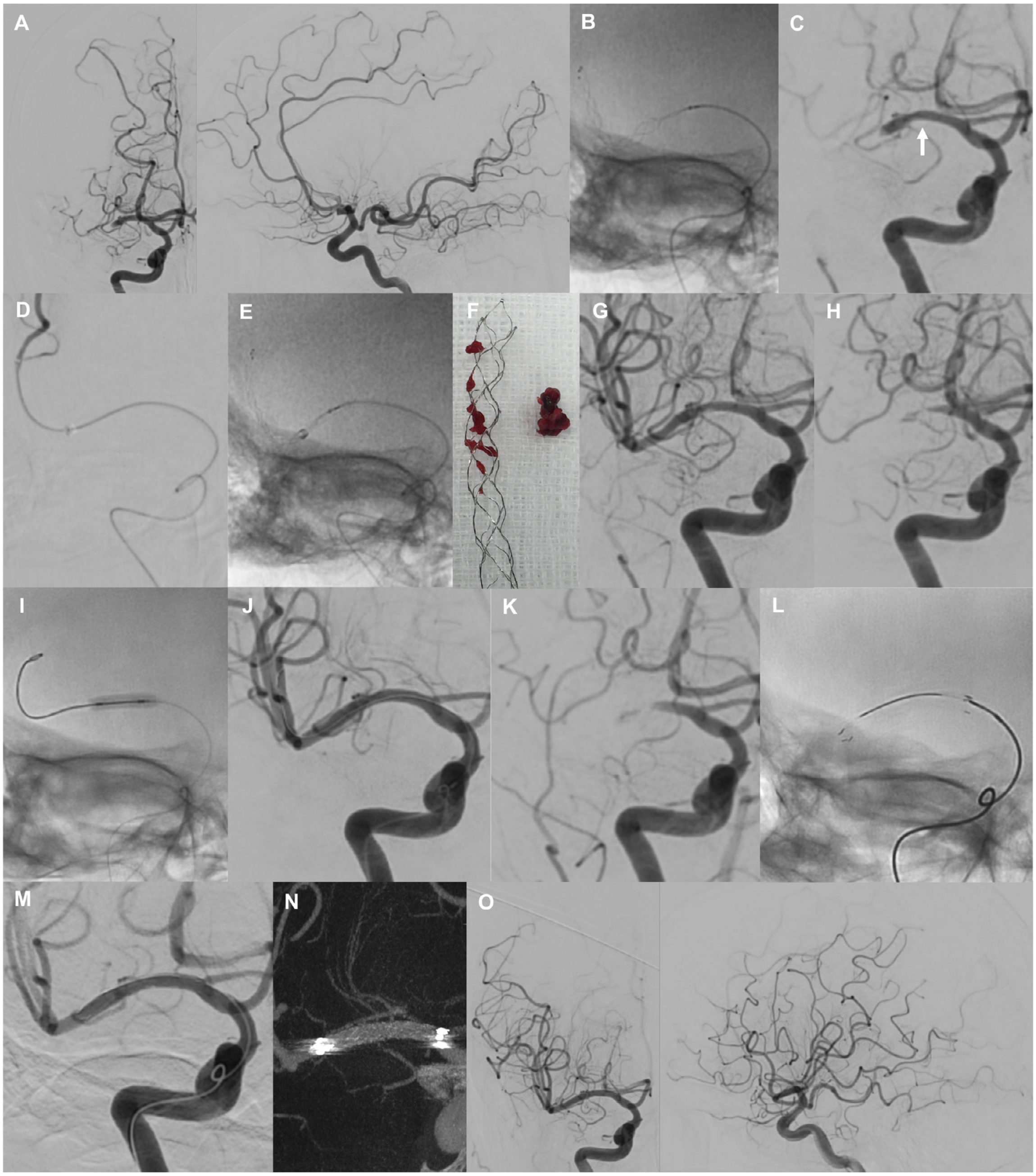

Fig. 4 – Case 2. (A) Initial angiography showing occlusion of the M1 of the right middle cerebral artery. (B, C) One pass of a simple stent retriever technique using a Trevo XP 4 mm x 20 mm failed to recanalize the occlusion. Note the mild atherosclerotic stenosis of the mid-M1 proximal to the occlusion (arrow). (D) During the second pass with a combined technique using a Penumbra 5MAX ACE 60 catheter, the Penumbra shifted to the occluded site through the mid-M1, which was initially non-occluded but mildly arteriosclerotic. (E) A Trevo XP 4 mm x 20 mm stent retriever placed beyond the Penumbra without repositioning the Penumbra. (F) The placed stent retriever and the Penumbra pulled together, and a hard clot was retrieved. (G) Angiography demonstrating recanalization. (H) Irregular stenosis noticed at mid-M1 which gradually progressed with decreasing peripheral blood flow. (I, J, K) Despite performing percutaneous transluminal angioplasty, the lesion is dilated and then restenosed repeatedly. (L, M, N) An Enterprise stent placed at the lesion, and the lesion successfully recovered with sufficient stent-wall apposition, as viewed on cone-beam computed tomography. (O) Final angiography confirming successful recanalization.

large-bore aspiration catheter shifted up into the distal vessel through the atherosclerotic lesion. Among the few previous reports of intracranial vessel dissection during mechanical thrombectomy, the aspiration catheter was reported as the estimated cause of dissection [17]. Various large-bore aspiration catheters for mechanical thrombectomy have been developed and are now widely used with contact aspiration or an SR and aspiration catheter combined. It has been reported that in older patients, it is prudent to use an appropriate inner catheter with the large-bore aspiration catheters in order to minimize the lip as it crosses the origin of the ophthalmic artery, while taking into account the amount of force applied to the aspiration catheter to reach the M1 segment [24]. Inadvertent shift of the aspiration catheter into arteriosclerotic vessels, even if the arteriosclerotic change is mild, should be avoided during mechanical thrombectomy. Although other mechanical thrombectomy procedures, including the simple SR technique, might cause vessel dissection, clinicians should manipulate the aspiration catheter to prevent shifting to distal vessels with arteriosclerotic changes, as shown in our 2 cases. Especially for relatively peripheral vessels, it is necessary to plan exactly what caliber of aspiration catheter to use and where to use it.

Currently there is no published evidence regarding the management of iatrogenic vessel dissection, especially in intracranial arteries. Generally, PTA or stenting may be considered if blood flow is strongly impaired [12]. In our 2 cases, repeated PTA with antithrombotic therapy failed to improve the lesion and to maintain the blood flow distally. The dissected lesions were rescued through emergent stenting, and the postoperative course in each case was uneventful. A DES for coronary use was employed in the Case 1 case because an intracranial stent was not available for emergency use at the time. However, the Enterprise stent, which had become available for emergency use at our institution, was applied in the Case 2. DES is not generally indicated for intracranial use, but there are some reports of its off-label use for intracranial arteries [25,26]. One of the problems with DES implantation is in-stent thrombosis, which usually requires long-term antiplatelet therapy to prevent [27]. The efficacy and safety of intracranial implantation of DES should be discussed after long-term follow-up. When performing mechanical thrombectomy, intracranial stents should be made available as a rescue treatment device, in order to manage refractory iatrogenic intracranial vessel dissection.

Conclusions

In this report, we describe 2 cases of iatrogenic intracranial artery dissection during mechanical thrombectomy that were rescued through emergent stenting. Our 2 cases suggest that an inadvertent shift of the aspiration catheter into arteriosclerotic vessels, even if the arteriosclerotic change is mild, is a probable cause of iatrogenic intracranial vessel dissection. When performing mechanical thrombectomy using an aspiration catheter, it is necessary to plan the exact placement and caliber of the aspiration catheter to prevent this complication. Stenting may be necessary in cases of dissection where blood flow to the periphery is not maintained, despite PTA with antithrombotic therapy.

Informed consent

Informed consent was obtained from each patient for inclusion of their information in publication of the case report and accompanying images.

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