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Case Report

Multiple large vessel occlusions resulting in vessel perforation in single pass of mechanical thrombectomy with stent retriever☆,☆☆

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ABSTRACT

Mechanical thrombectomy (MT) is a highly effective treatment for acute ischemic stroke, and hemorrhagic complications caused by vessel injury are rare. However, there is no evidence regarding the efficacy of MT for multiple large vessel occlusion or its procedural strategy. Herein, we report a case of MT with a stent retriever for multiple large vessel occlusion in the internal carotid artery and middle cerebral artery M1 distal, which resulted in vessel perforation in a single pass. A 79-year-old woman underwent MT for internal carotid artery occlusion, and multiple large vessel occlusion was observed on digital subtraction angiography. A longer and larger stent retriever was selected for thrombus retrieval in a single pass. Immediately after retrieval, digital subtraction angiography revealed internal carotid artery recanalization. Then, extravasation was observed from the M1 distal occlusion. Treatment was interrupted after hemostasis was confirmed. Nevertheless, rebleeding occurred after 4 hours. Emergency trapping was performed, and vessel perforation of >1 mm was observed. When retrieving a thrombus in a single pass with a stent retriever for multiple large vessel occlusion, vessel perforation may occur if the device is selected according to the diameter of the proximal occluded vessel. Based on the type of device, even a single pass may result in vessel perforation. Although aggressive MT intervention should be performed for multiple large vessel occlusion, a device that is appropriate for the pathological condition must be selected.

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Introduction

Mechanical thrombectomy (MT) is increasingly used in the treatment of acute ischemic stroke, with good rates of revascularization and clinical outcomes [1]. Large vessel occlusions (LVOs) account for approximately 30% of acute ischemic stroke cases [2] and multiple large vessel occlusions (MLVOs) for approximately 10.7% of LVO cases [3]. However, MLVO has been excluded from recent large-cohort studies. Thus, there is no evidence on the efficacy of MT or its procedural strategy in MLVO [4]. We experienced a case of vessel perforation caused by retrieving a thrombus in a single pass with a stent retriever (SR) for MLVO without considering the difference in vessel diameter. The current case indicates that a device with a diameter larger than the target vessel diameter should be cautiously selected.

Case report

Patient information

A 79-year-old woman with a history of hypertension and atrial fibrillation presented with acute-onset severe left hemiparesis. The patient was not taking any antithrombotic medications. Upon admission, she presented with decreased level of consciousness based on the Glasgow Coma Scale (E3V4M5) and left hemiparesis including the left face, with a baseline National Institutes of Health Stroke Scale score of 15. Brain magnetic resonance imaging with diffusion-weighted imaging showed acute cerebral ischemic change in the right middle cerebral artery territory (Fig. 1A). Magnetic resonance angiography revealed right internal carotid artery (ICA) occlusion (Fig. 1B). Then, the patient underwent MT.

Endovascular procedure

MT was performed under local anesthesia. A 9-Fr balloon guide catheter (BGC) (Optimo; Tokai Medical Products, Aichi, Japan) was placed in the right ICA using the transfemoral artery approach. In total, 4000 units of heparin was administered intravenously.

Right ICA angiography (ICAG) confirmed ICA terminal occlusion (Fig. 2A and B). SR monotherapy was used for clot retrieval under roadmap guidance. Further, the Marksman microcatheter (Penumbra, Alameda, CA) was advanced to the M2 segment of the middle cerebral artery. Microangiography revealed thrombus translucency in the M1 distal, which differed from that of the ICA occlusive lesion (Fig. 2C and D). The lesions were believed to be MLVO.

A longer and larger stent (6.0 × 40 mm, Solitaire, Medtronic, Irvine, CA) was selected and used to simultaneously retrieve both lesions. The proximal marker of the device was aligned with the ICA thrombus, and the distal marker was overlapped at the M2 origin to deploy the SR from the M2 segment into the supraclinoid portion of the ICA. ICAG immediately after deployment confirmed ICA restoration (Fig. 2E and F). After 120 seconds, the SR was slowly retrieved at a constant rate under BGC inflation and manual suction. The red embolic material was trapped near the proximal marker of the SR. After the ICA was released, the blood flow was restored on ICAG. However, the M1 distal was not restored. Due to new findings of extravasation from the M1 distal occlusion (Fig. 2G and H), the BGC was inflated again, and the patient's blood pressure was controlled below 100 mm Hg after heparin reversal with 5 mg protamine. The extravasation had disappeared after ICAG was performed again. After 5 minutes, hemostasis was maintained on ICAG, and the treatment was interrupted. Final angiography confirmed the absence of flow (Thrombolysis in Cerebral Ischemia: grade 0).

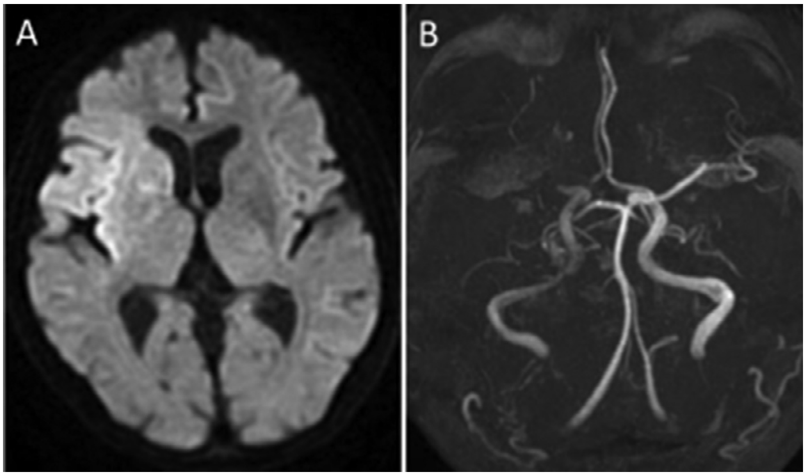

Fig. 1 – Initial magnetic resonance imaging. Diffusion-weighted imaging showing acute cerebral ischemic change in the right middle cerebral artery territory (A). Magnetic resonance angiography showing right internal carotid artery occlusion (B).

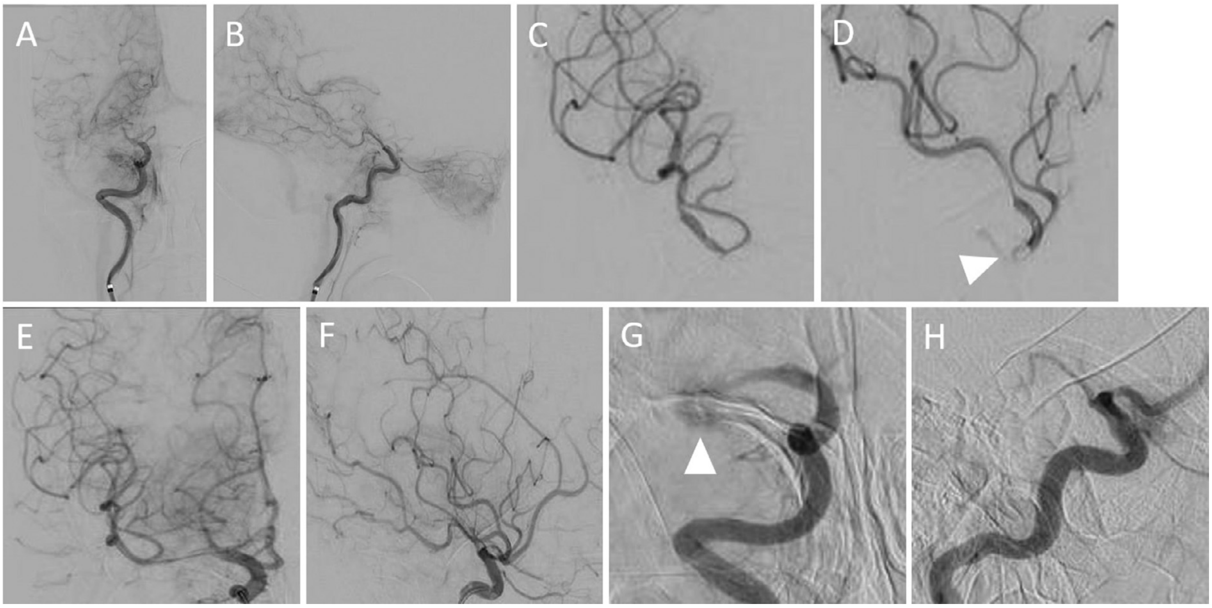

Fig. 2 – Digital subtraction angiography imaging. Right internal carotid artery (ICA) angiography (ICAG) showing ICA terminal occlusion (A: anterior, B: lateral). Microangiography showing thrombus translucency (arrowhead) in the M1 distal occlusion, which differs from that of the ICA occlusive lesion (C: anterior, D: lateral). ICAG immediately after deployment showing restoration of blood flow in the ICA (E, F). New findings of extravasation (arrowhead) from the M1 distal occlusion (G: anterior, H: lateral).

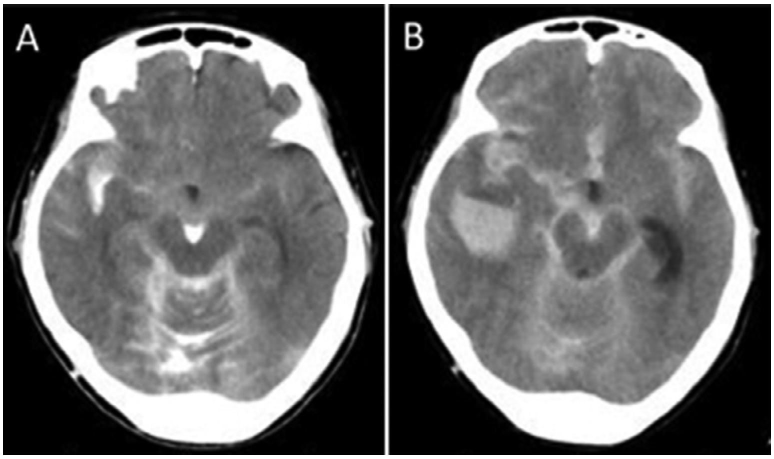

Fig. 3 – Computed tomography (CT) scan after mechanical thrombectomy. CT scan showing subarachnoid hemorrhage (SAH) (A). Follow-up CT scan after 4 hours showing an expanded SAH (B).

Clinical course

Postoperative computed tomography (CT) scan showed subarachnoid hemorrhage (Fig. 3A). However, the patient continuously received antihypertensive therapy and osmotherapy. After 4 hours, follow-up CT scan revealed an expanded subarachnoid hemorrhage (Fig. 3B). Hence, emergency craniotomy was performed as anisocoria was also noted simultaneously.

Craniotomy procedure

Right frontotemporal craniotomy was performed. The right M1 segment was identified using the subfrontal approach, and the Sylvian fissure was opened. A linear perforation with a diameter of 1 mm was observed in the M2 superior trunk immediately after the bifurcation, which was the site of SR deployment (Fig. 4A). The dissecting of vessel wall or pseudoaneurysm was not observed. To completely isolate the

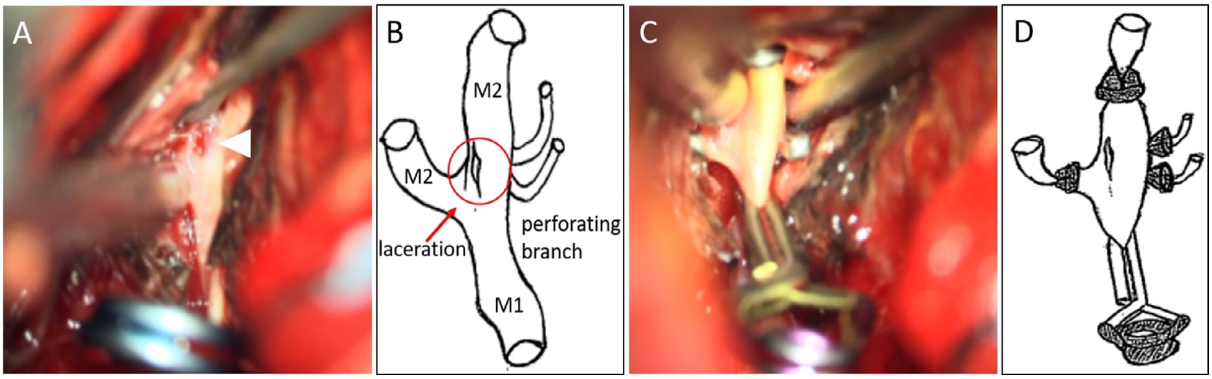

Fig. 4 – Intraoperative views with schema. A linear perforation measuring >1 mm (arrowhead) was observed on the M2 superior trunk immediately after the bifurcation (A, B). Trapping was performed at 5 points including the perforating branches (C, D).

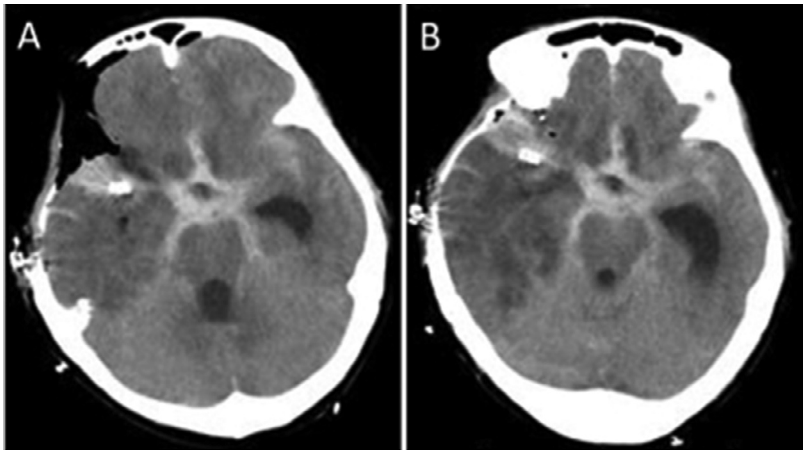

Fig. 5 – Computed tomography (CT) scan after craniotomy. CT scan showing good decompression after hematoma removal, and re-bleeding was not observed (A: immediately after, B: day 1).

perforation, trapping was performed at 5 points including the perforating branches (Fig. 4B).

Outcome

Postoperative CT scan revealed good decompression after hematoma removal, and there was no rebleeding (Fig. 5A and B). The patient continuously underwent rehabilitation and recovered (Glasgow Coma Scale score: E3V3M5). Then, she was transferred to a rehabilitation hospital, with a modified Rankin Scale score of 5.

Discussion

This case presented 2 points: First, when retrieving a thrombus in a single pass with an SR for MLVO, vessel perforation may occur if the device is selected according to the diameter of the proximal occluded vessel. The current case indicates a downstream multivessel occlusion in MLVO, which is relatively easy to manage with a good prognosis [3]. However, the distal occluded vessel is the important point. Notably, the procedure becomes more difficult if the occluded vessel is located more distally. By contrast, MLVO has a worse prognosis than single large vessel occlusion because of the collateral territory narrows. Moreover, if the distal occluded vessel is more proximal, the time to revascularization is more limited [2]. Recently, when the importance of the first-pass effect is discussed [5], the single-pass retrieval technique is commonly used in MLVO with relatively proximal lesions and a short distance between the 2 occluded vessels. However, this case reminded us that the use of a longer and larger SR without considering the difference in vessel diameter is not safe. The length, rather than the diameter, of the SR must be considered to safely achieve a high first-pass effect [6]. Large-cohort studies have not shown that stent diameter plays an essential role in vascular damage. However, there are experimental studies showing that the degree of endothelial injury increases with a larger SR diameter [7]. The general mechanism of endothelial injury is caused by increased friction due to the radial force of the stent [8]. In MT for distal lesions, the stent should be selected according to the diameter of the vessel from the viewpoint of vascular damage [9,10]. In the current case, the use of a 6-mm longer and larger SR matching the diameter of the proximal occluded vessel from the M2 to the ICA increased the radial force on the vessel wall at the M1/2 branch of the undersize. Further, the increased load could have caused vessel perforation.

Second, based on the type of device, even a single pass can cause vessel perforation. Peripheral vessels, vascular tortuosity, and number of passes are the main causes of hemorrhagic complications in MT with an SR [11–13]. As a potential mechanism associated with vessel damage, endothelial injury can occur with MT with a SR, and this has long been considered an issue [14]. In recent years, SR rather than contact aspiration is more likely to cause endothelial injury [15]. The rate of hemorrhagic complications increases at more than 3 passes of SR [16]. To the best of our knowledge, there have been no cases of vessel damage with intracranial hemorrhage in a single pass with an SR. Rather, not technical complications, with actual intraoperative craniotomy findings of vessel perforation, were observed. Intraoperative craniotomy revealed a linear perforation measuring >1 mm, which did not indicate technical vessel perforation caused by a micro-wire. There were no surrounding dissecting perforating branches, and perforating branch withdrawal injury was also not observed. No thinning of vessels or pseudoaneurysms, however, laceration in the normal vessel wall caused by the SR, was identified. Therefore, even a single pass can result in vessel perforation if the appropriate SR size for the vessel diameter is not selected.

This case shows that the use of SR with a diameter larger than the target vessel diameter can lead to vessel perforation even at a single pass due to the pathophysiology of MLVO. Previous studies have reported several hemorrhagic complications caused by vessel dissection and perforating branch withdrawal injury in MT with an SR [12,13]. However, there have been no reports of such complications in clinical cases with intraoperative craniotomy findings of vessel perforation. Recently, several types of SRs have been available, and their concepts of thrombus capture vary due to their different structures [17]. Hence, the load on the vessel wall based on radial force alone is challenging to evaluate. However, thrombus could have been safely captured by selecting a longer SR that matched the diameter of the distal occluded vessel rather than the proximal one.

Conclusion

When retrieving a thrombus in a single pass with an SR for MLVO, vessel perforation may occur if the device is selected according to the diameter of the proximal occluded vessel. Based on the type of device, even a single pass may cause vessel perforation. Although aggressive MT should be performed for MLVO, a device that is appropriate for the pathological condition must be selected.

Patient consent

The authors obtained a written consent for the submission and publication of this case report including images.

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