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Case Report

Thrombectomy for Upper Extremity Artery Occlusion with Major Cerebral Artery Occlusion Using Mechanical Thrombectomy Devices for Acute Ischemic Stroke

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Objective: We report two cases of thrombectomy for upper extremity artery occlusion with major cerebral artery occlusion using mechanical thrombectomy devices for acute ischemic stroke.

Case Presentations: Case 1 was a 79-year-old woman admitted for left internal carotid artery occlusion and left upper extremity artery occlusion. Case 2 was an 87-year-old woman admitted for left middle cerebral artery occlusion and bilateral upper extremity artery occlusion. After performing mechanical thrombectomy for the cerebral artery, we achieved good recanalization of the brachial artery using the same devices in Case 1 and Case 2.

Conclusions: Thrombectomy using acute ischemic stroke mechanical thrombectomy devices for upper extremity artery occlusion is useful for recanalization.

Keywords ▶ acute upper extremity artery occlusion, major cerebral artery occlusion, mechanical thrombectomy, mechanical thrombectomy devices for acute ischemic stroke

Introduction

Acute extremity artery occlusion affects the extremities and prognosis unless prompt diagnosis and sufficient treatment are performed; treatment for this disorder is important.[1] Patients with acute upper extremity artery occlusion are treated according to the methods for lower extremity artery occlusion. Treatment methods include thrombolysis and surgery such as catheter therapy.

Furthermore, the incidence of upper extremity artery occlusion is approximately 8% to 25%, being lower than that of lower extremity artery occlusion.[2] In particular, there are few reports on acute upper extremity artery occlusion complicated by cerebral infarction.[3,4] No study has reported acute upper extremity artery occlusion complicated by major cerebral artery occlusion. However, atrial fibrillation is the source of embolism in many patients with acute extremity artery occlusion; therefore, occlusion of other arteries, including the cerebral arteries, may develop simultaneously or metachronically.[5–7] The above disorder may be observed in routine stroke care.

In this study, we report two patients in whom mechanical thrombectomy for acute upper extremity artery occlusion was performed after revascularization for major cerebral artery occlusion, leading to recanalization, and review the literature.

Case Presentation

Case 1

The patient was a 79-year-old woman with consciousness disorder, aphasia, and right hemiparalysis.

She suddenly fell while preparing breakfast, and consciousness disorder was noted. She was transported to a local hospital by ambulance. Detailed examination led to a diagnosis of cerebral infarction related to left internal carotid

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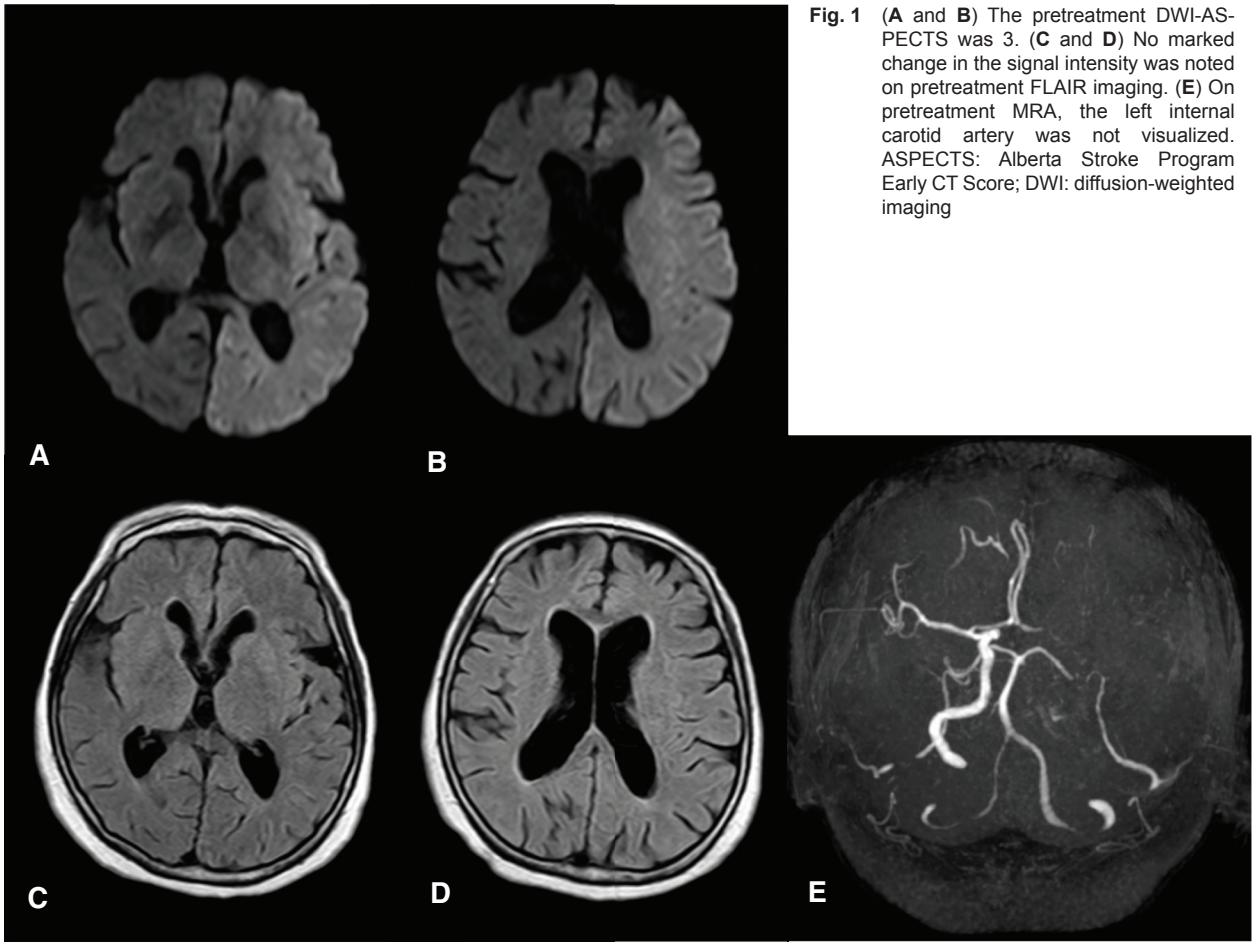

Fig. 1 (**A** and **B**) The pretreatment DWI-ASPECTS was 3. (**C** and **D**) No marked change in the signal intensity was noted on pretreatment FLAIR imaging. (**E**) On pretreatment MRA, the left internal carotid artery was not visualized. ASPECTS: Alberta Stroke Program Early CT Score; DWI: diffusion-weighted imaging

artery occlusion. For detailed examination and treatment, she was referred to our hospital 2 hours and 30 minutes after onset. Her medical history was Parkinson's disease.

The Japan Coma Scale (JCS) score was 3. The body temperature was 36.1°C. The percutaneous arterial oxygen saturation (SpO_2) was 100% (6-L mask). The right upper limb blood pressure was 152/86 mmHg, but it was impossible to measure the left upper limb blood pressure. Neither the left brachial nor radial arteries were palpable.

Left conjugate deviation was noted. Paralysis of the right upper and lower limbs (manual muscle test [MMT] score: 2) and aphasia were observed. The National Institutes of Health Stroke Scale (NIHSS) score was 19.

The white blood cell count was 11300/μL, demonstrating an increase, and the brain natriuretic peptide (BNP) level was abnormally high (396.4 pg/mL).

Electrocardiographic findings was atrial fibrillation.

MRI-diffusion-weighted imaging (DWI) revealed an extensive high-signal-intensity area in the middle cerebral artery (MCA). The Alberta Stroke Program Early CT Score (ASPECTS) was 3 (**Fig. 1A** and **1B**). There was no marked change in the signal intensity on FLAIR imaging (**Fig. 1C** and **1D**). On MRA , the left internal carotid artery was occluded (**Fig. 1E**).

After admission, mechanical thrombectomy was performed because of her family's wishes. It was impossible to measure the blood pressure in the left upper arm, and the possibility of brachial artery occlusion was considered. However, we adopted a strategy to initially perform intracranial revascularization and subsequently confirm brachial artery occlusion.

Endovascular surgery was performed as follows. Under local anesthesia, a 9Fr Optimo (Tokai Medical, Aichi, Japan) was guided into the left internal carotid artery. On angiography, disruption of an area distal to the C2 segment of the left internal carotid artery was noted (**Fig. 2A**). A Chikai 14 200 cm (Asahi Intecc, Aichi, Japan), Marksman microcatheter (Medtronic, Minneapolis, MN, USA), and Penumbra ACE68 (Penumbra, Alameda, CA, USA) were coaxially inserted, and the Marksman was guided to an area distal to the M1 segment of the left MCA. A Solitaire 6 × 40 mm (Medtronic) was deployed through the

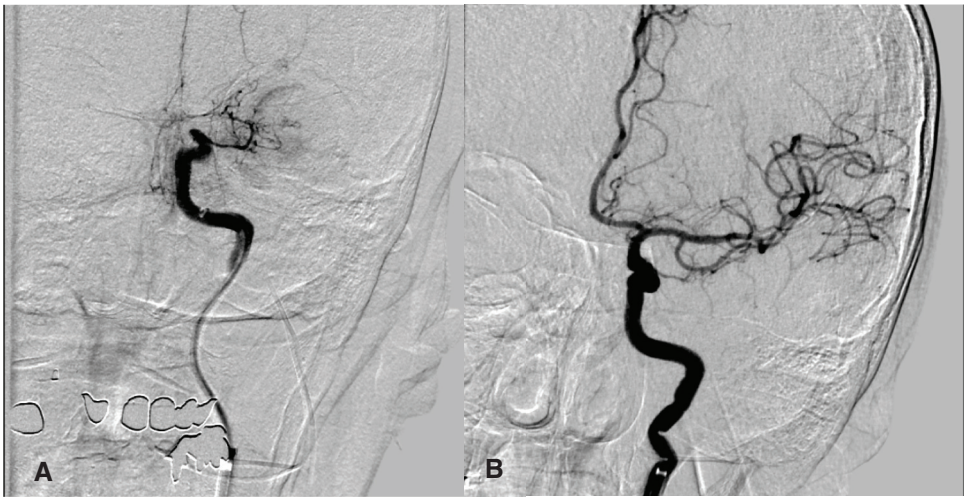

Fig. 2 (**A**) Angiography through an Optimo before treatment. The area distal to the siphon region of the intracranial internal carotid artery was not visualized. (**B**) After treatment, recanalization of the internal carotid artery was achieved.

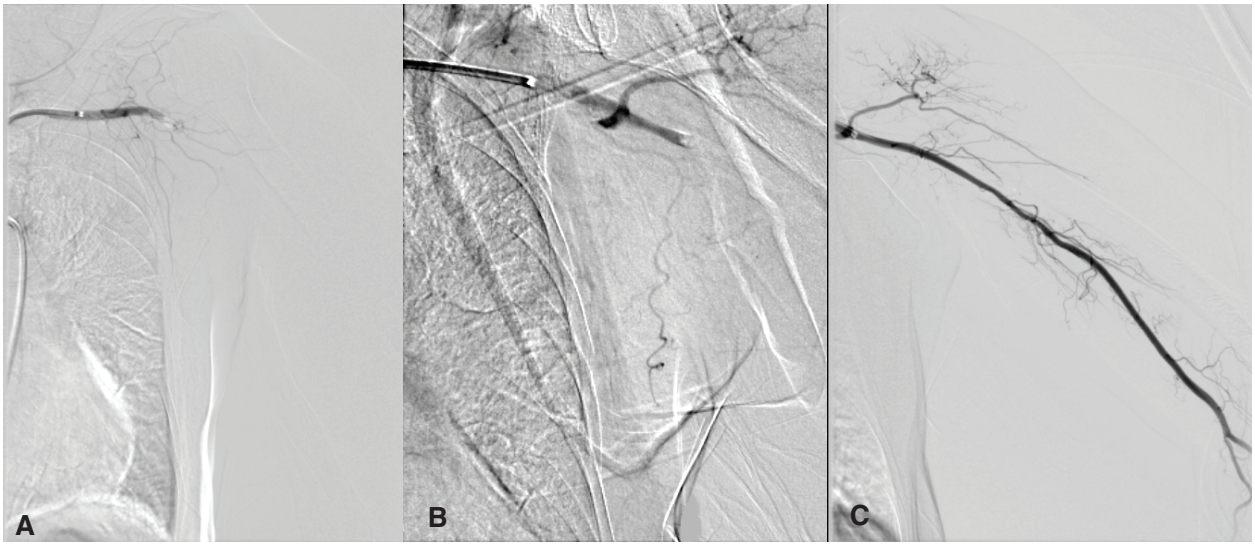

Fig. 3 Left brachial arteriography. (**A**) Before treatment, arteriography was performed through a Penumbra. (**B**) After 2 passes, partial recanalization was achieved. (**C**) After 6 passes, complete recanalization was achieved.

Marksman, and mechanical thrombectomy was performed. Two passes led to recanalization (modified thrombolysis in cerebral infarction [mTICI] grade: 3) (**Fig. 2B**). Subsequently, the Optimo was guided into the left subclavian artery. Angiography confirmed disruption of the left brachial artery (**Fig. 3A**), and mechanical thrombectomy with the system used in the intracranial blood vessel was selected. As described earlier, a Chikai 14, Marksman, and Penumbra ACE68 were coaxially inserted, and the lesion was crossed with the Chikai 14. The Marksman was guided to an area distal to the thrombus, and a Solitaire 6 × 40 mm was deployed. Using a combined technique, mechanical thrombectomy was performed. In total, 6 passes were required, but favorable recanalization was achieved after treatment (**Fig. 3C**).

After surgery, the left brachial and radial arteries became palpable, but there was no marked reduction of the neurological symptoms. Furthermore, marked pulmonary edema, which had been present since admission, required intubation management. Other complications also developed. The patient was referred to another hospital 50 days after admission with a modified Rankin Scale (mRS) score of 5.

Case 2

The patient was an 87-year-old woman with consciousness disorder and left hemiparalysis.

Her clinical history was that upon waking, her condition was normal, but there was no response to calling later. Paralysis of the left upper and lower limbs was observed, and her family requested an ambulance. She

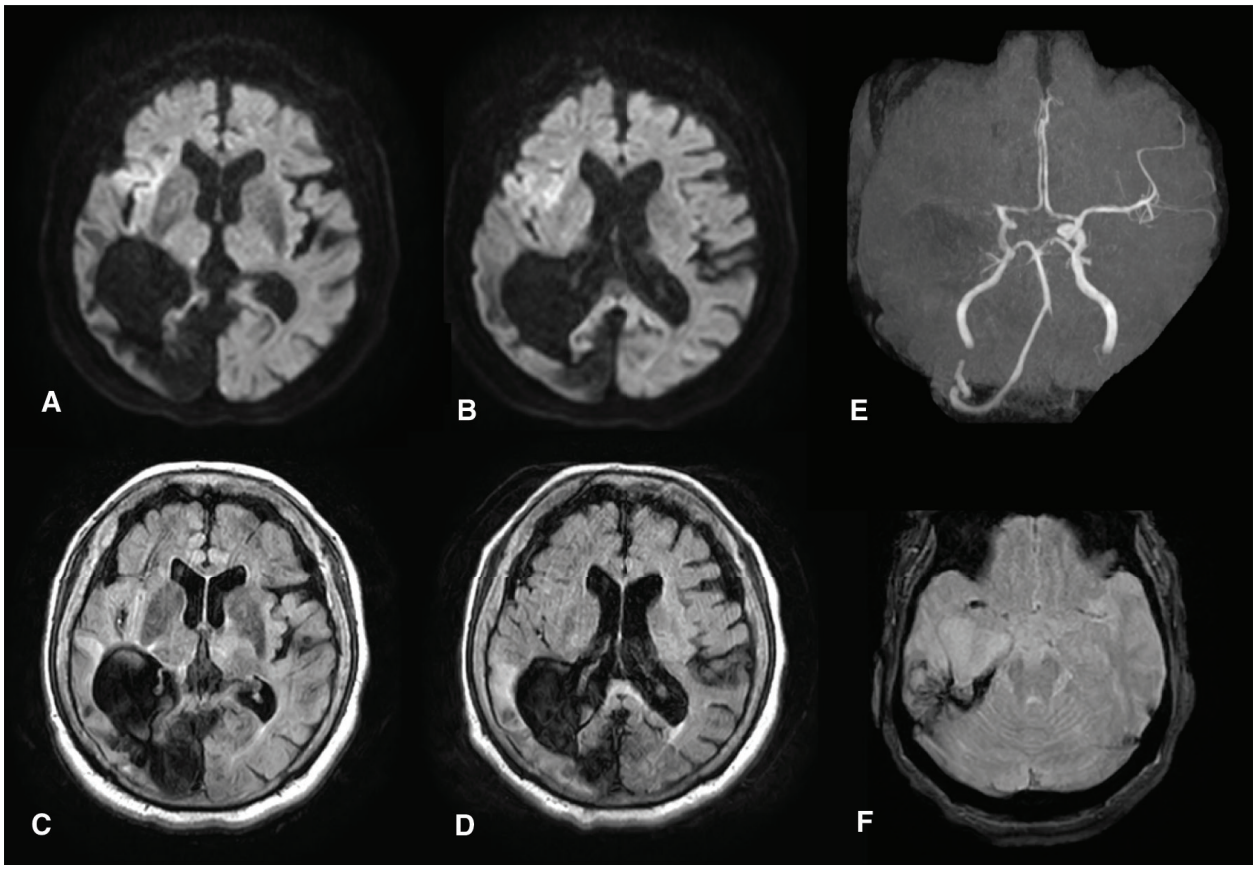

Fig. 4 (**A** and **B**) The pretreatment DWI-ASPECTS was 7. (**C** and **D**) Pretreatment FLAIR imaging showed old cerebral infarction involving the right temporal to occipital lobes. (**E**) On pretreatment MRA, neither the right middle cerebral nor left vertebral arteries were visualized. (**F**) T2-weighted imaging revealed an SVS in the right MCA. ASPECTS: Alberta Stroke Program Early CT Score; DWI: diffusion-weighted imaging; MCA: middle cerebral artery; SVS: susceptibility vessel sign

was brought to our hospital 1 hour and 27 minutes after the final event-free time. Her past medical history were atrial fibrillation, peripheral artery disease, and heart failure.

The JCS score was 100. The body temperature was 36.3°C. The SpO_2 was 96% (room air). Blood pressure measurement in both upper limbs was impossible, but the bilateral femoral arteries were palpable. The blood pressure in the right lower limb was 156/89 mmHg.

Right conjugate deviation was noted. Severe paralysis of the left upper and lower limbs (MMT score: 0), severe left sensory disturbance, and left hemispatial neglect were observed. The NIHSS score was 29.

The prothrombin time (PT)/international normalized ratio (INR) was 1.72. The BNP level was abnormally high (363.5 pg/mL).

Electrocardiographic findings was atrial fibrillation.

MRI-DWI revealed a high-signal-intensity area in the right MCA. The ASPECTS was 7 (**Fig. 4A** and **4B**). On MRA, the right MCA was occluded (**Fig. 4E**).

After admission, we considered that cerebral infarction related to right MCA occlusion was complicated by occlusion of the bilateral upper extremity arteries. We did not use recombinant tissue plasminogen activator because the PT/INR was higher than 1.7 and performed mechanical thrombectomy for MCA occlusion and intervention for brachial artery occlusion.

Endovascular surgery was performed as follows. Under local anesthesia, a 9Fr Optimo was guided into the right internal carotid artery, and angiography demonstrated disruption of an area distal to the origin of the right MCA (**Fig. 5A**). A Chikai 14 200 cm, Marksman microcatheter, and Penumbra ACE68 were coaxially inserted, and the Marksman was guided to the M2 segment of the left MCA. A Solitaire 4 × 20 mm (Medtronic) was deployed through the Marksman, and mechanical thrombectomy was performed. A single pass led to recanalization (mTICI grade: 3) (**Fig. 5B**). Subsequently, the Optimo was guided into the left subclavian artery, and disruption of the left brachial artery was noted on angiography (**Fig. 6A**). As described earlier, the

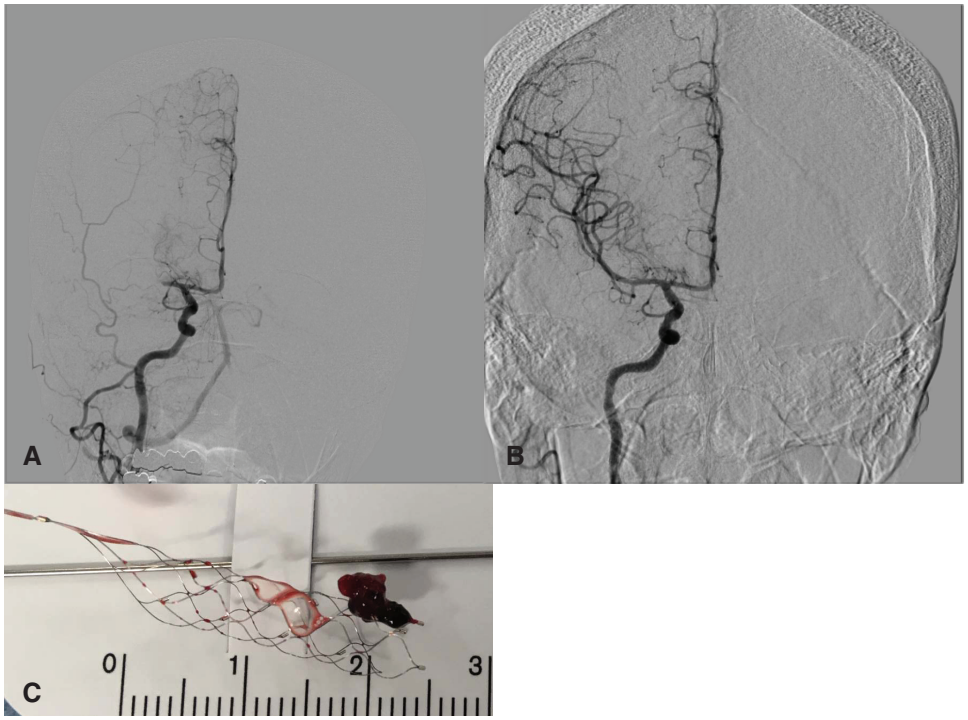

Fig. 5 (**A**) Before treatment, occlusion of the distal right MCA was observed. (**B**) After treatment. A single pass led to complete recanalization. (**C**) The Solitaire and thrombus were retrieved. MCA: middle cerebral artery

lesion was crossed with a Chikai 14. A Marksman was guided to an area distal to the thrombus, and a Penumbra ACE68 was guided to the proximal end of the thrombus in order for it to cut into the end. Using a Penumbra aspiration pump (Penumbra), aspiration was performed. Although thrombectomy was successful, residual thrombus was observed in a distal area. A similar procedure was carried out 4 times, leading to effective recanalization in which peripheral return was noted (**Fig. 6B**). Next, an Optimo was guided into the right subclavian artery and occlusion of the proximal brachial artery was observed (**Fig. 6E**). Initially, direct aspiration using the Optimo was performed. It was difficult to collect thrombi by manual aspiration using a syringe, but a Y-connector was removed and a Penumbra pump tube was directly connected for aspiration, resulting in retrieval of massive thrombi. In addition, the residual thrombi were observed in a distal area and aspiration was performed twice using a Penumbra ACE68, leading to effective recanalization in which peripheral return was noted. Surgery was then completed (**Fig. 6F**).

After surgery, the symptoms markedly reduced, and blood pressure measurement in both upper limbs became possible. During the course, heart failure developed and a specific period was required until discharge. However, improvement to wheel chair activities of daily living similar to those before admission was achieved, and the patient was discharged 28 days after admission with an mRS score of 4.

Discussion

Patients with acute upper extremity artery occlusion are treated according to the methods for acute lower extremity artery occlusion. In the case of lower extremity artery occlusion, the golden time of treatment is ≤6 hours after occlusion. A previous study reported that efficient limb salvage was possible within 6 hours, whereas amputation was performed on approximately 20% of patients after 24 hours.[8)]

In the case of upper extremity artery occlusion, complete ischemia involving the entire limb may not develop in comparison with the lower extremities due to collateral pathways or anatomical properties for blood supply even when relatively thick blood vessels are occluded.[2)] However, embolism is observed in most cases of acute upper extremity artery occlusion,[9)] and the development of a collateral pathway cannot be expected in many cases. Because acute extremity artery occlusion may lead to a poor outcome,[1)] prompt treatment is necessary.

In the treatment of acute extremity artery occlusion, thrombectomy using a balloon catheter (Fogarty catheter) became possible in 1963. This led to advances in thrombectomy and its establishment.[10–12)] Currently, this procedure is selected as a first-choice treatment.

In addition to thrombectomy using a Fogarty catheter, surgery, such as bypass; thrombolysis in which a multi-pore catheter is inserted into an arterial thrombus and urokinase

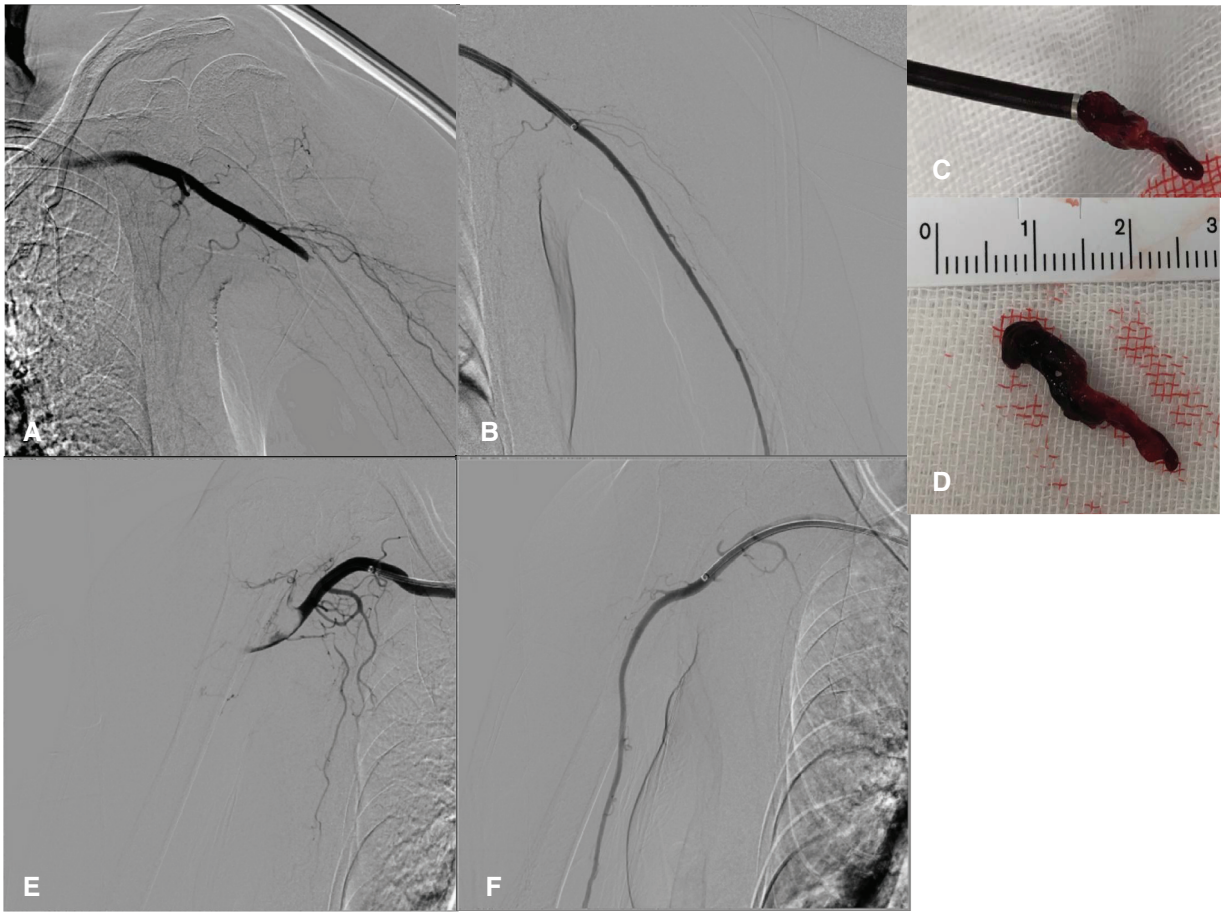

Fig. 6 (**A**) Right brachial arteriography before treatment demonstrated occlusion. (**B**) Right brachial arteriography after treatment confirmed recanalization. (**C**) The Penumbra and thrombus were retrieved. (**D**) Thrombus. (**E**) Left brachial arteriography before treatment revealed occlusion. (**F**) Left brachial arteriography after treatment confirmed recanalization.

is intra-arterially injected[8]; and percutaneous thrombus suction therapy in which a thrombus is directly aspirated without incising the skin to remove the thrombus,[13] differing from thrombectomy using a Fogarty catheter among types of thrombectomy employing a catheter, have been reported as treatment methods.

In particular, following the technical improvements of catheters, treatment using catheters other than a Fogarty catheter has been increasingly reported. A study involving a large number of patients suggested that percutaneous thrombus suction therapy is useful in patients with extremity artery occlusion.[14] In this study, devices for mechanical thrombectomy were used, suggesting their usefulness. Furthermore, these devices are routinely used for intracranial artery thrombus retrieval, but both stent-retriever- and suction-catheter-type devices for mechanical thrombectomy have also been used for thrombus-removing therapy for cerebral sinus thrombosis, suggesting their usefulness.[15,16] Devices for mechanical thrombectomy may be effective in retrieving thrombi in numerous blood vessels. This may be associated with the advantages of these devices; their inducibility is favorable even in markedly flexed/tortuous blood vessels[17] and the risk of vascular injury is low.[18] In particular, suction-catheter-type devices for mechanical thrombectomy may be useful for the treatment of brachial artery occlusion. We presented two patients, but suction- catheter-type devices for mechanical thrombectomy required a smaller number of passes before recanalization in comparison with stent-retriever-type devices. This was possibly related to the following characteristics of the respective devices: stent-retriever-type devices may push a thrombus to a distal area when guiding a microcatheter, whereas suction-catheter-type devices facilitate thrombus retrieval through suction at the proximal region.

Furthermore, in patients with acute extremity artery occlusion complicated by major cerebral artery occlusion, such as our patients, devices for mechanical thrombectomy may be highly useful for the following reasons, in addition to their effectiveness in thrombus retrieval described earlier: first, the interval until recanalization is short. In the treatment of acute extremity artery occlusion complicated by

major cerebral artery occlusion, revascularization for cerebral artery occlusion is prioritized due to cerebral ischemic tolerance, and treatment using devices for mechanical thrombectomy, such as stent retrievers and suction catheters, is initially performed. Subsequently, extremity artery treatment is initiated. However, when a Fogarty catheter is used, skin incision is necessary and a specific time is required for treatment involving preparations in comparison with treatment using a catheter alone; the interval until recanalization may be longer, reducing the possibility of limb salvage. Second, there is a medicoeconomical problem. When a new device is used in addition to the device used for cerebral thrombectomy, health expenditure for the additional device is required; therefore, health costs increase.

Based on the above results, cerebral thrombectomy using a device for mechanical thrombectomy followed by brachial thrombus retrieval using a similar device may be useful in patients with brachial artery occlusion complicated by major cerebral artery occlusion.

Conclusion

In clinical practice, physicians may need to treat patients with acute upper extremity artery occlusion complicated by major cerebral artery occlusion. In this study, we reported two patients in whom thrombectomy for acute upper extremity artery occlusion was performed using a similar device for mechanical thrombectomy following major cerebral artery treatment. Devices for mechanical thrombectomy were able to be safely used in the brachial artery, and recanalization was achieved. In particular, thrombus suction by a suction catheter was effective. Furthermore, this technique may lead to a reduction in the time or health expenditure. The use of devices for mechanical thrombectomy for brachial artery occlusion complicated by major cerebral artery occlusion may be useful for achieving recanalization.

Disclosure Statement

The authors declare no conflicts of interest.

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