Thrombectomy Using a Method to Directly Insert an Aspiration Catheter into a 6-Fr Sheath-introducer Placed into the Brachial Artery

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Objective: For thrombectomy, it is sometimes difficult to advance a guiding catheter using the transfemoral artery approach. In this study, we report five patients in whom intraoperative switching to the transbrachial artery approach led to successful results.

Case Presentations: This procedure was performed for five patients in whom it was difficult to guide a catheter using the transfemoral artery approach. A 6-Fr sheath-introducer was newly inserted into the brachial artery, and an aspiration catheter was directly inserted into the sheath’s insertion opening using an attached inserter and advanced to reach a target vessel. Subsequently, thrombectomy with the aspiration method or a stent retriever was conducted, and Thrombolysis in Cerebral Infarction (TICI) 2b or higher recanalization was achieved in four patients in a relatively short time.

Conclusion: The direct aspiration catheter insertion technique using the transbrachial approach may be useful as an alternative method for patients in whom transfemoral approach is difficult.

Keywords ▶ transbrachial approach, mechanical thrombectomy, aspiration catheter, acute ischemic stroke

Introduction

Percutaneous thrombectomy for acute major artery occlusion is frequently performed for elderly patients. It is sometimes difficult to guide a catheter or guidewire using the transfemoral artery approach.1–3) When it is possible to navigate a guidewire to a carotid artery, carotid compression/fixation of the guidewire2) or switching to a stiffer guidewire facilitates treatment in many cases. However, when it is impossible to navigate a guidewire due to anatomical reasons for the aortic arch and the proximal segment of its branching vessels, more complex strategies are required,4–8) or a change of the approaching site must be considered.9–11) Under such circumstances, we switched the transfemoral artery approach to the transbrachial artery approach, and guided a catheter using a simple method to directly insert an aspiration catheter into a sheath-introducer (direct aspiration catheter technique [DACT]), facilitating thrombectomy in a relatively short time. We report the details of this procedure.

Case Presentations

Thrombectomy was performed for 59 patients between January and December 2016. In five of these, transfemoral approach was difficult. A summary of the patients is shown in Table 1. It was difficult to guide a catheter in two cases of the right common carotid artery (CCA), a case of right vertebral artery (VA) and two cases of the left VA. A JB2-type diagnostic catheter (Medikit 4-Fr or 5-Fr 100-cm Todai-2; Medikit Co. Ltd., Tokyo, Japan) or a JB2-type intermediate catheter (Medikit 4-Fr or 5-Fr 120-cm Todai-2) that is coaxially inserted into a guiding catheter (Cello 9-Fr
90-cm; Medtronic, Minneapolis, MN, USA or FUBUKI 8-Fr 90-cm; Asahi Intecc Co., Aichi, Japan) was advanced to the aortic arch through the right femoral artery, and a 0.035-inch 150-cm angle-type guidewire (Radifocus Guidewire M standard type; Terumo Corporation, Tokyo, Japan) was guided into the target blood vessel. However, marked flexion/torsion of a proximal blood vessel made it difficult to advance the guidewire. The catheter was switched to a Simmons-type catheter (Medikit 4Fr 120-cm MS2 or CX-AII 5Fr 130-cm SY3; Gadelius Medical K.K, Tokyo, Japan), but it was impossible to navigate the guidewire, and the approaching site was switched to the brachial artery ipsilateral to the target blood vessel.

Initially, brachial puncture with a 4Fr 17-cm sheath-introducer (Medikit Super Sheath 4Fr; Medikit Co. Ltd.) was performed, and the sheath-introducer was exchanged for a 6Fr 25-cm type (Medikit Super Sheath 6Fr). Subsequently, a Penumbra 5MAX ACE (Penumbra Inc., Alameda, CA, USA) was directly inserted into a 6Fr sheath-introducer using an attached inserter (Fig. 1), and advanced with a Radifocus 0.035-inch 150-cm angle-type guidewire, facilitating passage over flexion of the proximal CCA or VA and stable insertion of the Penumbra 5MAX ACE into the cervical internal carotid artery (ICA) or VA V2 portion. At this point, the inserter should not be removed by peeling off, considering the possibility that it may be used on the second session or later. Subsequently, the guidewire was removed, and a microcatheter and microwire were coaxially inserted into the Penumbra 5MAX ACE, and then the Penumbra 5MAX ACE was navigated to the site of occlusion. Initially, forced thrombus suction with an aspiration catheter was attempted. However, when it was difficult to guide a Penumbra 5MAX ACE, or when aspiration was unsuccessful, the procedure was switched to treatment with a stent retriever. When a stenotic lesion remained after recanalization, a Penumbra 5MAX ACE was used as an intermediate catheter.

In the five patients, the median interval from puncture of the inguinal region until brachial puncture was 22 minutes (quartile range: 21–31 minutes), and that from brachial puncture until recanalization was 31 minutes (24–88 minutes). The median interval from puncture of the inguinal region until recanalization was 97 minutes (62–103 minutes).

The representative cases are presented below.

Case 1 (Fig. 2)

The patient was an 80-year-old male. Left hemiplegia and dysarthria suddenly occurred. He was brought to our hospital by ambulance 70 minutes after onset. The National Institutes of Health Stroke Scale (NIHSS) score was 6 points, and the Alberta Stroke Program Early CT Score (ASPECTS)-diffusion weighted image (DWI) was 8 points. MRA revealed occlusion at the M2 portion of the right middle cerebral artery (MCA). He was transferred to the angiography room while performing intravenous thrombolysis with recombinant tissue plasminogen activator (rt-PA). A 5Fr 25-cm sheath-introducer was inserted into the right femoral artery, and a 5 Fr JB2-type diagnostic catheter and Radifocus 0.035-inch angle-type guidewire were inserted/guided into the right CCA, but marked flexion involving the brachiocephalic artery to proximal right CCA made guidewire passage difficult (Fig. 2A). The catheter was switched to a Simmons-type (SY3) catheter, but the guidewire did not pass over the proximal CCA; therefore, the approaching site was switched to the right brachial artery. A 4Fr 17-cm sheath-introducer was inserted into the right brachial artery. Initially, a 4 Fr JB2-type diagnostic catheter and Radifocus 0.035-inch angle-type guidewire were inserted to make a diagnosis. They could be readily guided into the right CCA through the right subclavian artery. Angiography suggested

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Table 1  Summary of the cases

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age</th>
<th>Sex</th>
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<th>Puncture</th>
<th>Device</th>
<th>Pass</th>
<th>TICI</th>
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<td>ACE</td>
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</table>

ACE: Penumbra 5MAX ACE, Penumbra Inc., Alameda, CA, USA; BA: basilar artery; Gateway RX: Stryker, Kalamazoo, MI, USA; ICA: internal carotid artery; Integrity 3.5: Medtronic, Minneapolis, MN, USA; MCA: middle cerebral artery; PCA: posterior cerebral artery; Revive SE: Johnson & Johnson, Miami, FL, USA; TICI: thrombolysis in cerebral infarction scale; Trevo Xp: Stryker; VA: vertebral artery; 3MAX: Penumbra 3MAX Penumbra Inc.
occlusion at the right M2 portion. Thrombectomy was selected, and the 4-Fr sheath-introducer was switched to a 6-Fr 25-cm. A Penumbra 5MAX ACE was directly inserted into the 6-Fr sheath-introducer using an attached inserter, and guided with the Radifocus 0.035-inch guidewire, facilitating insertion into the right CCA through the right subclavian artery (Fig. 2B). The guidewire was removed, and angiography was performed. Occlusion at the origin of the right M2 portion was clearly visualized (Fig. 2C). A Marksman 150-cm (Medtronic) and Neuroute 0.014-inch guidewire (Medico’s Hirata, Tokyo, Japan) were inserted into the Penumbra 5MAX ACE so that they passed over the
A 72-year-old male, with marked consciousness disturbance, was brought to our hospital by ambulance 40 minutes after onset. The NIHSS score was 25 points, and the ASPECTS-DWI (PC-ASPECTS) was 6 points. On MRA, the visualization of the vertebral to basilar arteries was unfavorable. While performing intravenous thrombolysis with rt-PA, he was transferred to the angiography room. An 8-Fr 25-cm sheath-introducer was inserted into the right femoral artery. An 8-Fr FUBUKI guiding catheter was guided coaxially to a 5-Fr JB2-type catheter and Radifocus 0.035-inch angle-type guidewire, and the tip of 5-Fr catheter was inserted into the left subclavian artery. The angiography revealed the occlusion at the V4 portion of the left VA. As it was present at the low-position origin of the left VA (Fig. 3A), it was difficult to guide the Radifocus 0.035-inch guidewire and microcatheter into the left VA; therefore, the approaching site was changed. A 4-Fr 17-cm sheath-introducer was inserted into the left brachial artery, and exchanged for a 6-Fr 25-cm. Subsequently, a Penumbra 5MAX ACE was directly inserted into the 6-Fr sheath-introducer using an attached inserter, and guided with the Radifocus 0.035-inch guidewire, facilitating advance into the left VA through the left subclavian artery.

**Case 2 (Fig. 3)**

A 72-year-old male, with marked consciousness disturbance, was brought to our hospital by ambulance 40 minutes after onset. The NIHSS score was 25 points, and the ASPECTS-DWI (PC-ASPECTS) was 6 points. On MRA, the visualization of the vertebral to basilar arteries was unfavorable. While performing intravenous thrombolysis with rt-PA, he was transferred to the angiography room. An 8-Fr 25-cm sheath-introducer was inserted into the right femoral artery. An 8-Fr FUBUKI guiding catheter was guided coaxially to a 5-Fr JB2-type catheter and Radifocus 0.035-inch angle-type guidewire, and the tip of 5-Fr catheter was inserted into the left subclavian artery. The angiography revealed the occlusion at the V4 portion of the left VA. As it was present at the low-position origin of the left VA (Fig. 3A), it was difficult to guide the Radifocus 0.035-inch guidewire and microcatheter into the left VA; therefore, the approaching site was changed. A 4-Fr 17-cm sheath-introducer was inserted into the left brachial artery, and exchanged for a 6-Fr 25-cm. Subsequently, a Penumbra 5MAX ACE was directly inserted into the 6-Fr sheath-introducer using an attached inserter, and guided with the Radifocus 0.035-inch guidewire, facilitating advance into the left VA through the left subclavian artery.

**Fig. 3** Case 2. The left subclavian angiogram (A) shows that the left VA originated at a short distance from the aortic arch was highly meandering. The aspiration catheter (arrowheads) was smoothly advanced via the left brachial artery (B). The V4 portion of the left VA is occluded (C, asterisk) and the recanalization was obtained by aspiration thrombectomy (D, asterisk). Although additional thrombectomy using a stent retriever (D, arrow) was performed for the residual stenosis, the highly stenotic lesion still remained (E). Balloon angioplasty (F) and additional stent deployment (G) were performed and so the final view (H) shows sufficient dilatation of the stenotic lesion. The arrowheads of C, D, and E show the tip of the aspiration catheter. VA: vertebral artery.
(Fig. 3B). Angiography of the left VA confirmed occlusion at the V4 portion of the left VA (Fig. 3C). A Marksman and Neuroute 0.014-inch guidewire were inserted into the Penumbra 5MAX ACE, which was guided to the site of occlusion, and connected to a MAX pump, and submerged in the thrombus. After removing the Marksman and Neuroute guidewire, the Penumbra 5MAX ACE was removed with continuing forced suction. A gross thrombus was captured. The 6-Fr sheath was not occluded. The Penumbra 5MAX ACE was again inserted into the 6-Fr sheath, and guided into the left VA for angiography. Effective recanalization was confirmed, but residual stenosis was observed at the V4 portion. The Marksman was guided to a distal site, and a Revive SE 4.5-mm/22-mm (Johnson & Johnson, Miami, FL, USA) was deployed (Fig. 3D), which was removed through the Penumbra 5MAX ACE. A small volume of thrombi had been captured, but residual stenosis remained (Fig. 3E). An Okay II hemostatic valve (Asahi Intecc Co., Ltd) attached to the Penumbra 5MAX ACE was switched to a Radifocus hemostatic valve II (Terumo Corporation), and a Gateway RX 2.5-mm/9-mm (Stryker) was inserted for angioplasty (Fig. 3F). On balloon dilatation, a MAX pump connected to the hemostatic valve was functioned. Under loading with an antiplatelet agent, angioplasty was performed several times, but restenosis occurred; therefore, stenting was selected. However, for emergency use, an Integrity coronary stent 3.5-mm/12-mm (Medtronic) was deployed, but not an intracranial stent (Fig. 3G).

Discussion

In this procedure, an aspiration catheter is directly inserted into a 6-Fr sheath-introducer placed in the brachial artery, and advanced to the target vessel. Thrombectomy is performed by aspirating thrombi using the aspiration catheter alone or inserting a microcatheter and using a stent retriever. As a device for thrombectomy can be guided to the site of occlusion in a short time using a simple procedure, this method may be useful for achieving early recanalization.

As an application, angioplasty or stenting through an aspiration catheter is possible, as demonstrated in Case 2. In this case, it is necessary to change a hemostatic valve in accordance with the device length, considering that the length of a Penumbra 5MAX ACE is 132 cm.

When it is difficult to guide a diagnostic catheter or therapeutic guiding catheter via femoral artery approach, various management methods are adopted. If a catheter does not follow a guidewire that can be guided, the guidewire should be switched to a stiffer guidewire, such as half-stiff type, or the guidewire carotid-compression method or catheter exchange method should be initially adopted. The tip shape of an intermediate catheter should be changed from JB2 to Simmons types. If catheter insertion remains difficult, the catheter should be switched to one with a long tip (SY3 or SY6). In addition, the turn-over method, in which a catheter is reversed at the aortic valve, a method to navigate a catheter by anchoring with a Guardwire system (Medtronic) that is advanced into the external carotid artery, a method to stabilize a catheter using a Goose-neck snare catheter (Medtronic) inserted through the brachial artery, and the balloon-inflation anchoring technique, in which the balloon of a guiding catheter is effectively used, have been reported. On the other hand, if it is impossible to advance a guidewire, it should be switched to a Simmons-type guiding catheter (Neuro EBU 8-Fr; Gadelius Medical), or the parent and child balloon technique, in which a Guardwire system and guiding catheter’s balloon are concertedly used, should be adopted. Furthermore, there is an option to change the approaching site from the femoral artery to the radial artery, or the parent and child balloon technique, in which a Guardwire system and guiding catheter’s balloon are concertedly used, but extra time is required to add a puncture site; therefore, the option is considered not appropriate for thrombectomy as emergency treatment.

However, in institutions where the above devices are not equipped, these devices cannot be used on emergencies, such as thrombectomy. Furthermore, it is sometimes difficult to guide a catheter despite the use of various devices/procedures. In such cases, the waste of time may affect the clinical outcome. This method requires only simple devices, and it is available for every institution. Furthermore, the procedure is simple, and every operator can perform it. If an inserter attached to a Penumbra system is used, the tip of a soft aspiration catheter can be readily inserted into the sheath’s insertion opening. In our series (n = 5), it was possible to advance an aspiration catheter into a target blood vessel relatively readily; this method may facilitate thrombectomy in a short time without complex procedures. Initially, this method with simple devices should be selected, and, if the procedure is difficult, treatment should be continued using various devices as described above.

It is difficult to decide the timing of switching the femoral artery approach to the brachial artery approach. It must be decided in the early phase while watching guidewire/catheter movement. A study reported the usefulness of the radial artery approach, but 1.9 hours (mean) were required for switching from the femoral artery approach. In the
present cases, the brachial region was simultaneously sterilized and a 4-Fr sheath-introducer was inserted into the brachial artery while continuing efforts to guide a catheter through the femoral artery. For right brachial artery puncture, it is necessary to set an armrest alone. For left brachial artery puncture, it is necessary to transfer a monitor to the foot side in addition to set an armrest; there are no difficulties. As a result, the median interval from femoral artery puncture until 6-Fr sheath-introducer insertion into the brachial artery was 22 minutes (interquartile range: 21–31), being relatively short.

It may be difficult to guide a catheter into the left CCA using this method although there was no such case in our series. In case of bovine-type aortic arch, it may be possible to guide from the right brachial artery to the left CCA using an aspiration catheter alone by this method. However, if the left CCA originates from the aorta, as routinely observed, a catheter should be guided using various procedures through the femoral artery,2,4–8 or a Simmons-type guiding sheath should be used through the brachial artery.13,14 Furthermore, direct puncture of the left CCA11,16 may also be appropriate. In the case of the right CCA or bilateral VAs, it may also be important to confirm whether the brachial artery approach is appropriate by performing angiography from the vascular origin on the femoral artery approach.

In this method, a balloon guiding catheter is not used, and proximal blood flow blockage is impossible. A study reported the usefulness of a balloon guiding catheter for thrombectomy,18 and another study introduced a procedure to insert a balloon guiding catheter through the brachial artery for carotid artery stenting.15 In our method, a balloon guiding catheter was not used, considering the rapidity, simplicity, and accessibility. However, in Case 4, incomplete recanalization may have been associated with the absence of proximal blockage.

In this method, a guiding catheter is not inserted, and an aspiration catheter itself must be removed to outside the body in some cases, as demonstrated in Case 2. In such cases, it is necessary inserting a catheter again to perform confirmative angiography or for the second pass. If the aspiration procedure is considered to facilitate thrombectomy at a single pass, it may be appropriate. However, if reinsertion of an aspiration catheter through a brachial sheath is expected to lead to a waste of time, it may be more appropriate to insert a stent retriever into an aspiration catheter for thrombectomy on the first pass. Furthermore, sliding-down/scattering of thrombi on drawing an aspiration catheter under forced aspiration may cause embolism of the subclavian or brachial arteries. In our patients, there was no such complication. However, the procedure of removing an aspiration catheter itself should be avoided in institutions where trouble shooting by cardiovascular surgeons or neurologists is impossible on such an emergency.

### Conclusion

This procedure, in which an aspiration catheter is directly inserted into the 6-Fr sheath-introducer placed the brachial artery, makes it possible to promptly guide a catheter using simple devices. It may be useful as an option of additional procedure when it is difficult to advance a catheter using the femoral artery approach for thrombectomy.

### Disclosure Statement

There is no conflict of interest for the main author and coauthors.

### References