Transradial Approach for Mechanical Thrombectomy of Posterior Circulation Stroke

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Objective: We report the mechanical thrombectomy (MT) of posterior circulation large vessel occlusion (pc-LVO) in which the transradial approach (TRA) was selected as an initial approach route to reduce the duration of treatment.

Case Presentation: We performed MT using the TRA for four patients with pc-LVO between November 2015 and March 2017. The TRA was used as an initial approach route in patients in whom preoperative MRI showed that the right vertebral artery (VA) was predominant. In all patients, the procedure could be accomplished without changing the approach route. Thrombolysis in Cerebral Infarction (TICI) 2b or better recanalization was achieved in all patients (100%), and TICI 3 recanalization in three patients (75%). Mean time from radial artery puncture to initial intracranial angiography and to the effective recanalization was 7.3 ± 1.5 and 28.8 ± 6.2 minutes, respectively. There was no complication at the site of puncture.

Conclusion: Recanalization was promptly and effectively achieved by the MT of pc-LVO using the TRA. The results suggest that TRA can be utilized as an initial access route in patients in whom an approach to the right VA is possible.

Keywords: transradial approach, posterior circulation stroke, endovascular treatment, acute ischemic stroke, mechanical thrombectomy

Introduction

The development of thrombectomy devices, such as stent retrievers and large aspiration catheters, and evidence on efficacy have rapidly promoted the widespread application of endovascular treatment in clinical practice.1,2 With respect to thrombectomy or the recanalization rate, favorable results have been consistently obtained, but we have often encountered patients in whom it was difficult to guide a guiding catheter into an occluded blood vessel, with an increase in the number of patients to be treated by this therapy.3–6 Several studies reported that recanalization should be promptly performed to treat posterior circulation large vessel occlusion (pc-LVO), as indicated for the anterior circulation.7,8 However, when selecting the transfemoral approach (TFA) for patients in whom an approach to the right vertebral artery (VA) is necessary, a specific interval is sometimes required until reaching due to the tortuosity of the aortic arch. We speculated that the transradial approach (TRA) might be useful in patients in whom an approach to the right VA is necessary, and treated them using the TRA. We examined the efficacy and safety of the TRA for the mechanical thrombectomy (MT) of pc-LVO.

Case Presentation

Of 80 patients who underwent acute-phase MT in our hospital between November 2013 and March 2017, pc-LVO was observed in nine patients (12.5%). In these patients, the posterior circulation Alberta Stroke Program Early CT score (pc-ASPECTS)9 and degree of left/right VA development were evaluated on preoperative MRI.
When MRA showed that the right VA was predominant, the radial artery was used as the site of puncture after confirming a positive reaction on the Allen test. When the left VA was predominant, endovascular treatment was started using the femoral artery. When the degree of VA development was similar between the left and right sides, the operator selected a blood vessel to be punctured.

The interval between arterial puncture and initial intracranial angiography through a guiding catheter was defined as the access time. Success or failure in recanalization was evaluated using the Thrombolysis in Cerebral Infarction (TICI) classification. The interval from arterial puncture until TICI 2b or better recanalization was defined as the time to recanalization.

For four patients, MT was performed through the right VA using the TRA. These patients showed positive reactions on the Allen test. The mean age was 82.0 ± 10.7 years. The preoperative Glasgow Coma Scale (GCS) score was 6.5 ± 4.4, and the preoperative National Institute of Health Stroke Scale (NIHSS) score was 21.0 ± 16.0. The pc-ASPECTS was 6.5 ± 3.3. Intravenous thrombolysis with recombinant tissue plasminogen activator (rt-PA) was performed in three patients (75%). In three patients with out-of-hospital onset, the mean interval from onset until arrival was 86.7 ± 50.3 minutes, and that from arrival until arterial puncture was 127.7 ± 73.6 minutes. In one patient with in-hospital onset, the interval from onset until arterial puncture was 125 minutes. The occluded blood vessels were P1 segment of the posterior cerebral artery (PCA) in two patients, basilar trunk in one patient, and basilar tip in one patient. In all patients, it was possible to start thrombectomy without changing the approach route. The mean access time was 7.3 ± 1.5 minutes. TICI 3 recanalization was achieved in three patients (75%), and TICI 2b recanalization in one patient (25%). The mean time to recanalization was 28.8 ± 6.2 minutes.

Under local anesthesia, radial artery puncture was performed using a 21G puncture needle. After a 4 Fr. sheath was inserted, it was exchanged for a guiding catheter using a guidewire. As a guiding catheter, a guiding sheath was used in all patients. An ASAHI FUBUKI Dilator 6 Fr. (Asahi Intecc, Aichi, Japan) was adopted for the first patient, and an ASAHI FUBUKI Dilator 4 Fr. was used in the subsequent three patients. Concerning devices for thrombectomy, a stent retriever was selected for patients with proximal occlusion of the basilar trunk or those in whom the thrombus volume was expected to be large, and an aspiration catheter for those with distal occlusion involving the basilar tip. A Trevo XP ProVue Retriever 4 × 20 mm (Stryker, Kalamazoo, MI, USA) was combined with a Penumbra 3MAX (Penumbra, Alameda, CA, U.S.A.) in one patient. A Penumbra 4MAX was used in one patient, and a Penumbra 3MAX in two patients. The mean frequency of the procedure was 1.8 ± 1.0 times. For all patients, hemostasis was performed using a TR band (Terumo Corporation, Tokyo, Japan). Concerning the outcome, the mean GCS score at 24 hours after treatment was 12.5 ± 4.4, and the mean NIHSS score was 16.5 ± 12.3. A favorable outcome was achieved in one patient (20.0%), with a modified Rankin Scale (mRS) score of ≤ 2 after 3 months. There was no complication at the site of puncture in any patient treated using the TRA. The details are shown in Table 1.

During the same period, the MT of pc-LVO via the TFA was performed for five patients in our hospital. For all patients, an access to the left VA was selected. The mean access time was 11.0 ± 5.2 minutes. TICI 2a recanalization was achieved in one patient (20%), and TICI 2b recanalization in four patients (80%). In the latter, the mean time to recanalization was 35.5 ± 14.9 minutes. Regarding devices for thrombectomy, a 3MAX ACE was used in one patient, a 3MAX in one patient, the combination of a 4MAX and Trevo XP ProVue Retriever 4 × 20 mm in two patients, and the combination of a 4MAX and Solitaire FR 4 × 20 mm (Medtronic, Minneapolis, MN, USA) in one patient. The mean frequency of the procedure was 2.8 ± 1.5 times. As a complication at the site of puncture, a retroperitoneal hematoma was noted in one patient (20.0%). As shown in Table 2, the treatment results were compared between the TRA and TFA.

**Representative case**

Our case is an 86-year-old male. Consciousness disorder occurred while having a meal. He was brought to our hospital by ambulance 80 minutes after onset. The consciousness level on arrival was E1V1M3 by the GCS score, and the NIHSS score was 31. On MRI diffusion-weighted images (DWIs), high-signal-intensity areas were partially detected in the left occipital lobe and pons. Small high-signal-intensity areas were also detected in the midbrain and bilateral thalamus, and the pc-ASPECTS was 2 (Fig. 1A and 1B). On intracranial MRA, the basilar artery was not visualized (Fig. 1C). On cervical MRA, the right VA was visualized, but the left VA was not (Fig. 1D). The platelet count was 30000/µL, which did not meet indication criteria of the intravenous thrombolysis with rt-PA, and thus it was not performed. Although the condition was
severe, the patient was diagnosed as complete basilar artery occlusion, and MT was considered to be necessary. Based on preoperative MRA information, an approach from the radial artery to the right VA was selected. The interval from hospital arrival until arterial puncture was 95 minutes. Under local anesthesia, the radial artery was punctured using a 21G needle, and a 4 Fr. sheath (Terumo Corporation) was inserted. Subsequently, it was exchanged for an ASAHI FUBUKI Dilator 4 Fr. using Radiofocus wire (Terumo Corporation). The dilator was removed, and a guiding catheter was inserted into the right VA through the right subclavian artery using a 4 Fr. OK-2 M (Cathex, Tokyo, Japan) as an inner catheter. Intra-cranial angiography was performed 8 minutes after arterial puncture. At the basilar trunk, a thrombus was detected, and anterograde blood flow was blocked. As the thrombus volume was expected to be large, a stent retriever was selected. A Marksman (Medtronic) was guided into the right PCA, and thrombectomy was performed using a Trevo XP ProVue Retriever 4 × 20 mm. Anterograde blood flow from the basilar artery to the right PCA was resumed at 24 minutes after arterial puncture. Still the thrombus involving the basilar tip to P1 segment of the left PCA remained, therefore, thrombectomy was performed using a Penumbra 3MAX. A delay in left PCA blood flow was noted, and treatment continued with TICI 2b recanalization. After surgery, no improvement in consciousness disorder was observed. The mRS score after 3 months was 5.

Discussion

For endovascular treatment in acute ischemic stroke, a reduction in the interval from the onset of cerebral infarction until recanalization significantly contributes to an improvement in the outcome. However, the duration of treatment is an important factor for shortening the duration of treatment. Patients with PC-LVO, the prognosis becomes unfavorable in approximately 90% when recanalization is unsuccessful. In several studies, the route was changed, or the use of devices was devised in such patients. Of patients with PC-LVO, the prognosis becomes unfavorable in approximately 90% when recanalization is unsuccessful.

Table 1 Summary of the patients selected for the transradial approach

<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Pre-GCS</th>
<th>Pre-NIHSS</th>
<th>pc-ASPECTS</th>
<th>IV rt-PA Location</th>
<th>Onset to door (min)</th>
<th>Door to puncture (min)</th>
<th>Access time (min)</th>
<th>Time to recanalization (min)</th>
<th>TICI</th>
<th>Guiding sheath</th>
<th>Device Number of procedure</th>
<th>Post-GCS mRS</th>
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<tr>
<td>1</td>
<td>86</td>
<td>E1V1M3</td>
<td>31</td>
<td>2</td>
<td>No</td>
<td>BA trunk</td>
<td>80</td>
<td>95</td>
<td>8</td>
<td>24</td>
<td>2b</td>
<td>FUBUKI Dilator 4 Fr.</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>94</td>
<td>E1V1M1</td>
<td>38</td>
<td>9</td>
<td>Yes</td>
<td>PCA (P1)</td>
<td>40</td>
<td>212</td>
<td>6</td>
<td>30</td>
<td>3</td>
<td>FUBUKI Dilator 6 Fr.</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>E3V4M6</td>
<td>10</td>
<td>6</td>
<td>Yes</td>
<td>BA tip</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>24</td>
<td>3</td>
<td>FUBUKI Dilator 4 Fr.</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>78</td>
<td>E1V1M3</td>
<td>5</td>
<td>6</td>
<td>Yes</td>
<td>PCA (P1)</td>
<td>140</td>
<td>76</td>
<td>9</td>
<td>37</td>
<td>3</td>
<td>FUBUKI Dilator 4 Fr.</td>
<td>2</td>
</tr>
</tbody>
</table>

Mean: 82.0, 21.0, 6.5, 86.7, 127.7, 7.3, 28.8, 1.8, 4.0

Patient 1 was in hospital onset ischemic stroke, BA: basilar artery; Fr.: French; GCS: Glasgow Coma Scale; IV: intravenous infusion; mRS: modified Rankin Scale; NIHSS: National Institute of Health Stroke Scale; PCA: posterior cerebral artery; pc-ASPECTS: the posterior circulation Alberta Stroke Program Early CT score; rt-PA: recombinant tissue plasminogen activator; TICI: thrombolysis in cerebral infarction.
not achieved. On the other hand, recent studies indicated that the endovascular treatment related effective recanalization rate was approximately 70%–80%, and that a favorable outcome was achieved in 30%–40%.7,8,12,13) Concerning the MT of pc-LVO, some studies reported that prompt, effective recanalization of occluded blood vessels contributed to the prognosis, as demonstrated for anterior circulation; a fast access route with a high success rate should be selected.7,8)

In the field of cerebral endovascular treatment for cerebral aneurysms or VA stenosis, the success rates of transradial or -brachial approaches are high, suggesting their efficacy.14-17) These approaches have the following merits: direct cannulation from the subclavian artery to the VA is possible regardless of the aortic tortuosity, and a guiding catheter stays stable after insertion.

According to previous studies of endovascular treatment for acute ischemic stroke, TRA and transbrachial

### Table 2: Procedural outcomes of TRA and TFA

<table>
<thead>
<tr>
<th></th>
<th>total n:9</th>
<th>TRA n:4</th>
<th>TFA n:5</th>
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<tr>
<td>Age (years)</td>
<td>75.7 ± 11.9</td>
<td>82.0 ± 10.7</td>
<td>68.4 ± 9.8</td>
</tr>
<tr>
<td>Access time (min)</td>
<td>9.3 ± 4.3</td>
<td>7.3 ± 1.5</td>
<td>11.0 ± 5.2</td>
</tr>
<tr>
<td>Time to recanalization (min)</td>
<td>40.4 ± 27.1</td>
<td>28.8 ± 6.2</td>
<td>35.5 ± 14.9</td>
</tr>
<tr>
<td>TICI 2b or 3(%)</td>
<td>8 (88.9)</td>
<td>4 (100)</td>
<td>4 (80.0)</td>
</tr>
<tr>
<td>TICI 3(%)</td>
<td>3 (33.3)</td>
<td>3 (75.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Number of the procedure</td>
<td>2.2 ± 1.3</td>
<td>1.5 ± 0.6</td>
<td>2.8 ± 1.5</td>
</tr>
<tr>
<td>Access site complication (%)</td>
<td>1 (11.1)</td>
<td>0 (0)</td>
<td>1 (20.0)</td>
</tr>
</tbody>
</table>

TFA: transfemoral approach; TICI: thrombolysis in cerebral infarction; TRA: transradial approach

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**Fig. 1** (A and B) The diffusion-weighted MRI showed ischemic stroke at the left occipital lobe, mid brain, and bilateral thalamus. (C) The intracranial MRA showed basilar artery occlusion. (D) The cervical MRA showed the right vertebral artery that is the dominant side (arrow). (E and F) The guiding catheter was navigated into the right vertebral artery via the transradial approach. (G and H) The DSA showed the basilar trunk was occluded by the thrombus (arrowhead) and TICI 2b reperfusion was achieved after thrombectomy. TICI: thrombolysis in cerebral infarction.
approach was chosen only for patients who switched from unsuccessful TFA.\textsuperscript{4–6} Haussen et al.\textsuperscript{4} reported 15 patients who underwent endovascular treatment for acute ischemic stroke via the TRA. In 12 of these, the TFA was unsuccessful, requiring a switch to the TRA. They suggested the TRA as an alternative and useful method for patients in whom the TFA is difficult. Furthermore, 10 patients had posterior circulation stroke, and the TRA was more appropriate. To our knowledge, this is the first report predominantly selecting the TRA rather than the TFA in MT of pc-LVO which allows an approach to the right VA.

When performing MT, the selection of an initial approach route is an influential for the duration of treatment; it should be carefully selected.\textsuperscript{2} Cerebral endovascular treatment has been performed via the TFA in many cases. For patients with pc-LVO, an access to the left VA via the TFA may be an initial access route if an approach to the left VA is possible. On the other hand, there are differences in the difficulty of an access to the right VA via the TFA, depending on the position of the bifurcation between the aorta and brachiocephalic trunk; this may prolong the duration of treatment or contribute to the instability of a guiding catheter. We selected the TRA as an initial access route for patients requiring an access to the right VA, considering more prompt recanalization and the stability of a guiding catheter. In all patients for whom the TRA was selected, treatment was possible. Furthermore, the access time, time to recanalization, and effective recanalization rate were similar to those in patients in whom an access to the left VA via the TFA was used during the same period in our institution.

An access to the right VA via the TRA is a prompt, safe, and effective method in patients in whom an access to the right VA is possible, while the TRA to the left VA is not appropriate for endovascular treatment for the following reasons: puncture is complex, and the TFA is easy.

When adopting the TRA, 4 Fr. and 6 Fr. guiding sheaths were used. A Stent Retriever and Penumbra 3MAX are available for 4 Fr. guiding sheaths. In addition to the former, a Penumbra 5MAX ACE and Penumbra 4MAX are available for 6 Fr. guiding sheaths. We performed treatment with a Penumbra 4MAX using a 6 Fr. guiding sheath for one patient in the initial phase. However, we currently consider that treatment with a Stent Retriever or Penumbra 3MAX is possible. When conducting the endovascular treatment of pc-LVO via the TRA, treatment is started using a 4 Fr. guiding sheath. With respect to the selection of devices for thrombectomy, a stent retriever was selected for patients with proximal occlusion of the basilar trunk or VA or those in whom the thrombus volume was expected to be large, and an aspiration catheter for those with distal occlusion of the basilar tip or PCA. Balloon guiding catheters,\textsuperscript{18} which are useful for treating the anterior circulation occlusion, are not used for the treatment of the posterior circulation occlusion due to the presence of contralateral VA blood flow and a small VA diameter. Concerning the site of puncture, the radial artery, where the incidence of puncture-site complications is lower than at the brachial artery, is adopted,\textsuperscript{19} as IV rt-PA therapy is combined in many cases.

Recently, MRI has been skipped to reduce the time of examination in the treatment of the anterior circulation occlusion.\textsuperscript{20} However, posterior circulation stroke causes various neurologic symptoms; therefore, endovascular treatment is performed after a definitive diagnosis is made based on MRI findings.

In this study, an improvement in the GCS score was achieved immediately after MT in three of the four patients. However, three of the four patients showed unfavorable outcomes; deaths were related to a low pc-ASPECTS, advanced age, and postoperative aspiration pneumonia. pc-LVO uniformly leads to an unfavorable outcome if recanalization is not achieved. Therefore, treatment must be indicated for a larger number of patients, and serious stroke-related complications may occur, raising issues.

In the MT of pc-LVO, the limitations of the initial TRA include the prolongation of the puncture time, flexion of the brachial artery, and a vasospasm-related delay in approaching. Furthermore, the course of the subclavian artery or bifurcation angle between the subclavian and VAs may make the approach difficult in some patients. Although there are strategies to overcome these problems, the TRA should be promptly switched to other approaches, such as the TFA, for time-sensitive MT. Therefore, disinfection at the femoral artery region or draping beforehand is effective.

However, the number of patients in this study was small, and a larger number of patients should be examined in the future.

### Conclusion

In four patients in whom the MT of pc-LVO was started via the TRA, recanalization was promptly and effectively achieved without changing the approach route, suggesting the usefulness of this approach method.
Disclosure Statement

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

References