Simultaneous Approach to Tandem Occlusion in Acute Ischemic Stroke Patients: Percutaneous Transluminal Angioplasty (PTA) Using Push Wire of Stent Retriever

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Objective: For patients with tandem occlusion (TO), it is controversial whether an antegrade approach or retrograde approach should be undertaken. Here, we report our strategy for treating patients with TO by simultaneous approach. First, a microcatheter was advanced to the distal occlusion site along with a microwire. Second, a stent retriever (SR) was deployed as an anchor at the distal lesion, and percutaneous transluminal angioplasty (PTA) was performed at the proximal lesion using push wire of SR. After that, the microwire was removed and PTA balloon as well as the guiding catheter (GC) was advanced along the wire of SR. Finally, the SR was withdrawn with clot.

Case Presentations: Cases 1 and 2, who were confirmed as TO, were treated by the method described above. We could re-perfuse successfully. These two cases had favorable outcomes, indicating a modified Rankin scale 2 at the time of discharge.

Conclusion: Our therapeutic strategy for TO might be useful for early reperfusion of a distal occlusion site and associated with favorable outcome.

Keywords: tandem occlusion, acute ischemic stroke, endovascular treatment, simultaneous approach

Introduction

The efficacy of endovascular treatment of cerebral large vessel occlusion (LVO) in acute ischemic stroke patients has been shown by meta-analysis,1) but the treatment method for extracranial carotid artery occlusion accompanied by internal carotid and/or middle cerebral artery occlusions distant to it, that is, tandem occlusion (TO), is controversial.2) In the treatment for TO, two methods, indicating antegrade and retrograde approaches, have been reported. In the former method, stenting of the proximal lesion is first applied followed by an approach to the distal occlusion while treatment starts in the distal lesion followed by percutaneous transluminal angioplasty (PTA) or stenting of the proximal lesion. In the latter method, distal occlusion is prioritized, but the timing of intervention for the proximal occlusion or stenosis is a problem. The retrograde approach had been employed in our hospital and its procedure was as follows: After PTA of the proximal lesion, the balloon catheter for angioplasty was removed and replaced with a microcatheter, and then the distal lesion was approached. However, the procedure of the previous method was complex. In this report, a new simultaneous approach to improve complexity is described. In this method, after deployment of a stent retriever (SR), a balloon catheter for PTA was advanced along with its push wire to the proximal lesion, thus both lesions were simultaneously treated (Fig. 1). The details
Strategy for tandem occlusion at origin of Internal carotid artery and middle cerebral artery

Case Presentations

Case 1 (Fig. 2) was a 69-year-old male inpatient of our hospital. One morning, he was found left hemiplegia with conjugate eye deviation to the right. The last known well (LKW) episode was in the previous night when he was going to the restroom. His National Institute of Health Stroke Scale (NIHSS) score was 26. Stroke was suspected, and he was referred to our department. Right internal carotid artery (ICA) occlusion and thrombus in the middle cerebral artery (M1) were noted on MRI. A diffusion-weighted image (DWI) - Alberta Stroke Programme Early CT Score (ASPECTS) was 8 on DWI, showing clinical-diffusion mismatch. As the onset time was unclear and 5 hours and 35 minutes had already passed since the LKW, it was decided to perform endovascular treatment without tissue plasminogen activator (t-PA) administration. Preoperative contrast-enhanced CT revealed the presence of arteriosclerotic lesion of the ICA. The onset-to-groin puncture time was 6 hours and 20 minutes. A 9Fr sheath was placed in the right femoral artery and an Optimo 9F balloon catheter (Tokai Medical Products, Aichi, Japan), was guided into the right common carotid artery (CCA) using a 6Fr Tokudai Sp (Togo Medikit, Miyazaki, Japan), and 0.035 inch Radifocus guidewire (Terumo Co., Tokyo, Japan). Using 0.014 inch CHIKAI (Asahi Intec...
Simultaneous Approach for Tandem Occlusion

Fig. 2 (A) Ischemic lesions were visualized as a high-intense lesions in the right MCA-perfused territory (basal ganglia and insular cortex) on diffusion-weighted imaging (arrowheads). (B) The MCA and ICA were occluded on magnetic resonance angiography (arrowheads). (C) The SVS was noted in the horizontal lesion of the middle cerebral artery on T2*-weighted imaging, suggesting tandem occlusion (arrowhead). (D) The ICA was occluded at the origin on angiography (arrow). (E) While the SR was exposed in the distal thrombus (arrowheads), the PTA balloon was advanced to the proximal lesion along the push wire to dilate the proximal lesion (arrows). (F) After the balloon guiding catheter was guided to a site distal to the occluded lesion of the carotid artery, the SR was retrieved. On subsequent angiography, severe stenosis of the ICA remained and blood flow delayed (visualization of the ICA was delayed compared with that of the external carotid artery [arrowheads]). (G) A stent for the coronary artery was placed in the severe stenosis lesion. (H) On the final angiography, recanalization, classified as (TICI) 2B, was achieved but the thrombus was partially remained in the distal lesion (arrowhead). ICA: internal carotid artery; MCA: middle cerebral artery; PTA: percutaneous transluminal angioplasty; SR: stent retriever; SVS: susceptibility vessel sign; TICI: thrombolysis in cerebral infarction

Co., Ltd., Aichi, Japan), and 0.021 inch Prowler Select Plus (Johnson and Johnson, Miami, FL, USA) microcatheter was passed through the occluded lesion of the ICA and advanced to the distal thrombus. Then, a SR, Trevo ProVue 4 × 30 mm (Stryker, Kalamazoo, MI, USA), was deployed and anchored, the microcatheter was removed, and a Sterling Balloon Dilatation Catheter 3.5 × 30 mm (Boston Scientific Co., Natick, MA, USA) was guided to the proximal lesion along the push wire of the SR. PTA was applied, and GC was advanced to partially cover the balloon. Next, the balloon was slightly inflated to eliminate the ledge between the wire and GC to advance the catheter to the site distal to proximal lesion, and the SR was retrieved together with the PTA balloon catheter. A microwire was inserted in the GC and the tip was placed at a site distal to the proximal lesion to secure a true lumen. In this state, the GC was repositioned toward the CCA and an image was acquired. Intracranial recanalization was achieved but recoil of the proximal lesion was noted, for which stent placement was decided. Since the vascular diameter was about 3 mm, two antiplatelet agents (300 mg aspirin and 300 mg clopidogrel) were loaded and a stent for the coronary artery, Integrity 3.5 × 22 mm (Medtronic Vascular, Santa Rosa, CA, USA), was placed and the treatment was completed. The groin puncture-to-recanalization time was 48 minutes.

Case 2 (Fig. 3) was an 82-year-old male. He presented right conjugate deviation, left hemiplegia, and dysarthria. And he was transferred to a clinic. The right ICA was occluded on MRI and small infarct areas were diffusely present on DWI. Cortical symptoms accompanied and his NIHSS score was 15. Clinical-diffusion mismatch was noted and t-PA was administered at 3 hours and 5 minutes after the onset. As LVO was apparent, he was transferred to our hospital for endovascular treatment. The patient arrived at our hospital at 3 hours and 52 minutes after the onset. The procedure was initiated at an onset-to-groin puncture time of 4 hours and 35 minutes. The same devices as those used in Case 1 were used except for the different size of the balloon catheter for angioplasty. A 9Fr sheath was placed in the right femoral artery, and an 9Fr Optimo balloon catheter was advanced to the right CCA. An arteriosclerotic lesion accompanied by ulceration was present at the origin of the ICA on control run.
One reason may be the presence of various pathologies of proximal lesions of the carotid artery (arteriosclerosis, dissection, embolus and compression by the surrounding lesions). Technically, in the antegrade approach, a true lumen is secured to easily advance recanalization devices, such as an SR, to the distal lesions, but recanalization of the distal lesion may delay. In the retrograde approach, when the distal lesion is approached after PTA of the proximal lesion, the time to removal of the distal thrombus may be shortened compared with that in the antegrade approach, but the PTA balloon catheter and microcatheter have to be replaced using 300 cm microwire or extension wire, which requires multiple operators in many cases. The simultaneous approach as described in this study does not require this exchange procedure, it acquires flow restoration early, and shortening of the time to recanalization can be expected. However, the embolic complication may increase depending on the location of the distal occlusion because the GC is advanced to the distal lesion without protection of the proximal lesion. The risk of embolic complication may be low when TO is limited to the ICA, but when it is present at a site distal to M1, as noted in Case 2,

Fig. 3  (A) Ischemic lesions were diffusely present in the right middle cerebral artery-perfused lesion on diffusion-weighted imaging (arrowheads). (B) The middle cerebral artery (M2) and ICA were occluded on magnetic resonance angiography (arrow). (C) The SVS was noted in the middle cerebral artery M2 on T2*-weighted imaging, suggesting tandem occlusion (arrowhead). (D) The ICA was occluded at the origin on angiography (arrow). (E) The SR was exposed in the distal thrombus (arrows) and the proximal lesion was dilated by the PTA balloon placed along the push wire (arrowheads). (F) The balloon guiding catheter was guided to a site distal to the occluded lesion of the carotid artery, and the SR was retrieved. Moderate stenosis remained in the ICA on angiography. Since this patient received t-PA and blood flow was not delayed, no stent was placed in the carotid artery. (G) On the final angiography, complete recanalization was acquired. ICA: internal carotid artery; PTA: percutaneous transluminal angioplasty; t-PA: tissue plasminogen activator; SR: stent retriever; SVS: susceptibility vessel sign

Using 0.014-inch CHIKAI, Prowler Select Plus was guided to the occluded lesion of the middle cerebral artery, and Trevo ProVue 4 × 30 mm was exposed. Then, the microcatheter was removed, Sterling 4.0 × 40 mm was advanced to the proximal lesion along the push wire of the SR and PTA was applied. The GC was advanced to a distal site so as to follow the push wire. The GC balloon was inflated, and the SR was retrieved together with the PTA balloon catheter. An image of the CCA was acquired in the state securing a true lumen using the microwire. There was no delay in blood flow distal to the carotid artery. New embolism was of concern, but it did not occur. Since the stenosis rate was moderate, treatment was completed without stenting. The groin puncture-to-recanalization time was 34 minutes.

Discussion

No consistent viewpoint has been reached for the treatment method of TO, but preceding studies reported that the prognosis is poor and the mortality rate is high compared with those of patients with a single intracranial lesion.

One reason may be the presence of various pathologies of proximal lesions of the carotid artery (arteriosclerosis, dissection, embolus and compression by the surrounding lesions). Technically, in the antegrade approach, a true lumen is secured to easily advance recanalization devices, such as an SR, to the distal lesions, but recanalization of the distal lesion may delay. In the retrograde approach, when the distal lesion is approached after PTA of the proximal lesion, the time to removal of the distal thrombus may be shortened compared with that in the antegrade approach, but the PTA balloon catheter and microcatheter have to be replaced using 300 cm microwire or extension wire, which requires multiple operators in many cases. The simultaneous approach as described in this study does not require this exchange procedure, it acquires flow restoration early, and shortening of the time to recanalization can be expected. However, the embolic complication may increase depending on the location of the distal occlusion because the GC is advanced to the distal lesion without protection of the proximal lesion. The risk of embolic complication may be low when TO is limited to the ICA, but when it is present at a site distal to M1, as noted in Case 2,
it is necessary to pay attention to the possibility that the embolus migrates to the anterior cerebral artery. Moreover, when multiple distal lesions between proximal lesion and furthest lesion are present, the GC may be occluded by the thrombus and aspiration may not be possible when aspiration is applied advancing the catheter to the distal lesion. Thus, it is necessary to confirm the absence of thrombus between the most distal occlusion and proximal lesion. It is important to confirm the absence of the residual thrombus at a site distal to the proximal lesion by guiding the microcatheter to distal occlusion under contrast imaging, and also the angiography in the other vessel is required for checking collaterals and the presence of the thrombus in the affected vessel by a retrograde fashion. Furthermore, in the simultaneous approach, selection of a balloon catheter for angioplasty is limited. The push wire of the SR was 0.018 inches in width (exc.0.015 inches in Trevo ProVue 3 × 20 mm; Stryker) and it is necessary to use a balloon catheter for angioplasty fit to it. On the other hand, in the method advancing the GC to the distal lesion after angioplasty of the proximal lesion, embolic complication can be prevented by placing Carotid Guardwire PS (Medtronic Vascular) or a filter device at a site distal to the proximal lesion under flow control by inflation of the balloon attached to the GC at CCA. However, exchange of the Carotid Guardwire PS and PTA balloon for the microwire and microcatheter is required in this method.

Moreover, it may be difficult to advance the GC to the distal side after angioplasty or the GC length may be short in some cases. Use of intermediate catheter may be considered. As this method is focused on early reperfusion of the ischemic brain with TO whose proximal lesion is considered atherosclerotic lesion, this should not be applied when proximal lesion is suspected due to the emboli. Thus, cause of the proximal lesion should be assessed before procedure by ultrasonography and/or MR imaging.

### Conclusion

For TO in acute ischemic stroke patients, the simultaneous approach treating the distal and proximal lesions may achieve effective recanalization. Approaching the thrombus in the distal lesion prior to proximal lesion may achieve early transient recanalization of the distal lesion.

### Disclosure Statement

None of the first and co-authors has conflict of interest.

### References


