Thrombectomy Using Penumbra System for In-stent Reocclusion after Revascularization with Stent for Acute Stroke: A Case Report

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Objective: The authors report a case treated using the Penumbra system for in-stent reocclusion after revascularization with stent for acute intracranial artery occlusion.

Case Presentations: The patient was a 37-year-old woman. Endovascular treatment was performed for acute occlusion of the M1 segment of the left middle cerebral artery, and recanalization was achieved eventually by placing an Enterprise Vascular Reconstruction Device (VRD). In-stent reocclusion was noted 9 hours after the procedure, and revascularization was achieved by aspirating the thrombus at the site of occlusion using the Penumbra system. Treatment using the Penumbra system was possible without interference by the stent.

Conclusion: Thrombectomy using the Penumbra system is an option for in-stent reocclusion after stent placement for acute intracranial large vessel occlusion.

Keywords ▶ in-stent occlusion, Penumbra system, thrombectomy, revascularization

Introduction

Efficacy and safety of mechanical thrombectomy for acute revascularization of large intracranial vessels have been demonstrated1) and it is becoming a standard treatment for large vessel occlusion. An improvement in the recanalization rate is a factor of an improvement in the outcome of acute revascularization therapy,2) but recanalization may not be achieved even by the use of novel devices.1) In such cases, attempting recanalization by placing intracranial stents, such as the Enterprise Vascular Reconstruction Device (VRD; Cordis Neurovascular, Inc., Miami Lakes, FL, USA), is a treatment option.3–6) However, there is a possibility of in-stent reocclusion after stenting in the acute period. In addition, discussion about the revascularization procedure for in-stent reocclusion remains insufficient. This report presents a case in which revascularization could be achieved using the Penumbra system (Penumbra Inc., Alameda, CA, USA) after in-stent reocclusion following recanalization by stent placement for acute middle cerebral artery occlusion.

Case Presentations

A 37-year-old female presented with paralysis of the right upper and lower extremities and aphasia. She was treated for uterine cervical cancer but had no other histories, in particular.

She underwent extended hysterectomy for uterine cervical cancer 2 months before the onset. She had anorexia and diarrhea due to the effects of postoperative radiotherapy. She was examined at the emergency department of our hospital 1 hour and 20 minutes after the onset of neurological symptoms.
On arrival, hemiparesis of the right upper and lower extremities and aphasia were noted, and the National Institutes of Health Stroke Scale (NIHSS) score was 11. Diffusion-weighted imaging (DWI) of head MRI showed faint hyperintensities in the left putamen and corona radiata, and the Alberta Stroke Programme Early CT Score (ASPECTS)-DWI was 9. MRA revealed occlusion of the left middle cerebral artery (MCA). On blood tests, no cytopenia was noted despite chemotherapy, and there were no other particular findings. Blood coagulation test also yielded no particular findings. On electrocardiogram, arrhythmia was negative.

The administration of tissue plasminogen activator (tPA) was initiated approximately 3 hours after the onset. Mild alleviation was observed in paralysis of the right upper and lower extremities 15 minutes after the beginning of the administration, and the NIHSS score improved to 9, but aphasia showed no change. Since neurological symptoms persisted 30 minutes after the beginning of the administration, the effect of tPA was judged to be insufficient, and revascularization therapy was performed.

**First revascularization procedure**

Occlusion of a proximal M1 segment of the left MCA was noted by angiography (Fig. 1A). Thrombectomy was attempted twice using Solitaire FR 6–30 mm (eV3 Covidien, Irvine, CA, USA), but recanalization could not be achieved (Figs. 1B and 1C). Since marked stenosis was observed at the time of temporary recanalization immediately after the deployment of Solitaire (Fig. 1B), an atherosclerotic stenotic lesion was considered possible, and angioplasty was performed using a micro-balloon catheter (Gateway 2–9 mm; Stryker, Kalamazoo, MI, USA) (Fig. 1D). Although the site of occlusion was temporarily recanalized, it soon showed marked stenosis and caused stagnation of the blood flow (Fig. 1E). Therefore, stent placement was considered necessary. The Enterprise VRD was selected because of the closed cell type stent design, appropriate radial force, and guidability. A Prowler Select Plus (Cordis Neurovascular, Inc., Miami Lakes, FL, USA) was advanced to the lesion, and an Enterprise VRD 4.5–22 mm was placed. Before stent placement, cilostazol 200 mg and clopidogrel 300 mg were orally administered, and ozagrel sodium 80 mg was intravenously administered. Although recanalization was achieved by
stenting, stenosis remained, and balloon dilation was made in the stent using a Gateway 2.0–9 mm. A thrombus appeared in the stent, but as the thrombus appeared to gradually resolve after intra-arterial injection of a 10-fold dilution of 40 mg ozagrel sodium, the procedure was ended (Thrombolysis in cerebral infarction [TICI] 3) (Figs. 1F and 1G). No change in neurological findings (NIHSS: 9) was observed after the endovascular treatment. Cone beam CT showed limited expansion of the Enterprise VRD at the site of occlusion (Fig. 1H).

Second revascularization procedure
Paralysis of the right upper and lower extremities was exacerbated 9 hours after the initial treatment, and the NIHSS score deteriorated to 11. On MRI DWI, the hyperintensities observed at previous imaging became clearer, a new faint hyperintense area appeared in the cortex of the MCA region, and the ASPECTS-DWI was 7. Since the MCA distal to the stent was not delineated, revascularization therapy was performed again, suspecting reocclusion of the stent.

Angiography confirmed reocclusion in the stent placed in the M1 segment of the left MCA (Fig. 2A). Since a stent (Enterprise VRD) was already placed, the use of a stent retriever was considered difficult. Also, as the effect of balloon angioplasty was insufficient at the initial treatment, the Penumbra system was selected.

A Penumbra 3MAX reperfusion catheter (3MAX; Penumbra Inc.) and a Penumbra 5MAX reperfusion catheter (5MAX; Penumbra Inc.) were coaxially advanced to the lesion (Figs. 2B and 2C). Caution was exercised to avoid interference by the large-bore 5MAX at the proximal end of the stent. First, a 3MAX was inserted to a distal part of the M1 through the site of in-stent occlusion. Tracking the 3MAX, a 5MAX was advanced through the site of occlusion (Fig. 2E). Hereafter, by withdrawing the 5MAX to a proximal part of the stent while aspirating, small clots could be retrieved in the syringe (Fig. 2F). Although a small amount of clots remained in the stent, re-recanalization of the site of occlusion could be achieved (TICI 3) (Fig. 2G). On cone beam CT, the...
Enterprise VRD expanded more compared with the state at the end of the initial treatment (Fig. 2H).

Postoperative course
Right paresis was resolved on the day after the second treatment, and the NIHSS score improved to 4 despite partial persistence of aphasia. After the procedure, dual-antiplatelet therapy using cilostazol at 200 mg/day and clopidogrel at 75 mg/day was continued. Trousseau syndrome was considered possible, but no abnormality was noted on blood coagulation tests after admission. No finding that clearly suggested the mechanism of embolization was noted on other examinations. Since there was no risk factor of atherosclerosis, arterial dissection or deterioration of the general condition due to anticancer chemotherapy was considered as a cause of MCA occlusion but no clear conclusion was reached. Aphasia nearly disappeared in the subsequent course, and the modified Rankin Scale score 3 months after the onset was 1. In addition, no stenosis was noted at the site of stenting on cerebral angiography performed 6 months after the onset.

Discussion
Stent type thrombus-retrieving devices have become generally available and the efficacy and safety of stent retriever for acute stroke has been demonstrated. Additionally, high recanalization rates have been reported by the direct aspiration first pass technique (ADAPT), which is a modification of the conventional procedure using the Penumbra system. However, acute occlusion of major intracranial arteries may be caused by embolic lesions that cannot be recanalized by the above devices as well as atherosclerotic lesions and arterial dissection. In revascularization therapy for acute occlusion of major intracranial arteries, in which recanalization is a prognostic factor, stenting is an option to achieve recanalization. In the patient presented here, the cause of vascular occlusion was unclear, but recanalization could not be achieved by treatments using stent retriever or balloon dilation but was achieved by stenting at the initial treatment. Recanalization by stenting is an effective measure, but there is concern over the possibility of in-stent occlusion after stenting in the acute period due to causes including an insufficient effect of antiplatelets. In addition, there have been few reports on revascularization for acute in-stent reocclusion, and its evaluation is insufficient. If reocclusion occurs in the stent after its placement, a stent retriever for mechanical thrombectomy is difficult to use because it is considered to interfere with the stent that has been placed. Therefore, treatments for acute in-stent occlusion include intra-arterial drug therapy, balloon dilation, stent in stent, and aspiration of the thrombus using the Penumbra system. Mocco et al. reported two cases in which recanalization could be achieved by intra-arterial infusion of glycoprotein IIb/IIIa inhibitors after reocclusion of the Enterprise VRD and three cases in which recanalization could be achieved by placing the Enterprise VRD after treatment with Wingspan stent. In our patient, we first selected thrombus aspiration using the Penumbra system. A point that should be considered in attempting recanalization of in-stent occlusion using the Penumbra system is interference between the Penumbra catheter, which is larger in diameter than the usual microcatheter and the stent. In our patient, the diameter of the MCA was about 2–2.5 mm, and the Enterprise VRD was known to be dilated to an extent by cone beam CT performed at the initial treatment. By coaxial navigation of a 3MAX (external tip diameter: 0.050 inch, 1.27 mm) and a 5MAX (0.074 inch, 1.78 mm), even the large-bore 5MAX could be led to the lesion easily without interference by the stent strut.

In the thrombus aspiration procedure using the Penumbra system, the catheter is usually advanced antegradely, but we performed aspiration while withdrawing the catheter to avoid interference in the stent. The thrombus is considered to have been fragmented by the Penumbra catheter passing through the occluded part in the stent. We did not perform cone beam CT before recanalization therapy, and the stent may have been dilated due to the radial force of the Enterprise VRD itself. However, as the Enterprise VRD was expanded after the second treatment compared with the state at the end of the first treatment, passing the Penumbra catheter through the occluded area in the stent is considered to have an angioplastastic (stent dilating) effect.

Conclusion
Thrombus aspiration using the Penumbra system is an option for the treatment of reocclusion after revascularization by stent placement for acute occlusion of major intracranial vessels.

Disclosure Statement
The first author and coauthors have no conflicts of interest to disclose regarding this paper.
References


