Percutaneous Mechanical Thrombectomy in a Patient with Symptomatic Carotid Stenosis and Ipsilateral Middle Cerebral Artery Occlusion

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Abstract

Objective: We report a case of acute internal carotid artery (ICA) severe stenosis completely recanalized using a stent placement and a Solitaire FR.

Case presentation: A 72-year-old man presented with sudden onset of left hemiplegia and dysarthria. MRI showed early ischemic changes in the right insular cortex and frontal cortex along with right severe ICA stenosis. Cerebral angiography demonstrated severe stenosis at the origin of the right ICA and middle cerebral artery (MCA) occlusion. The ICA stenosis was improved by stent placement at the origin of ICA, and MCA occlusion was done by thrombectomy using the Solitaire FR resulting in neurological improvement.

Conclusion: IV-tPA therapy was not particularly useful in patients with ICA severe stenosis. However, if standard medical management is ineffective in patients with acute cerebral infarction due to tandem arterial lesions, combined percutaneous revascularization of each lesions can prevent catastrophic events.

Key words: acute cerebral infarction, carotid artery stenting, percutaneous mechanical thrombectomy, Solitaire FR, tandem lesion

Introduction

Intravenous recombinant tissue plasminogen activator (iv rt-PA) therapy and emergency percutaneous revascularization are important in the treatment of acute cerebral infarction due to distal embolic or hemodynamic ischemia attributable to extracranial carotid artery stenosis, which carries the risk for rapidly progressing cerebral ischemia. However, even with rapid reperfusion via a pharmacological or mechanical approach the treatment of tandem arterial lesions of extracranial and intracranial blood vessels can be difficult.  

We report a patient in whom carotid artery stenting (CAS) and percutaneous mechanical thrombectomy (PMT) using a Solitaire flow restoration device (Solitaire FR, ev3 Covidien, Irvine, CA, USA) were useful for achieving revascularization for acute cerebral infarction due to middle cerebral artery (MCA) occlusion attributable to internal carotid artery (ICA) stenosis.

Case Report

This 72-year-old man with a history of hypertension suddenly experienced dysarthria and paralysis of the left upper and lower limbs. He was transported to our hospital 1 hour post-onset. On arrival, his consciousness level was I-1 on the Japan Coma Scale and he presented with left hemiparesis that included the face [6 on the National Institute of Health Stroke Scale (NIHSS)]. Blood biochemistry findings revealed no evidence of inflammation or coagulation system abnormalities. Electrocardiography indicated sinus rhythm at 80 beats/
min. Head CT showed no cerebral parenchymal lesions, however, hyperdense MCA signs were observed in the right Sylvian fissure. Diffusion-weighted magnetic resonance imaging (DW-MRI) disclosed lesions consistent with his acute cerebral infarction throughout the right cerebral hemisphere (6 on the Alberta Stroke Program Early CT Score on DWI). The right ICA region was poorly depicted on MR angiograms (Figs. 1A and B). Based on his clinical symptoms and our imaging findings that showed the extent of the ischemic lesions and vascular occlusion, we made a diagnosis of hyperacute cerebral infarction. We started iv rt-PA therapy following intravenous administration of edaravone 3.5 hr post-onset. Angiographs acquired 30 min after the start of iv rt-PA therapy showed severe stenosis at the origin of the right ICA (North American Symptomatic Carotid Endarterectomy Trial score 95%) and occlusion of the right MCA [Thrombolysis in Cerebral Infarction (TICI) grade 0]. As collateral blood flow from the contralateral anterior- and the posterior circulation was poor and his clinical symptoms continued to worsen gradually we delivered emergency reperfusion therapy.

Endovascular Treatment

An 8-Fr balloon-tipped guiding catheter (Optimo, Tokai Medical Products, Aichi, Japan) was placed in the right common carotid artery (CCA) via the trans-femoral approach. After blockage of blood flow in the proximal CCA we advanced a Spider FX device (eV3 Neurovascular, Irvine, CA, USA) over the micro-guidewire crossing the stenotic lesion and deployed a filter at the distal ICA. After releasing blockage of the proximal blood flow in the ICA the vessel was predilated with a balloon catheter, and a 10–24-mm Carotid Wallstent (Boston Scientific, Natick, MA, USA) was placed (Figs. 2A, 2B).

Imaging study performed after stent placement demonstrated good dilation of the stenotic ICA lesion at 5 hr 30 min post-onset. However, because the MCA occlusion remained unchanged (Fig. 3A) the Optimo catheter was advanced to the ICA segment distal to the stent after retrieval of the Spider FX device. A microcatheter Marksman (ev3 Covidien, Irvine, CA, USA) was advanced over a 0.014-inch guidewire (ASAHI CHIKAI, Asahi Intecc, Aichi, Japan) to the segment distal to the occlusion, and a Solitaire FR (SFR 4–15 mm) device was placed at the occluded segment. Recanalization was thereby obtained. Due to re-occlusion at the same segment 10 min later, the blood flow in the proximal ICA was blocked with the Optimo, and the Solitaire FR was gently retrieved. Subsequent angiography confirmed successful
Fig. 2
A: Right common carotid artery angiogram (lateral view) shows severe stenosis at the origin of the internal carotid artery (arrow).
B: Right common carotid artery angiogram (lateral view) shows improved carotid stenosis after carotid artery stenting.

Fig. 3
A: Right common carotid artery angiogram (A-P view) shows right middle cerebral artery (MCA) occlusion (arrow).
B: Right common carotid artery angiogram (A-P view) shows right MCA recanalization.
recanalization of the MCA (TCI grade 3) (Fig. 3B) and removal of thrombi at 6 hr post-onset (Fig. 4). After reperfusion therapy, his neurological symptoms gradually resolved.

Immediately after these procedures we started treatment with ozagrel sodium and systemic heparinization (10,000 U/day); dual-agent antiplatelet therapy (aspirin 100 mg/day and cilostazol 200 mg/day) was added the following day. Neither new cerebral infarction nor re-occlusion of the blood vessels was observed. Although mild impairment of dexterity of the left hand and fingers persisted, the patient was discharged home with an NIHSS and a modified Rankin Scale score of 1 on post-procedural day 14.

Discussion

In patients with acute cerebral infarction due to severe stenosis or occlusion of the ICA, the effect of iv rt-PA therapy alone has been reported to be low.\(^4,5\) When stenosis at the origin of the ICA elicits artery-to-artery embolism in the distal segment of the blood vessel, the decreased perfusion volume promotes thrombus formation and this results in the rapid expansion of the cerebral infarction.\(^1,2\) In our patient physiological findings made cardiogenic embolism unlikely, therefore we thought that his MCA occlusion was due to artery-to-artery embolism attributable to atherothrombosis elicited by ICA stenosis. Because the effect of iv rt-PA therapy alone was insufficient we added PMT and obtained satisfactory therapeutic effects. We first performed CAS followed by PMT. Another PMT strategy is to pass the proximal carotid artery occlusion or the artery communicating with the circle of Willis before extracranial recanalization.\(^6,7\)

However, PMT before CAS may be difficult because severe ICA stenosis would prevent navigation of a guiding catheter to the distal ICA. In addition, timely recanalization of the ICA stenosis not only improves the collateral flow to the ischemic penumbra but also augments the regional perfusion pressure and delivers fresh blood to the MCA occlusion site. This facilitates endogenous thrombolysis and may result in immediate or delayed recanalization even if PMT fails.\(^8\)

In Japan, the Merci Retrieval System (Concentric Medical, Mountain View, CA, USA), the Penumbra Aspiration System (Penumbra Inc., Alameda, CA, USA), TrevoProVue (Stryker, Kalamazoo, MI, USA), and the Solitaire FR are approved devices for PMT to address intracranial arterial
occlusion. While we could have used any of these devices, we performed PMT with the Solitaire FR because it is a stent-based thrombectomy device that allows recanalization immediately after placement. Its reported recanalization rate is the same as or higher than that of the other devices at the same or lower complication rate.\(^9\)\(^{-}\)\(^{11}\)

For CAS and PMT to treat acute cerebral infarction we emphasize certain particularly important points. With respect to CAS, the selection of a self-expandable stent and an embolic protection device (EPD) is important. Although we were unable to evaluate our patient's carotid plaques because he required emergency treatment, due to the presence of tandem lesions we strongly suspect that he harbored vulnerable plaques. Because CAS with an open-cell stent often elicits embolic complications due to plaque protrusion, we selected a self-expandable closed-cell stent and we were careful to avoid over-dilating the lesion.\(^{12}\)\(^{-}\)\(^{13}\)

Furthermore, closed-cell stents can be advanced without interference from the stent struts because the carotid Wallstent is a closed cell design self-expanding stent composed of biomedical DFT (Drawn Filled Tubing) alloy monofilament wires braided in a tubular mesh configuration. Woong et al also report that closed-cell type Wallstent made it easier to advance the guiding catheter than open-cell type stents.\(^8\)

Emboli may arise when the EPD crosses areas of severe stenosis involving many plaques. Therefore, although placement of a proximal flow reversal system (FRS) is recommended in cases where the carotid stenosis consists of a floating thrombus or a pseudo-occlusion, it should be noted that patients with isolated intracranial circulation are intolerant of flow arrest or flow reversal.\(^{14}\)\(^{11}\) A temporary FRS such as the "seat and air bag technique" tends to be used to address this problem.\(^{14}\) We blocked the blood flow in the proximal CCA only when advancing the filter-design EPD through the lesion, thereby maintaining the anterograde cerebral blood flow.

In fact, we found that temporarily blocking the proximal blood flow was useful for the subsequent additional PMT. The second important point is the location of the tip of the guiding catheter at the time of Solitaire FR retrieval. Unlike with the Penumbra Aspiration System, thrombi are removed to a guiding catheter when the Solitaire FR or the Merci Retrieval technique is used. We were concerned that when the thrombi were removed, the retrieval device might be caught on the carotid artery stent and that this would render its extraction difficult.\(^{15}\)\(^{-}\)\(^{16}\) Therefore we advanced a balloon-tipped guiding catheter to the distal ICA and slowly inflated the balloon under fluoroscopic guidance. This made retrieval of the Solitaire FR easy. Post-procedural imaging study showed no signs of vascular dissection or vasospasm at the site of the blocked blood flow.

The risk of intracranial hemorrhage due to hyperperfusion is potentially high in patients with acute stroke receiving emergent CAS because anticoagulation and antiplatelet medications must be administered during or after the procedure.\(^{17}\) In our case, although anticoagulation and antiplatelet therapy were added immediately after CAS and PMT, there was no intracranial hemorrhage. Although we did not perform preoperative hemodynamic study due to the emergency nature of this case, we suspect that our patient's cerebral infarction was due to artery-to-artery embolism rather than hemodynamic ischemia which may affect the incidence of hyperperfusion syndrome after emergent CAS. In cases such as ours, the development of hyperperfusion syndrome may be avoided by strict blood pressure control.

**Conclusion**

In patients with acute cerebral infarction associated with tandem arterial lesions, iv rt-PA therapy alone may not exert an adequate therapeutic effect. Therefore, we advocate therapeutic strategies that involve additional percutaneous revascularization. PMT using the Solitaire FR device achieves successful recanalization and can be safely and effectively performed by adjusting the placement site of a balloon-tipped guiding catheter that is used concurrently for CAS.

**Conflicts of Interest Disclosure**

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices used in this article. All authors who are members of The Japan Neurovascular Society have registered online self-reported COI Disclosure Statement Forms.
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