Carotid-cavernous Fistula Caused by Vessel Injury while Withdrawing a Stent Retriever during Mechanical Thrombectomy for Acute Ischemic Stroke: A Case Report

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Objective: A rare complication, a carotid-cavernous fistula (CCF), that developed during stent retriever thrombectomy for acute ischemic stroke is reported.

Case Presentation: A 67-year-old woman with consciousness disturbance and left hemiparesis underwent stent retriever thrombectomy for acute right M1 proximal occlusion of the middle cerebral artery (MCA) 6 hours after onset. There were several tortuous vascular segments in the approach route. Strong resistance was felt while the stent retriever was withdrawn. The cavernous segment of the internal carotid artery (ICA) was stretched by anchoring of the balloon and the stent retriever. Angiography immediately after thrombectomy showed a CCF although successful recanalization was obtained. This was probably caused by pull-out vessel injury of the meningohypophyseal trunk branching from the cavernous segment of the ICA. The CCF was treated with transvenous coil embolization 3 weeks after thrombectomy and disappeared angiographically.

Conclusion: If there is strong resistance while pulling back a stent retriever, the risk of vascular injury, such as a CCF, should be kept in mind.

Keywords ▶ carotid-cavernous fistula, stent retriever, thrombectomy, acute ischemic stroke

Introduction

Mechanical thrombectomy for the treatment of acute ischemic stroke has recently shown significant advances. The use of new revascularization devices and techniques for thrombectomy has improved the recanalization rates and clinical outcomes remarkably. Recent randomized studies and meta-analysis of them have shown the benefits of endovascular treatment for acute ischemic stroke.1–10

Two main mechanical thrombectomy techniques have been used, including stent retrievers or direct aspiration using a large-bore aspiration catheter.11 These techniques lead to the highest degree of recanalization. However, complications related to the procedure, such as embolic events or hemorrhagic events, occur at a constant rate, which could affect eventual clinical outcomes.

A case of a rare complication, a carotid-cavernous fistula (CCF), due to possibility of pull-out vascular injury caused by vessel stretching during withdrawal of a stent retriever device is presented. The mechanism of occurrence of the CCF is discussed, and the pitfalls and prevention of complications during withdrawal of a stent retriever are considered.

Case Presentation

A 67-year-old woman was admitted to our institution with consciousness disturbance. She presented with severe dysarthria, eye deviation to the right, and left hemiparesis. She had no previous history of atrial fibrillation and electrocardiogram (ECG) on admission showed no atrial fibrillation.
Computed tomography on admission showed a light low-density area in the right middle cerebral artery (MCA) territory, the Alberta Stroke Program Early CT (ASPECT) score was 6 points, and diffusion-weighted magnetic resonance imaging showed an extensive high-intensity signal area in the right MCA territory. Magnetic resonance angiography demonstrated right M1 proximal occlusion of the MCA. The National Institutes of Health Stroke Scale (NIHSS) score was 21 points. Since more than 4.5 hours from the final confirmation had passed, recombinant tissue-type plasminogen activator was not administered. Mechanical thrombectomy was performed 6 hours after onset. All procedures were performed under minimal to moderate conscious sedation with a propofol infusion.

A 9-Fr Optimo balloon guiding catheter (BGC; Tokai Medical Products, Aichi, Japan) was navigated over a 5-Fr diagnostic catheter into the proximal right internal carotid artery (ICA) through a right femoral artery 9-Fr sheath. Right ICA angiography confirmed the right M1 proximal occlusion of the MCA and vascular tortuosity of the ICA (Fig. 1). Through the BGC, a Trevo 18 microcatheter (Stryker, Kalamazoo, MI, USA) was navigated into the right M2 segment of the MCA over a 0.014-inch microwire (Transend; Stryker). The M2 segment distal to the thrombus was confirmed with gentle manual injection through the microcatheter. Using standard technique, a Trevo ProVue 4 mm × 20 mm thrombectomy device (Stryker) was deployed across the occlusion from the M2 segment into the ICA terminal segment. After deployment of the stent retriever, a control angiogram was performed, and it demonstrated revascularization of the MCA and normal appearance of the proximal cervical and intracranial ICA, which appeared to be so-called immediate flow restoration. The stent retriever was left in position for 3–4 minutes and then gently withdrawn with proximal balloon inflation. However, strong resistance was felt while pulling the stent retriever. The stent retriever device did not move at all, and the blood vessel, which included the proximal segment of M1, the cavernous segment of the ICA, and the extradural ICA, was stretched by anchoring of the balloon and the stent retriever (Fig. 2). After repeated pulling of the stent retriever in a careful manner, this resistance subsequently disappeared. Finally, the stent retriever was withdrawn into the BGC. Thrombus was observed in the removed stent retriever device. After thrombectomy, complete revascularization was confirmed, but angiography also demonstrated a CCF in the cavernous segment of the ICA. Blood flow from the CCF was mainly antegrade to the inferior petrosal sinus (IPS) and basilar venous plexus, and partially retrograde to the superior ophthalmic vein (SOV), with no reflux to the cerebral vein (Fig. 3). The procedure was terminated, and it was decided to follow-up the CCF.

The patient underwent external decompression surgery 3 days after thrombectomy because of hemorrhagic infarction and brain edema. Her consciousness became clear, but she still showed left hemiplegia, left homonymous hemianopia, and left half spatial neglect. She also had left eyelid swelling, hyperemia, and conjunctival edema. Follow-up angiography was planned 2 weeks after thrombectomy. However, cerebral edema due to hemorrhagic infarction continued and general condition was poor because of urinary tract infection; therefore, the follow-up angiography...
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Fig. 2 The monitor screen shows that the stent retriever has been properly placed in the thrombus (A). The white line represents the stent retriever and its wire (B). The monitor screen shows that the wire of the stent retriever is stretching from the extracranial ICA segment to the terminal ICA segment although the stent retriever does not move at all (C) under balloon inflation (arrow). The white line represents the stent retriever and its wire (D). ICA: internal carotid artery

Fig. 3 Right internal carotid angiography immediately after thrombectomy shows a carotid-cavernous fistula that is draining into the inferior petrosal sinus and partially reversing to the superior ophthalmic vein (A) front image; (B) lateral image.

performed 3 weeks after treatment. Since follow-up angiography 3 weeks after thrombectomy showed increase in the shunt volume and reflux to the superficial middle cerebral vein as well as the SOV, transvenous coil embolization was performed for the cavernous shunt compartment under general anesthesia (Fig. 4). A 6-Fr guiding catheter was navigated over a 4-Fr diagnostic catheter to the internal jugular vein. Two microcatheters were introduced through the IPS into the cavernous sinus. One was positioned in the posterior compartment of the cavernous sinus, and the
other was positioned in the anterior compartment. The shunt compartment was treated with coil embolization using double-catheter technique. Shunt flow was markedly reduced by only posterior compartment sinus packing (Fig. 4). Angiography performed immediately after treatment showed no shunt flow, and the ocular symptoms gradually disappeared and there was no ocular movement disorder. She underwent cranioplasty 2 weeks after coil embolization. Paroxysmal atrial fibrillation was observed in Holter ECG for 24 hours during hospitalization. The patient was transferred to another rehabilitation hospital with a modified Rankin Scale score of 4 and an NIHSS score of 10, 3 months after onset.

Discussion

A rare case of CCF during stent retriever thrombectomy using a Trevo ProVue for acute M1 proximal occlusion was described. To the best of our knowledge, there have been no reports of a CCF caused by a vessel injury during stent retriever thrombectomy. This occurred probably as a result of pull-out vessel injury of the meningo-hypophyseal trunk branching from the cavernous segment of the ICA. The main mechanism contributing to the pull-out vessel injury was mechanical stretching of the vessel while withdrawing the stent retriever due to vessel tortuosity.

Recently, vascular injuries, as complications during stent retriever thrombectomy for acute ischemic stroke, have been reported.12–14) Leishangthem et al. reported a case of vessel perforation during withdrawal of a Trevo ProVue stent retriever during mechanical thrombectomy for acute ischemic stroke for the first time.15) Although they gently withdrew the stent retriever without difficulty, angiography immediately after demonstrated active extravasation from the posterior wall of the communicating segment of the ICA. Neurologic deterioration was not seen.
by reversal of anticoagulation and conservative treatment. Mokin et al. reported vessel perforation during stent retriever thrombectomy in detail.\textsuperscript{13} They reported that intra-procedural perforations during stent retriever thrombectomy were rare, but when they occurred, they were associated with high mortality, and they most commonly occurred at distal occlusion sites and were often characterized by difficulty traversing the occlusion with a microcatheter or microwire, or while withdrawing the stent retriever. As a rare case, Misaki et al. reported pseudoaneurysm formation on the M2 proximal portion caused by withdrawal of a Trevo ProVue stent.\textsuperscript{14} They demonstrated a pseudoaneurysm by 3D CT after stent retriever thrombectomy, and they treated the lesion with open surgical clipping to the injured distal M2 segment of the MCA. They thought that the pseudoaneurysm was likely formed by avulsion of a fine vessel during withdrawal of the stent retriever at a tortuous vessel.

Recently, it has been proposed that not only disruption of cerebral microvascular permeability barriers, but also the stretching of arteries and accompanying veins in the subarachnoid space during the withdrawal of the stent retriever plays an important role in the mechanism of angiographically occult ruptures with extravasation of blood and/or contrast material.\textsuperscript{17,18}

If vessel injury occurs in the cavernous segment of the ICA, it may result in a CCF. In the present case, navigation of the microwire or the microcatheter was smooth and the stent retriever passed easily through the cavernous segment; however, it cannot be denied that the possibility of vessel perforation by the microwire or vascular dissection by the stent retriever. As another cause, we speculated that the CCF was likely to be pull-out vessel injury of the meningo-hypophyseal trunk branching from the ICA during withdrawal of a Trevo ProVue stent retriever. 3D rotation angiography was useful to identify the fistulous portion of the ICA. The pull-out-injured vessel was likely the meningo-hypophyseal trunk from the anatomical point of view because the shunt point seemed to be located in the posterior wall of the cavernous segment of the ICA on 3D rotation angiography. Because the fistulous hole was thought to be small, natural disappearance of the CCF was expected. However, follow-up angiography 3 weeks after thrombectomy demonstrated a residual CCF. Since it seemed difficult to enter the cavernous sinus via the ICA route, the transvenous approach via the IPS route was selected. The microcatheter was easily delivered into the cavernous sinus, and the fistulous compartment was selectively occluded in the cavernous sinus with coils. In the present case, follow-up angiography 3 weeks after thrombectomy showed increase in the shunt volume and reflux to the superficial middle cerebral vein as well as the SOV. We should have performed follow-up angiography and the treatment as soon as possible, even if the symptoms did not change.

In the present case, there were several tortuous vascular segments in the approach route from the extracranial proximal ICA to the M1 distal segment, such as the petrous segment, the carotid siphon, the ICA terminal segment, and the MCA bifurcation. It was easy to deliver the microcatheter and the stent retriever into the M2 segment. However, when the stent retriever was withdrawn, there was strong resistance on pull-back of the stent retriever, and the distal stent did not move at all. When the pulling force was increased slowly, the fluoroscopic screen showed that the wire of the stent retriever was stretched between the cavernous segment and the M1 proximal segment. This suggested that vascular dislocation had occurred due to the anchoring effect of the stent retriever radial force, and it enabled the stent retriever to straighten and be withdrawn, which triggered avulsion of a vessel branching from the cavernous segment of the ICA. This was the first case of stent retriever thrombectomy in our institution in early period. Trevo ProVue stent retriever of 4 m–20 mm might be too large size for M2 segment. In this case, probably Trevo ProVue stent retriever of 3 m–20 mm should be selected for M2 segment if it is now. Several vascular tortuositites in the access route increase the difficulty of withdrawing a stent retriever due to the anchoring effect and make it difficult for the traction force to be transmitted to the stent retriever in the periphery. To avoid such complications, the following methods can be considered at present. 1) The use of a distal access or intermediate catheter combined stent retriever may be useful, and it should be advanced into the ICA or M1 proximal portion. 2) Partial resheathing of the deployed stent retriever by advancing Trevo 18 microwasher again may be effective. 3) Partial deployment of the stent retriever from the beginning may also be safe and effective in the case of severe vascular tortuosity. 4) Aspiration device should be selected from the beginning in the case of severe vascular tortuosity.

In the present case, it should be reflected that the complication could be avoided if the above measures were performed properly during the thrombectomy. It is important for operators who are unfamiliar with stent retriever to have knowledge of rare complication and appropriate troubleshooting methods.
In conclusion, if there is strong resistance while pulling back a stent retriever, the risk of vascular injury, such as the development of a CCF, should be kept in mind.

Disclosure Statement

The first author and coauthors have no conflicts of interest.

References