

Vessel perforation during withdrawal of Trevo ProVue stent retriever during mechanical thrombectomy for acute ischemic stroke

Case report

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The authors report a case of an intracranial extravasation during the withdrawal of a Trevo ProVue stent retriever device in a patient being treated for acute ischemic stroke. An 82-year-old woman developed sudden left hemiparesis and aphasia during an urgent cardiac catheterization procedure for a non-ST elevation myocardial infarction. She had a baseline National Institutes of Health Stroke Scale (NIHSS) score of at least 10 and no improvement with intravenous administration of tissue plasminogen activator (tPA). Cerebral angiography was performed with conscious sedation, confirming an occlusion of the superior division of the right middle cerebral artery (MCA). Using standard technique, a Trevo thrombectomy device was deployed across the clot. Post-thrombectomy control angiography demonstrated complete revascularization of the right MCA. The device was then gently withdrawn without difficulty. Immediately afterward the patient's blood pressure showed a sudden and significant elevation. Immediate posttreatment angiography demonstrated active extravasation from the posterior wall of the communicating segment of the right internal carotid artery. Rapid cessation of bleeding was achieved with intravenous administration of protamine and induced hypotension. Immediate neurological assessment was performed, which showed motor improvement. An immediate postintervention CT scan confirmed a moderate-sized subarachnoid hemorrhage and contrast in the prepontine cistern. The patient was discharged home on postoperative Day 3 with an NIHSS score of zero. At 6-month follow-up in the neurointerventional clinic, her NIHSS and modified Rankin Scale scores were both zero.

Endovascular stent retriever devices are increasingly being used as first-line thrombectomy devices in acute embolic strokes. A unique and previously undescribed complication is vessel perforation during withdrawal of a stent retriever. Conservative treatment options and reversal of anticoagulation should be the first line of treatment for such complications. In the authors' case, performing the procedure without anesthesia was helpful in assessing the patient's neurological status.

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KEY WORDS • **mechanical thrombectomy** • **ischemic stroke** • **stent retriever** • **Trevo ProVue** • **interventional neurosurgery**

STENT retrievers are the newest FDA-approved devices specifically designed for mechanical thrombectomy in patients with acute ischemic stroke. Clinical experience with these new devices is limited.

We present here what is to the best of our knowledge the first reported case of an intracranial hemorrhage due to vascular trauma caused during withdrawal of a stent retriever device, Trevo ProVue (Stryker Neurovascular). The risk of endovascular trauma during device removal has not been previously described and the frequency of such injuries may be greater than has been recognized.

The goal of this paper is to raise awareness that such a rare complication may occur while treating acute ischemic stroke with stent retriever devices and to suggest that conservative management, including reversal of heparin and lowering the patient's blood pressure may be sufficient to stop the bleeding. Vessel sacrifice can be reserved as a treatment option to be employed if there is continued bleeding despite conservative measures. We also highlight the advantages of performing intraarterial thrombectomy with conscious sedation rather than general anesthesia.

Case Report

Clinical Presentation. An 82-year-old female presented to our hospital with non-ST elevation myocardial infarction. She underwent urgent cardiac catheterization.

Abbreviations used in this paper: ICA = internal carotid artery; IV = intravenous; MCA = middle cerebral artery; NIHSS = National Institutes of Health Stroke Scale; TICI = thrombolysis in cerebral infarction; tPA = tissue plasminogen activator.

After a diagnostic left coronary angiogram was performed, it was noted that the patient was aphasic and had left hemiparesis. A stroke alert was initiated, and the patient was found to have a baseline National Institutes of Health Stroke Scale (NIHSS) score of at least 10. The patient was transferred to the neurointerventional suite, and a DynaCT scan did not demonstrate any definite evidence for gross hemorrhage or complete infarction. Tissue plasminogen activator (tPA) with a standard weight-based intravenous (IV) bolus followed by continued IV drip, but no clinical improvement was observed. Cerebral angiography was performed with conscious sedation.

Intervention. Through a right common femoral artery 8-Fr sheath, a 6-Fr shuttle guide catheter was navigated over a 5-Fr 125-cm Cook VTK diagnostic catheter and a Terumo 180-cm Glidewire Advantage in the proximal right internal carotid artery (ICA) under real-time fluoroscopy and with road map guidance.

A right ICA angiogram confirmed an occlusion of the right distal M_1 and proximal superior division of the M_2 segment of the middle cerebral artery (MCA) (Fig. 1A). Using standard technique, a Trevo 18 microcatheter was navigated into the right MCA over a Stryker Neurovascular Synchro2 soft 200-cm 0.014-inch microwire. Intravascular position distal to the thrombus was confirmed with gentle hand injection through the microcatheter. Using standard technique, a Trevo ProVue 4 mm \times 20-mm thrombectomy

device was deployed across the occlusion from the M_2 segment into the distal ICA. After deployment, a control angiogram was performed and demonstrated revascularization of the MCA and normal appearance of the proximal cervical and intracranial ICA (Fig. 1B). The device was left in position for 3–4 minutes and then gently withdrawn without difficulty into the right ICA shuttle sheath while a second operator aspirated the shuttle sheath. Postthrombectomy angiography demonstrated near-complete revascularization, thrombolysis in cerebral infarction (TICI) score 2b flow, but there was also brisk active extravasation from the posterior wall of the communicating segment of the right ICA (Fig. 1C). This perforation was proximal to the initial deployment site of the device and was not evident on the initial angiogram or on the control angiogram with the Trevo ProVue deployed. Rapid neurological assessment noted improvement in the patient's motor deficit and aphasia. The device was withdrawn gently and without difficulty, but immediately after it was removed, the patient's blood pressure showed a sudden and significant elevation. The patient's blood pressure was lowered with IV metoprolol and she was given 25 mg IV protamine. Serial neurological assessment demonstrated continued improvement. Five-minute angiography demonstrated cessation of extravasation, which was confirmed on 10-minute follow-up angiography (Fig. 1D).

Postoperative Course. The patient was transported

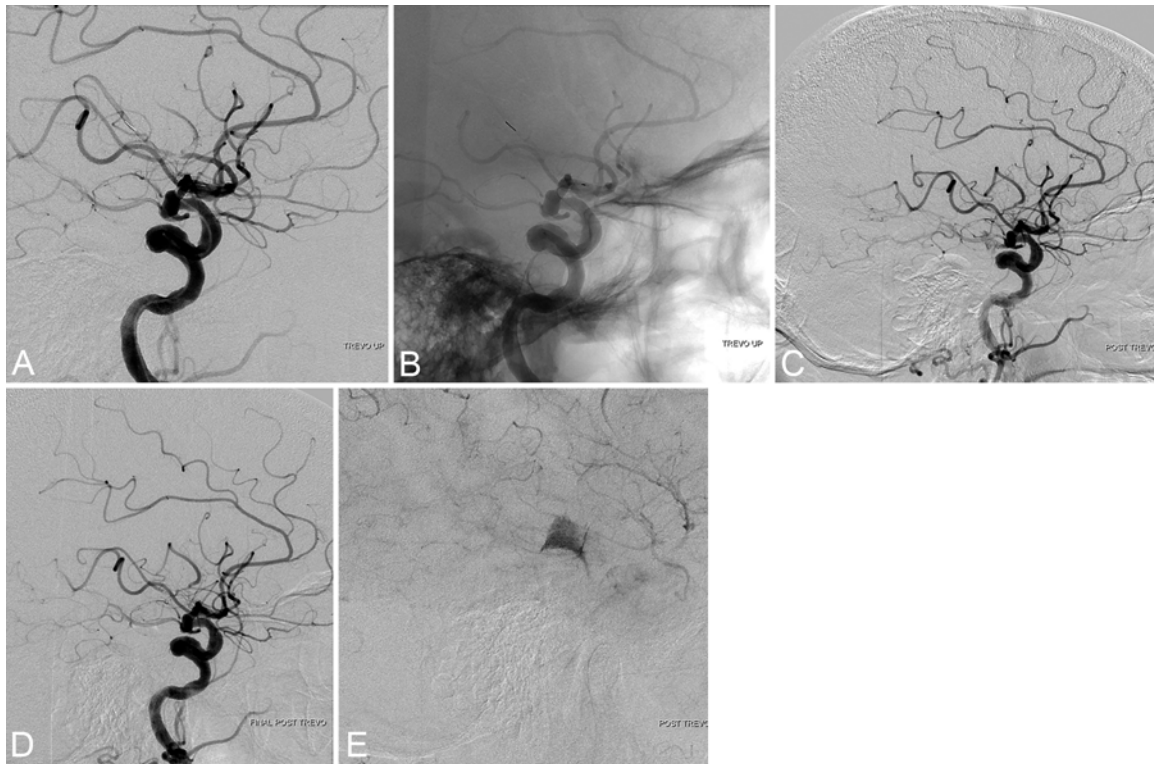


Fig. 1. **A:** Right ICA angiogram (lateral view) showing the Trevo ProVue deployed in the distal ICA into the superior division of the right M_2 with occlusive right M_1 - M_2 thrombus. **B:** Right ICA angiogram (lateral view) (unsubtracted image) showing the position of the Trevo ProVue. **C:** Right ICA angiogram (lateral view) showing active extravasation from the communicating segment of the ICA proximal to where the Trevo device was deployed. **D:** Right ICA angiogram (lateral view) obtained 10 minutes postthrombectomy demonstrating spontaneous cessation of bleeding. **E:** Right ICA venous-phase angiogram demonstrating blood pooling in the prepontine cistern.

Vessel perforation during Trevo ProVue treatment

to the CT scanner, which confirmed subarachnoid hemorrhage and contrast in the prepontine cistern; however, no acute transcortical infarction was noted (Fig. 1E). The patient was transferred to the neurointensive care unit for close observation and blood pressure control. Her NIHSS score was zero (no symptoms) 24 hours after the thrombectomy. A 12-hour follow-up noncontrast CT study demonstrated near-complete resorption of the subarachnoid hemorrhage (Fig. 2 left). A 24-hour follow-up MRI study showed minimal occipital lobe subarachnoid hemorrhage and MR angiography showed complete, TICI 3 revascularization of the right MCA (Fig. 2 right). The patient was discharged home on postoperative Day 3 and resumed aspirin therapy (81 mg per day) on postoperative Day 8. She underwent uneventful cardiac angiography and stent treatment of her left anterior descending coronary artery without complication approximately 6 weeks later. Her modified Rankin scale score at 3 months after the MCA occlusion and treatment was zero (no symptoms).

Discussion

Stroke is the fourth leading cause of death in the United States⁶ and a leading cause of serious long-term disability.¹² Currently, the standard of care for treatment of acute ischemic stroke is urgent thrombolysis using IV recombinant tPA within 3–4.5 hours.^{1,3,5} A subset of appropriately triaged patients may benefit from treatment with intraarterial mechanical thrombectomy devices.^{2,7} There has been rapid evolution of FDA-approved devices from the first such device, Merci (Stryker Neurovascular) in 2004,^{8,10,11} following on to the approval of stent retriever devices, Solitaire (Covidien/ev3, approved in March 2012) and Trevo (Stryker Neurovascular, approved in August 2012).⁴ The most recent trials, SWIFT (Solitaire With the Intention for Thrombectomy) and Trevo II, have shown higher recanalization rates, lower complication rates, and better clinical outcomes than were achieved with previous-generation devices.^{7,10} Stent retriever devices have been shown to have faster recanalization results than earlier mechanical devices as well as being easier to navigate into the cerebral vasculature due to improved

proximal support catheter technology and compatibility with smaller microcatheters.^{9,12}

Trevo ProVue is the most recently approved thrombectomy device (having been approved in August 2012). Due to improved design, the stent retrievers have demonstrated better revascularization rates, compared with the first FDA approved mechanical device, Concentric Merci. Currently the only two FDA-approved stent retrievers in the US market are the Solitaire device (Covidien) and the Trevo device (Stryker Neurovascular), although there are several versions of each device available. The passive deployment of the Trevo ProVue device by unsheathing the microcatheter should eliminate any potential vascular injury that could be caused by the device tip. The Trevo ProVue is also constructed of a single closed-cell nitinol hypotube and has no free margins, which should make retrieval of the device atraumatic. In comparison with the Solitaire FR stent retriever, the Trevo ProVue has higher radial force; it also has vertically oriented struts, which, in theory, should improve thrombus integration and extraction.⁷

A potential complication during deployment of the Trevo ProVue device could occur if the distal end of the device were pushed out of the delivery catheter, rather than being passively unsheathed. (Unsheathing the device minimizes the risk of vessel perforation during delivery.) This would not explain the bleeding far more proximal to the delivery site that we saw in our patient, which suggests the injury to the vessel occurred during retrieval of the device.⁷

To our knowledge, ours is the first reported case of a hemorrhage occurring during withdrawal of the Trevo ProVue device. Given the construction of the device, retrieval should be atraumatic and injury to the proximal vessel should theoretically be very unlikely. In our case, the perforation of the vessel during navigation of the microwire was unlikely because the vessel was imaged prior to navigation of the wire, after deployment of the Trevo device, and if there was an injury at that point, it would have been seen. The extravasation was seen immediately after withdrawal of the Trevo and corresponding to the spike in the patient's blood pressure.

In our patient, there was moderate tortuosity of the supraclinoid ICA. She may also have some intracranial atherosclerotic disease. Although we cannot be sure, a potential mechanism for injury was a perforation of the vessel related to tearing of plaque or injury to a small artery. We are, however, not sure of the exact cause of the bleeding and have no suggestion as to how to prevent this complication. We carefully withdrew the device using standard technique and have never seen this type of vessel injury during withdrawal of a stent retriever device in the 48 stent retriever cases (30 Solitaire and 18 Trevo) performed in our institution to date.

Having the patient awake allowed us to assess her condition and allowed us to confirm improvement in neurological examination findings. These factors could not be evaluated in a patient under general anesthesia, and the ability to evaluate them was critical to our management approach. Given the stable blood pressure and improving neurological examination findings, the operator

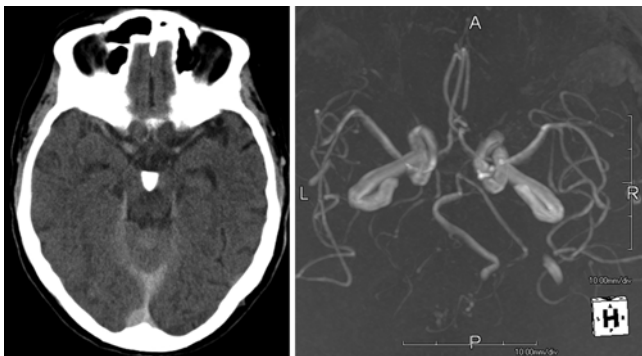


FIG. 2. **Left:** Immediate postprocedure noncontrast axial CT image demonstrating hyperdense material in the prepontine cistern, corresponding with the angiogram, and compatible vessel perforation and extravascular contrast. **Right:** Time-of-flight MR angiogram obtained 48 hours after the procedure demonstrating TICI 3 revascularization. A = anterior; L = left; P = posterior; R = right.

was comfortable in not immediately performing aggressive intervention to treat the perforation (such as balloon occlusion or vessel sacrifice). The conservative approach included anticoagulation reversal using protamine sulfate and rapid reduction in blood pressure. Rapid conservative medical management led to spontaneous cessation of the bleeding. The patient recovered fully without any residual neurological signs or symptoms at 6-month follow-up.

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Disclosure

Dr. Satti reports a consultant relationship with Stryker Neurovascular.

Author contributions to the study and manuscript preparation include the following. Conception and design: Satti. Drafting the article: both authors. Critically revising the article: both authors. Reviewed submitted version of manuscript: both authors. Approved the final version of the manuscript on behalf of both authors: Satti. Administrative/technical/material support: Leishangthem.

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