S TENT 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.
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 × 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...
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 States and a leading cause of serious long-term disability. Currently, the standard of care for treatment of acute ischemic stroke is urgent thrombolysis using IV recombinant tPA within 3–4.5 hours. A subset of appropriately triaged patients may benefit from treatment with intraarterial mechanical thrombectomy devices. There has been rapid evolution of FDA-approved devices from the first such device, Merci (Stryker Neurovascular) in 2004, following on to the approval of stent retriever devices, Solitaire (Covidien/ev3, approved in March 2012) and Trevo (Stryker Neurovascular, approved in August 2012). 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. 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.

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 deviceatraumatic. 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.

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.

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 microcatheter 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 had 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...
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.

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