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CASE REPORT

Complex Thrombectomy of Chronic Deep Vein Thrombosis

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A 72-year-old woman with a history of diabetes, dyslipidemia, hypertension, and previous right lower extremity deep vein thrombosis (DVT) presented with progressive left lower extremity swelling. The patient was originally treated 3 years earlier for unprovoked DVT with warfarin, which was discontinued after 6 months. She underwent uncomplicated ventral hernia surgery 6 weeks prior to her office visit. Two weeks after her surgery, she developed painful left lower extremity swelling and was found on venous duplex ultrasound to have extensive DVT involving the common femoral vein to the infrapopliteal veins. She was managed conservatively with intravenous heparin. A permanent inferior vena cava (IVC) filter was placed by her surgeon due to concerns over potential bleeding risk in the postoperative setting. She was discharged on oral rivaroxaban. Due to progressive, severe post-thrombotic syndrome (PTS), she was referred to my clinic by her primary care physician.

EXAMINATION AND INITIAL THERAPY

The patient's initial exam was notable for marked unilateral left lower extremity swelling (Figure 1). She reported daily pain with ambulation despite medications. There were few varicosities noted. Edema was seen even in the morning. There was recent skin pigmentation with mild inflammation and erythema. Extensive induration with recent onset of one small weeping venous ulceration was also noted. She was mostly compliant with compression stocking therapy (although she was in light uniform compression from the hospital setting). Based on these findings, she was noted to have C6 disease according to the CEAP classification with a Venous Clinical Severity Score (VCSS) of 18.[1,2]

Discussed treatment options included ongoing conservative management with anticoagulation and stronger compression stocking therapy (thigh-high measured graduated compression stockings of at least 20 to 30 mm Hg strength) versus interventional therapy. Due to her symptoms, the patient opted for the latter. She was maintained on rivaroxaban throughout her procedure and started on appropriate compression stocking therapy immediately.

INTERVENTIONAL PROCEDURE

The original treatment strategy was to attempt same-day therapy utilizing the 8-F AngioJet™ ZelanteDVT™ catheter (Boston Scientific Corporation) in combination with Power Pulse™ spray of alteplase (Genentech), a recombinant tissue plasminogen activator (tPA), into the chronic thrombus. The ZelanteDVT is a dual-lumen device that performs rheolytic thrombectomy via delivery of high-velocity pulsatile saline jets that help macerate thrombus.[3] The port can also be rotated to direct the thrombectomy (Figure 2). Power Pulse therapy allows delivery of physician-specified agents (usually a thrombolytic) into thrombus in a pulsatile fashion.[4]

On the first day, access was achieved in the right common femoral vein with the intention of going to the contralateral side for treatment over the iliac vein bifurcation. Direct access of the left popliteal vein (despite being thrombosed) could have been possible if we did not have to address extensive infrapopliteal thrombus as well. In our experience, if the inflow into the femoral vein is not established, the declotted segment can rethrombose rapidly due to stasis. Unfortunately, accessing the contra-

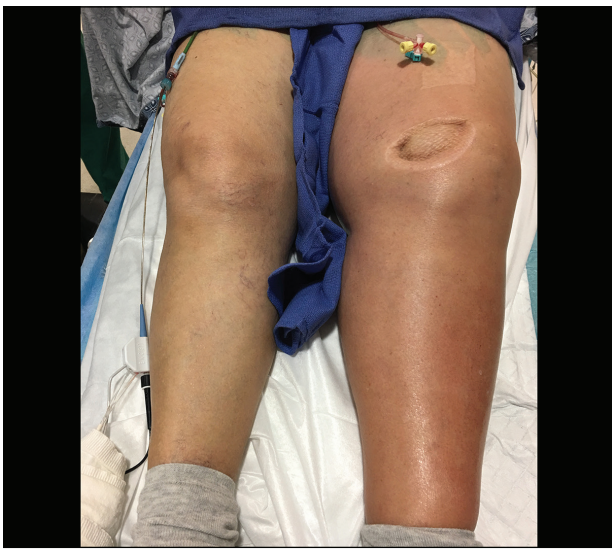

Figure 1. Initial presentation to the cardiac cath lab with marked swelling of the left lower extremity.

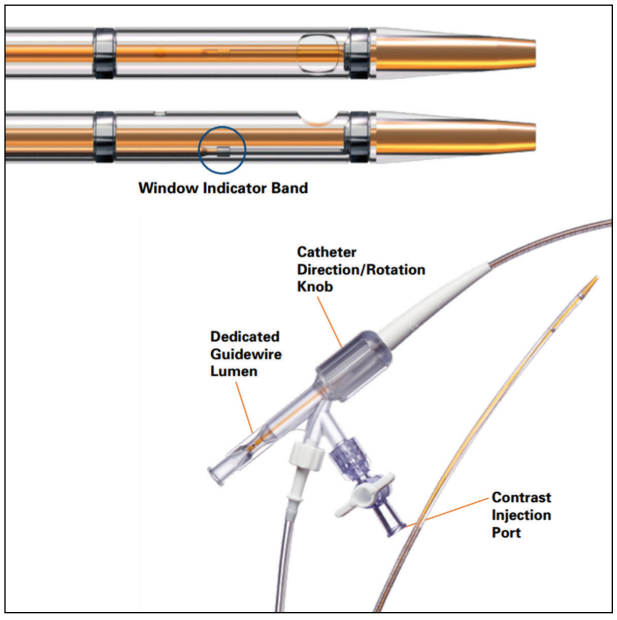

Figure 2. The AngioJet ZelanteDVT catheter.

lateral limb with a 5-F Contra catheter (Boston Scientific Corporation) and a hydrophilic guidewire was not possible due to apparent thrombosis of the entire left iliac venous system, which was not appreciated on previous outpatient imaging (Figure 3). We decided to perform ipsilateral pharmacomechanical catheter-directed thrombolysis (PCDT). The left common femoral was accessed within the thrombosed segment, and Power Pulse spray was performed using the ZelanteDVT catheter (16 mg of tPA in 50 mL normal saline instilled into the occluded segment from the left common iliac to the common femoral vein). After 45 minutes, we performed pharmacomechanical thrombectomy (PMT) with the ZelanteDVT catheter to remove thrombus. Intravascular ultrasound (IVUS) confirmed dense fibrotic changes and compression due to an overriding iliac artery (Figure 4). The presence of extensive May-Thurner syndrome (iliac vein compression) was likely a contributing factor to the patient's extensive thrombosis.[5] Additional balloon angioplasty was performed with an 8- X 200-mm noncompliant balloon at 20 atm, which created a reasonable outflow channel (Figure 5). We then were able to access the contralateral side from the right groin, using a crossing catheter to carefully navigate through the chronically thrombosed femoral vein until we could identify a patent infrapopliteal segment (Figure 6). A 50-cm EkoSonic MACH 4 catheter (BTG International) was deployed across the treatment zone infusing 1 mg tPA for 16 hours along with low-dose heparin.

The next day, we used the ZelanteDVT catheter to perform PMT from the level of the distal veins back into the femoral vein (Figure 7). An 8- X 200-mm noncompliant

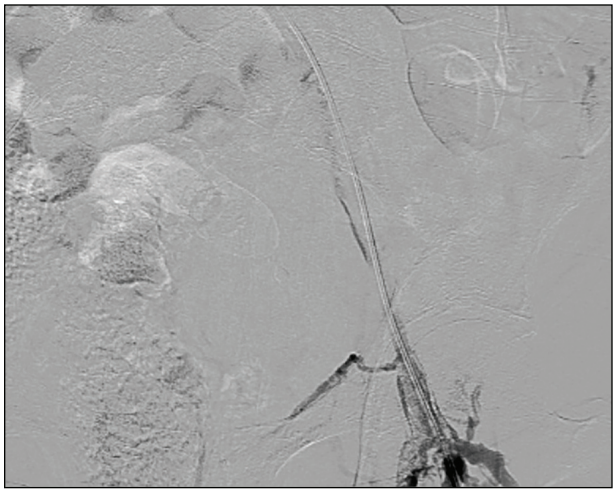

Figure 3. Occlusion of the left common iliac vein.

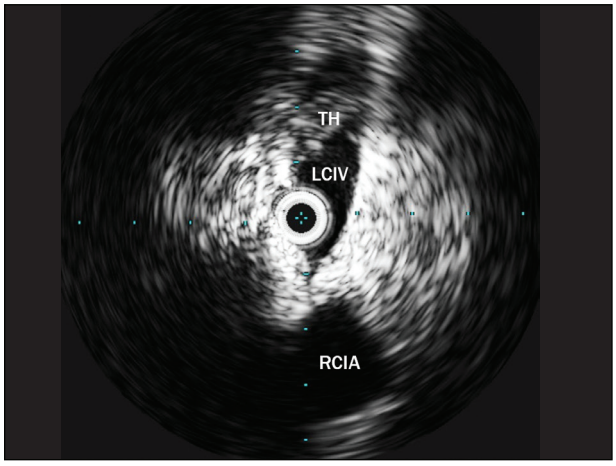

Figure 4. IVUS of the left common iliac vein demonstrating compression consistent with May-Thurner syndrome with overriding right common iliac artery. Abbreviations: LCIV, left common iliac vein; RCIA, right common iliac artery; TH, thrombus.

balloon was used for serial inflations in the femoral vein and a 10- X 80-mm balloon at the level of the common femoral vein. IVUS revealed that the compression originated at the level of the external iliac vein into the ostium of the common iliac vein. Access was achieved in the left common femoral vein, and a 16- X 90-mm self-expanding stent was deployed from the common to external iliac veins, postdilated distally with a 12-mm balloon and a 14-mm balloon proximally (Figure 8). IVUS revealed excellent wall apposition and resolution of compression. Final IVUS imaging confirmed no residual thrombus.

FOLLOW-UP

At her 2-week follow-up, the patient demonstrated remarkable recovery and improvement of symptoms. She reported no pain with ambulation, mild varicosities, edema

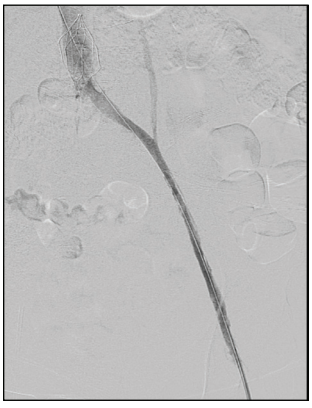

Figure 5. After balloon angioplasty of the left iliac veins.

Figure 6. Left infrapopliteal venogram demonstrating femoral venous occlusion and patent distal segment.

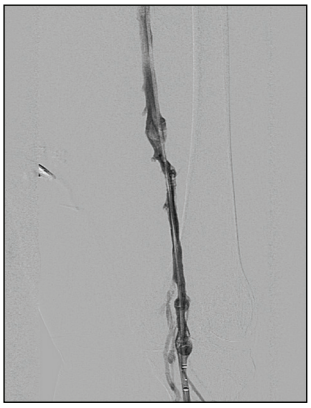

Figure 7. AngioJet ZelanteDVT of the left femoral vein.

Figure 8. Post-iliac vein stenting with resolution of compression.

only in the late afternoon/evening, limited old pigmentation with no inflammation, mild induration without ulceration, and some compliance with compression stockings (C3, VCSS 6) (Figure 9). She was maintained on anticoagulants and scheduled for surveillance ultrasonography of her iliac vein stent and femoral veins at 3 and 6 months. Compliance with compression therapy was also reinforced.

DISCUSSION

Management of chronic or acute on chronic venous thrombosis can be challenging, because it may require a multimodality approach to achieve procedural success and symptomatic improvement. At our institution, the 8-F ZelanteDVT catheter remains a cornerstone of therapy, but it is at times combined with other technologies. In the setting of acute thrombosis (generally < 2 weeks), PCDT with AngioJet can be very effective and can offer same-day DVT therapy.[6] We have found that waiting at least 30 minutes or more will allow for more effective fibrinolysis within the thrombus. Maceration of the thrombus with a balloon prior to fibrinolysis may also increase efficacy. Even patients who are deemed poor candidates for systemic thrombolysis may still benefit from local thrombolysis, because little escapes into the systemic circulation.[7] We have successfully treated postsurgical patients, including those with orthopedic injuries or major intraperitoneal operations suffering from acute DVT with this method. For those who truly cannot receive thrombolysis, ZelanteDVT without thrombolytic- or nonlytic-based devices can be used, including the ClotTriever (Inari Medical Inc.) and Indigo CAT8 (Penumbra, Inc.) catheters. However, adjunctive therapy with the ZelanteDVT is often necessary to facilitate residual clot removal. Rotational devices like the Cleaner 15 or Cleaner XT (Argon Medical Devices, Inc.) macerate thrombus without extraction. They are perhaps used more effectively when in conjunction with a thrombectomy catheter like the ZelanteDVT to remove the residual debris rather than allowing it to embolize to the lungs.

Chronic thrombosis presents a therapeutic challenge, given the nature of the thrombus and recalcitrance to treatment. Organized clot can eventually remodel, making it resistant to even prolonged balloon angioplasty and extraction. Moreover, occluded veins can experience intimal hyperplasia, which may affect thrombolysis outcomes.[8] Chronic thrombus can, however, have mixed morphology that may make it amenable to fibrinolytic therapy. In our institution, we will use Power Pulse thrombolysis with the ZelanteDVT catheter and/or overnight, acoustic pulsed thrombolytic therapy with the EkoSonic device. In the setting of EKOS, we will usually go back with the ZelanteDVT catheter the next day to remove softened clot. We have also had excellent experience in using the Indigo CAT8 device to "cork" pieces of chronic thrombus not responsive to initial rheolytic therapy. Though effective in extracting dense clot, this process can be time consuming. It is most effective when the 8-F or greater sheath is placed in close proximity to the thrombus, preferably with a removable valve to facilitate clot extraction from the sheath. The AngioVac device (AngioDynamics) is also useful, typically for massive thrombosis, but is limited by needing a perfusion circuit and large-bore venous access, usually via the internal jugular. Inadequate flow through the circuit will limit the amount of thrombus removed. In addition, this device in its current iteration typically cannot be brought down into the infrainguinal femoral vessels due to size and working length constraints. Although we have used this

Figure 9. Left lower extremity on follow-up demonstrates visual improvement.

device within thrombosed iliocaval/iliofemoral vessels (often with a thrombosed IVC filter), we have also used ZelanteDVT effectively in larger iliac veins. Other than for iliocaval or iliofemoral compression, we do not use stents for chronic thrombosis (eg, below the common femoral veins), mostly due to a paucity of data and lack of venous-specific platforms.[9,10] Concerns remain regarding migration, fracture, thrombosis, and long-term patency within the femoral veins.

With the number of tools now available with relative ease of use, safe operation is exceedingly important. For example, with powered aspiration devices not on a continuous circuit (eg, Indigo CAT8), there is a concern regarding rapid blood loss when outside of thrombus and in open vessel. This requires care to make sure that the device is deactivated when outside of clot. This is less of a concern with AngioJet devices because they are isovolumic, meaning that the blood removed is equal to the amount of saline administered; the volume aspirated is approximately 1 mL/s. However, one can achieve prolonged run times during massive thrombosis cases. Hematuria (due to hemolysis) is common, but rarely clinically significant and usually can be managed with hydration. Significant hemoglobinuria with renal dysfunction requiring urine alkalinization (eg, with sodium bicarbonate) is uncommon.[11,12] This may potentially be avoided if thrombectomy is limited only to occluded venous segments. Despite the hematuria, anticoagulation should not be stopped when it is seen postprocedure, as venous rethrombosis is a concern. Pancreatitis is also very rare and usually resolves with adequate hydration.[13] We have seen this only in patients with very prolonged run times. Boston Scientific has run time guidelines for each of its catheters. Bradycardia has been reported with rheolytic therapy. Usually, this is uncommon in the treatment of lower extremity DVT.[14] Routine pretreatment for bradyarrhythmias is not recommended.[14]

Management of symptomatic DVT remains an evolving field. A multimodality approach to interventional therapy coupled with best medical practices can offer meaningful quality-of-life improvements in appropriately selected patients. ■

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