

Central Venous Occlusions: From Simple Solutions to Advanced Techniques

Assessing and treating complete central venous occlusions on the side
of a functioning arteriovenous access.

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Before attempting to treat central venous occlusions (CVOs) (not central venous stenosis), it is important to keep in mind what one is seeking to accomplish for the patient. Is the planned intervention for symptomatic relief, is it for access dysfunction, or for access placement? Additional considerations include the overall access situation of the patient, characterization of symptoms, potential complications, and durability of the intervention.

It is important to be aware of how effective interventions are rather than simply obtaining a good final image. Interventions for CVOs have technical success rates of 70% to 100% with overall primary patency (including angioplasty and/or stenting) ranging from 14% to 67% at 12 months.¹⁻³ Multiple interventions are the rule rather than the exception, and in-stent restenosis and frequent stent fractures are common. These complications have no approved therapy. Stent grafts have gained recent interest, with up to an 80% primary patency rate at 1 year observed in one study.⁴

Severe complications are possible, and before attempting advanced techniques, one must understand that there is the potential to puncture into the mediastinal, pleural, or pericardial spaces, as well as the aorta. With flows from arm accesses reaching up to 2 L/min, bleeding into these areas is potentially fatal. Given patient safety considerations, advanced interventions should be limited to centers with

experience in central venous recanalizations and with appropriate acute surgical support.

ASSESSMENT

When considering treatment for CVOs, the clinical symptomatology, location and type of access, previous accesses, future potential accesses, life expectancy, potential for transplantation, and presence of a pacemaker should all be taken into consideration. For instance, if the access has multiple other lesions, is advanced in age, and there are many other potential access sites, perhaps treatment is not needed because a new access can be created and the old access ligated. On the other hand, if the patient has a single access remaining with poor flows and no opportunity for transplantation, more aggressive measures can be considered. CVOs are rarely the cause for access thrombosis due to the fact that most of the patients develop collateral circulation.

If the patient's symptoms of arm/face swelling are relatively acute, waiting a few weeks may allow development of sufficient venous collaterals that reduce symptoms with minimal access dysfunction. If there are minimal elevated venous pressures or recirculation, we prefer to avoid intervention unless a nephrologist considers these problems to be major, taking into consideration the limited patency and potential acute and chronic complications of intervening.

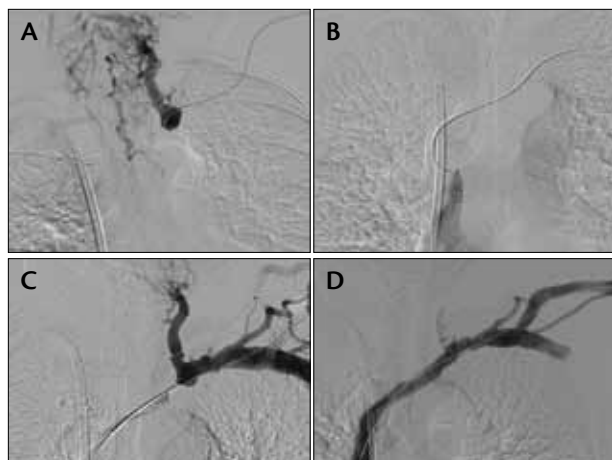


Figure 1. Complete left innominate vein occlusion (A). A 4-F Kumpe catheter has been advanced to the point of occlusion. A Glidewire was used to successfully traverse the occlusion (B). A Kumpe catheter was advanced over the wire to the open vein segment, and contrast injection verifies the intraluminal location. After advancement of a stiff wire to the inferior vena cava, serial dilations are performed with increasing balloon sizes (C). Venography was performed after 6-mm percutaneous transluminal angioplasty to exclude significant venous perforation. A self-expanding stent was placed after 12-mm percutaneous transluminal angioplasty in which the lumen collapsed. Rapid direct line flow was reestablished, with decompression of collaterals (D).

Imaging assessment is primarily performed via venography using the dialysis access and advancing a catheter up to the occlusion to obtain imaging beyond 5 seconds. The goal is to characterize the location and length of the occlusion, collaterals, and the point at which the central vein segment becomes patent again. Occasionally, computed tomograph-

ic venography of the chest may help to assess the feasibility of the intervention and characterize the CVO. Duplex ultrasound usually has no role in CVO assessment.

SIMPLE METHOD FOR TREATING CVO

In most cases, crossing the occlusion is a relatively simple endeavor. A 65-cm, 4-F Kumpe directional catheter (Cook Medical, Bloomington, IN) is typically advanced up to the occlusion site. A focal beak-like area of narrowing before the occlusion can be seen. The catheter is advanced into this beak-like area (venous stump), and then attempts to pass a hydrophilic angled 0.035-inch guidewire (GlideWire, Terumo Interventional Systems, Inc., Somerset, NJ) across the occlusion are performed. Preference is given to manipulate the lesion from the hemodialysis access because it is easier, with limited room and a shorter distance as opposed to working from the femoral approach through the atrium, which might require a long introducer sheath for stable access. Once the occlusion is crossed with the hydrophilic wire, which can be determined by free rotation of the wire tip and reduction in resistance compared to crossing the occlusion, the catheter is then advanced across the occlusion, and the intravenous location is verified.

If the Kumpe catheter cannot be advanced, it is exchanged for a 4-F hydrophilic catheter (Glidecath, Terumo Interventional Systems, Inc.). Exchange for a stiffer wire is required to facilitate passage of a balloon catheter across the occlusion. The typical balloon size is 10 to 12 mm corresponding to the adjacent normal vein segment. Prolonged inflation and/or high-pressure balloon catheters (Atlas, Bard Peripheral Vascular, Inc., Tempe, AZ) are often required to overcome the occlusion. Serial dilations are recommended, starting with a small balloon diameter (usually a 4-mm-diameter balloon) followed by increasing diameters with intervening venography to exclude perforation between dilation steps (Figure 1).



Figure 2. A self-expanding stent fractured (arrows) at the costoclavicular junction 3 months after placement (A). Note the intimal hyperplastic narrowing at the site of fracture. A Fluency stent graft was placed to exclude the narrowing and fracture (B). The internal jugular vein was not covered and remained patent (C). Reprinted with permission from Springer Science+Business Media from Rajan DK: *Essentials of Percutaneous Dialysis Interventions*, 1st ed. New York, NY, Dheeraj Rajan, 2011, p. 363–364.

Chest pain should always be interpreted cautiously, as it may indicate venous rupture.

Generally, stents should be avoided in CVO treatment, especially in the subclavian-brachiocephalic segment. However, self-expanding stents may be used in cases of rupture, occlusion (such as in residual complaint stenosis), and technical failures with the goal to improve flow. Self-expanding stents have the advantage of being crush resistant and return to their normal size if they are compressed. A balloon-expandable stent can be used within the superior vena cava or in the brachiocephalic vein as long as it extends to the costoclavicular transition. If a large rupture has occurred or if there is obvious bleeding into the mediastinal, pleural, or pericardial spaces with an expanding hematoma, then a stent graft is used for clinical salvage. The size of the stent or stent graft is determined by the size of the adjacent normal vein segment but is usually in the size range for corresponding vein segments discussed previously.

During stent placement, it is imperative to avoid covering uninvolved vein segments such as the internal jugular vein or the innominate/superior vena cava junction. Again, stents should usually be avoided, as they are prone to fracture and developing in-stent intimal hyperplasia. Fractures are particularly common at the costoclavicular junction and lead to aggressive and accelerated intimal hyperplasia (Figure 2). In-stent restenosis tends to occur along the entire

length of the stent rather than focally, with no on-label approved therapies to deal with this problem.

All procedures are performed on an outpatient basis with intravenous moderate sedation or, occasionally, anesthetic assistance (due to difficult airway access or cardiorespiratory comorbidities). Continuous oximetry and electrocardiographic monitoring are performed throughout the intervention, and heparin is not systemically administered for these procedures.

ADVANCED TECHNIQUES FOR TREATING CVO

For occlusions that cannot easily be crossed, sharp recanalization should be considered. This method can be performed from a single upper arm approach for short lesions. More difficult occlusions often require upper extremity and femoral approaches and imaging in multiple planes (obliquities) to ensure that the needle used is crossing the area of occlusion. In this situation, contrast is injected from either side of the occlusion to determine the location and length and to guide the direction of puncture. The sharp devices that can be used for puncture are the back end of a Glidewire, the directional sheath needles from transjugular intrahepatic portosystemic shunt (TIPS) kits (Haskal and Rösch-Uchida sets, Cook Medical), and the Colapinto needle (Cook Medical).

Additional methods that may be used include placing an open loop snare (10 mm) on the central side of the occlusion to use as a target to aim for with the needle or wire (Figure 3). Another method we have occasionally used is to inflate an angioplasty balloon adjacent to the site of occlusion. This allows for improved stability, pushability, and centering of the guidewire lumen to the long axis of the occluded vein segment, and the back end of the Glidewire can then be passed through the balloon wire lumen, centered through the lesion. Also, advancing a guiding catheter or sheath up to the occlusion may provide the added support needed to cross the occlusion.

For occlusions that cannot be crossed with a balloon (very rare), a through-and-through access is established from the arm access through to a femoral sheath (called a “body floss”). This technique provides the most stability and requires snaring the wire and pulling it through the femoral sheath (Figure 3). A 260-cm-long stiff wire should be utilized to create a stable track that allows devices to be advanced across the lesion that might not otherwise pass through.

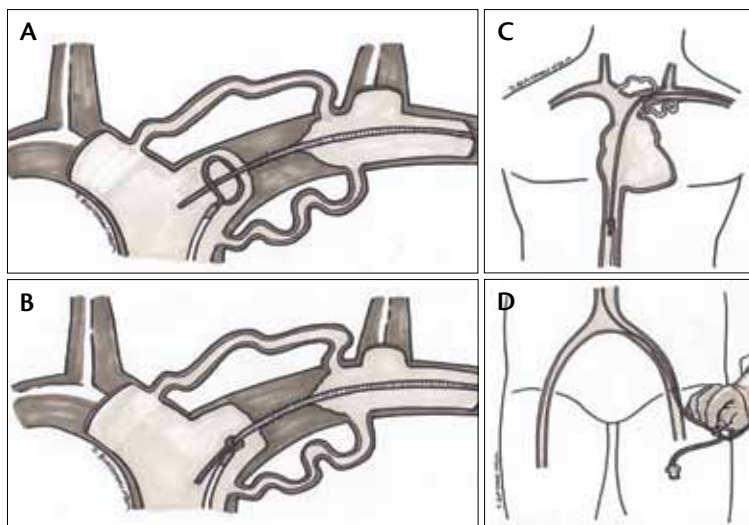


Figure 3. Via femoral venous access, a loop snare is advanced to the central side of the occlusion and used as a target for sharp-needle puncture across the occlusion (A). The wire or wire through the needle is captured with the loop snare (B). The wire can be pulled out through the femoral puncture, thereby establishing wire access from the arm to the groin with external control of both ends of the wire (body floss) (C, D). Reprinted with permission from Springer Science+Business Media from Rajan DK: *Essentials of Percutaneous Dialysis Interventions*, 1st ed. New York, NY, Dheeraj Rajan, 2011, p. 367.

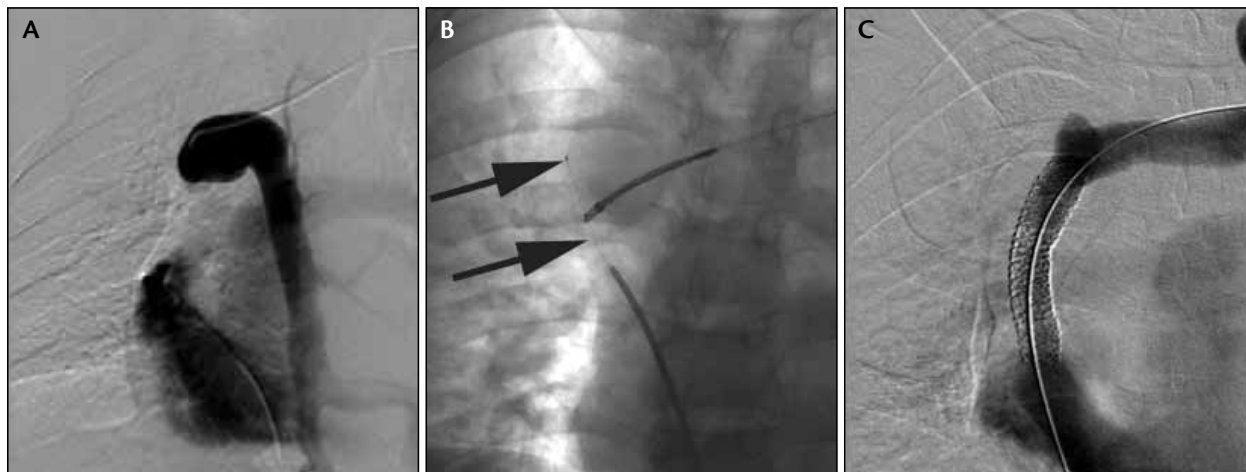


Figure 4. Initial central venography through dual-venous access (brachial and femoral) is important to study the occluded segment (identification of the venous stump[s], diameters, and length of the occluded segment) (A). Once the alignment between the radiofrequency wire and the snare is confirmed in the posteroanterior, right anterior oblique, and left anterior oblique views, the radiofrequency wire (arrows) is advanced carefully toward the snare located in the other side of the occlusion, which is used as a target (B). The snare is used to pull the radiofrequency wire out. The body floss technique is then established to facilitate pre-stent balloon angioplasty and stent placement. Final central venography demonstrates successful superior vena cava recanalization with stent placement (10- X 37-mm Express LD stent, Boston Scientific Corporation, Natick, MA) (C).

Another newer endovascular alternative that facilitates the crossing of difficult CVOs is the PowerWire device (Baylis Medical Company, Inc., Montreal, Quebec, Canada). When using this device, central venography is performed by simultaneous injections through brachial (micropuncture kit under ultrasound guidance) and femoral approaches. It helps to know the CVO length, diameter, and location of the venous stumps. It should be determined whether the PowerWire should be advanced from a caudocranial or a craniocaudal direction (Figure 4). Typically, 5-F Tegtmeier, Kumpe, or Cobra C2 catheters (Cook Medical) are used to guide the advancement of the PowerWire a few millimeters at a time.

A semicurved diagnostic catheter used with a straight PowerWire tip offers improved precision as the wire is gently advanced toward a 10-mm Amplatz GooseNeck snare (Covidien, Mansfield, MA). The snare, introduced through a 5-F diagnostic catheter, is used as a target in the opposite venous stump, typically from the femoral approach. Before the tip of the device is activated by the generator and advanced, its alignment with the snare must be checked in 30° right/left anterior oblique and posteroanterior views. After crossing the occlusion, the radiofrequency wire is snared out and exchanged for a 260-cm stiff 0.035-inch wire (Figure 4). The body floss technique is then employed. If the radiofrequency wire reaches a nontarget area, another careful attempt is performed after checking the radiofrequency wire and the snare alignment in the three views previously mentioned.

CONCLUSION

Many CVOs can be crossed with minimal difficulty. However, there is a subset of lesions that require advanced treatment techniques. It is important to assess the need and the potential risks and patency of the intervention. In addition, one should practice discretion when using stents because although it provides a great completion image, it can cause bigger problems down the road. ■

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