Venous Outflow Obstruction

Managing intervention after iliofemoral thrombolysis.

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Venous thromboembolism has been in the spotlight during the last few years, including its prevention, diagnosis, and treatment. In 2008, recognizing that venous thromboembolism is a major public health problem, the acting Surgeon General Steven K. Galson released a Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism. The same year, the American College of Chest Physicians released the 8th edition of the CHEST guidelines. This was the first edition in which aggressive treatment of deep vein thrombosis (DVT) with thrombolysis was recommended to prevent postthrombotic syndrome (PTS).

The mainstay therapy for DVT has been anticoagulation, and in properly treated patients, thrombus propagation is prevented and recurrent thrombosis is reduced.[1] However, restoration of early luminal integrity and preservation of valve function has been shown to be minimal, resulting in a significant increase in the long-term complications.[1-4]

The strongest predictors in the incidence and severity of PTS include ipsilateral recurrent DVT, iliofemoral thrombosis, and the intensity of persistent signs and symptoms in the first month after the episode of acute DVT.[5-8] The risk of recurrent DVT is 40% (95% confidence interval [CI], 35.4–44.4) after 10 years: 53% (95% CI, 45.6–59.5) occur in patients with unprovoked DVT and 22% in those with secondary DVT (95% CI, 17.2–27.8).[1] The recurrence may be higher in patients who undergo a shorter duration of anticoagulation, in those with incomplete thrombus resolution or iliofemoral thrombosis, and in patients with high D-dimer levels after stopping anticoagulation.[5,9-11] Patients with extensive proximal DVT such as iliocaval or iliofemoral occlusions have also been shown to have worse prognoses when compared to patients with infrainguinal thrombosis. The resolution of venous obstruction with iliac thrombosis is often incomplete, and the incidence of PTS is higher.[4,5]

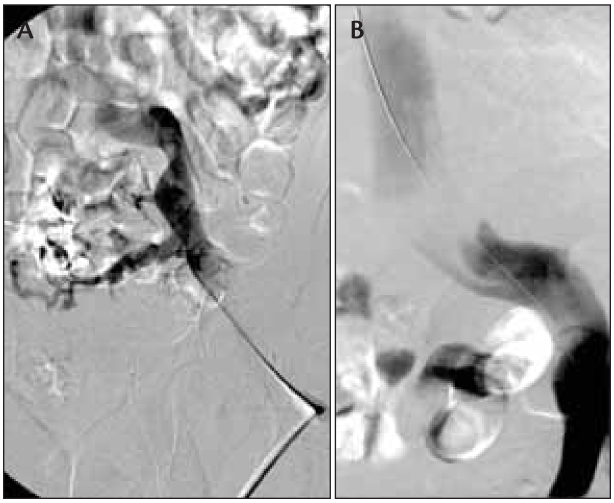

Figure 1. Venogram with venous outflow obstruction suggested by filling of cross pelvic collaterals (A) and widening of the common iliac vein, also described as pancaking or thinning of contrast (B).

The primary goal of thrombolysis is to modify the natural course of the disease by acting on thrombus load and thus improve venous function and outflow. By restoring venous flow, the objective is to prevent valve damage, venous obstruction, and recurrent thrombosis, which, other than exposing the patient to possible pulmonary embolism, also increases the chance for PTS significantly.

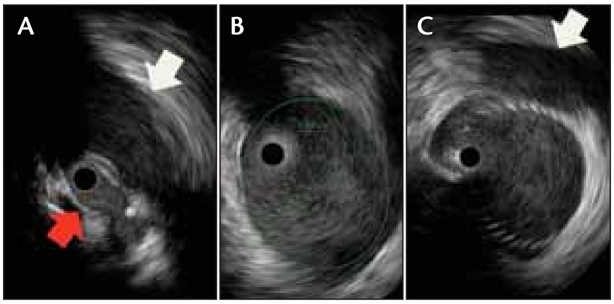

Figure 2. Intravascular ultrasound (IVUS) after thrombolysis for iliofemoral vein thrombosis before and after venous stenting. The catheter at the level of the common iliac vein (red arrow), which is severely compressed by the overlying right common iliac artery (white arrow) (A). The normal iliac vein below the compression site measuring 1.64 cm (B). The iliac vein at the site of compression after stent deployment and balloon dilatation (C).

INCIDENCE AND INDICATIONS OF VENOUS STENTING

After successful treatment of iliofemoral DVT with either catheter-directed thrombolysis or pharmacomechanical thrombolysis, it is common to unmask an underlying iliac vein obstruction. The obstruction may be extrinsic, intraluminal, or both. Although there are no reported comparative studies on correcting venous obstruction versus not intervening, clinical experience has shown that successful interventions depend on restoration of adequate outflow to prevent rethrombosis. Treatment of underlying venous obstruction has been reported to occur in excess of 50% to 60% in patients after thrombolysis.[12-14] Angioplasty alone has not worked well in the venous system, and placement of a stent is paramount in preventing recoil, relieving any external compression, and establishing adequate venous outflow.

Deciding when to stent venographic findings of the iliac vein after successful thrombolysis can be challenging. There are no accurate diagnostic tests available to determine hemodynamic significant lesions. Measuring pressure gradients across lesions can be performed, but due to the low pressure in the venous system, it is unclear how to interpret the results. Currently, there are no reporting standards for these lesions, but some of the reported indications for iliac vein stenting include external compression, intravascular synechiae or webs, presence of collateral veins, chronic obstruction, and significant residual thrombus that is resistant to further thrombolysis.

The diagnosis of venous outflow obstruction after thrombolysis is made either with multiplane venography or more accurately with IVUS. Because there is no definitive hemodynamic test, we rely mostly on anatomic criteria. Venous lesions resulting in a > 50% diameter reduction have been described as clinically significant and require intervention.[15] Venography may show definite obstruction or suggest such with indirect signs such as the presence of collaterals, cross-pelvic filling, and flattening of the iliac vein (Figure 1). IVUS has been shown to be superior to venography in terms of accurate identification of significant venous stenosis. It allows accurate measurements of diameter reduction, identifies areas of external compression, and provides intravascular imaging to identify webs or residual thrombus (Figure 2). IVUS can also be used to measure vessel diameter and the length of vein segment that requires stenting. Underlying venous outflow obstruction may be identified before thrombolysis with computed tomographic (CT) or magnetic resonance venography (Figure 3). In our own series, 80% of patients with acute iliofemoral thrombosis were identified to have underlying May-Thurner syndrome or inferior vena cava (IVC) pathology on preintervention CT venography.

VENOUS STENTING

The largest series in the literature on the efficacy of venous stenting comes from the treatment of chronic venous outflow obstruction.[16] It has been shown to be a safe and efficacious procedure.[16-18] Long-term studies have shown a high patency rate, low rate of in-stent restenosis, and limited need for reinterventions. Significant factors associated with stent occlusion are younger age, chronic thrombotic disease, occluded vein segment, and stent extension into the common femoral vein. Thrombophilia has not been associated with stent thrombosis or severe in-stent recurrent stenosis.[19]

Figure 3. CT scan showing compression of the left common iliac vein by the right common iliac artery (white arrow).

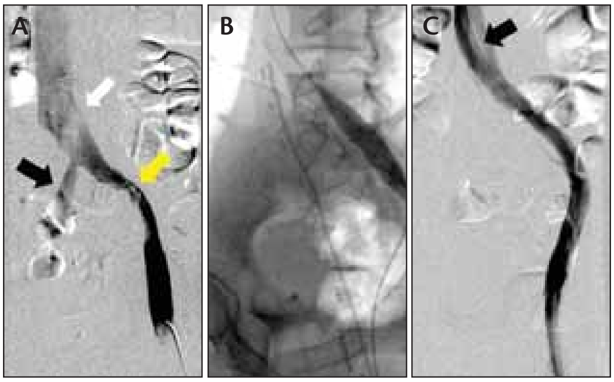

Figure 4. Treatment of chronic venous obstruction after thrombolysis. A venogram illustrating left common iliac vein compression (white arrow), residual chronic obstruction in the external iliac vein (yellow arrow), and retrograde flow into the internal iliac vein (black arrow) (A). Balloon dilatation after stent deployment (B). A completion venogram showing patent veins with the stent (black arrow) extending across the lesion into the IVC (C).

Although venous stenting is a not a very challenging procedure, attention to detail along with certain key technical points are required for optimal results (see *Technical Tips for Venous Stenting* sidebar). Knowledge obtained from arterial stenting, although helpful, may not necessarily be applied to the venous system. With arterial stenting, depending on the location, you may choose to use either self-expanding or balloon-expandable stents. Placing stents across joints is not recommended, and positioning of long stents extending well into a normal vessel is avoided. Finally, aggressive postdeployment ballooning is not suggested to avoid neointimal hyperplasia. These technical tips do not apply when treating venous obstruction.

Currently, there is no dedicated venous stent that has been approved by the US Food and Drug Administration. Most interventionists are placing stents that are indicated for use in the arterial system. However, unlike the arterial system, the iliac veins require larger and longer stents, limiting what is available for use. In addition, given the different technical requirements in placing venous stents and their behavior differences when compared to arteries, the development of a dedicated venous stent is required.

Characteristics of an ideal venous stent include availability of large-diameter and long-length self-expanding stents with minimal foreshortening and good radial force. Currently, the most widely used stent for venous interventions is the Wallstent (Boston Scientific Corporation, Natick, MA) because it provides some of these characteristics, although it does have some limitations, such as significant foreshortening, which may result in misplacement. Until a dedicated venous stent with the above characteristics becomes available, the Wallstent is a suitable option.

TECHNIQUE

Venous stenting in the setting of thrombolysis is usually performed under sedation because the patient may require repeat trips to the interventional suite and is usually in the prone position. The timing of stenting varies depending on the technique of thrombolysis and the residual thrombus that is present in the iliac segment. If catheter-directed thrombolysis is planned, stenting occurs during follow-up venography, whereas when pharmacomechanical thrombolysis is performed, stenting can be performed in the same setting provided that the majority of acute thrombus has been cleared. If significant residual acute thrombus is still present in the venous outflow, further thrombolysis is preferred before stenting. IVUS can be helpful in evaluating the nature of residual iliac obstruction by diagnosing extrinsic compression, chronic pathology, acute thrombus, or any combination of the three (Figure 4).

When venography is used alone for stent placement, both anterior-posterior and lateral projections should be obtained to identify anatomic landmarks and determine the location of proximal and distal landing zones. IVUS is superior for selecting the optimal lesion length to be treated, measurement of vessel diameter for stent sizing, identification of disease-free landing sites, and to ensure proper stent expansion, all of which ensures proper deployment. If IVUS is not available to obtain these measurements, we recommend the following protocol: for the common iliac vein, place 16- to 18-mm stents; for the external iliac vein, place 14- to 16-mm stents; and when extension into the common femoral vein is

TECHNICAL TIPS FOR VENOUS STENTING

- Use IVUS to identify proximal and distal landing zones.
- Ensure good inflow from below and outflow from above to prevent stent thrombosis.
- Appropriate stent sizing with 2- to 4-mm oversizing to prevent recoil.
- Postdeployment dilatation with appropriately sized high-pressure balloons and extended inflation time to minimize recoil.
- If multiple stents are required, place with 3 to 5 mm of overlap, and a same-sized stent should be used to provide smooth transition points.
- Perform a completion IVUS to identify any residual defects.

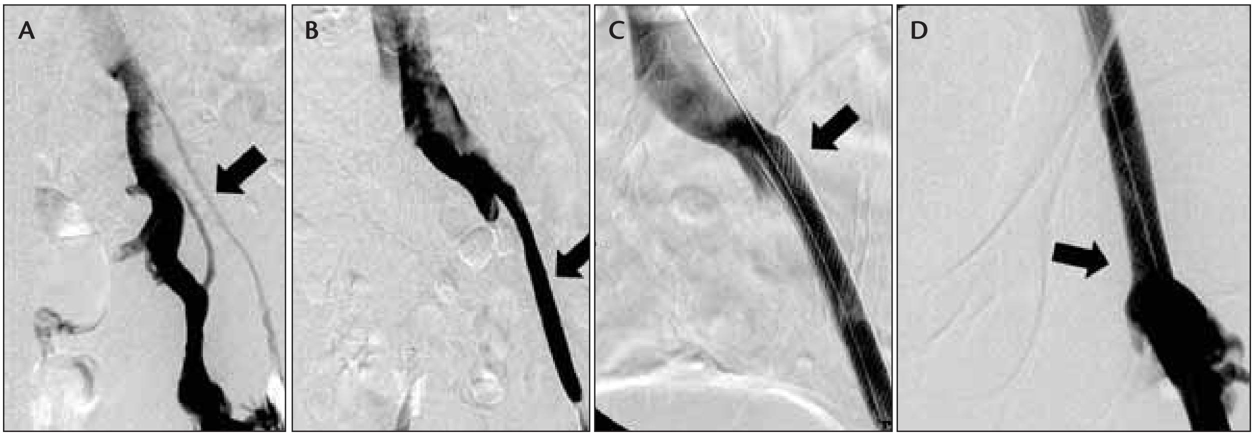

Figure 5. Stenting across the inguinal ligament. A venogram after thrombolysis showing chronic external iliac vein obstruction (arrow) with large collateral from the deep femoral to the internal iliac vein (A). Suboptimal result of balloon dilatation of the external iliac vein (arrow) due to recoil (B). A completion venogram after stenting (arrow) of the external iliac vein (C). Due to chronic common femoral vein disease, the stent was placed across the inguinal ligament terminating above its confluence (arrow) (D).

required, 12- to 14-mm stents are used (Table 1). Predilatation is usually not required after thrombolysis. We routinely use 60- to 90-mm-length stents to provide adequate coverage of the lesion.

If multiple stents are required, they are placed with 3 to 5 cm of overlap to minimize shelving, and same-diameter stents are used through all of the recanalized segments. This creates a smooth transition at sites of stent overlaps. During postdeployment, balloon dilatation is performed to the size appropriate for each segment (Table 1). It is useful to use high-pressure balloons and keep them expanded for at least a minute to prevent recoil. After balloon dilatation, a completion IVUS examination and venography are performed to confirm technical success. Defects such as residual compression, incomplete dilatation, and improper stent apposition are corrected by repeat ballooning. Residual untreated significant obstruction (> 50%) should be treated with stent extension.

The key to venous stenting is to cover all diseased segments and obtain good inflow and outflow. To achieve this, the interventionist may need to extend the stent well into the IVC or below the inguinal ligament. Attempts to deploy the stent at the origin of the iliac vein may result in inadequate decompression of external compression. Anatomically, the right iliac artery crosses over the left iliac vein at or above the caval confluence, and in such cases, stent extension into the cava is required. Extension of stents into the external iliac vein, or even in to the common femoral vein, may be required in some situations. Chronic obstruction may be present after thrombolysis of acute thrombus, and this requires stenting. As previously mentioned, when the disease extends into the common femoral vein, the stent can be safely extended to just above its confluence (Figure 5). Patency rate does not seem to be affected by stent length or by crossing the inguinal ligament in patients with thrombotic obstruction as long as there is good inflow from either the femoral vein or the deep femoral vein.[20]

TABLE 1. REFERENCE SIZING FOR VENOUS STENTING AND BALLOONING

Location	Stent/Balloon Sizing
Inferior vena cava	20 mm
Common iliac vein	16–18 mm
External iliac vein	14–16 mm
Common femoral vein	12–14 mm

CONCLUSION

Aggressive venous interventions for iliofemoral vein thrombosis often unveil underlying venous outflow obstruction that requires treatment to prevent rethrombosis. Optimal evaluation and guidance during treatment can be provided with IVUS, although it is not absolutely necessary to perform such interventions. Current stent technology is suboptimal but applicable until a dedicated venous stent is available. Knowledge of key technical tips is required to obtain the best results. ■

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