Diagnosing Venous Disease With IVUS: How I Do It

How to diagnose deep vein disease with intravascular ultrasound, including access techniques, assessing for stenosis or occlusion, and assisting with stent placement.

BY PAUL J. GAGNE, MD

Intravascular ultrasound (IVUS) is an essential imaging modality for diagnosing deep vein disease as well as guiding safe and effective endovascular treatment, as shown in the VIDIO trial. I use the clinical, etiologic, anatomic, pathophysiologic (CEAP) classification to initially screen patients for deep vein disease who are candidates for IVUS evaluation. In clinical CEAP C3 to C6 chronic venous disease patients, when transcutaneous duplex ultrasound does not provide an explanation for the patient's clinical presentation, I then interrogate the deep venous system with IVUS to identify undetected venous occlusive disease. Given the many etiologies of leg edema and the limited response to intervention, I evaluate CEAP C3 patients for deep vein treatment cautiously and infrequently.

DEEP VEIN ACCESS

My preferred access is the popliteal vein given the ease of visualization for cannulation and the ability to easily see and work in the iliac and common femoral vein (CFV) segments. The necessary prone position for popliteal vein access, especially when done under conscious sedation, may not be possible in obese patients, some patients with back problems, and patients with chronic obstructive pulmonary disease or sleep apnea. These patients are then evaluated in the supine position, either through the mid-thigh femoral vein or the internal jugular (IJ) vein.

There are several challenges associated with mid-thigh femoral vein access. When cannulating the femoral vein, needle access requires finding a "window" around the superficial femoral artery, which is frequently anterior to the femoral vein on initial transcutaneous ultrasound imaging. In larger thighs, needles and sheaths can be too short due to the depth of the femoral vein from the skin. Also, to minimize the distance from the skin to the vessel in larger thighs, a more perpendicular cannulation angle to the vein is adopted, which can lead to sheath kinking and difficulty working through the sheath. In addition, with larger thighs, we often must access the femoral vein more cranial in the thigh. Once the sheath is cranial to the lesser trochanter of the femur, it is likely you will lose the ability to fully image and treat the CFV. Finally, the access site is compressed for 15 minutes after sheath removal and then a compression bandage is placed for 2 hours. We see more access site hematomas and ecchymoses in femoral access patients than in popliteal vein or internal jugular vein access due to the depth of the vein and the superficial thigh muscles, which can interfere with effective compression.

The IJ vein is an effective access site for IVUS imaging of the iliac vein and CFV, allowing simple bilateral imaging. Postprocedure access site compression is almost unnecessary in most patients once the patient assumes the sitting position. The challenge with IJ access is that it is sometimes difficult to intervene on the iliofemoral veins from this access.

IVUS TECHNIQUE

After cannulation, I gain wire access to the inferior vena cava (IVC) from the popliteal or femoral vein

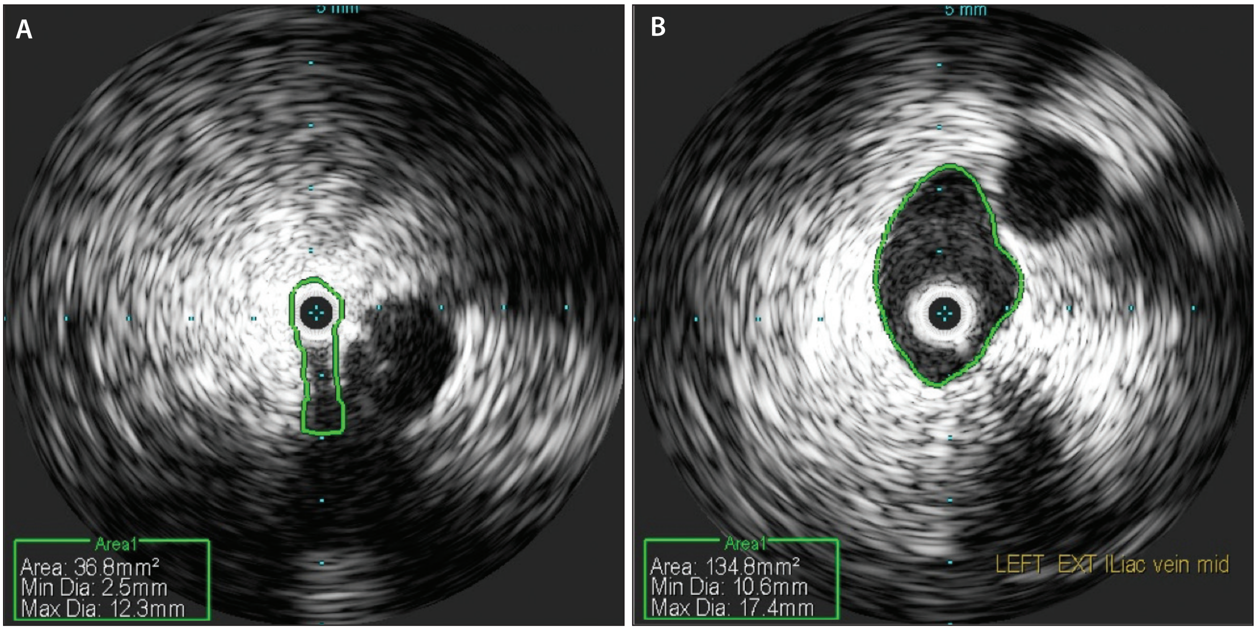

Figure 1. IVUS showing a compressed EIV (A) as compared with a normal vein segment (B).

access. Then, I use a relatively soft wire, such as an 0.035-inch Bentson wire, to perform IVUS. This limits distortion of the venous structures during the IVUS pullback. Sometimes, I pull the wire out of the IVUS catheter before I withdraw to better center the catheter in the lumen if artifact interferes with the IVUS field of view or if I am concerned the wire/catheter bias in the tortuous veins of the pelvis is causing distortion and an artifactual stenoses.

I use the Visions PV 0.035-inch catheter (Philips) to obtain images from the renal vein junction with the IVC to the femoral vein confluence with the deep femoral vein, usually at the level of the lesser trochanter of the femur. This IVUS catheter has the field of view necessary to image the large deep veins of the pelvis.

EVALUATING THE IVC

During the initial pullback, I first evaluate the IVC for phasic changes. When the IVC is distended and without phasic changes, the patient likely has congestive heart failure and is fluid overloaded. Many patients seen by cardiology and without a cardiac etiology to their leg edema will have evidence of right heart failure on IVUS to explain their clinical presentation. I also evaluate the diameter of the most inferior IVC. Just above the confluence of the common iliac veins (CIVs), the IVC can vary in size. If I need to extend a stent into the IVC, I don't want the stent to be as big as or bigger than the IVC to avoid jailing the contralateral CIV and inducing a contralateral leg deep vein thrombosis.

EVALUATING FOR STENOSIS OR OCCLUSION

The CIV, external iliac vein (EIV), and the CFV are evaluated for compression (Figure 1) and postthrombotic disease (Figure 2). Compression can occur anywhere along the length of the left or right CIV or EIV. The most cranial portions of each vein segment are the most common but not exclusive locations for significant compression. The CFV can be compressed at the inguinal ligament, although I have found that postthrombotic scar is a more common problem in this segment.

Often, it is unclear whether a significant stenosis or occlusive lesion was identified after the first iliofemoral vein pullback. In a patient with CEAP C4 to C6 venous disease, the burden of proof that the veins are normal must be met. To this end, I then place my catheter at the CIV confluence and withdraw the catheter very slowly through the CIV, EIV, and CFV, often without a wire, so that the IVUS catheter "centers" in the lumen. I often identify short segment areas of severe compression or intraluminal or intramural hyperechoic scar/postthrombotic disease, which are indicative of an abnormal vein. I use a 50% cross-sectional area reduction as my threshold (Figure 1) to consider intervention of a compression stenosis. The area of stenosis (Figure 1A)

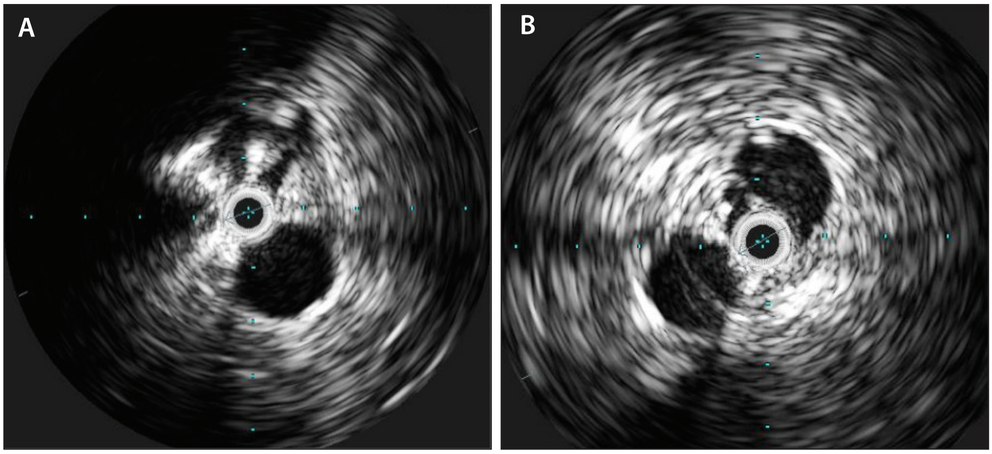

Figure 2. IVUS showing hyperechoic intraluminal (A) and intramural scars (B) in the deep veins.

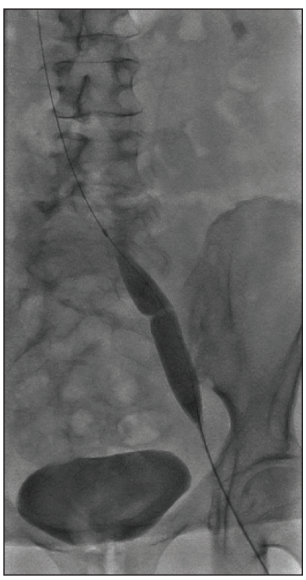

Figure 3. Webs identified by inflation of a percutaneous transluminal angioplasty balloon.

is referenced to an adjacent normal vein segment (Figure 1B) that should be of equal or smaller size, usually the same vein segment or a more peripheral vein segment. Although this threshold for compression stenosis has led to significant clinical improvement in several large-cohort studies, a randomized prospective trial to compare this criterion for "severe" stenosis with other criteria (eg, absolute cross-sectional area, long segment narrowing < 50%) is required. One caveat is that, more commonly in the EIV than the CIV, in some patients, IVUS suggests that the vein is normal and free from scar, but the vein cross-sectional area is small along the length of the segment. With deep breaths, even more so than with the Valsalva maneuver, I have seen these veins increase by as much as 30% in size to become normal-sized veins. If the veins are not restricted by a "fixed" stenosis, there is no indication to intervene.

If I detect hyperechoic intraluminal (Figure 2A) or intramural scars (Figure 2B) in the deep veins, and it is not obvious that the lumen is stenosed, I employ the balloon test to identify restrictive occlusive disease. By inflating a percutaneous transluminal angioplasty balloon sized to the vein segment at low pressures (ie, 0–3-mm atm), we have identified webs (Figure 3) and sclerotic deep vein segments stenosed, in part due to decreased vein wall compliance compared with adjacent normal vein segments. Treatment of these lesions has been most satisfying for providing clinical improvement.

USING IVUS FOR STENT PLACEMENT

Finally, at intervention with stent placement, IVUS allows exact vein segment sizing and lesion length measurement, which is not possible with other imaging modalities. IVUS can determine vein diameters in real time in the dynamic and compliant veins affected by intravascular volume and respiratory efforts, and it can detect subtle vein scar not reliably imaged with transcutaneous duplex ultrasound or axial imaging. If the disease isn't properly and completely identified and the stent is not sized properly with deployment confirmed, then clinical outcomes may be adversely affected. Undersized stents embolize, and inadequately deployed stents will not resolve the outflow obstruction identified.

CONCLUSION

Until research indicates otherwise, IVUS should be used to identify all deep vein disease and confirm adequate endovascular intervention if consistently excellent clinical results are to be achieved. You can't treat what you can't see. ■

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