Tips and Tricks for Venous IVUS Success

An Australian perspective on using IVUS to diagnose and treat venous obstruction from patient preparation to access site to stent sizing.

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Intravascular ultrasound (IVUS) is an invaluable tool when managing central vein obstruction, not only because it provides accurate real-time information of the pathology and surrounding structures, but also because it is free of radiation and intravenous contrast agents. This feature should not be underestimated; most procedures are lengthy, and radiation can become dangerously high for the physician and patient alike. IVUS is also independent of patient body habitus, which allows the physician to treat morbidly obese patients safely. This article describes how we perform IVUS at our centers, including preballoon assessment, assessment of stenosis, and stent sizing.

OUR PROCESS

Patient Preparation and Access Approach

The patient is positioned supine to maximize access sites. Both lower limbs as well as the neck, preferably the right side, are prepped and draped in a sterile fashion.

Ultrasound guidance is essential for optimal access. In cases of acute deep vein thrombosis, the most distal patent vessel is accessed. In chronic occlusion cases, the femoral veins in the thigh are usually chosen. In cases of classic venous compression with no preoperative concerns regarding the inflow vessels, the great saphenous vein could be accessed as an alternative. However, attention should be paid to the common femoral vein (CFV), especially below the inguinal ligament. Adjunctive access from the internal jugular vein is very useful because it allows views of the femoral and deep femoral veins. Also keep in mind that the currently available IVUS catheter for venous interventions (Visions PV catheter, Philips) has a working length of 90 cm and requires a 9-F sheath and 0.035-inch wires ideally 260-cm long.

Figure 1. IVUS image next to a venogram.

Preballoon Assessment

Once access has been established and wires have crossed the obstruction, IVUS assessment can proceed. Simultaneous venography of the bilateral limbs can provide

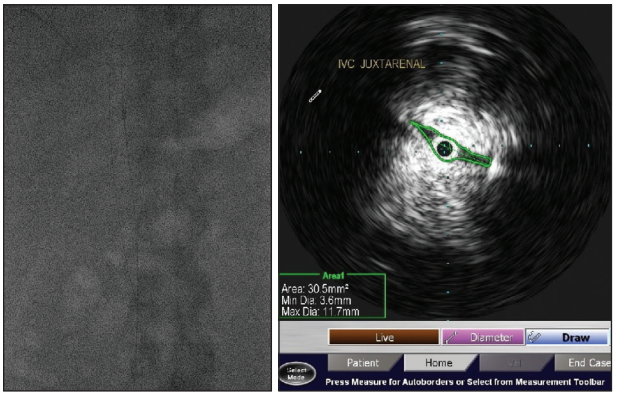

Figure 2. Apparent severe stenosis due to compression of the inferior vena cava in an obese patient. Note the lack of penetration of fluoroscopy due to body habitus and how the stenosis "disappears" in Figure 3 after inspiration.

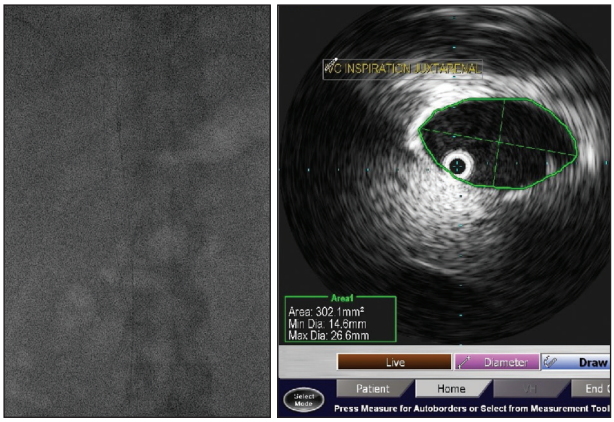

Figure 3. No stenosis in same patient as Figure 2 at the same level after inspiration.

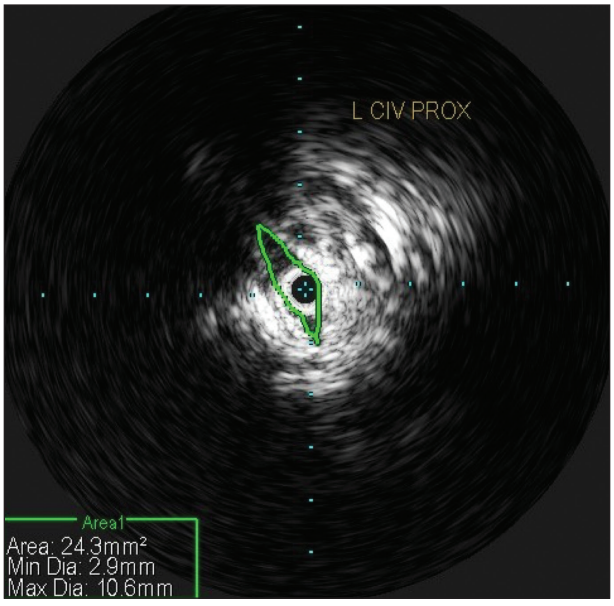

Figure 4. Severe stenosis with wall thickening.

a roadmap with anatomic landmarks and make interpretation of IVUS findings easier, especially for interventionalists accustomed to making decisions based on venography. The IVUS catheter can be introduced from either access site, provided that it allows for a thorough assessment of the situation from the right atrium to the femoral veins.

It is helpful to have the roadmap venogram as a reference alongside the IVUS image (Figure 1). A slow pullback on a recording mode serves as a first assessment of the situation and can be reviewed as needed using bookmarks for areas of interest. Wall thickness and intraluminal irregularities should be noted. In a healthy vein, the lumen is echolucent and the wall only mildly echogenic, which demonstrates significant wall movement with patient respiratory and circulatory cycles (Figures 2 and 3). A "true" stenosis will be static rather than dynamic with significant wall thickness (Figure 4).

Assessment of Stenosis

Possibly the most challenging task is obtaining an accurate appraisal of the stenosis. Choosing a reference vessel is difficult because most severe stenoses will have prestenotic dilatation below it, which means the percentage of stenosis may be overestimated. Using the contralateral side might be useful assuming it is not compromised; however, the contralateral side might also have dilated due to compensatory flow. It is also possible to have a lengthy segment of diseased vessel with no normal reference vessel.

The literature, primarily from Raju et al and Neglén et al,[1,2] and most recently from Gagne and the VIDIO trial investigators,[3] suggests that correcting a stenosis of > 50% correlates with symptom resolution and that there are "normal" areas of the vein segment that can be used as reference (Figure 5). In our own experience, all patients with significant symptoms who warranted examination and treatment had either complete occlusion or a decrease in total area to < 100 mm^2. The mean stenosis was found to be 72 mm^2 in the common iliac vein segment and 50 mm^2 in the external iliac/CFVs.

Stent Sizing

Selecting the correct stent size can also prove challenging, especially with the newer dedicated venous stents. Undersizing can lead to complications such as migration or early thrombosis. Oversizing can lead to chronic pain, damage of surrounding structures or turbulent flow, and thrombosis if there is a significant mismatch between the stent and the inflow vessel. As described previously, the inflow landing zone area may be overestimated because it represents prestenotic dilatation, and once the obstruction has been treated, the vessel may be too small for the stent. It is also important to note that ballooning can cause severe spasm; therefore, measurements must be performed before ballooning.

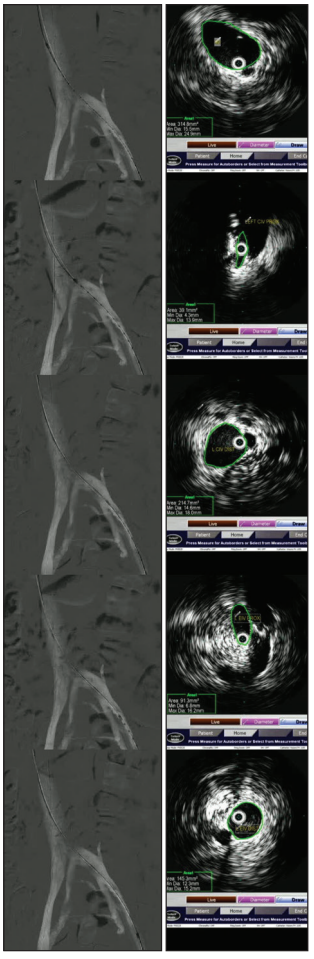

Figure 5. Multiple measurements obtained to assess degree of stenosis.

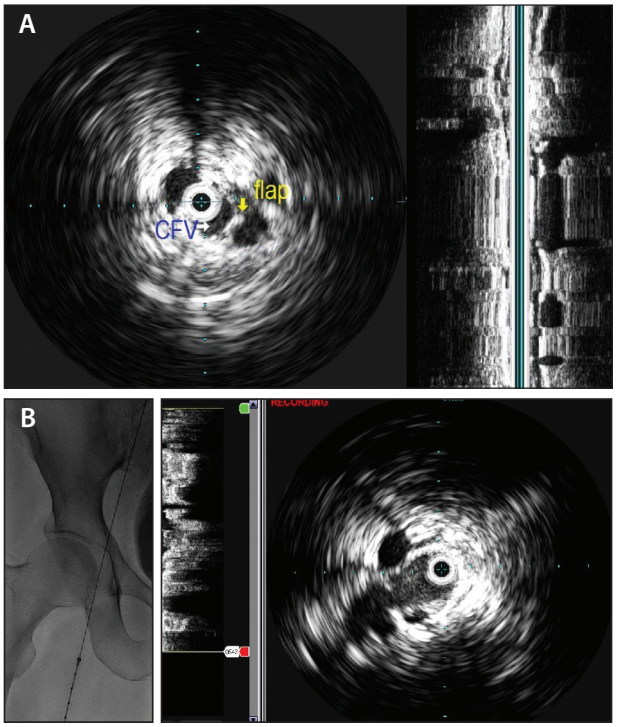

Figure 6. Evidence of intraluminal flap/webbing in postthrombotic case (A, B).

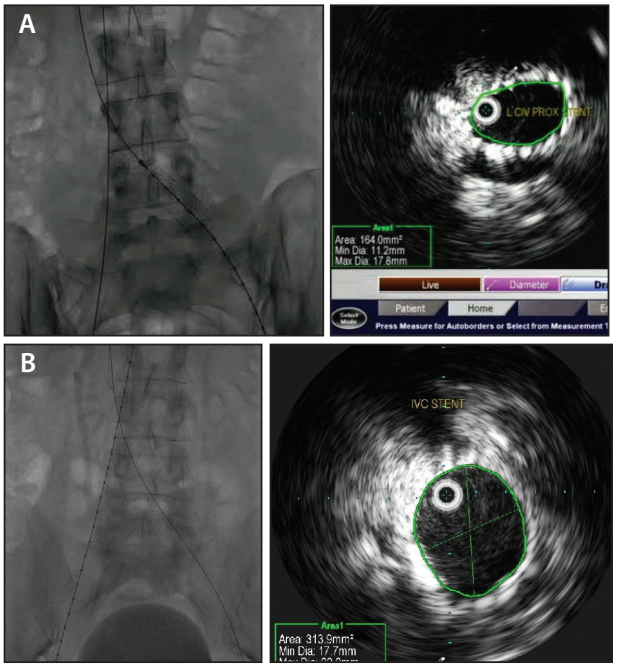

Figure 7. Poststenting IVUS assessment. Note the stent is not round (A) and the stent expansion (B).

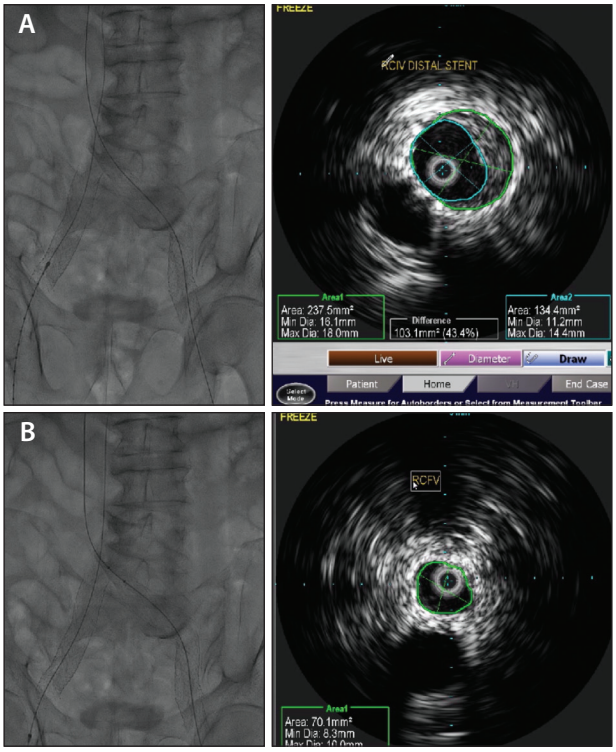

Figure 8. Evidence of in-stent restenosis due to missed inflow lesion (A, B).

Assessing Landing Zones

IVUS provides invaluable information when assessing inflow and outflow landing zones. The stent should be landed in a healthy vein. The iliac and femoral confluences and the sites of arterial crossing are difficult to assess accurately with venography alone and can be off by several centimeters.[4,5] In postthrombotic cases, assessing which channel the wire is in can prevent "caging" the main inflow vessel (Figure 6).

Evaluating Results

After balloon angioplasty and stenting, IVUS examination provides details on expansion and apposition of the stents as well as confirmation of a smooth transition with no significant size mismatch at the landing zones. Recent data presented at Charing Cross Symposium in April 2018 by Kabnick suggest that a rounder lumen shape poststenting has a positive correlation with outcomes and patency.[6] IVUS provides accurate information on lumen shape and can be repeated as many times as needed after reballooning without the concerns of increased radiation exposure of a cone-beam CT (Figure 7).

Avoiding False-Positive and False-Negative Results

Slow pullback, which allows for assessment of each vein segment during a respiratory cycle, measuring all segments in Valsalva maneuver, and paying close attention to anatomic landmarks and intraluminal details provide reliable, reproducible results.

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BENEFITS AND DISADVANTAGES

Reducing radiation exposure is probably the single-most relevant feature of IVUS technology. Data from the EVAR 1 and 2 trials demonstrate how vigilant we need to be in this area,[7] especially considering that most patients with venous disease are young and the long-term effects of low-dose radiation for interventionalists are unknown. IVUS is the only imaging modality that can differentiate a static/fixed/true stenosis from a dynamic stenosis, preventing unnecessary stenting, and because it is highly sensitive and accurate, it minimizes the chances of "missing" lesions that could compromise outcome (Figure 8).

However, IVUS technology is expensive and lacks reimbursement in many parts of the world. It also has a substantial learning curve and increases procedural times during initial use.

CONCLUSION

IVUS is an indispensable tool when assessing and treating patients with pelvic vein obstruction. It provides safe, accurate, and reproducible information that prevents under- or overtreating patients, improving not only clinical outcomes but also cost-effectiveness. ■

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Disclosures: None.

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Disclosures: None.