The Utility of Venous Imaging

Deciding which modalities to use for determining patient candidacy, procedural planning, course, and follow-up.

BY JOSE I. ALMEIDA, MD, FACS, RPVI, RVT

Chronic venous disease (CVD) management has undergone dramatic changes during the past decade as a result of technological developments. Fluoroscopy with contrast venography remains useful for selected cases but is no longer the workhorse for diagnosis and treatment of venous disease. Fluoroscopy generates images by delivering ionizing radiation and requires intravenous injection of nephrotoxic iodine-based solutions for visualization of the venous system. The risk of radiation-induced and/or contrast-induced toxicity makes fluoroscopy a less attractive venous imaging modality.

**Diagnostic Imaging**

Duplex ultrasonography (DU) includes noninvasive (nontoxic) visualization of anatomic structures, allowing assessment of both reflux and obstruction of the deep, superficial, and perforating veins. It is possible to distinguish congenital, primary, and secondary causes of CVD in the majority of cases. The physical examination allows for determination of the clinical class in the CEAP system, and it also guides the amount of time spent investigating a venous segment by noninvasive imaging. DU is a necessary adjunct to the history and physical examination for determination of the etiologic, anatomic, and pathophysiologic elements of the CEAP classification. In patients presenting with telangiectasias (clinical class 1), DU is of minimal importance and can be omitted. For class 2 (varicose veins) and 3 (venous edema) disease, a comprehensive scan is warranted to identify reflux and obstruction in the deep, superficial, and perforating systems. In advanced venous insufficiency (clinical classes 4–6), a full and detailed examination of all of the segments is necessary when interventions are being considered.

Venography retains a critical role in the evaluation of advanced CVD before and perhaps after venous reconstruction. Ascending venography provides an overall anatomic map of the lower extremity veins and pathways of venous return. Manipulation of patient position from horizontal to vertical, combined with tourniquets at various levels, can reveal important physiologic data about partial and complete segmental obstruction. Descending venography is the standard for analyzing sites of venous valves, distinguishing primary valve disease from secondary, and estimating the severity of reflux. It may also provide further information regarding patent venous channels in obstructive disease.

CT and magnetic resonance venography will likely have an increasingly important role in the future.

**Deep Venous System**

The interventionist needs to have a good understanding of the status of the deep venous system before proceeding with treatment. The study is ideally performed from the inferior vena cava to the tibial veins. Information regarding anatomic variability, status of valve competency, areas of stenosis/obstruction, and presence or absence of thrombus can be obtained with DU.

The patient should be studied on an examining table tilted at a slight angle to dilate the deep system, which makes the identification of veins easier and improves the velocity signals. The exam proceeds from the inguinal ligament to the ankles and includes the common femoral, deep femoral, femoral, popliteal, and tibial veins. Anatomic variability, such as duplication and atresia, should also be documented in the report.

The ability to fully compress the vein walls confirms the presence or absence of thrombus formation. Acute thrombi are characterized by vein dilatation and noncompressible echolucent intraluminal material.
Chronic thrombi take on a speckled echogenic ultrasonic appearance. Areas of obstruction/stenosis are documented; however, there are no criteria available at this time to accurately quantify the degree of stenosis in the venous system.

Continuous flow in a common femoral vein during interrogation with pulsed-wave Doppler is a clue for proximal obstruction. Reflux (venous flow away from the heart after release) is determined at locations of interest by adjusting the color box in the measurement location and adjusting the velocity scale (maximum = 25 cm/s). While a signal is being obtained, the technician compresses the calf below the probe, and the color box should demonstrate an increase in velocity toward the heart with compression. On release, the vein should demonstrate no velocity or minimal velocity away from the heart. Reflux of 0.5- to 2-second duration is mild; reflux is severe if present for > 2 seconds.

Patients with postthrombotic CVD are often seen with symptom severity that is disproportionately high compared to the soft clinical signs present. The valvular reflux and varicose changes in primary disease are readily distinguished from the luminal scarring and obstructive pattern of postthrombotic disease, even though the postthrombotic vein may also show significant reflux. It is easy to underestimate the morbidity in terms of pain and limb discomfort experienced by these patients unless a targeted history is taken.

Superficial Venous System

The superficial venous examination is carried out in the erect position. With the patient properly positioned, the technician moves the probe to the inguinal ligament and focuses on the great saphenous vein (GSV). A normal GSV extends from the saphenofemoral junction to the ankle and is surrounded by superficial fascia above and muscular fascia below. At a minimum, diameter measurements (and the presence or absence of reflux) are recorded at three locations in the GSV: (1) the saphenofemoral junction, (2) mid-thigh, and (3) below the knee. The same evaluation is repeated for the small saphenous vein, which originates in the ankle and can terminate in the upper thigh. Generally, the maximum small saphenous vein diameter is recorded in millimeters, and a reflux assessment is performed.

Perforator Venous System

The lower extremity has some common perforators that may play significant roles in venous insufficiency. Hunterian perforating veins are located in the midthigh. Dodd perforating veins are located at the distal thigh. The Boyd perforating vein is located below the knee at the upper/medial calf. Finally, we have Cockett No. 1, 2, and 3 perforating veins located respectively between the ankle and the lower calf. If present, perforators should be assessed regarding diameter, degree of reflux, and extension to other superficial structures.

Varicose Veins of the Perineum

Multiparous women presenting with perineal varicosities are a unique subgroup. Often, the varicosities coursing down the thigh are the result of pelvic congestion syndrome or ovarian vein reflux. DU is not the best modality to identify these defects; magnetic resonance venography or contrast venography may be more helpful. A high index of clinical suspicion based on a careful history and physical examination is the key to identifying these lesions.
Endovascular update

Endogenous vein, positioning of wires and catheters, and delivery of perivenous local anesthesia. It is useful during ultrasound-guided sclerotherapy of venous structures below the skin.

For iliofemoral venous stenting cases, intravascular ultrasound (IVUS) is invaluable both in diagnosis and as an intraoperative tool in stent placement because contrast venography, even with the transfemoral approach, has poor sensitivity in the assessment of the iliac venous segment (Figure 1). The use of DU for femoral vein access has eliminated complications related to inadvertent arterial puncture. Use of a large stent (16 to 18 mm), extension of the stent into the vena cava, and use of intraoperative IVUS for the detection and treatment of all stenotic areas in the iliac venous segment are believed to be important technical details in the reduction of the incidence rate of restenosis.

**POSTOPERATIVE IMAGING**

Postoperatively, all three components of color-flow DU (B-mode, Doppler, color) are used for determining the adequacy of target vein closure and the presence or absence of deep vein thrombosis. Areas of venous recanalization after ablation and stent patency after iliofemoral intervention, and their need for further treatment, can be monitored with DU.

**CONCLUSION**

With superficial venous management, DU will be sufficient for the majority of the job. As catheter-based strategies continue to evolve for deep venous system treatment, contrast venography using fluoroscopy has been resurrected. IVUS is a necessary adjunct for iliofemoral occlusive disease treatment.

Jose I. Almeida, MD, FACS, RPVI, RVT, is Director of the Miami Vein Center and Voluntary Associate Professor of Surgery at the University of Miami-Jackson Memorial Hospital in Miami, Florida. He is Managing Member of Vascular Device Partners, LLC. Dr. Almeida may be reached at dralmeida@mac.com.

Note: This article is an update to “Optimal Imaging for Varicose Vein Procedures” by Dr. Almeida, which was originally published in the March 2008 issue of Endovascular Today.