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Diagnostic Evaluation in patients with Venous Leg Ulcer: What is needed to plan venous intervention?

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Abstract

Venous Leg Ulcer (VLU) is a debilitating condition that affects millions of individuals worldwide. Improved venous drainage both by ablating reflux and correcting obstruction to venous outflow in reflux and occlusion, respectively may result in improved ulcer healing and reduce recurrence. However, minimum diagnostic imaging to confirm anatomy, location of the problem and severity, deciding management options in patients with VLU is still debated among care givers. The aim of this review article is to provide an overview of advantages and disadvantages of different diagnostic modalities currently described in the literature.

Keywords: Venous leg ulcer; Diagnostic imaging; Venous intervention

Introduction

VLU is defined as an open skin lesion of the leg or foot that occurs in an area affected by venous hypertension. [1]. It has been estimated that approximately 2.5 million people suffer from Chronic Venous Insufficiency (CVI) in the United States, and of those, about 20% develop a venous ulcer [2]. The economic impact is substantial too. A recent study examined a cohort of patients with non-healing VLU (CEAP6) who presented to a wound clinic [3]. The mean total cost of treating VLU was $ 15,732. Inpatient admission for infected ulcer markedly increased costs ($ 33,629). By contrast, VLU treated with surgical intervention of the superficial venous system did not significantly increase total cost over that of patients receiving best medical therapy ($ 11,960 vs. $ 12,304), but significantly reduced recurrence rate (34% vs. 5%) [3]. Both reflux and obstruction accounts for pathophysiologic mechanism of VLU, and leads to venous hypertension. Obstruction from secondary venous disease and venous reflux including Post Thrombotic Syndrome (PTS) are associated with a much more rapid progression of disease and a higher rate of venous ulceration, as compared to primary venous disease [4-6]. Detailed history and physical examination is recommended as the first step in the approach to a patient with VLU. It has also been recommended in published practice guidelines that an arterial examination and ankle –brachial examination is performed on all patients with suspected VLU [1].

Imaging the superficial venous system

Contrast Venography: Ascending venography is rarely used anymore to delineate anatomical information about patency of the venous system. Descending venography can be used to assess valvular incompetence [7]. However, venography is invasive, expensive, uncomfortable for patients, and associated with a small incidence of deep vein thrombosis and other complications related to contrast administration.

Duplex ultrasonography: DUS has essentially replaced contrast venography for the evaluation of most venous disorders because it is accurate, reproducible, non-invasive, and inexpensive [8]. DUS combines B-mode imaging of the deep and superficial veins with pulsed Doppler assessment of blood flow. B-mode imaging can visualize blood vessel as well as other anatomic structures that can produce pain and swelling and mimic venous disease, such as popliteal cyst, hematoma, arterial aneurysm, and other soft tissue masses [9]. Pulsed or color Doppler identifies vessels and the presence and direction of blood flow [Figure 1]. It helps in detecting venous reflux or venous obstruction and identifies its anatomic location. Pulse Doppler also helps in flow analysis. Analysis can be performed by listening to the audible signal or by recording the spectral analysis of the signal. A computer analysis then determines the flow velocity, direction, normal respiratory phasicity [Figure 2a], augmentation [Figure 2b], reflux [Figure 3] and the characteristics of flow (laminar vs. turbulent).

DUS is the standard for assessing venous reflux in the great and small saphenous veins as well as accessory saphenous veins [10,11]. To detect reflux, the patient is usually examined upright, and non- weight bearing for the extremity being examined. Blood pressure cuffs are placed on the thigh, calf and above the ankle; the veins are imaged with B-mode ultrasound. Cuffs are serially inflated to occlude venous flow and then rapidly deflated to

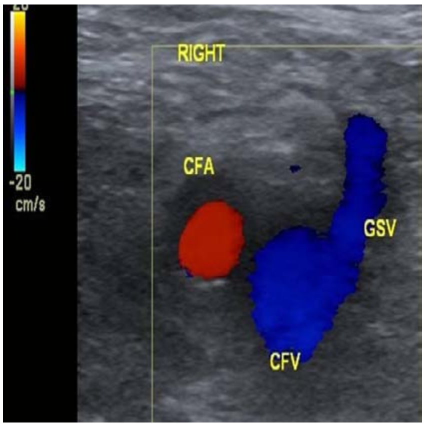

Figure 1: Color Doppler image of the groin in Normal individual. The common femoral artery (CFA), common femoral vein (CFV) and great saphenous vein (GSV) can be visualized, medial to Common femoral artery.

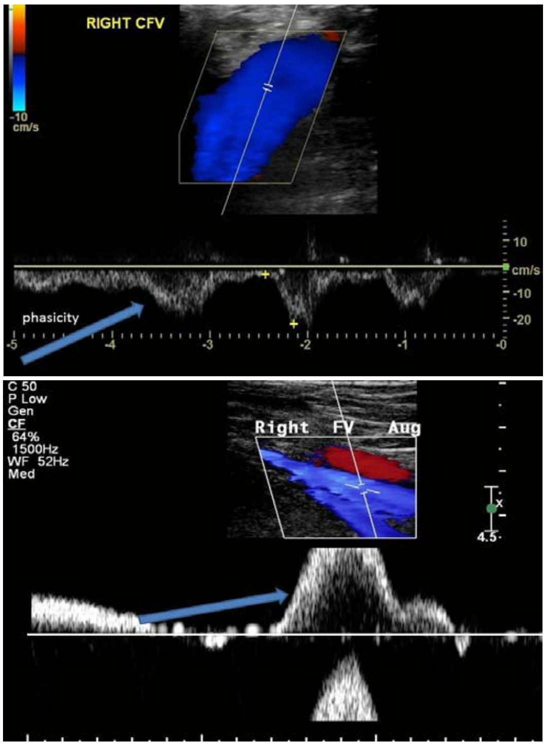

Figure 2: Color Doppler image of common femoral vein. Spectral analysis depicting respiratory phasicity (arrow) (A) and augmentation of flow (arrow) (B) with augmentation maneuvers.

assess the reflux with the pulsed Doppler component of duplex scanner. Some vascular labs prefer to test for reflux in the supine position. A reflux time that is > 0.5sec in duration is abnormal and indicates valvular insufficiency at that level [Figure 3]. Some experts suggest using a greater degree of reflux (> 1 second) for the deep system versus 0.5 seconds for the superficial venous system. One study found velocity and peak flow at the peak of reflux correlated better with clinical severity as compared to the reflux time [12].

Other test for detecting reflux

Air Plethysmography (APG): APG is a noninvasive physiological test that measure volume changes in the limb in response to postural changes and muscular activity. APG cannot precisely localize sites of venous reflux, and provides, primarily an overall estimate of venous function and monitor overall venous hemodynamics. The test is performed in some vascular laboratories as a research tool or by clinicians who perform large numbers of venous procedures as a means to assess the hemodynamic results of venous interventions [13].

Photoplethysmography (PPG): PPG can be used to assess overall venous hemodynamics [14]. Unlike DUS, it cannot accurately identify the location of reflux. To perform the test, a light emitting diode is placed over the medial ankle region. Transmitted light is reflected back to the PPG diode with the intensity of the reflection indicative of the red cell content of the subcutaneous tissue. After establishing a baseline, the patient is asked to perform tiptoe maneuvers or sequential dorsiflexion and plantar flexion of the ankle 10 times. These maneuvers serve to empty the subcutaneous veins and the PPG recording decreases. In the presence of reflux, veins fill more quickly. A venous refill

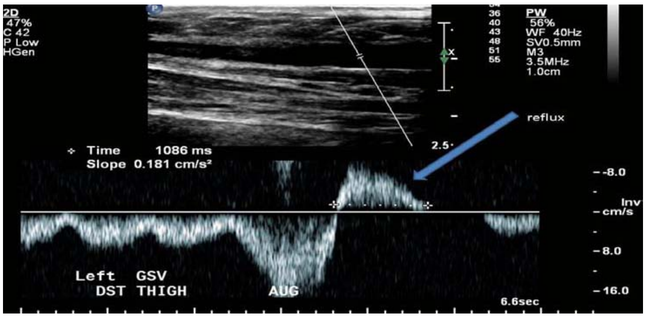

Figure 3: DUS imaging of great saphenous vein in distal thigh. B-mode imaging & spectral analysis shows patent vein with reflux time of > 1 second (arrow).

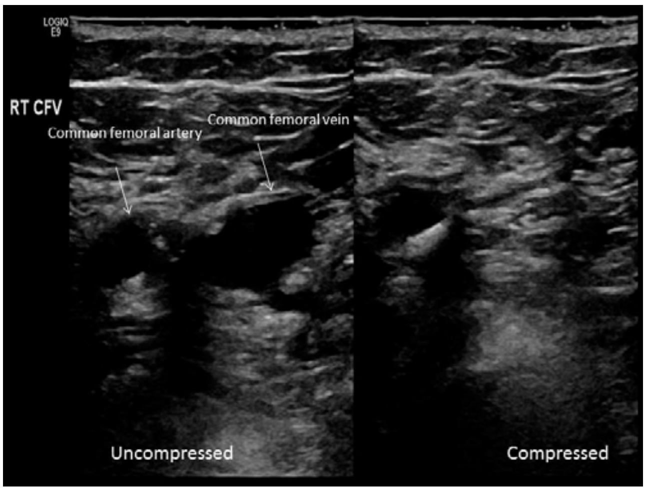

Figure 4: B-mode imaging of common femoral vein in groin showing uncompressed image (left) compressibility of normal vein (right).

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time less than 20sec indicate venous reflux. Although typically performed in a vascular laboratory, hand-held PPG devices are available and may be used as screening tool for Chronic Venous Insufficiency (CVI) [15].

Imaging the deep venous system

Much has improved with regard to management for deep vein obstruction (DVO) over the past two decades [16]. It is important to identify chronic DVO in patients with CVI. Additionally, moderate to severe post-thrombotic syndrome (PTS) negatively affects patients on a daily basis, with a reported lower quality of life related to this disease especially recurrent venous ulceration [17]. It has been shown that patients' quality of life suffering from PTS can be improved with interventional treatment [18]. Imaging modalities mentioned beloware primarily used to assist in patient evaluation, treatment planning, and confirmation of clinical suspicion of severity to predict the treatment outcome. One recent study reported how different levels of obstruction (caval, iliocaval, iliofemoral, femoral) have shown different outcomes after recanalization, stenting, and selected cases endophlebectomy [18].

DUS: B-mode imaging is the noninvasive test to assess the compressibility of the veins. Normal veins collapses with the application of pressure using the probe [Figure 5] but thrombosed veins do not collapse. Doppler examination of common femoral vein (CFV) waveform can be used to predict proximal obstruction. CFV waveform should be phasic and vary with respiration. If blunted or flat waveform with respiration is found, a more proximal Deep Vein Thrombosis (DVT) should be suspected [19]. In Chronic Venous Obstruction (CVO), specific attention should be paid to insufficiency of deep vein below the inguinal ligament, post thrombotic changes [Figure 5], and iliac obstruction. Pelvic and groin collaterals, non-reversibility of compression with augmentation, and an increased velocity ratio > 2.5 are also valuable in identifying chronic obstruction [20].

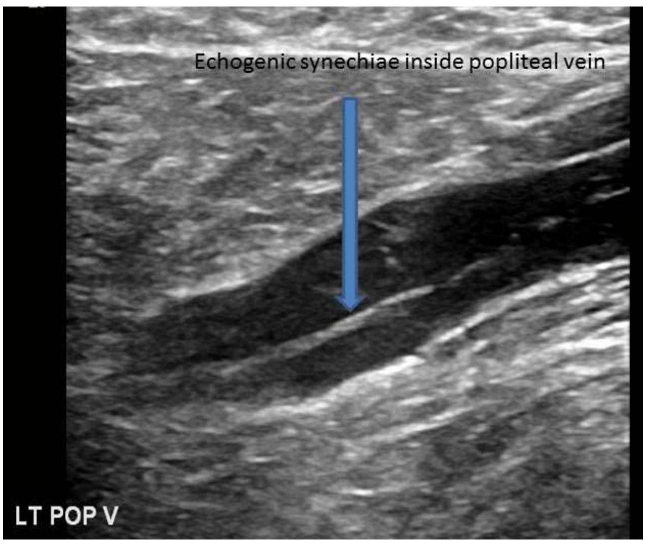

Figure 5: B-mode imaging of popliteal vein shows echogenic synechiae (arrow) inside the popliteal vein, suggesting post thrombotic changes.

Other tests: Other imaging modalities such as conventional venography, CT Venography (CTV), and Magnetic Resonance Venography (MRV) are considered when DUS is inconclusive or not possible.

CTV: In some institutions, CTV is used. When evaluating the ilio-caval segments, external compression or chronic venous obstruction should be reported.

MRV: MRV when available can provide an excellent overview of chronic vein changes in the leg, pelvis, and abdomen. DVT changes, external compression, chronic obstruction, collateral pathways, and/or flow redistribution can all be visualized. Dynamic imaging can show inflow and outflow of the pelvis vasculature [21]. It is currently used in combination with DUS to plan deep vein interventions in some centers in United States.

Contrast venography: Ascending venography is the classic, but rarely needed, "gold standard" for diagnosing deep venous thrombosis. It provides an objective anatomic and hemodynamic evaluation of the venous system [7]. In patients, already debilitated with severe symptoms coupled with disadvantages mentioned earlier, this is used only rarely and in centers where noninvasive imaging is not available.

Conclusion

Currently, acute deep venous thrombosis is managed with anticoagulation by a variety of specialties and inconsistent guidelines. Sometimes PTS results because in a large number of patients the natural history of thrombi results in sufficient valvular damage to lead to CVI. Other times the anticoagulation or thrombolysis is inadequate sometimes leaving patients with severe PTS and recurrent VLU. There are ongoing trials on acute DVT and CVO interventional treatment outcomes [22-23]. Once data is finalized, then incorporating them in current clinical practice guidelines coupled with awareness to providers will hopefully reduce suffering and the economic burden from VLU. Until then, properly performed noninvasive testing i.e. DUS as initial test of choice alone in experienced hands or/and when DUS is inconclusive, then MRV/CTV has potential to delineate underlying pathology and location of problem better. This will help plan venous interventions and improve outcomes of patients presenting with VLU in the future.

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