Duplex Ultrasound for the Diagnosis of Acute and Chronic Venous Diseases

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KEYWORDS

• Duplex ultrasound • Venous reflux • Chronic venous insufficiency
• Acute venous thrombosis • Chronic venous obstruction

KEY POINTS

- Venous diseases are highly prevalent medical conditions, mostly caused by valve incompetence (reflux) and/or obstruction of the vein lumen.
- Duplex ultrasound (DUS) is the first choice and, in many instances, the gold standard imaging technique for the diagnosis of reflux and obstruction.
- DUS is also used for obtaining venous access, guiding venous procedures, determining the immediate outcome of treatment, and short-term and long-term follow-up of patients.
- Cutoff value for venous reflux in the common femoral vein, femoral vein, and popliteal vein is greater than 1000 milliseconds; a lower cutoff (>500 milliseconds) is used in the superficial, perforating, and rest of the deep vein systems.
- Noncompressibility of the veins on axial axis, using grayscale technique, is the most sensitive and specific finding in acute deep vein thrombosis.

INTRODUCTION

Venous disease (VD) is a highly prevalent medical condition in Western countries.[1,2] VD manifests with a variety of signs and symptoms that are caused by obstruction of the vein lumen (acute or chronic) and/or valve incompetence (reflux). The diagnosis of VD, for the most part, relies on correlating the information gathered from patient's history, physical examination, and imaging findings. Contrast venography, impedance plethysmography, duplex ultrasound (DUS), computed tomography venography (CTV), magnetic resonance venography (MRV), and intravascular ultrasound (IVUS) are the main imaging modalities used for the diagnosis of VD.

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DUS is the imaging method of choice because it is very accurate, noninvasive, cost-effective, and reproducible. DUS is the only imaging modality that provides information on both the anatomy and function of the veins.[3] The treatment strategies for acute vein thrombosis and chronic venous insufficiency (CVI) are based on DUS findings. Additionally, venous DUS is widely used for screening, perioperative guidance, and follow-up. Many other conditions are ruled in or out with DUS (eg, aneurysms, hematomas, cysts, and tumors).

However, an accurate and reliable DUS result depends on the equipment and the protocol used for scanning, as well as the expertise of the technologist performing the study and the physician interpreting the images. Many societies have suggested, to improve patient's care, the use of guidelines and standards for venous DUS equipment, examination protocols, and interpretation.[4–9]

BASIC PRINCIPLES

To achieve an accurate diagnosis, the examiner should be familiar with the indications and limitations of venous DUS. Most DUS studies are performed in patients with suspected acute deep venous thrombosis (DVT), less than 20% reveal abnormalities.[10] Evaluation of CVI, superficial thrombophlebitis, postprocedural assessment of endovenous ablation (EVA), and phlebectomies, as well as, less frequently, venous malformation, aneurysms, and tumors, are among other possible indications. Limitations include obesity, restrictive mobility, severe leg swelling, and the presence of wounds, casts, or dressings.

The patient should be informed about any examination prerequisite (eg, 4–6 hours fasting to evaluate the suprainguinal veins), the maneuvers and techniques involving the study, and the average duration. The Society for Vascular Ultrasound[7] recommends a total time allotment of 75 minutes for performance of bilateral lower extremity venous examination to maximize quality and accuracy, 40 to 60 minutes for direct examination components (equipment optimization and hands-on), and 15 minutes for indirect examination components (obtaining previous examination data; initiating examination worksheet and paperwork; equipment and examination room preparation; patient assessment and positioning, patient communication; postexamination room cleanup; compiling, reviewing, and processing examination data for preliminary and/or formal interpretation; and patient charge and billing activities).

Relevant clinical information, obtained by interviewing the patient or reviewing available medical records, and a focused physical examination are essential elements for a good quality venous DUS. It can help the technologist better target the examination and save valuable scanning time. It also ensures that no pathologic complication is overlooked.[11]

The room and gel should be comfortably warm to prevent vein spasm. For evaluation of CVI, the patient needs to be placed in an upright or reverse Trendelenburg position to better assess the diameter of the veins and valve competence.

Multilinear high-resolution array transducers are used to image superficial veins and any deep structure up to 6-cm depth. Lower frequency (1–5 MHz) curvilinear transducers are preferred for imaging deep veins and obese or edematous patients because of better penetration. The machine settings should be adjusted to acquire high-quality images and reliable blood velocities.[8,12] B-mode images are obtained in transverse and longitudinal axis. The time-gain compensation should be properly set to overcome ultrasound attenuation so that the lumen of the vein appears dark in the absence of stasis and thrombosis. The focal zone is typically positioned at the vein lumen or the deeper wall to maximize lateral resolution. Multiple focal zones