Emergency Ultrasonography
Vascular Applications

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KEYWORDS

• Doppler • Deep venous thrombosis • Compression • Abdominal aortic aneurysm
• Inferior vena cava • Septic thrombophlebitis • Intima-media thickness

KEY POINTS

- Evaluation for deep venous thrombosis is indicated in symptomatic patients.
- Diagnosis of deep venous thrombosis relies on compression.
- Two-point compression is adequate for evaluation of deep venous thrombosis.
- Thromboses distal to the popliteal vein are generally not treated with anticoagulation.
- Abdominal aortic aneurysms may present with nonspecific symptoms.
- Most aneurysms occur distal to the renal arteries.
- Abdominal aortic aneurysm rupture has high mortality.
- Evaluation of the inferior vena cava may help determine intravascular volume status.
- Inferior vena cava diameter varies with respiration.

Videos identifying the deep venous system of the lower extremities as well as the abdominal aorta and inferior vena cava accompany this article at http://www.ultrasound.theclinics.com/

INTRODUCTION

Point-of-care ultrasonography of vascular structures such as the aorta and lower extremity deep venous system to evaluate for aneurysm and deep venous thrombosis (DVT), respectively, are core applications of emergency ultrasonography, as outlined by the American College of Emergency Physician's *Emergency Ultrasound Guidelines*.[1]

In this article, these applications as well as imaging of the inferior vena cava (IVC) and potential future applications of emergency ultrasonography are discussed. Standard water-based ultrasound gel should be used as an ultrasound medium with all of the following studies.

DVT

Clinical Problem/Statistics

The incidence of symptomatic DVT in the United States is estimated to be approximately 250,000 adults per year.[2] Ultrasonography use for diagnosis of DVT was just more than 25% in the emergency department (ED) in 2006, and ED patients were nearly 2 times more likely to receive ultrasonography for diagnosis.[3] Approximately 60,000 to 100,000 Americans are estimated to die each year from DVT or pulmonary embolism (PE), 10% to 30% of whom die within 1 month of diagnosis.[4] One-third of patients with a PE present with symptoms of DVT.[5] With the comorbidity

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and mortality associated with venous thromboembolism, recognizing warning signs and symptoms, as well as timely evaluation of potential DVT, is an important skill set in the practice of emergency medicine. Limited access to formal ultrasonography to evaluate for DVT can lead to delays in care or subject patients to the risk of anticoagulation, given the necessity to treat despite diagnostic uncertainty.

Although formal radiology Doppler studies have traditionally imaged the entire proximal deep venous system from the common femoral vein to the termination of the popliteal vein, studies have shown that compression at 2 points, the common femoral vein and the popliteal vein, is just as sensitive and specific as imaging the entire proximal deep venous system using duplex ultrasonography for diagnosis of DVT in symptomatic patients.[6,7] In patients with a high pretest probability of DVT, 1 study has shown that combining compression ultrasonography in the ED has a high likelihood ratio for DVT as well.[8,9] ED physicians have a significant agreement with radiology in the interpretation of ED ultrasonography for evaluation of DVT.[10] In addition, a correlation between vascular laboratory studies has been seen with the added benefit of increased speed with ED bedside ultrasonography.[11,12]

Anatomy

Proximally to distally

As the external iliac vein crosses the inguinal ligament, it becomes the common femoral vein and subsequently bifurcates into the superficial and deep femoral veins, both classified as parts of the deep venous system. The femoral vein is found just lateral to the common femoral artery immediately after the inguinal ligament and before the common femoral artery and vein take an anterior-posterior relationship, respectively. Similar to the vein, the common femoral artery then bifurcates into the superficial and deep femoral arteries.

The popliteal vein begins in the proximal popliteal fossa and terminates as it diverges in the anterior and posterior tibial veins.

Imaging Protocols

Transducer

A linear transducer ranging from 7.5 to 10 MHz.

Positioning

The patient may be placed in a supine position or sit on the edge of a gurney or examining table, with knees flexed at 90°. If the patient is supine, leg should be mildly abducted and externally rotated at the hip to provide convenient access to the common femoral vein and its proximal branches. In this position, the knee may be passively flexed from 30° to 80°, allowing for comfort and evaluation of the popliteal fossa. Depending on the side being imaged, the sonologist may choose to stand to the patient's left or right side. An easy way to find the best starting position when evaluating the common femoral vein is by palpating the common femoral artery pulse a few centimeters distal to the inguinal crease. The transducer should be placed perpendicular to the skin, with the indicator toward the patient's right.

It is important to remember anatomic relationships when differentiating between the common femoral artery and vein, particularly their relationship to one another. The common femoral vein is medial to the artery. When comparing sides, the ultrasonographic images appear as mirror images of each other. Other factors allowing for differentiation include the relatively thick walls and pulsatile nature of the artery (which may be more apparent with the use of color flow Doppler). The vein should be more compressible than the artery, but in the presence of a DVT, this is not always a reliable characteristic. Pulse wave Doppler may be used for further differentiation of the artery and vein.

1. Identify the common femoral artery and common femoral vein (**Fig. 1**, Video 1).
2. Identify the greater saphenous vein joining the common femoral vein medially and compress at this level. The amount of pressure applied should not collapse the artery (Video 2).
3. Proceed distally to the branching of the common femoral vein into the superficial and deep femoral veins and evaluate compressibility at the bifurcation and proximal segments of each vein. Thromboses may be more prone to form around points of divergence (when assuming a proximal to distal viewpoint) in the vascular system (eg, as the common femoral vein bifurcates to form the superficial and deep femoral veins) (Video 3).

Proceed to the popliteal fossa:

1. Place the transducer in the proximal popliteal fossa. The popliteal vein and artery typically have an anterior-posterior relationship, respectively. In the ultrasonographic image, the vein appears more superficial (**Fig. 2**).
2. Follow the popliteal vein down, and intermittently compress every 1 cm until it divides into the fibular vein and the posterior and anterior tibial veins (Videos 4 and 5).