Radiology Rounds

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Janet Cochrane Miller, D.Phil., Author **Susanna I. Lee, M.D., Ph.D., Editor**

Diagnosis of Lower Extremity Deep Vein Thrombosis

- **Compression ultrasound (US) is highly sensitive and specific for the detection of deep vein thrombosis (DVT) in the upper leg.**
- **Lower extremity US can give indirect evidence of pelvic DVT. However, MR venography is recommended for direct diagnosis of suspected pelvic DVT.**
- **US is not sufficiently sensitive to rule out thromboses below the knee and, if clinical suspicion remains high, US examination should be repeated after a week because of the danger of thrombus propagation into the thigh veins**
- **CT pulmonary angiography combined with CT venography of lower extremity is recommended for patients with symptoms of pulmonary embolism to detect emboli in the lung and to screen for DVT.**

Deep vein thrombosis (DVT) is not only a common disorder, affecting some 250,000 people in the USA each year, but is also difficult to diagnose clinically and potentially life threatening. In cases of untreated DVT, it has been estimated that up to 50% develop pulmonary embolism. Therefore, it is important to diagnose DVT. However, when patients are symptomatic the cause may be Baker's cyst, cellulitis, lymphedema, chronic venous disease, or a musculoskeletal disorder rather than DVT. Alternatively, patients may be asymptomatic but have DVT, especially after major surgical procedures such as total knee or hip arthroplasty.

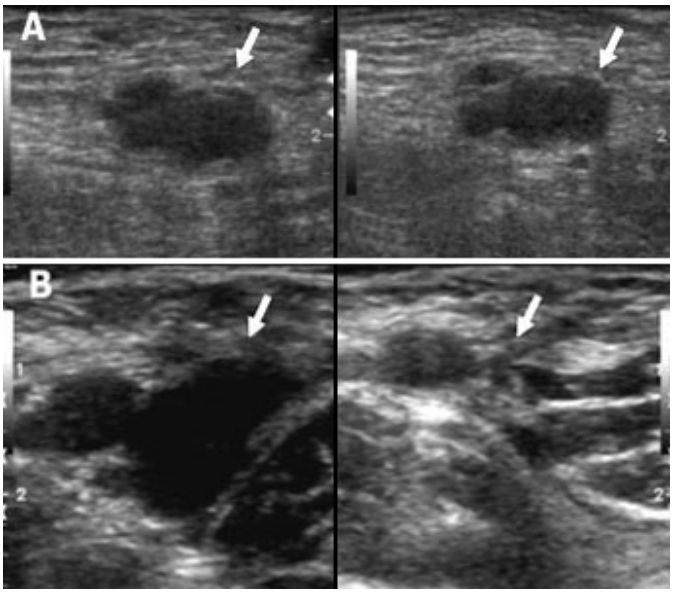
The D-dimer assay, which detects one of the products of fibrin breakdown in the blood, is commonly used as a rapid initial test for DVT as well as for pulmonary embolism. Studies have shown that a value of <500 ng/mL from an ELISA D-dimer test rules out DVT and pulmonary embolism in the vast majority of cases.

Sensitivity and Specificity for Diagnostic Imaging of Lower Extremity DVT

	Sensitivity	Specificity
Compression Ultrasound	93%	98%
MR Venography	100%	100%
CT Venography	89-100%	94-100%

Sonography

US imaging has both high sensitivity and specificity for the detection of thromboses in the proximal leg veins. In gray scale (B-mode) US, normal veins appear dark, whereas a blood clot is more echogenic. In addition, the veins are typically dilated if DVT is present. The definitive test is compression US, as pressure applied by the scanning probe over the region of interest will compress a normal vein but not one that contains thromboses. Color Doppler imaging provides more information on both the speed and direction of flow. If there is an occlusive blood clot, it will show no flow within the vein segment or, if partially occlusive, there may be limited flow surrounding the blood clot.

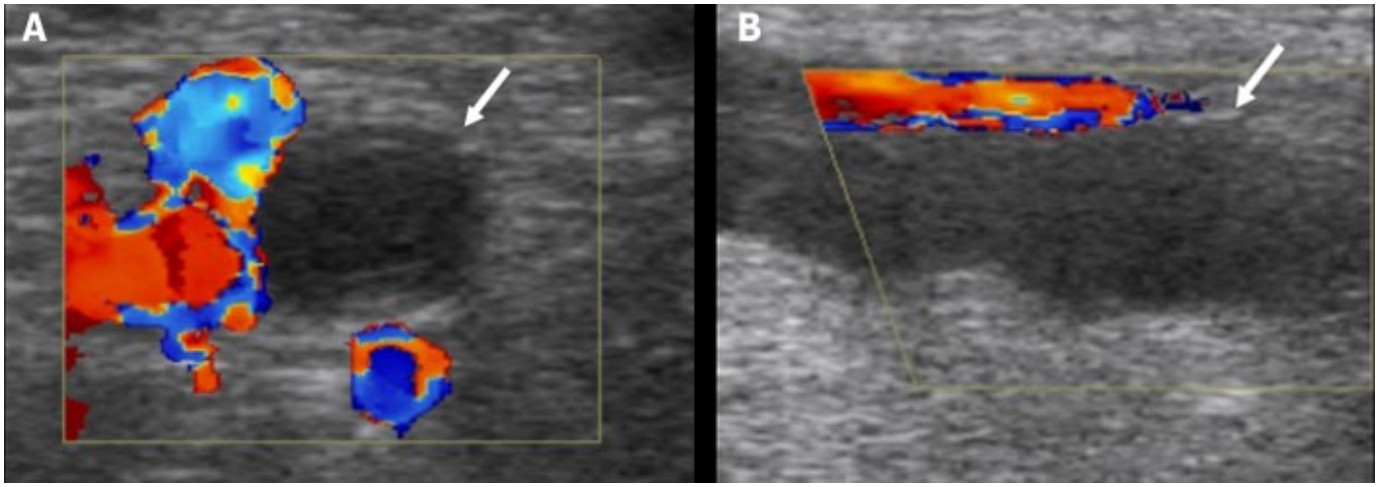


Compression US of the right leg in (A) a patient with and (B) a patient without common femoral vein thrombus. Note that a vein with acute thrombus demonstrates no intraluminal echoes. Thrombus is only detected by lack of compression. In contrast, a normal vein is easily compressible.

In addition, there are ultrasound techniques that give indirect evidence of thromboses above and below the site of examination. During inspiration and expiration,

there are changes in pressure within the body that modulate the flow rate in healthy veins, which can be detected by Doppler ultrasound. If no fluctuations in flow rate are observed, there may be an obstruction present. The Valsalva maneuver will increase the pressure within the body and will affect venous blood flow in a normal system, except in cases of pelvic or inferior vena cava obstructions in which lower extremity venous pressures is greater than that produced by the Valsalva maneuver. Thus, if there is no change in blood flow, there is indirect evidence of an obstruction above the level of the ultrasound transducer. In addition, pressure on the calf muscles or thigh muscles will normally increase the blood flow through the deep veins of the thigh. If no increase in blood flow is detected in the femoral vein, then this is indirect evidence that that there is an obstruction between the site of manual compression and the transducer.

Direct US examination of the calf veins is only performed if there are indirect indications of DVT below the knee. US is less sensitive for detecting thromboses in the deep veins of the calf because it is not always possible to visualize all three of the major veins in this region. Therefore, if no DVT is detected but symptoms or suspicion persists, the US examination should be repeated after a week to detect formerly occult calf vein thrombus that might have propagated into the deep popliteal or femoral veins.



Right lower extremity (A) transverse and (B) saggital images from color Doppler ultrasound demonstrates blood flow in the femoral artery but not in the common femoral vein (arrows). This is an indirect finding that suggests common femoral DVT.

Techniques for the diagnosis of DVT		
	Advantages	**Disadvantages**
D-Dimer assay	Rapid Inexpensive	Sensitivity depends on assay method
Ultrasound	Sensitive and specific for proximal lower extremity DVT Least expensive imaging method Can be done at patient's bedside	Lower sensitivity for DVT in calf and pelvis Pain, bandages, or casts may limit or prevent examination
MR Venography	Direct imaging of pelvic veins and vena cava Highly sensitive and specific No toxicity problems from contrast agent Examination not affected by bandages or casts	Contraindicated for patients with pacemakers and other metallic implants (see MRI Safety issue, Radiology Rounds, February 2005) Not readily available
CT Venography	Can be performed at same time as pulmonary angiography Can be used when MRI is contraindicated	Large volume of contrast agent required to achieve opacification of veins Contrast agent toxicity Radiation exposure

MR Venography

MR venography will directly detect thromboses in the deep veins of the pelvis, abdomen, and extremities but it is not used as an initial examination because it is expensive, MR scanners are not available on short notice, and the examination is time consuming. However, if US imaging indicates a suspicion of DVT downstream of the upper leg, the patients should be further evaluated by MR venography of the pelvis and abdomen. MRI has several advantages over CT for this purpose. Visualization is better because MRI is sensitive to low concentrations of contrast agents. In addition, MR contrast agents are well tolerated and there is no exposure to ionizing radiation. Furthermore, although the spatial resolution of MRI is lower than that of CT, this is not an issue because of the size of the deep pelvic veins. However, MRI may be contraindication for some patients, such as those with pacemakers or other metallic implants. In these patients, CT venography can be used to further evaluate the extent of DVT.

In cases of suspected pulmonary embolism (see Diagnosis of Pulmonary Embolism, Radiology Rounds, July 2003), CT angiography of the pulmonary arteries followed by CT venography is recommended. The additional examination time required for CT venography is only approximately 2 minutes and no extra contrast agent is injected for the venography phase of the examination.

Scheduling

Ultrasound evaluation for DVT is performed on the main MGH campus, Mass General West Imaging in Waltham and in the MGH Chelsea Healthcare Center. Appointments can be scheduled at all locations by calling 617-724-9729 or, for the main campus only, through the Radiology Order Entry system, http://mghroe/.

Further Information

For further questions, please contact Suhny Abbara, M.D., (617-726-0796) Director of Cardiovascular Imaging in the Cardiovascular Imaging and Intervention Division. We would like to thank Michael Laposata, M.D., Ph.D., Director of Clinical Laboratories, for his assistance and advice for this issue.

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