

**American College of Radiology
 ACR Appropriateness Criteria®**

Clinical Condition: Suspected Lower Extremity Deep Vein Thrombosis

Radiologic Procedure	Rating	Comments	<u>RRL</u>*
US lower extremity with Doppler	9	With compression.	O
MRI venography lower extremity and/or pelvis	7	Primary modality for pelvic DVT and for thigh DVT if US nondiagnostic. See statement regarding contrast in text under "Anticipated Exceptions."	O
CT venography lower extremity and/or pelvis	7	Primary modality for pelvic DVT and for thigh DVT if US nondiagnostic.	☢ ☢ ☢
X-ray venography pelvis	6	If US findings and/or clinical symptoms/signs suggest proximal (iliocaval) disease or when thrombolysis is planned.	☢ ☢
X-ray venography lower extremity	4	Used primarily in conjunction with thrombolysis.	☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

SUSPECTED LOWER EXTREMITY DEEP VEIN THROMBOSIS

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Summary of Literature Review

Lower extremity deep venous thrombosis (DVT) has an estimated annual incidence of approximately 5 per 10,000 in the general population, with incidence increasing with advancing age [1]. DVT typically starts distally below the knee but may extend proximally above the knee and potentially result in pulmonary embolism, which may be fatal, if severe. Pulmonary embolism can occur in 50%-60% of patients with untreated DVT, with an associated mortality rate of 25%-30% [2-3]. Mortality associated with venous thromboembolism is more commonly seen in patients who present with pulmonary embolism or have advanced age, cancer, or underlying cardiovascular disease [4].

It is clinically important to determine the location and extent of DVT [3,5]. DVT limited to the infrapopliteal calf veins (ie, below-the-knee or distal DVT) often resolves spontaneously and rarely is associated with pulmonary embolism or other adverse outcomes [3,6-7]. Above-the-knee or proximal DVT, on the other hand, is strongly associated with the risk of pulmonary embolism. Treatment of choice for DVT is anticoagulation with the intent of reducing the risk for DVT extension and pulmonary embolism, but also for reducing the likelihood for recurrent DVT and post-thrombotic syndrome. It is generally accepted that the benefits of anticoagulation therapy in patients with proximal DVT outweigh its risks [3,5]. Since below-the-knee DVT rarely results in pulmonary embolism, the role of anticoagulation therapy in patients with distal DVT remains controversial [3,5,8]. However, because one-sixth of patients with distal DVT

will experience extension of the thrombus proximally above the knee, serial imaging assessment at one week to exclude proximal DVT extension is recommended if anticoagulation therapy is not initiated at presentation [3,5].

Classically, a patient with symptomatic lower extremity DVT presents with either local pain or tenderness or with edema and swelling of the lower extremity. However, approximately one-third of patients with DVT do not have any signs or symptoms [9]. Symptoms are often not apparent until there is involvement above the knee [3]. The clinical diagnosis of DVT using clinical risk stratification scores (eg, Wells score) alone has therefore been less than ideal [9]. Wells et al [10-11] have suggested the use of clinical DVT prediction score (a.k.a. Wells score) in combination with the blood evaluation for plasma D-dimer, a degradation product of cross-linked fibrin that is elevated during thromboembolic events. DVT is unlikely if the clinical prediction score is low and the D-dimer levels are normal [3,5,9-11]. However, the highly variable nature of DVT presentation, numerous potential pathologic mimics for DVT, and variations in performance of the D-dimer assays in certain populations limit the reliability of DVT diagnosis solely on clinical DVT prediction score and D-dimer testing. Imaging is frequently required for definitive exclusion of DVT as well as proper documentation of the extent of venous thrombosis, which is critical for proper therapeutic management of DVT. Moreover, clinical prediction score and D-dimer level are often unreliable for the diagnosis of recurrent DVT and are unable to diagnose alternative conditions, such as intact or ruptured Baker's cyst, cellulitis, lymph edema, chronic venous disease, and various musculoskeletal disorders that can clinically mimic DVT.

Imaging remains critical for the proper diagnosis and management of DVT. Lower extremity contrast x-ray venography has been the traditional gold standard for diagnosis of DVT but is now rarely used in routine DVT assessment, with the exception of complex cases, such as the exclusion of acute DVT in a patient with a prior history of DVT. In most cases, contrast x-ray venography has been replaced by less invasive techniques, especially ultrasound (US), but also magnetic resonance venography (MRV) and computed tomography venography (CTV).

Imaging Options

Contrast X-ray Venography

Contrast x-ray venography is the historic and *de facto* "gold standard" for diagnosing DVT [3,5,9-10]. With this technique, proximal compression tourniquets are applied and a series of overlapping radiographs are obtained following the injection of an iodine-containing contrast medium into a dorsal vein in the foot. DVT is present if a distinct filling defect is present in a deep vein, typically in the calf or thigh but often may extend or involve more proximal veins such as in the pelvis. Less specific

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findings for DVT include abrupt contrast cut-off, absence of contrast filling, or the presence of collateral venous vessels. Contrast x-ray venography is particularly helpful for the assessment of recurrent acute DVT in patients with prior history of DVT in whom venous anatomy is often complex and difficult to evaluate using other methods.

Ultrasound

US is widely recognized as the most cost-effective and preferred imaging modality for the diagnosis of proximal DVT [2-3,5-7,9-11]. Real-time duplex US is noninvasive, easily performed to include at the patient's bedside, and can be reliably used for serial evaluation. It is, however, less consistent in diagnostic performance above the inguinal canal and below the knee. The major sonographic criterion is the failure of complete compression of imaged vein walls when pressure is applied to the skin during real-time imaging. US evaluation for DVT is often combined with real time Doppler imaging, such as duplex, continuous-wave, and/or color-flow Doppler imaging. Color-flow Doppler imaging can assist in the characterization of a clot as obstructive or partially obstructive. Augmentation of venous flow with duplex US rarely provides additional information when diagnosing DVT, but may be useful as a secondary diagnostic tool [12]. A recent meta-analysis found US to have a very high sensitivity (range, 93.2%-95.0%; pooled sensitivity, 94.2%) and a high specificity (range, 93.1%-94.4%; pooled specificity, 93.8%) for diagnosing proximal DVT [5]. In the same study, US was found to have a much lower sensitivity (range, 59.8%-67.0%; pooled sensitivity, 63.5%) for the diagnosis of distal DVT, which confirmed a widely known diagnostic limitation for this technique [5].

Magnetic Resonance Venography

MRV is another noninvasive alternative to contrast x-ray venography that shares many of the clinical advantages of US, such as not requiring the exposure of the patient to ionizing radiation or iodinated contrast media [13-17]. However, US remains the preferred first choice for DVT imaging because of its relatively lower cost, wider availability, and portability that facilitates evaluation of critical patients at bedside. MRV does have inherent advantages over US, especially in its ability to delineate extravascular anatomy. MRV may provide proper identification of potential sources of extrinsic venous compression that may be an underlying cause for the DVT or suggest alternative diagnoses that mimic DVT.

MRV has been shown to successfully diagnose DVT using any of a variety of pulse sequences or techniques [13-17]. Patency or thrombosis of a deep vein can typically be determined without the administration of contrast media using a variety of MRI techniques, such as spin echo, fast spin echo, time-of-flight, phase contrast, steady-state free precession, or flow-independent imaging. Cardiac gated cine bright blood MRI can be used to differentiate transient flow artifacts from true filling defects that persist over the cardiac cycle. Contrast media enhanced MRV, however, may also be helpful in more complex cases. Despite the wide variety of

techniques, however, a recent meta-analysis found MRV to have both a high sensitivity (range, 87.5%-94.5%; pooled sensitivity, 92%) and specificity (range, 92.6%-96.5%; pooled sensitivity, 95%) [16]. When evaluating for proximal DVT, MRV is as sensitive and specific as US or contrast x-ray venography; however, it should be noted that MRV has been evaluated in far fewer studies. MRV does, however, have contraindications and is not recommended in certain patients, such as those with MRI unsafe devices.

Computed Tomography Venography

CTV can also be used to diagnose DVT [5,17-18]. CTV, however, has the same clinical concerns as contrast x-ray venography, namely, patient exposure to ionizing radiation and iodinated contrast media. CTV can be performed either as direct CTV, using venous injection of iodinated contrast media in a pedal vein similar to contrast x-ray venography, or as an indirect CTV using a typical antecubital venous iodinate contrast media injection and a delayed imaging acquisition suitable for deep venous contrast media opacification. CTV, like MRV, has the inherent advantages of cross-sectional imaging for identification of extravascular sources of extrinsic compression that may be an underlying cause for DVT. In patients with suspected pulmonary embolism, a recent meta-analysis found CTV for the diagnosis of proximal DVT to have a high sensitivity (range, 71%-100%; pooled sensitivity, 95.9%) and high specificity (range, 93%-100%; pooled specificity, 95.2%) comparable to that of US [17]. CTV can also be incorporated into comprehensive examination that includes pulmonary CT angiography for evaluation for both pulmonary embolism and proximal DVT [18]. There is very little evidence to support the use of CTV for DVT outside of a workup for pulmonary embolism, but based on published experience with pulmonary embolism, it may be a reasonable alternative to MRI for pelvic CTV, or when US is nondiagnostic in the calf.

Summary

- The initial screening for possible DVT should be performed using a combination of clinical risk stratification score (ie, Wells score) and plasma D-dimer assessment.
- DVT typically begins in the distal calf veins, often extending above the knee. DVT can result in a variety of complications, notably pulmonary embolism which can be fatal. The likelihood for pulmonary embolism is sufficiently high for proximal DVT to merit initiation of anticoagulation therapy. The role of anticoagulation therapy for distal DVT remains controversial.
- Both clinical risk stratification scoring and D-dimer assessment, however, have limitations, and imaging ultimately is typically required for the confirmation of DVT and proper treatment planning.
- Noninvasive imaging for DVT is most cost-effectively performed using US. While highly sensitive and specific for proximal DVT, US is far

less sensitive for distal DVT; and repeat US at one week is recommended to exclude proximal extension of thrombus, which has increased risk for pulmonary embolism and necessitates the initiation of anticoagulation therapy. US can also be used to tailor the duration of anticoagulant therapy [19].

- MRV and CTV are viable imaging options, especially in patients unable to undergo US (eg, patient in a cast), with a high suspicion for pelvic DVT or with nondiagnostic US exams.
- MRV and CTV have a distinct advantage over US for demonstration of overall venous clot burden, especially within the inferior vena cava and pelvic veins. MRV and CTV provide good illustration of extravascular anatomy, which may be particularly useful for diagnosing external sources of venous compression or alternative diagnoses (eg, Baker’s cyst).
- Contrast x-ray venography is the time-honored gold standard that is helpful for evaluation of more complex cases, such as acute DVT in patients with chronic DVT.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [20].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional

information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕ ⊕	0.1-1 mSv	0.03-0.3 mSv
⊕ ⊕ ⊕	1-10 mSv	0.3-3 mSv
⊕ ⊕ ⊕ ⊕	10-30 mSv	3-10 mSv
⊕ ⊕ ⊕ ⊕ ⊕	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Contrast Information](#)
- [Evidence Table](#)

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.