American College of Radiology
ACR Appropriateness Criteria®
Suspected Lower Extremity Deep Vein Thrombosis

Variant 1: **Suspected lower extremity deep vein thrombosis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler lower extremity	Usually Appropriate	O
CT venography lower extremity and pelvis with IV contrast	May Be Appropriate	☢☢☢
MR venography lower extremity and pelvis without and with IV contrast	May Be Appropriate	O
MR venography lower extremity and pelvis without IV contrast	May Be Appropriate	O
Catheter venography pelvis and lower extremity	Usually Not Appropriate	☢☢☢

SUSPECTED LOWER EXTREMITY DEEP VEIN THROMBOSIS

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Summary of Literature Review

Introduction/Background

Lower extremity deep venous thrombosis (DVT) has an estimated annual incidence of approximately 5 per 10,000 in the general population, with the incidence increasing with advancing age [1]. DVT typically starts distally below the knee but can extend proximally above the knee and potentially result in life-threatening pulmonary embolism. Pulmonary embolism can occur in 50% to 60% of patients with untreated DVT, with an associated mortality rate of 25% to 30% [2,3]. See the ACR Appropriateness Criteria® topic on "Suspected Pulmonary Embolism" [4] for further details. Mortality associated with venous thromboembolism is higher in patients who present with pulmonary embolism or have advanced age, cancer, or underlying cardiovascular disease [5].

It is clinically important to determine the location and extent of DVT [3,6]. DVT that is limited to the infrapopliteal calf veins (ie, below-the-knee or distal DVT) often resolves spontaneously and is rarely associated with pulmonary embolism or other adverse outcomes [3,7,8]. Above-the-knee or proximal DVT, on the other hand, is strongly associated with an increased risk for pulmonary embolism. The treatment of choice for DVT is anticoagulation to reduce the risk of DVT extension, recurrent DVT, pulmonary embolism, and post-thrombotic syndrome. It is generally accepted that the benefits of anticoagulation therapy in patients with proximal DVT outweigh its risks [3,6]. Because below-the-knee DVT rarely results in pulmonary embolism, the role of anticoagulation therapy in patients with distal DVT remains controversial [3,6,9]. However, because one-sixth of patients with distal DVT experience extension of thrombus proximally above the knee, serial imaging to exclude proximal DVT extension is recommended at 1 week if anticoagulation therapy is not initiated at presentation [3,6]. This issue is complicated by the variability in evaluation for below-the-knee DVT as part of a routine examination.

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 symptoms [10]. Often, symptoms are 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 [10]. Wells et al [11,12] suggested using a clinical DVT-prediction score (aka, Wells score) in combination with a 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 [3,6,10-12]. However, the highly variable nature of DVT presentation, numerous potential pathologic mimics for DVT, and variations in D-dimer assay performances in certain populations limit the reliability of diagnosis solely on the clinical DVT prediction score and D-dimer testing. DVT screening of select high-risk patients in intensive care units because of prolonged immobility has also shown benefit [13,14]. Lower extremity ultrasound (US) has also been included in an algorithm for the workup of patients who have a fever of unknown origin after more common causes have been excluded [15,16].

Imaging is frequently required to definitively exclude DVT and properly document the extent of venous thrombosis, which is critical for proper therapeutic management of DVT. Moreover, the clinical-prediction score

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and D-dimer level are often unreliable for diagnosing recurrent DVT and are not useful for diagnosing alternative conditions, such as an intact or ruptured Baker cyst, cellulitis, lymphedema, chronic venous disease, and various musculoskeletal disorders that can clinically mimic DVT.

Discussion of Procedures by Variant

Variant 1: Suspected lower extremity deep vein thrombosis. Initial imaging.

Catheter Venography Pelvis and Lower Extremity

Contrast catheter venography is the historic and de facto gold standard for diagnosing DVT [3,6,10,11]. With this technique, proximal compression tourniquets are applied, and a series of overlapping radiographs are obtained following an iodine-containing contrast medium injection 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 it can often extend to or involve more proximal veins, such as those in the pelvis. Less specific findings for DVT include an abrupt contrast cut-off, the absence of contrast filling, or the presence of collateral venous vessels. Although the techniques have evolved to catheter-directed venography using fluoroscopy, the risks and benefits are felt to be the same.

US Duplex Doppler Lower Extremity

US is widely recognized as the preferred imaging modality for diagnosing proximal DVT [2,3,6-8,10-12]. Real-time duplex US is noninvasive, portable, 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 to identify the failure of complete compression of 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 color-flow Doppler imaging. Color-flow Doppler imaging can assist in characterizing a clot as obstructive or partially obstructive. Using duplex US for the augmentation of venous flow rarely provides additional information when diagnosing DVT, but it can be useful as a secondary diagnostic tool [17]. A recent meta-analysis found US to have a high sensitivity (range, 93.2%–95.0%; pooled sensitivity, 94.2%) and high specificity (range, 93.1%–94.4%; pooled specificity, 93.8%) for diagnosing proximal DVT [6]. In the same study, US was found to have a much lower sensitivity (range, 59.8%–67.0%; pooled sensitivity, 63.5%) for diagnosing distal DVT, which confirmed a widely known diagnostic limitation for this technique [6]. Although there are suggestive US findings, using imaging alone to distinguish acute from chronic DVT can be difficult [18].

MR Venography Lower Extremity and Pelvis

MR venography (MRV) is a noninvasive alternative to contrast catheter venography. MRV does have inherent advantages over US, especially in its ability to delineate extravascular anatomy. MRV can help identify potential sources of extrinsic venous compression (ie, May-Thurner syndrome or a mass) that can be an underlying cause for DVT or suggest alternative diagnoses that mimic DVT.

MRV has been shown to successfully diagnose DVT using any variety of pulse sequences or techniques [19-23]. Patency or DVT can typically be determined without contrast media by 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, but it requires real-time review and expertise. Contrast media–enhanced MRV, however, is more reproducible and less susceptible to artifacts. Despite the wide variety of techniques, however, a recent meta-analysis found MRV to have both high sensitivity (range, 87.5%–94.5%; pooled sensitivity, 92%) and specificity (range, 92.6%–96.5%; pooled sensitivity, 95%) [22]. When evaluating for proximal DVT, MRV is as sensitive and specific as US or contrast catheter venography. MRV has the advantage over US in evaluating veins above the inguinal ligament, as 20% of DVTs are isolated to the pelvic veins [24]. As such, MRV has been used for evaluating patients with cryptogenic stroke [25].

CT Venography Lower Extremity and Pelvis

CT venography (CTV) can also be used to diagnose DVT [6,23,26]. CTV can be performed either as direct CTV using a venous injection of iodinated contrast media in a pedal vein similar to contrast catheter venography or, more commonly, as an indirect CTV using an antecubital vein for a contrast media injection and a delayed imaging acquisition suitable for deep venous opacification. CTV, like MRV, has the inherent advantages of cross-sectional imaging for identifying extravascular sources of extrinsic compression that could be underlying causes for DVT. In patients who have a suspected pulmonary embolism, a meta-analysis found CTV to have high sensitivity (range, 71%–100%; pooled sensitivity, 95.9%) and high specificity (range, 93%–100%; pooled

specificity, 95.2%) comparable to that of US for diagnosing proximal DVT [23]. CTV can also be incorporated into a comprehensive examination that includes pulmonary CT angiography for evaluating both pulmonary embolism and proximal DVT [26], but it should not be performed routinely in all patients who are being evaluated for pulmonary embolism [27]. There is little evidence to support the use of CTV to diagnose DVT; however, based on the published experience with pulmonary embolism, CTV may be considered a reasonable alternative to MRV for pelvic DVT or when US is nondiagnostic.

Summary of Recommendations

- **Variant 1:** US duplex Doppler lower extremity is the recommended initial imaging examination for patients with suspected lower extremity DVT.

Summary of Evidence

Of the 28 references cited in the *ACR Appropriateness Criteria® Suspected Lower Extremity Deep Vein Thrombosis* document, 2 are categorized as therapeutic references including 1 well-designed study. Additionally, 24 references are categorized as diagnostic references including 5 good-quality studies, and 5 quality studies that may have design limitations. There are 15 references that may not be useful as primary evidence. There are 2 references that are meta-analysis studies.

The 28 references cited in the *ACR Appropriateness Criteria® Suspected Lower Extremity Deep Vein Thrombosis* document were published from 1990 to 2013.

Although there are references that report on studies with design limitations, 6 well-designed or good-quality studies provide good evidence.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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, because of both 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 with 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 [28].

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 (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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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.