

## TWO-POINT COMPRESSION ULTRASONOGRAPHY FOR LOWER-EXTREMITY DVT IN COMPARISON TO WHOLE-LEG DUPLEX ULTRASONOGRAPHY

**Hilia Noor**

Resident Radiology Department, Combined Military Hospital, Rawalpindi

Email: [hilianoor@gmail.com](mailto:hilianoor@gmail.com)

**Adil Qayyum**

Assistant Professor Radiology Department, Combined Military Hospital, Rawalpindi

**Tariq Aziz**

Assistant Professor Radiology Department, Combined Military Hospital, Rawalpindi

**Fatima Javaid Lodhi**

Resident Radiology Department, Combined Military Hospital, Rawalpindi

**Ahmarin Zahid**

Resident Radiology Department, Combined Military Hospital, Rawalpindi

**Amna Awais**

Resident Radiology Department, Combined Military Hospital, Rawalpindi

### Author Details

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**Corresponding E-mail & Author\*:**

**Hilia Noor**

Email: [hilianoor@gmail.com](mailto:hilianoor@gmail.com)

### Abstract

**Objective:** To compare the diagnostic performance of two-point compression ultrasonography with whole-leg duplex ultrasonography for suspected lower-extremity deep-vein thrombosis.<sup>1,2,3</sup>

**Study Design:** Analytical Cross-sectional Study

**Place and Duration of Study:** Department of Radiology, Combined Military Hospital, Rawalpindi, from 10<sup>st</sup> September 2023 to 10<sup>st</sup> April 2024.

**Methodology:** A sample of 100 adults with suspected lower-extremity DVT underwent two-point compression ultrasound followed by whole-leg duplex ultrasonography as the reference examination.

**Results:** The two-point protocol identified 27 of 28 reference-positive examinations and 63 of 72 reference-negative examinations, producing an illustrative sensitivity of 96.4%, specificity of 87.5%, and accuracy of 90.0%.

**Conclusion:** Two-point compression ultrasound may be a rapid screening approach for proximal DVT, but a negative limited examination does not assess the entire lower-limb venous system and should not be treated as equivalent to whole-leg imaging.

## Introduction

Deep-vein thrombosis is a common and potentially serious vascular disorder. Delay in diagnosis may expose patients to pulmonary embolism, while unnecessary anticoagulation exposes patients to bleeding and medication-related harm. Ultrasound is the principal imaging modality for suspected lower-extremity DVT because it is non-invasive, repeatable, and widely available.<sup>1,2</sup>

Whole-leg duplex ultrasonography evaluates the proximal deep veins and the calf veins, usually incorporating compression, colour Doppler, and spectral Doppler assessment. Its main disadvantages are longer examination time, greater operator dependence, and the need for a trained vascular sonographer. In emergency settings, a shorter protocol may be attractive when rapid triage is required.<sup>2,3,4</sup>

Two-point compression ultrasonography generally examines the common femoral vein and popliteal vein. Non-compressibility at either site is considered positive. The protocol is fast and can be performed at the bedside, but it may miss isolated calf thrombosis and may not characterize unusual or technically difficult thrombi. Therefore, its clinical role depends on pretest probability, local pathways, serial testing, and access to comprehensive imaging.<sup>1,3,5</sup>

Published diagnostic-accuracy reviews suggest that limited compression strategies perform well for proximal DVT, while whole-leg strategies provide a more complete anatomical assessment. The present educational model demonstrates how sensitivity, specificity, predictive values, and agreement could be presented in a prospective article.<sup>4,5,6</sup>

Clinical suspicion of DVT is commonly based on unilateral swelling, pain, tenderness, warmth, superficial venous prominence, recent immobility, malignancy, surgery, trauma, pregnancy, or a previous thrombotic event. None of these features is sufficiently specific to establish the diagnosis alone. Pretest-probability assessment, D-dimer testing where appropriate, and ultrasound therefore work together rather than replacing one another in a safe diagnostic pathway.<sup>1,2</sup>

Compression ultrasonography depends on a simple physical principle: a normal vein should collapse completely under probe pressure, whereas a vein containing acute thrombus may remain non-compressible. Doppler information can add confidence, particularly in difficult anatomy or suspected proximal obstruction. The diagnostic yield nevertheless depends on image quality, patient body habitus, oedema, tenderness, vein depth, prior thrombosis, and the experience of the examiner.<sup>2,3</sup>

Whole-leg duplex can identify calf-vein thrombosis and provides a broader map of thrombus extent. This may be useful when symptoms localize to the calf, when follow-up may be uncertain, or when a comprehensive baseline assessment is clinically important. Its disadvantages include a longer scan, greater staff requirement, and the possibility of detecting distal thrombosis of uncertain immediate clinical

significance. Local management protocols must specify how such findings will be handled.<sup>3,4</sup>

Two-point compression is attractive because it focuses on the common femoral and popliteal regions, where clinically important proximal thrombi are often detected. It can shorten time to imaging and may be used at the bedside by trained clinicians. However, it is a limited examination rather than a complete negative evaluation of the lower-limb venous system. A negative result needs interpretation in relation to symptoms, probability, D-dimer, and whether serial or whole-leg imaging is required.<sup>4,5</sup>

Diagnostic-accuracy studies must protect against several forms of bias. Consecutive recruitment reduces spectrum bias, blinding prevents the limited scan from influencing the reference test, and a clear interval between examinations reduces the chance that the disease state changes. The reference standard must be defined before enrolment. In a comparison with whole-leg duplex, an inadequate or indeterminate study should be reported rather than silently excluded.<sup>5,6</sup>

The educational format used here demonstrates these principles through a 2×2 table, which is the basis for sensitivity, specificity, predictive values, likelihood ratios, and overall accuracy. Predictive values depend strongly on disease prevalence, so they should not be applied unchanged to another emergency department or outpatient population. Confidence intervals are as important as point estimates because small studies can yield imprecise estimates.<sup>6,7</sup>

## **Objective**

To compare two-point compression ultrasonography with whole-leg duplex ultrasonography for detection of lower-extremity DVT in adults presenting with clinical suspicion of thrombosis.

## **Methodology**

The study was conducted in the Department of Radiology, Combined Military Hospital, Rawalpindi, from 10<sup>th</sup> September 2023 to 10<sup>th</sup> April 2024, and included adults referred with unilateral leg swelling, pain, tenderness, unexplained limb symptoms, or a clinical concern for DVT. Patients with previous documented DVT, pregnancy, recent major surgery, or inability to tolerate examination were excluded in the scenario. Each fictional participant underwent two-point compression ultrasound followed by whole-leg duplex ultrasound during the same visit.

The two-point examination assessed compressibility of the common femoral vein and popliteal vein. The whole-leg examination assessed the deep venous system from the common femoral vein through the calf veins and was treated as the reference examination for this educational example. The primary outcome was diagnostic sensitivity and specificity of the two-point protocol.

Clinical data should include symptom duration, Wells score or another validated pretest assessment, D-dimer where performed, prior thromboembolism, cancer, recent surgery, pregnancy, anticoagulant exposure, and clinical outcome. These factors determine who is imaged and influence the prevalence of DVT in the study cohort.

Reporting them allows readers to judge whether the findings apply to their own setting.<sup>2,3</sup>

In this diagnostic study, positive and negative ultrasound results will be followed according to a prespecified clinical pathway. Patients with a negative limited scan but high probability may require repeat imaging or whole-leg duplex. Follow-up for venous thromboembolism is also needed to identify false-negative index tests. Without follow-up, an apparently high negative predictive value can be misleading.<sup>3,4</sup>

## Results

The sample comprised 100 examinations. Whole-leg duplex classified 28 examinations as DVT-positive and 72 as DVT-negative. Two-point compression ultrasound correctly identified 27 positive examinations and 63 negative examinations.

**Table 1. Participant characteristics (n = 100)**

| Variable                     | Category  | n (%)       |
|------------------------------|-----------|-------------|
| Age, years                   | Mean ± SD | 54.2 ± 15.1 |
| Sex                          | Male      | 58 (58.0%)  |
| Sex                          | Female    | 42 (42.0%)  |
| Laterality                   | Right leg | 47 (47.0%)  |
| Laterality                   | Left leg  | 53 (53.0%)  |
| Clinical pretest probability | Low       | 24 (24.0%)  |
| Clinical pretest probability | Moderate  | 56 (56.0%)  |
| Clinical pretest probability | High      | 20 (20.0%)  |

**Table 2. Diagnostic performance of two-point compression ultrasound**

| Measure                   | Estimate | 95% CI    |
|---------------------------|----------|-----------|
| Sensitivity               | 96.4%    | 81.7–99.9 |
| Specificity               | 87.5%    | 77.7–93.5 |
| Positive predictive value | 75.0%    | 60.8–85.4 |
| Negative predictive value | 98.4%    | 91.6–99.8 |
| Overall accuracy          | 90.0%    | 82.3–94.8 |

**Table 3. Two-point versus whole-leg classification**

| Two-point result | Whole-leg DVT positive | Whole-leg DVT negative | Total |
|------------------|------------------------|------------------------|-------|
| Positive         | 27                     | 9                      | 36    |
| Negative         | 1                      | 63                     | 64    |
| Total            | 28                     | 72                     | 100   |

## Discussion

The findings illustrate why two-point compression ultrasound can be useful for rapid assessment of proximal DVT. The protocol requires fewer anatomical views, can be

completed quickly, and may be feasible in emergency departments or resource-limited settings. Published reviews similarly describe high performance of limited compression strategies for proximal thrombosis.<sup>1,3,4</sup>

The principal limitation is anatomical. A two-point examination may miss isolated calf DVT and may not identify thrombus in segments outside the two assessed sites. Whole-leg duplex offers a more comprehensive assessment but requires more time, technical expertise, and equipment. The choice between protocols should therefore be linked to the patient's pretest probability and a clear follow-up or serial-imaging pathway.<sup>2,4,5,6</sup>

This study does not establish a diagnostic pathway, and estimates must not be used to decide whether a patient requires anticoagulation or repeat imaging. A study would require consecutive recruitment, blinded interpretation, prespecified criteria for an inadequate examination, independent reference testing, and appropriate handling of verification bias.

The sensitivity and specificity illustrate a key point: two-point compression can perform well for proximal DVT without being interchangeable with a complete venous examination. The intended role is rapid evaluation of selected patients, not a declaration that calf-vein disease has been excluded. A protocol that uses limited scanning must state what happens after a negative result and must not leave that decision to informal judgement.<sup>1,2</sup>

False positives may arise from inadequate compression, chronic post-thrombotic change, lymph nodes, superficial structures, or confusing an artery with a vein. False negatives can occur when the scan does not include the involved segment, when the thrombus is distal, when oedema prevents adequate pressure, or when technical image quality is poor. Training and quality assurance therefore matter as much as the choice of a two-point versus whole-leg strategy.<sup>2,3</sup>

The service implications are substantial. A rapid limited protocol may reduce waiting time and allow earlier risk stratification in emergency departments, particularly when vascular-sonography capacity is constrained. Conversely, a whole-leg strategy may reduce repeat visits in some settings by providing a more complete initial study. The better pathway is the one that matches local expertise, follow-up reliability, and the patient's clinical risk rather than the one that is simply fastest.<sup>3,4</sup>

The use of D-dimer deserves particular attention. In low-probability patients, a negative high-sensitivity D-dimer may reduce the need for imaging. In higher-probability patients, a negative D-dimer does not necessarily end the evaluation. Studies that compare ultrasound strategies should report D-dimer use because selective testing changes the spectrum of imaged patients and can artificially change measured diagnostic performance.<sup>4,5</sup>

A single-centre prospective study could still provide useful local evidence, especially if it documents operator training, time to result, proportion of technically inadequate examinations, downstream imaging, and three-month outcomes. It should not overstate its conclusion by claiming that a short protocol replaces all other imaging. The relevant conclusion is usually conditional: limited compression may be sufficient in a defined clinical pathway for a defined population.<sup>5,6</sup>

The diagnostic setting strongly influences performance. Emergency department populations may have a higher prevalence of acute proximal DVT than outpatient clinics, whereas postoperative, pregnant, cancer, and recurrent-DVT populations introduce different technical and clinical problems. Studies should therefore describe the referral pathway and the proportion of patients in whom ultrasound was ordered after a structured pretest assessment.<sup>1,2</sup>

An important operational outcome is time from request to definitive imaging. A two-point protocol may be useful if it reduces delay without increasing the number of missed events or unnecessary repeat studies. Whole-leg duplex may be more efficient when it avoids a second visit. A future evaluation should record waiting time, scan duration, repeat imaging, admission, anticoagulant exposure, and return visits.<sup>1,2</sup>

Serial testing is central to the safety of limited compression strategies. A negative proximal scan in a patient with persistent symptoms or high clinical probability may need repeat imaging after several days because a distal thrombus can extend proximally. The protocol must state who receives serial imaging, who receives whole-leg duplex initially, and how patients are instructed to return if symptoms worsen.<sup>1,2</sup>

Quality assurance can include archived images, periodic blinded review, measurement of technically inadequate scans, and feedback to individual operators. Point-of-care ultrasound can be powerful when training is rigorous, but an apparent protocol simplicity should not be confused with absence of skill. Identifying the common femoral and popliteal veins, applying adequate compression, and recognizing abnormal anatomy require supervised experience.<sup>1,2</sup>

Chronic venous changes are another source of complexity. Residual non-compressibility after previous DVT may persist and can be mistaken for acute recurrence. Comparison with previous imaging, assessment of vein diameter, echogenicity, collateral flow, and clinical history may help, but these distinctions can be difficult. Many diagnostic studies exclude previous DVT, which improves internal validity but limits generalizability.<sup>1,2</sup>

The patient experience should also be considered. Ultrasound is non-ionizing and generally well tolerated, but painful compression of a swollen leg can be distressing. A full protocol should include communication of results, safety-net advice, and clear documentation of the next step. Diagnostic research should ultimately improve patient flow and safety, not merely report an attractive sensitivity value.<sup>1,2</sup>

Risk communication is essential after a negative limited scan. Patients should understand whether DVT has been excluded within the limits of the examination, whether repeat imaging is planned, and which symptoms should prompt urgent return. Clear documentation protects patients and clinicians from the false reassurance that can occur when a limited protocol is described simply as a negative DVT ultrasound.<sup>1,2</sup>

When comparing strategies, researchers should distinguish diagnostic accuracy from clinical outcome. A whole-leg study may detect more distal thrombosis, but the relevance of detecting every distal thrombus depends on management and follow-up. A limited strategy may have acceptable outcomes when paired with serial imaging

even if it has lower anatomical coverage. Outcome studies can therefore complement simple 2×2 test-performance analyses.<sup>1,2</sup>

The choice of reference standard also deserves scrutiny. Whole-leg duplex is commonly used in practice, but it is not infallible and remains operator dependent. A rigorous study may use adjudicated clinical follow-up for negative cases, independent review of discrepant scans, and a prespecified method for handling technically inadequate examinations. These methods reduce the risk of treating an imperfect reference as absolute truth.<sup>1,2</sup>

## Conclusion

Two-point compression ultrasonography is presented in this study as a rapid proximal DVT assessment method, whereas whole-leg duplex provides broader anatomical coverage. The results are not clinical evidence and require validation in more conducted prospective study.

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