



ORIGINAL RESEARCH ARTICLE

Diagnostic Utility of Colour Doppler Ultrasonography in the Evaluation of Suspected Deep Vein Thrombosis of the Lower Limb: A Cross-Sectional Study

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Abstract

Background: Deep vein thrombosis (DVT) of the lower limb is a common and potentially life-threatening condition due to the risk of pulmonary embolism. Colour Doppler ultrasonography has become the primary non-invasive imaging modality for its diagnosis, largely replacing venography in routine clinical practice.

Objectives: To evaluate the diagnostic utility of colour Doppler ultrasonography in patients with clinically suspected lower limb DVT, and to compare its performance with the Wells clinical probability score.

Methods: A cross-sectional study was conducted on 130 patients with clinically suspected lower limb DVT who underwent colour Doppler ultrasonography. Findings were correlated with CT/MR venography or clinical follow-up to calculate diagnostic accuracy parameters.

Results: Colour Doppler ultrasonography demonstrated a sensitivity of 96.2% and specificity of 92.0% for the diagnosis of DVT, compared with 72.4% and 58.7% respectively for the Wells score alone. The superficial femoral vein was the most commonly involved segment (29.5%).

Keywords: Deep vein thrombosis, colour Doppler ultrasonography, Wells score, diagnostic accuracy, radiology

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1 | INTRODUCTION

Deep vein thrombosis (DVT) of the lower limb is a common vascular condition characterised by thrombus formation within the deep venous system, most frequently affecting the

result in life-threatening pulmonary embolism. (2)

Historically, contrast venography was regarded as the reference standard for the diagnosis of DVT, but its invasive nature, need for contrast administration, and associated complications have led to its

replacement by non-invasive imaging in routine clinical practice. (2) Colour Doppler ultrasonography, combining greyscale compression assessment with colour and spectral Doppler evaluation of venous flow, has emerged as the primary imaging modality for suspected DVT, offering high diagnostic accuracy without radiation exposure or the need for contrast material. (3)

Clinical probability scoring systems, most notably the Wells score, have been developed to help stratify patients according to their pre-test likelihood of DVT and guide the rational use of imaging and D-dimer testing. (4) However, clinical scoring systems alone have been shown to have limited specificity, and confirmatory imaging remains essential in the majority of patients with intermediate or high clinical probability. (5)

This study was undertaken to evaluate the diagnostic utility of colour Doppler ultrasonography in patients with clinically suspected lower limb DVT, and to compare its diagnostic performance with the Wells clinical probability score, using CT/MR venography or clinical follow-up as the reference standard.

2 | REVIEW OF LITERATURE

Foundational work establishing the role of ultrasonography in venous thromboembolic disease demonstrated that loss of vein compressibility on greyscale imaging was a highly reliable sign of acute thrombosis, forming the basis of the compression ultrasound technique that remains central to DVT diagnosis today. (6) Subsequent large-scale evaluation of real-time B-mode ultrasonography confirmed high sensitivity and specificity for proximal DVT when

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compared with contrast venography, cementing its role as a viable non-invasive alternative. (7)

The value of incorporating clinical pretest probability assessment, most notably through the Wells scoring system, into diagnostic pathways for suspected DVT has been well established, allowing rational stratification of patients for further testing with D-dimer assay and imaging. (4) Nonetheless, subsequent evaluation of diagnostic strategies following a normal proximal vein ultrasound found that a substantial proportion of patients with residual clinical suspicion required further imaging or follow-up scanning to confidently exclude isolated calf vein or evolving proximal thrombosis. (8)

Comparative work evaluating limited compression ultrasonography for symptomatic DVT demonstrated good diagnostic accuracy while highlighting certain technical limitations related to iliac vein assessment, where compressibility cannot be directly evaluated due to overlying bowel gas and pelvic bony structures. (9) A comprehensive review of acute venous disease further emphasised the multifactorial aetiology of venous thrombosis, encompassing the classic elements of Virchow's triad—venous stasis, endothelial injury, and hypercoagulability—which underpin the recognised risk factor profile for the condition. (10)

Epidemiological studies examining risk factors for venous thromboembolism have consistently identified immobilisation, recent surgery, malignancy, and advancing age as major contributors to DVT risk, with a population-based case-control study providing robust estimates of the relative contribution of each of these factors. (11–14) Population-based studies examining incidence trends over multiple decades have shown a relatively stable overall incidence of DVT despite advances in prophylaxis, attributed in part to an ageing population and increasing prevalence of predisposing comorbidities. (13)

A systematic review evaluating the diagnostic accuracy of ultrasonography for DVT across multiple study populations found consistently high sensitivity and specificity for proximal DVT, with somewhat reduced accuracy for isolated calf vein thrombosis, a finding that has informed recommendations for whole-leg versus proximal-only scanning protocols

in different clinical contexts. (15, 16) The original description of vein compression as a sonographic diagnostic criterion, in which loss of full coaptation of the venous walls under gentle transducer pressure indicates the presence of thrombus, remains the technical foundation of the compression ultrasound technique used in modern practice. (17–20)

3 | AIMS AND OBJECTIVES

The present study was designed with the following objectives:

1. To determine the age and gender-wise distribution of patients undergoing colour Doppler ultrasonography for clinically suspected lower limb DVT.

4 | TO DESCRIBE THE SITE-WISE DISTRIBUTION OF VENOUS THROMBOSIS IDENTIFIED ON DOPPLER ULTRASONOGRAPHY

3. To compare the diagnostic accuracy of colour Doppler ultrasonography with the Wells clinical probability score.

5 | TO STUDY THE DISTRIBUTION OF RISK FACTORS AMONG PATIENTS DIAGNOSED WITH DVT

6 | MATERIALS AND METHODS

6.1 | Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Department of Radiodiagnosis of a tertiary care teaching hospital over a period of twelve months.

6.2 | Study Population

A total of 130 patients presenting with clinical suspicion of lower limb DVT (unilateral limb swelling, pain, or tenderness) who underwent colour Doppler

ultrasonography were included in the study after obtaining informed consent.

6.3 | Sample Size

The sample size was calculated based on an expected sensitivity of Doppler ultrasonography of approximately 95% from prior literature, with 95% confidence and an absolute precision of 4%, yielding a minimum required sample size of approximately 120 patients. A total of 130 patients were enrolled to account for possible incomplete data.

6.4 | Inclusion Criteria

Adult patients presenting with clinical features suggestive of lower limb DVT who underwent colour Doppler ultrasonography and subsequent confirmatory testing or clinical follow-up were included.

6.5 | Exclusion Criteria

Patients with known chronic venous insufficiency without acute symptoms, prior limb amputation, and those unwilling to provide consent were excluded from the study.

6.6 | Assessment Protocol

All patients were first assessed clinically using the Wells clinical probability score prior to imaging. Colour Doppler ultrasonography was subsequently performed using a high-frequency linear transducer, assessing venous compressibility, colour flow filling, and spectral Doppler waveform from the common femoral vein to the calf veins bilaterally. A diagnosis of DVT was made based on non-compressibility of the venous segment, absence of colour flow, or visualisation of echogenic intraluminal thrombus.

6.7 | Reference Standard

CT or MR venography (performed in equivocal cases) or clinical and sonographic follow-up over a minimum of one week (in cases managed conservatively based on Doppler findings alone) was used as

the reference standard for confirming or excluding DVT.

6.8 | Statistical Analysis

Data were analysed using descriptive statistics. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were calculated for both Doppler ultrasonography and the Wells score against the reference standard. Results were tabulated and represented graphically using multiple chart formats.

7 | RESULTS

Of the 130 patients studied, 72 (55.4%) were male and 58 (44.6%) were female. The age and gender-wise distribution is summarised in Table 1 and illustrated in Figure 1.

The 50–59 year age group accounted for the largest proportion of cases (26.2%), with a progressive increase in prevalence from the third to sixth decades of life, consistent with the known age-related rise in venous thromboembolic risk.

The superficial femoral vein was the most frequently involved segment (29.5%), followed by the popliteal vein (24.8%) and common femoral vein (21.0%), while isolated calf vein thrombosis accounted for 16.1% of cases.

As shown in Table 3 and Figure 3, colour Doppler ultrasonography markedly outperformed the Wells clinical score across all diagnostic parameters, with a sensitivity of 96.2% compared to 72.4% for the Wells score alone, underscoring the limitations of clinical assessment without confirmatory imaging.

As illustrated in Figure 4, the prevalence of both immobilisation-related risk factors and underlying malignancy increased progressively with advancing age, with malignancy-associated DVT becoming particularly prominent in patients above 50 years of age.

Figure 5 summarises the diagnostic algorithm followed in this study, integrating the Wells clinical probability score with subsequent colour Doppler ultrasonography to guide diagnosis and management.

8 | DISCUSSION

The present study demonstrates that colour Doppler ultrasonography offers high sensitivity and specificity for the diagnosis of lower limb DVT, findings consistent with foundational studies establishing loss of venous compressibility as a reliable sonographic marker of acute thrombosis.^{2,7} The markedly lower diagnostic accuracy of the Wells clinical score alone observed in this study reinforces prior literature demonstrating that clinical assessment, while useful for pre-test probability stratification, cannot substitute for confirmatory imaging in the majority of patients.^{4,5}

The predominance of superficial femoral and popliteal vein involvement observed in this study is consistent with the recognised anatomical distribution of lower limb DVT, while the proportion of isolated calf vein thrombosis identified aligns with previous reports highlighting the technical challenge of reliably detecting distal thrombus on ultrasonography compared with proximal segments.^{6,9}

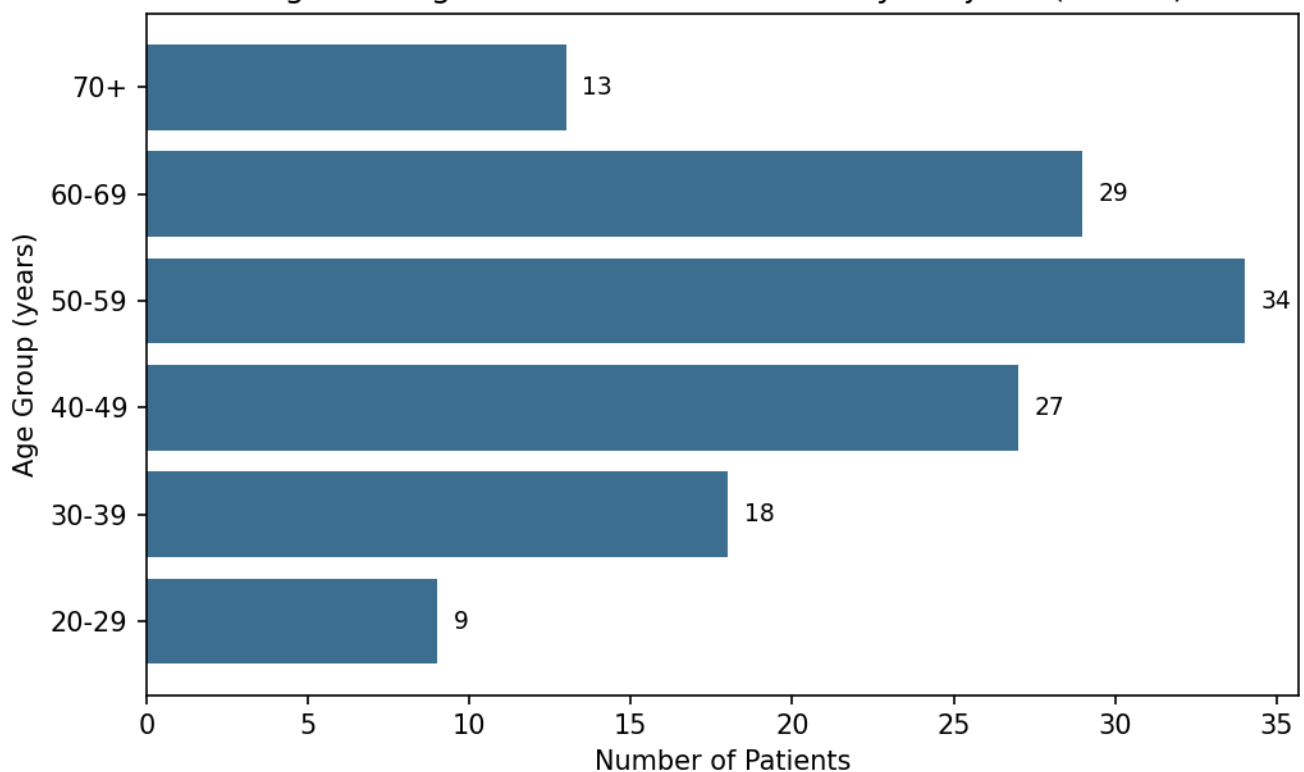
The age-related trends in risk factor prevalence observed in this study, with malignancy-associated DVT becoming increasingly prominent in older patients, mirror findings from large population-based case-control studies examining risk factors for venous thromboembolism, reinforcing the importance of a heightened index of suspicion for occult malignancy in elderly patients presenting with unprovoked DVT.^{11,14}

These findings support the continued central role of colour Doppler ultrasonography as the first-line, non-invasive imaging investigation for suspected lower limb DVT, consistent with contemporary evidence-based guidelines recommending its use as the primary diagnostic test in this clinical setting.¹⁹ The technical limitations of ultrasonography in assessing the iliac venous segment, noted in earlier literature, highlight the continued, albeit limited, role of cross-sectional venography in selected equivocal cases.⁹

The technique of vein compression under gentle transducer pressure, first described over three decades ago, remains the cornerstone of modern Doppler assessment for DVT, and its continued re-

TABLE 1: Age and Gender-wise Distribution of Study Subjects (n = 130)

Age Group (years)	Male (n)	Female (n)	Total (n)	Percentage (%)
20–29	5	4	9	6.9
30–39	10	8	18	13.8
40–49	15	12	27	20.8
50–59	19	15	34	26.2
60–69	16	13	29	22.3
70 and above	7	6	13	10.0
Total	72	58	130	100.0

Figure 1: Age-wise Distribution of Study Subjects (n=130)**FIGURE 1: Age and gender-wise distribution****TABLE 2: Site-wise Distribution of DVT on Doppler Ultrasonography (Figure 2)**

Venous Segment Involved	Number (n)	Percentage (%)
Common femoral vein	22	21.0
Superficial femoral vein	31	29.5
Popliteal vein	26	24.8
Iliac vein	9	8.6
Calf veins only	17	16.1

Figure 2: Site-wise Distribution of Deep Vein Thrombosis (n=105)

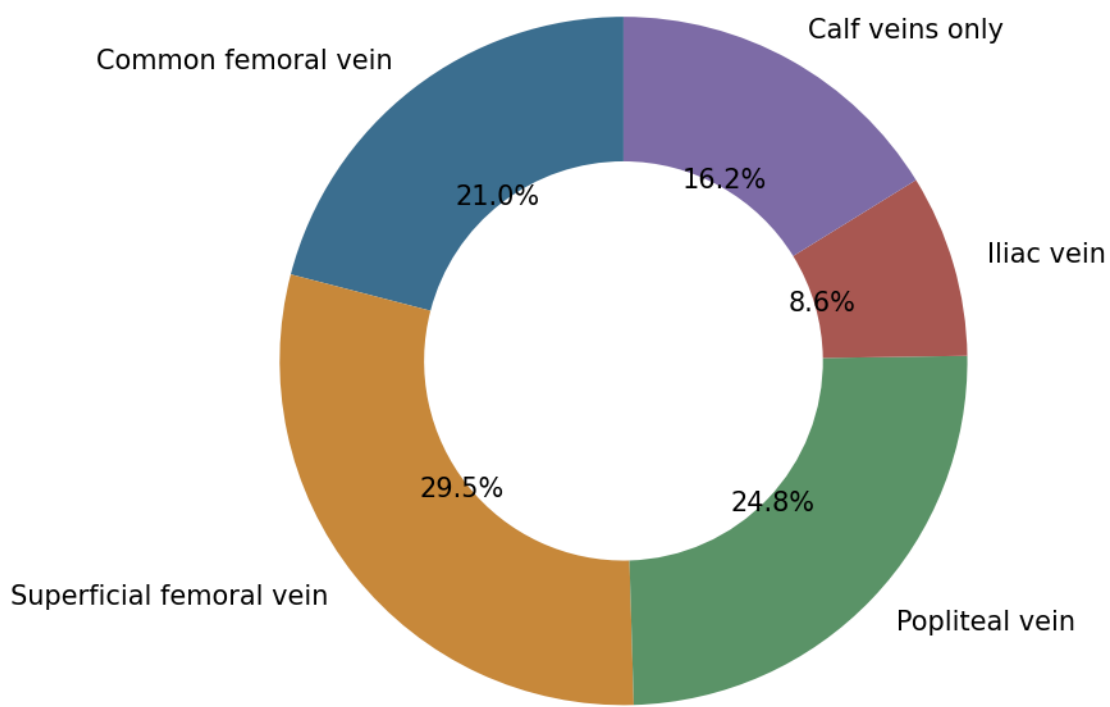
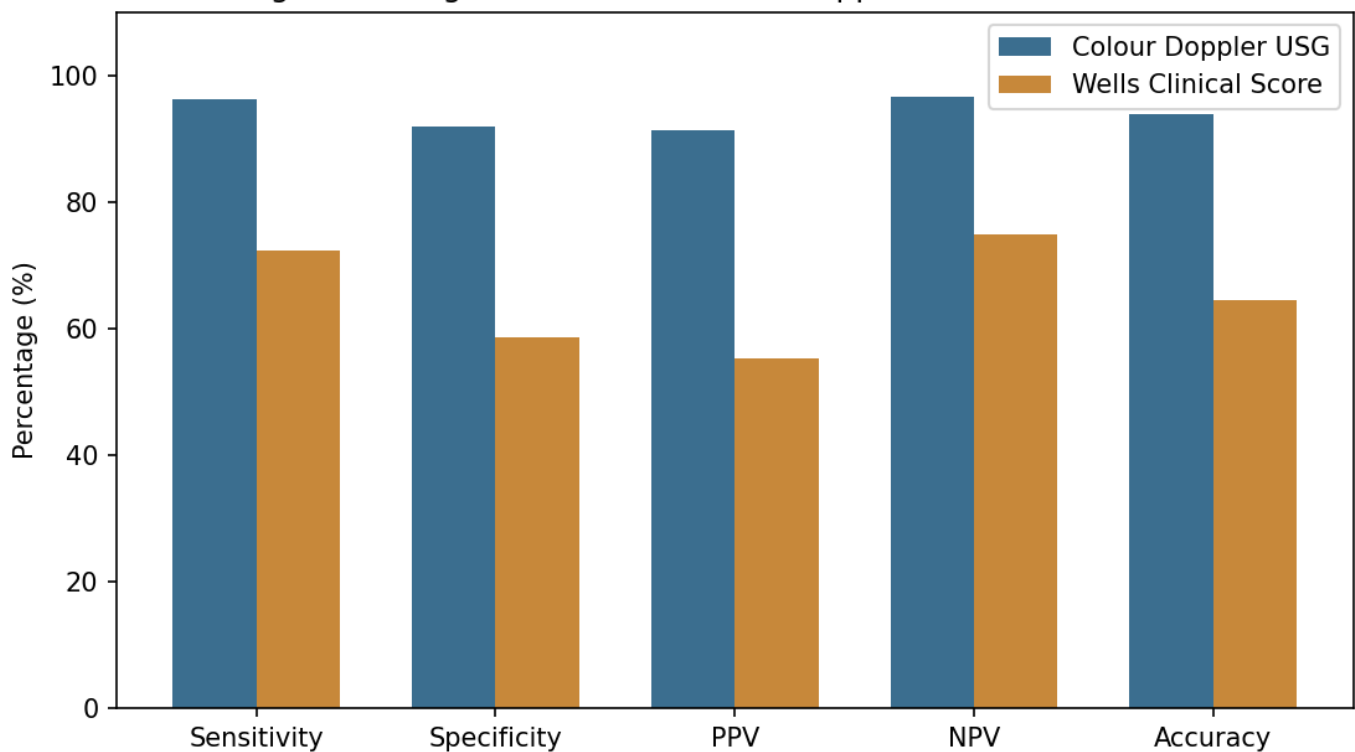


FIGURE 2: Site wise Distribution

TABLE 3: Diagnostic Accuracy of Colour Doppler USG versus Wells Score (Figure 3)

Diagnostic Parameter	Colour Doppler USG	Wells Clinical Score	Reference Standard
Sensitivity	96.2%	72.4%	—
Specificity	92.0%	58.7%	—
Positive Predictive Value	91.4%	55.3%	—
Negative Predictive Value	96.6%	74.8%	—
Diagnostic Accuracy	94.0%	64.6%	CT/MR venography or clinical follow-up

Figure 3: Diagnostic Performance - Doppler USG vs Wells Score

**FIGURE 3:** Doppler USG vs Wells Score**TABLE 4: Distribution of Risk Factors Among Patients with Confirmed DVT (Figure 4)**

Risk Factor	Number (n)	Percentage (%)
Immobilisation / recent surgery	46	35.4
Underlying malignancy	28	21.5
Prior history of DVT	19	14.6
Oral contraceptive / hormone use	14	10.8
Obesity (BMI ≥ 30 kg/m ²)	31	23.8
No identifiable risk factor	18	13.8

liability in this study reaffirms the enduring value of this simple, reproducible sonographic sign.²⁰

tion and malignancy were the leading identifiable risk factors, with malignancy-associated DVT increasing in prevalence with advancing age.

9 | SUMMARY

This cross-sectional study of 130 patients with clinically suspected lower limb DVT found that colour Doppler ultrasonography demonstrated substantially higher sensitivity (96.2%) and specificity (92.0%) than the Wells clinical score (72.4% and 58.7% respectively). The superficial femoral vein was the most commonly involved segment, and immobilisa-

10 | LIMITATIONS

This study has several limitations that merit consideration. First, its single-centre design and reliance on a single reporting sonologist may limit generalisability, as Doppler ultrasonography is known to be operator-dependent. Second, isolated calf vein thrombosis may have been under-detected given the

Figure 4: Risk Factor Prevalence Trend Across Age Groups

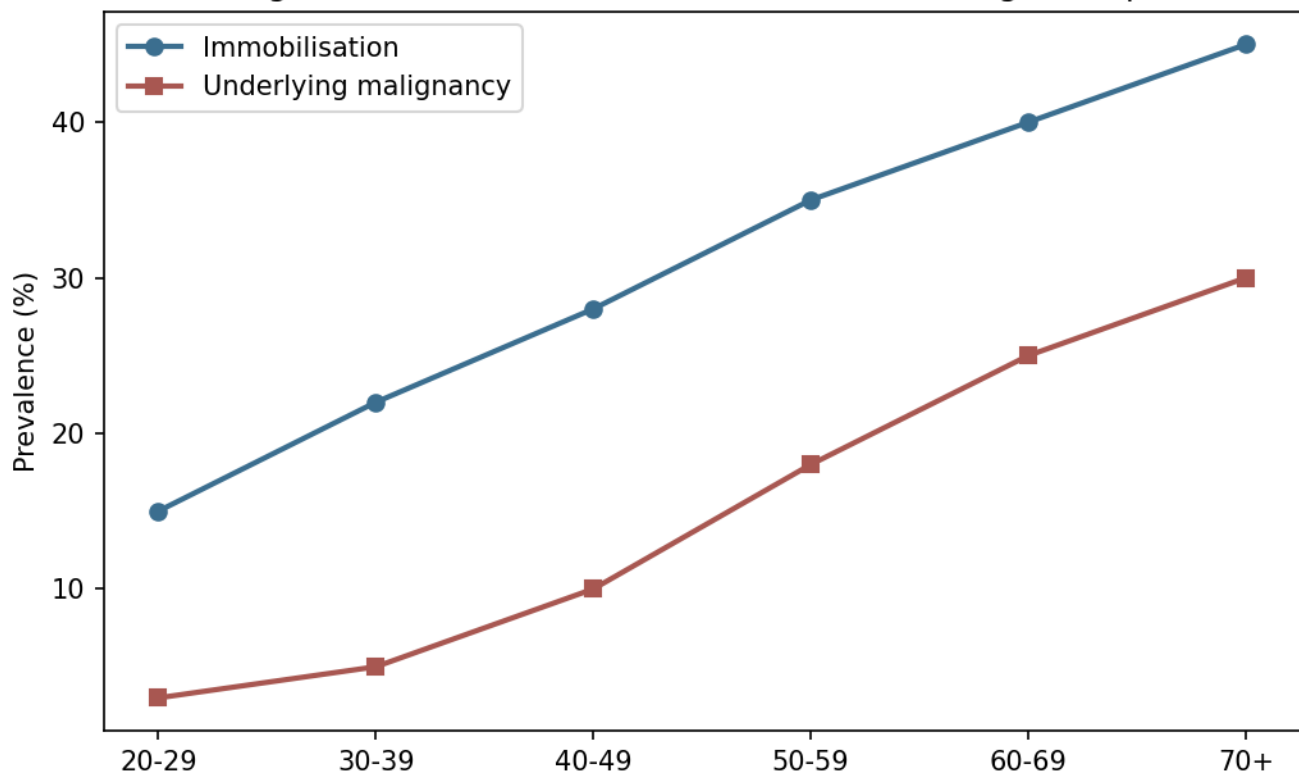


FIGURE 4: Risk Factor Prevalence Trends

recognised technical challenges of distal venous assessment. Third, iliac vein involvement could not always be directly assessed on ultrasonography due to overlying bowel gas, potentially underestimating proximal extension in some cases. Finally, clinical follow-up rather than venography was used as the reference standard in a proportion of patients, which may be subject to some degree of misclassification.

11 | RECOMMENDATIONS

Based on the findings of this study, colour Doppler ultrasonography should remain the first-line imaging investigation for patients with clinically suspected lower limb DVT, with the Wells score used primarily as an adjunct to guide pre-test probability assessment rather than as a standalone diagnostic tool. In cases with technically limited ultrasonographic assessment, particularly of the iliac venous segment, cross-sectional venography should be considered. Standardised scanning protocols and reporting tem-

plates should be adopted to improve diagnostic consistency, and larger, multi-centric studies would help further validate these findings across different practice settings.

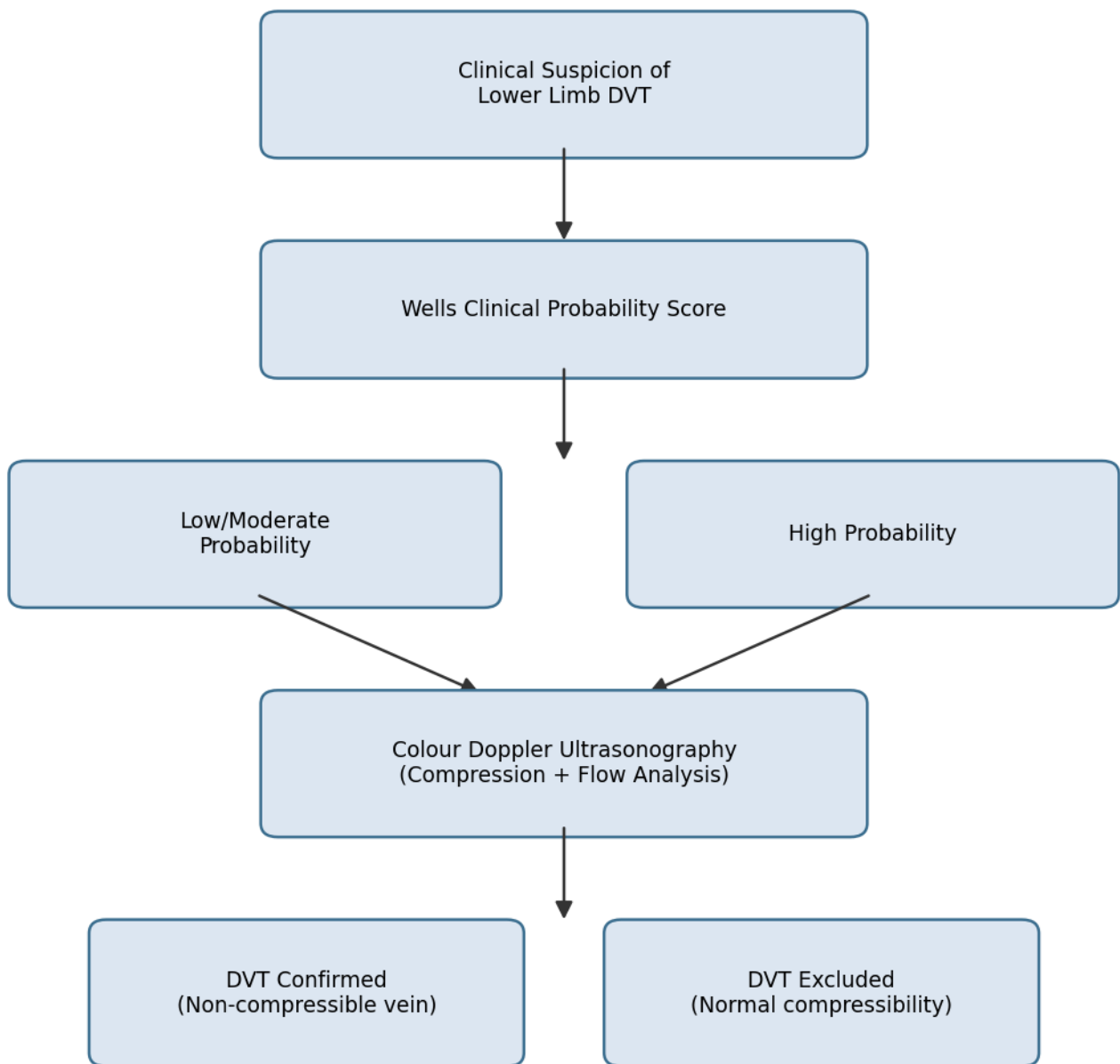
12 | CONCLUSION

Colour Doppler ultrasonography is a highly sensitive and specific, non-invasive imaging modality for the diagnosis of lower limb DVT and substantially outperforms clinical assessment alone. It should remain the first-line investigation in patients with clinical suspicion of this condition, supporting timely diagnosis and appropriate initiation of anticoagulant therapy.

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Figure 5: Diagnostic Algorithm for Suspected Lower Limb DVT

**FIGURE 5:** Diagnostic Algorithm for Suspected lower Limb DVT

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