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Comparison of Two-Point Compression Ultrasonography Performed by Emergency Medicine Doctors and Radiologists in Detection of Deep Vein Thrombosis

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Abstract

Introduction Venous thromboembolism (VTE) is a serious coagulation disorder that includes deep vein thrombosis (DVT) and pulmonary embolism and is an important cause of hospitalization and death. This study aimed to evaluate the compliance of the emergency doctor and radiologist in diagnosing DVT in the emergency department using the two-point compression ultrasonography (USG) method.

Patients and Methods This prospective cross-sectional study was performed between February and July 2022 in the Emergency Medicine Clinic of a tertiary university hospital with patients who were thought to have DVT and had lower extremity venous USG indication. Demographic information of patients, clinical markers used in the Wells score, and USG results of the emergency doctors and radiologists were recorded in the study form.

Results A total of 400 patients were included in the study. The mean age of the study patients was 59.8 ± 18.0 years, and 54.4% ($n = 217$) of the patients were male. There was a significant difference in the incidence of DVT between those with a Wells score of 2 or less and those above 2 ($n = 67$, 21.8% vs. $n = 41$, 47.1%; $p < 0.001$). Regarding interobserver agreement in the evaluation of DVT by emergency medicine doctor and radiologist, kappa values were 0.81 (95% confidence interval [CI]: 0.71–0.91) for the right femoral vein, 0.89 (95% CI: 0.81–0.97) for the left femoral vein. It was found to be 0.81 (95% CI: 0.76–0.86) for all lower extremity vein USGs.

Conclusions There is a very good level of agreement between the emergency department and the radiologist in diagnosing DVT with USG.

Keywords
- deep vein thrombosis
- emergency medicine doctor
- radiologist
- two-point compression ultrasound

Introduction

Venous thromboembolism (VTE) is a serious coagulation disorder that includes deep vein thrombosis (DVT) and pulmonary embolism. Rapid and accurate detection of DVT is important in emergency medicine to prevent a fatal disease such as pulmonary embolism.[1] Although DVT is frequently seen in the lower extremity veins, it can occur in the entire venous system. Thrombosis in the deep venous system of the extremities may cause symptoms such as pain, swelling, redness, and diameter difference in the acute phase of the disease. The Wells score for diagnosing DVT is one of

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the most commonly tested scores to determine the probability of disease. However, it has recently been modified due to problems in using the Wells score. Modified Wells score can be applied to patients whose clinical presentation is concerning for a DVT for risk stratification. Physicians recommend additional testing at values of 2 and above in calculating this score.[2,3] Considering DVT, the Wells score is the most well-known and is used to determine probability and classify patients with suspected DVT.[2,3]

In addition to probability classifications, another tool used in the diagnostic process is 'D-dimer,' a fibrin degradation product. However, history, physical examination, probability classifications, and biochemical parameters such as d-dimer are only guides in the process leading to the diagnosis, and more is needed to make the final diagnosis. The definitive diagnosis of DVT in the emergency department (ED) is made by lower extremity venous USG. Duplex USG of the lower extremity (color and flow Doppler USG) and compression USG is an imaging method that is non-invasive and has a high diagnostic value.[4,5]

It is listed as one of the basic emergency ultrasonography applications in the emergency ultrasonography guidelines of the American College of Emergency Physicians and has been widely used by many emergency physicians in recent years. It can be applied quickly at the bedside as it is easy to apply and promptly guide the appropriate treatment. In this application, the simplified two-point compression technique focuses on evaluating the lower extremity's common femoral and popliteal vessels for complete compression.[2,4,5] Two-point compression USG is an ideal diagnostic tool for emergency practice because it is a fast, effective, easy-to-apply, and noninvasive procedure.[6] In departments where patient flow is fast and intense, such as the ED, evaluating patients as quickly as making the correct diagnosis is important. Steps such as transferring the patient to the radiology department and reporting the USG prolong the patient's diagnosis process. Bedsides, USG performed by emergency doctors may shorten the diagnosis time of patients with the possibility of DVT.[7] This study aimed to determine the interobserver agreement in diagnosing DVT using the two-point compression USG method by emergency doctors and radiologists in patients who are thought to be likely to have DVT and need diagnostic intervention in the ED.

Patients and Methods

After the ethics committee's approval, this prospective cross-sectional study was performed with patients who were thought to have DVT and had lower extremity venous USG indication in a third step university hospital emergency medicine clinic between February and July 2022. Informed consent was obtained from all patients included in the study, and the consent of the patient or their relatives was obtained. The criteria for inclusion in the study were over 18 years of age and the emergency doctor's indication for lower extremity USG due to the suspicion of DVT. Patients younger than 18 years of age, those who did not give their consent for the study or those whose data were missing, patients whose relevant parts of both lower extremities cannot be visualized due to bodily features such as loss of a limb loss, patients with a diagnosis of arterial circulatory disorder known to affect the lower extremity, and those with DVT or patients who had a recent duplex USG (within the last month) were excluded from the study.

Demographic data, admission complaints, vital signs (systolic blood pressure, diastolic blood pressure, pulse, respiratory rate, fever, oxygen saturation value (SO_2), physical examination findings, concomitant diseases, anticoagulant–antiaggregant drug use, and two-point compression USG findings performed by emergency medicine and radiologist of patients eligible for the study were recorded in the study form. In addition, clinical symptoms were recorded in the study form by the Wells score in study patients.[7] In determining the interobserver agreement between emergency medicine doctors and radiologists, patients were evaluated by separate physicians in each application; so, repetitive applications were not excluded from the analysis.

USG examinations were performed with Mindray Medical (Germany) device, with a 7.5 MHz linear probe. The patients were placed in the supine position. For two-point compression USG, compression was performed at the common femoral vein and popliteal vein points. The common femoral vein emerges from the inguinal fold or just a few cm below it. The probe on the transverse axis compresses it. The popliteal vein is located in the popliteal fossa. In the popliteal vein examination, the USG device should be on the patient's right side, and the patient should be repositioned for the study. The patient is placed in the left lateral position, and the popliteal vein is detected in the transverse plane in the popliteal fossa from the posterior side. The probe compresses the remaining 3 to 4 cm in the popliteal fossa.

Data were analyzed with the MedCalc 20.110 program. Continuous data are expressed as mean (standard deviation), and frequency data are expressed as percentages. Two-group comparisons for frequency data were performed with the Chi-square test. Inter-rater agreement (inter-rater agreement) was determined by the kappa value and 95% confidence interval was used to evaluate possible DVT in the lower extremity veins by emergency medicine doctors and radiologists using USG. All hypotheses were established in pairs, and the α critical value was accepted as 0.05.

Results

Out of 406 patients eligible for the study, 4 were excluded because of incomplete data and 2 did not give consent; thus, 400 patients were included in the final analysis. The mean age of the patients was 59.8 ± 18 years. In all, 54.4% ($n = 217$) of the patients were male, and 45.6% ($n = 183$) were female. When the symptoms and physical examination findings of the patients were evaluated, complete swelling of one lower extremity and difference in diameter relative to the other extremity in 82.5% ($n = 329$) of patients, local tenderness

Table 1 Descriptive data and co-morbidities of study patients

Variable Değişken	Ort ± SS
Age (y)	59.8 ± 18
Pulse	91 ± 17
Systolic blood pressure	135 ± 23
Diastolic blood pressure	82.6 ± 16
Oxygen saturation	96.2 ± 5,7
Sex	
Male	217 (54.4)
Female	183 (45.6)
Diabetes	74 (18.5)
Cardiovascular disease	71 (17.8)
hypertension	58 (14.5)
Cerebrovascular condition	20 (5)
Entire swelling of lower extremity and difference in diameter	329 (82.5)
Local sensitivity along the deep venous system trace	220 (55.1)
Edema in symptomatic leg	184 (46.1)
Observation of collaterals in superficial veins (no varicose)	54 (13.5)
Active cancer	34 (8.5)
Paralysis, paresthesia, or immobilization of the lower extremity with a patch	27 (6.8)
Bed rest for more than 3 days or major surgery in the last 4 weeks	13 (3.3)
High probability of alternative diagnosis other than DVT	92 (23.1)

along the deep venous system trace in 55.1% ($n = 220$), 46.1% ($n = 184$) had pitting edema in the symptomatic leg. Moreover, 11.4% ($n = 45$) of the study patients were using antiaggregant drugs, and 17% ($n = 27$) were using anticoagulant drugs. Demographic data and clinical findings of the patients are given in ►**Table 1**.

There was a significant difference between those with a Wells score of 2 and below and those above 2 in DVT diagnosis ($n = 67$, 21.8% vs. $n = 41$, 47.1%; $p < 0.001$). There was no significant difference between patients using antiaggregant or anticoagulants and patients not using them (►**Table 2**). The findings in evaluating lower extremity veins related to DVT for DVT are given in ►**Table 3**. In determining the consistency of emergency medicine, doctors and radiologists in the evaluation of lower extremity veins for DVT, the kappa value was 0.81 (95% CI: 0.71–0.91) for the right femoral vein, 0.89 (95% CI: 0.81–0.97) for the left femoral vein, and the right popliteal vein. It was found to be 0.81 (95%CI: 0.72–0.91) for the left popliteal vein, 0.73 (95% CI: 0.62–0.84) for the left popliteal vein, and 0.81 (95% CI: 0.76–0.86) for all lower extremity vein USGs (►**Table 4**).

Table 2 Relationship between patients' Wells score, antiaggregant use, and anticoagulant use with the diagnosis of DVT

Variable	DVT (−) *n* (%)	DVT (+) *n* (%)	*p*-Value
Wells score			< 0.001
≤2	240 (78.2)	67 (21.8)	
>2	46 (52.9)	41 (47.1)	
Antiaggregant			0.15
None use	250 (71.4)	100 (28.6)	
Use	36 (81.8)	8 (18.2)	
Anticoagulant			0.53
None use	265 (72.2)	102 (27.8)	
Use	21 (77,8)	6 (22.2)	

Abbreviations: DVT: deep vein thrombosis.

Table 3 Two-point compression ultrasound interobserver consistency in terms of DVT by emergency medicine and radiology physicians

	Emergency doctor	Radiologist	
Right femoral vein	+	–	Total
ED (+)	32 (82)	7 (18)	39
ED (−)	5 (2,5)	196 (97,5)	201
Left femoral vein			
ED (+)	37 (90,2)	4 (9,8)	41
ED (−)	3 (2,1)	140 (97,9)	143
Right popliteal vein			
ED (+)	39 (84,8)	7 (15,2)	46
ED (−)	7 (3,6)	187 (96,4)	194
Left popliteal vein			
ED (+)	41 (87,2)	6 (12,8)	47
ED (−)	14 (10,2)	123 (89,8)	137
All lower extremity Veins			
ED (+)	149 (86,1)	24 (13,9)	173
ED (−)	29 (4,3)	645 (95,7)	674

Abbreviation: ED, emergency doctor.

Discussion

The mean age of the patients participating in the study was 59.8 years. In the study by Kim et al,[8] the mean age of the patients was calculated as over 50 years. Olaf et al[1] also reported that the incidence of DVT increases with age. The results of our study are compatible with the literature. Long-term immobilization and previous major surgery are risk factors in DVT risk scoring.[9] It was found that 13 patients in our study had bed rest for more than 3 days or had a history of major surgery in the last 4 weeks. In the 2018 DVT

Table 4 Kappa values in determining the interobserver consistency of emergency medicine doctor and radiologist in the evaluation of lower extremity veins for DVT

Evaluated vein	Kappa value (%95 Cl)
Right femoral vein	0.81 (0.71–0.91)
Left femoral vein	0.89 (0.81–0.97)
Right popliteal vein	0.81 (0.72–0.91)
Left popliteal vein	0.73 (0.62–0.84)
All lower extremity veins	0.81 (0.76–0.86)

Abbreviation: CI, confidence interval.

guideline, it was stated that previous surgery and immobilization cause an increase in the risk of DVT.[10] In line with our study's results, prophylactic anticoagulants in prophylactic doses should not be neglected in patients who are planned for long-term immobilization and major surgery.

The most common clinical finding in patients for whom USG is requested with the suspicion of DVT in the emergency department is complete swelling of the lower extremity and the difference in diameter compared with the other extremity (82.5%). Local tenderness (55.1%) along the deep venous system trace, symptomatic pitting edema (46.1%), and nonvaricose collaterals in the superficial veins (13.5%) are other findings following lower extremity swelling and diameter difference. Liang et al[11] in their DVT study published in 2022 found swelling in the extremity, detection of diameter difference with the other lower extremity, and tenderness along the venous system tracing as the most common physical examination findings in patients diagnosed with DVT. Wells score is one of the best-known and most commonly used scoring systems in diagnosing DVT and pulmonary embolism.[12,13] According to the results of this study, the incidence of DVT in patients with a Wells score of 2 and below (low probability) was significantly lower than in those with a Wells score above two (21.8% vs. 47.1%). It is an expected result that the likelihood of DVT decreases as the Wells score drops, and it is compatible with previous studies on this subject.

The first imaging method to diagnose DVT is lower extremity venous Doppler USG. For the diagnosis of DVT, 2-point compression USG at the bedside has been performed by emergency medicine physicians in the emergency departments for diagnostic purposes in recent years.[14] In USG performed for the diagnosis of DVT in all lower extremity vessels, emergency medicine physicians reported DVT in 173 patients, while radiologists found DVT in 178 patients. In a study conducted by Kim et al[8] with 296 patients, an emergency medicine physician and a radiologist diagnosed DVT in 50 patients. In five patients, the emergency medicine physician said there was no DVT, while the radiologist diagnosed DVT.[8] In a study by Crisp et al,[15] in which emergency physicians and radiologists compared the USG skills for DVT diagnosis, the radiologist stated that only 1 of the 153 patients whom emergency medicine physicians called negative for DVT had positive USG findings. Canty et al[16] found that the sensitivity of compression USG for DVT was 95% (87–99%) and the specificity 96% (87–99%) by emergency physicians in the ED. In our study, 149 (86%) of 173 patients diagnosed with DVT by ED physicians in the whole lower extremity vein ultrasound were also agreed by radiologists. In a study by Abbasi et al,[17] the kappa value was calculated to be in a significant range (0.9) in the consistency comparison of the compression USG made by the ED physician and the radiologist for the diagnosis of DVT. In our study, in the comparison of the consistency of emergency medicine physicians and radiology physicians in the evaluation of lower extremity veins for DVT, the kappa value for the right femoral vein was in a significant range (0.81), and the kappa value for the left femoral vein (0.89). When examined for all lower extremity veins, the kappa value was calculated as 0.81, which was found to be very compatible.

The results found in our study, which were observed to be compatible with the literature, were found to be sensitive to two-point compression USG performed by emergency medicine physicians for DVT USG.

This study had some limitations. The USG indication of study patients was left to the clinical judgment of the physician rather than a standard set of criteria. Although this reduces internal validation and increases the likelihood of variation in results, it is a pragmatic approach more suited to daily practice. This limitation should always be considered, as the USG is user-dependent due to the study's methodology. In contrast, the diameter difference between the legs of the study patients could not be measured using a standard method with an instrument measuring distance and length. Instead, it is left to the clinician's decision as to whether there is a difference in diameter. The existing but faint diameter differences may have been overlooked in this case.

Conclusion

The most common clinical finding in patients with suspected DVT in the ED is complete swelling of the lower extremity and diameter difference. The incidence of DVT is higher in patients with intermediate and high probability, according to the Wells score. There is good interobserver agreement among emergency medicine and radiologists in diagnosing DVT by USG.

Authors' Contributions

All authors contributed substantially to the study's planning and conduct and the manuscript's drafting and finalization.

Compliance with Ethical Principles

Ethics committee's approval was obtained by the Institution Review Board and informed consent was obtained from all patients included in the study, and the consent was obtained from the patient or guardian.

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Conflict of Interest
None declared.

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