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Brief Report

The accuracy of limited B-mode compression technique in diagnosing deep venous thrombosis in lower extremities

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Abstract

Background: Deep vein thrombosis (DVT) is prevalent in the emergency departments. Nearly 60% of them may lead to pulmonary embolism. A complete color-flow duplex ultrasound (CFDU), performed by the radiologists, is the most common diagnostic method used to detect DVT. A limited B-mode compression technique (BMCT) can also be useful for the emergency specialists visiting suspicious cases.

Objectives: The purpose of this study was to compare the sensitivity, specificity, and accuracy of a BMCT done by emergency medicine residents with that of a CFDU in diagnosing the proximal DVT of lower extremities.

Methods: This prospective study was conducted on 74 patients (41 men and 33 women) presenting with painful and swollen lower limbs in the emergency department of Imam Khomeini Hospital. First, the affected lower extremity was examined by a BMCT carried out by one of the 2 emergency medicine residents. Then, the CFDU was performed by a radiologist blinded to the results of the BMCT. The sensitivity, specificity, and accuracy of the BMCT were compared with that of the CFDU as a gold standard.

Results: The mean age of the patients was 55.16 ± 17.4 years. Positive results were reported in 35 patients (47.3%) using the 2 tests. Compared with CFDU, BMCT had a sensitivity, specificity, accuracy, positive predictive values, and negative predictive values of 100%.

Conclusion: These findings suggest that BMCT performed by the emergency medicine specialists to diagnose proximal DVT of lower extremities is not only an acceptable method but also less time-consuming when compared with CFDU.

1. Introduction

Deep vein thrombosis (DVT) is prevalent in the emergency departments [1]. Although its accurate prevalence is unknown, it is considered as the reason for hospitalization of about 600 000 patients in the United States. Nearly 60% of untreated DVTs may lead to pulmonary embolism, causing

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over 50 000 deaths annually [2,3]. Clinical findings, on their own, are not diagnostic for DVT [4]. Commonly, a complete color-flow duplex ultrasound (CFDU) is the preferable but time-consuming method to detect the condition. The fact that the radiologists or the ultrasound specialists responsible for doing the test are not always readily available in the emergency department, however, has limited their use in emergency cases. Moreover, most cases of pulmonary embolism occur within the first 24 hours [5,6].

In contrast, carrying out a limited B-mode compression technique (BMCT) (B-mode imaging with direct pressure on the veins and deciding based on the compressibility of the veins) by the emergency medicine specialists in the emergency department both accelerates the pace of diagnosis and treatment and reduces the cost of the treatment [7].

The sensitivity and specificity of BMCT in diagnosing proximal DVT in lower limbs are reported to be between 93% and 100% and 97% and 100%, respectively. Kearon et al [4] found that BMCT had in general a sensitivity of 89%, specificity of 94%, positive predictive value of 94%, and negative predictive value of 90%; these results, however, remarkably improved to values equal to 95%, 96%, 97%, and 98%, respectively, when the test was used to diagnose proximal DVT in the lower limbs.

Cogo et al [6] found that BMCT, which had a sensitivity of 100% in diagnosing proximal DVT, can effectively reduce the time of performance. A sensitivity and specificity of 91% and 99%, respectively, were noted in inpatients having the condition.

Poppiti et al [7] studied BMCT in a group of 72 patients and concluded that the tool has a sensitivity and specificity of 100% and 98%, respectively, in diagnosing DVT. Moreover, the study indicated a substantial reduction in the test time, from 37 minutes for CFDU to 5.5 minutes for BMCT.

In a study performed by Jang et al [8], 8 emergency residents with no experience in diagnosing DVT performed BMCT on 2 normal individuals and 72 patients after participating in a training program consisting of a 1-hour lecture on DVT in the form of a PowerPoint presentation. The mean scan time was 11.7 minutes, and the test was reported to have 100% sensitivity and 91.8% specificity.

The American Radiology Association, however, does not fully agree with the use of compression ultrasound in diagnosing DVT. Frederick et al [9] studied 721 patients presenting with clinical symptoms of lower-limb DVT in a vascular laboratory. As 21% of the studied DVT cases were limited to a single vein (eg, popliteal vein), radiologists concluded that BMCT should not be performed in such population.

The purpose of this study was to compare the sensitivity, specificity, positive predictive value, and negative predictive value of BMCT done by emergency medicine residents with that of CFDU in diagnosing proximal DVT of lower extremities.

2. Patients and methods

After receiving an approval from the ethical board committee of Tehran University of Medical Sciences, the patients referred to the emergency department of Imam Khomeini Hospital with DVT symptoms, including painful and swollen lower limbs, during a 1-year period in the working shift hours of the researchers were recruited. The cases were selected from among the subjects with no history of chronic DVT as well as those who had never been examined by other diagnostic methods, especially CFDU.

Two emergency medicine residents trained by a board-certified radiologist who was a faculty member of Tehran University of Medical Sciences were responsible for performing BMCTs. The training program consisted of a 1-hour lecture in PowerPoint format about B-mode ultrasound and using a linear array transducer for BMCT and 2 hours of practice on real patients.

B-mode compression technique on saphenofemoral and saphenopopliteal junctions of each patient was

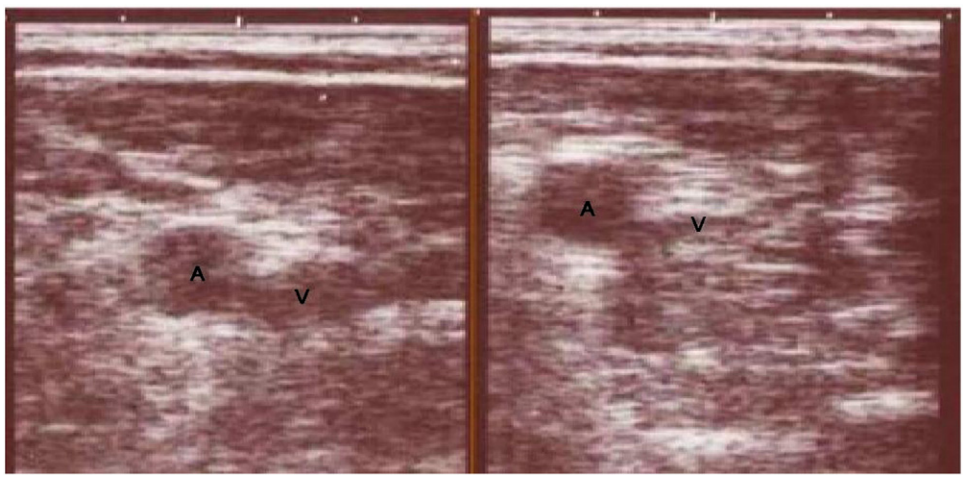

Fig. 1 Normal Femoral View before (left) and after (right) compression. A, artery; V, vein.

performed by one of the 2 trained emergency medicine residents using a portable FF Sonic UF-4300R FUKUDA DENSHI ultrasound device with a 7.5 MHz linear array transducer in the emergency department. A hard copy of B-mode imaging was recorded.

As for achieving the ultimate diagnosis, a board-certified radiologist blinded to the BMCT results examined the limbs independently by CFDU in the radiology department and documented the results. The time interval between the 2 methods was maximally 3 hours. The results of both BMCT and CFDU were reviewed by a third independent emergency medicine specialist. The demographic data (age and sex) of the patients and the results of the tests were recorded in a prepared questionnaire by him.

3. BMCT technique

In the BMCT method, the emergency residents studied 2 vein segments, the iliofemoral and the popliteal veins, in 2 different locations: the iliofemoral segment from saphenofemoral junction up to 10 cm below it and the popliteal segment from saphenopopliteal junction up to tibial vein confluence. Whenever the vein was compressible in these 2 locations, the scan was reported negative. The scan was considered positive for DVT whenever the vein in at least one of these locations was noncompressible. It should be noted that the pressure of probe was not too high, which caused the compression of the arteries. Hard copies of black and white real-time B-mode imaging were made. Figs. 1 and 2 show the compressible veins in femoral and popliteal views, respectively.

4. Results

The prospective study was conducted on 74 patients presenting with the symptoms and signs of lower-limb DVT in the emergency department of Imam Khomeini Hospital. The mean age of patients was 55.16 ± 17.4 years, ranging from 19 to 88 years. About 41 (55.4%) of the patients were men, and 33 (44.6%) were women.

From among the 74 studied patients who underwent BMCT, DVT was diagnosed in 35 patients (47.3%). Color-flow duplex ultrasound performed by a board-certified radiologist, similarly, revealed positive results for DVT in 35 (47.3%) of the subjects.

The compression technique was 100% specific, 100% sensitive, had a positive and negative predictive value of 100%, and 100% accuracy in detecting DVT.

5. Discussion

The present study revealed that CFDU and BMCT have a similar sensitivity, specificity, and accuracy of 100% in detecting proximal DVT. These findings are contrary to the findings of Biondetti et al [10] who compared the sensitivity and specificity of the compression ultrasound with that of venography and reported 87% sensitivity, 100% specificity, and 96% accuracy for the former test. They reported that the 6 isolated distal DVTs of lower limbs, diagnosed by venography, were falsely reported to be normal in BMCT.

Similar to the study that was conducted by Jang et al [8], we trained 2 of our emergency medicine residents by attending a brief training course, and similar sensitivity and specificity were reported.

6. Conclusion and suggestions

Our study suggests that the compression ultrasound can be considered as a reasonable alternative to the color Duplex ultrasound for diagnosing proximal DVT in lower extrem-

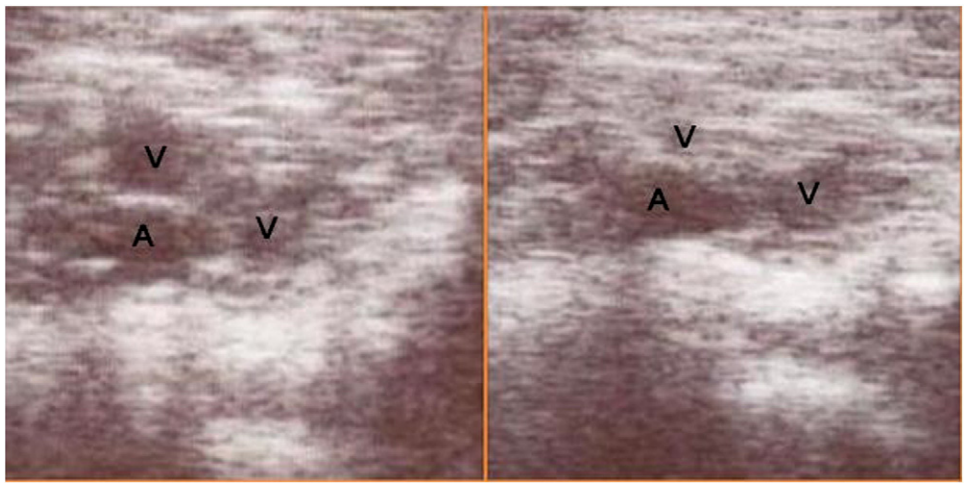

Fig. 2 Normal Popliteal view before (left) and after (right) compression. A, artery; V, vein.

ities. In addition, it showed that short-term training courses for BMCT can effectively teach emergency medicine residents to accurately diagnose proximal DVT in lower limbs. Compared with CFDU, BMCT can be performed easily and rapidly in bedside of those suspicious of having proximal DVT in lower extremities, particularly in the emergency department. Bedside BMCT can also reduce the diagnostic costs of detecting proximal DVT in lower extremities. It was the first experience in our emergency department, and in this era of developing emergency medicine, we recommend that a training course for emergency medicine residents be included to learn how to use BMCT to examine patients who are clinically suspicious for proximal DVT of lower limbs. Nonetheless, we recommend further studies with a larger number of trained emergency medicine specialists to confirm the accuracy of BMCT in detecting DVT in lower extremities.

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