

The Use of Doppler Ultrasound to Diagnose Deep Vein Thrombosis of the Lower Limbs

Nagla Hussein Mohamed Khalid*

Department of Diagnostic Radiology, Faculty of Applied Medical Sciences, Najran University, Najran, KSA

***Corresponding Author:** Nagla Hussein Mohamed Khalid, Department of Diagnostic Radiology, Faculty of Applied Medical Sciences, Najran University, Najran, KSA.

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Abstract

In most cases of pulmonary embolism, death occurs as a result of deep vein thrombosis (DVT) of the lower extremities. Therefore, to avoid DVT complications and sequel, DVT must be diagnosed as early as possible and this can be achieved via B-mode and colour Doppler imaging. The present paper seeks to investigate the suitability of the imaging method of ultrasound for lower extremity DVT diagnosis and to explore the outcomes of the use of this method in DVT cases. To this end, the paper undertakes a retrospective descriptive study of 50 cases of ultrasound-based diagnosis of DVT at King Khalid Hospital in the period between January 2019 and August 2020. Half of the cases were subjected to compression, colour and duplex ultrasound, 14 cases were subjected to compression and duplex ultrasound and 11 cases were subjected to compression and colour Doppler. The mean age across all cases was 46.2 ± 19.9 years. The majority of cases (56%) were in the age range 22 - 41 years old ($n = 28$), while 28% of cases were in the age range 42 - 61 years old ($n = 14$), 6% of cases were in the age range 62 - 81 years old ($n = 3$) and 10% of cases were in the age range 82 - 102 years old ($n = 5$). Regarding sex, females accounted for 60% of cases, while males accounted for the rest of 40%. Furthermore, in 90% of cases ($n = 45$), just one lower extremity was affected, whereas in 10% of cases ($n = 5$), both lower extremities were affected. Regarding thrombus location, it was found mostly in the area above the knee, particularly the popliteal vein (34%), common femoral vein (18%) and superficial femoral vein (20%). Moreover, 2% of cases presented thrombus in the calf vein. In 26% of cases, multiple veins were affected. DVT was acute in 76% of cases ($n = 38$) and chronic in 24% of cases ($n = 12$). It is concluded that symptomatic and at-risk cases benefit from the use of ultrasound for DVT diagnosis. The suitability of this method stems from its lack of invasiveness and capability to assess thrombus location, magnitude and stage.

Keywords: Deep Vein Thrombosis (DVT); Post-Thrombotic Disorder (PTS); Doppler Ultrasound; Lower Limbs Ultrasound; Doppler; Deep Vein; Thrombosis; Lower limbs; Patients

Overview

Deep vein thrombosis (DVT) is a condition whereby one or multiple blood clots form in a large vein of the body, especially a vein in the muscles of the lower extremities [1]. DVT is distinguished into non-occlusive and occlusive thrombosis; the former involves partial vein obstruction, while the latter involves complete vein obstruction. The condition may only be discovered or become symptomatic when a vein is obstructed completely [2]. DVT primarily manifests as pain, swelling, redness, and vein enlargement

in the affected area. However, DVT may be asymptomatic in some cases [3]. PE that could be potentially lethal and post-thrombotic disorder (PTS) are the main DVT complications [4,5].

DVT is associated with high rates of morbidity and death. In the absence of appropriate treatment, DVT is particularly likely to develop (40 - 60%) in cases admitted to medical orthopaedic wards with venographic DVT incidence [6]. In developing nations, it is probable that a true picture of DBT prevalence, incidence, morbid-

ity, and mortality is lacking given that the condition can go unnoticed. The majority of affected individuals live with DVT without problems, but long-term complications can occur and venous stasis syndrome or post-phlebotic syndrome develops in almost 33% of cases [5].

The annual number of DVT diagnoses is around 1 million. This condition is highly complex, even more so than intense myocardial dead tissue or intense stroke [7]. The manifestations of acute DVT (e.g. inflammation, pain, swelling) can be misinterpreted as infection or oedema of non-venous causes [8], leading to inconsistencies and even mistakes in clinical assessments.

Venous ultrasonography, both invasive and non-invasive, is the preferred method for diagnosing acute DVT, while the main non-invasive method of DVT diagnosis is duplex ultrasound, which is a key tool for fringe venous testing, as stipulated by the Intersocietal Commission for the Accreditation of Vascular Laboratories (ICAVL). The diagnostic efficiency of duplex ultrasound could be improved by supplementary instruments like IPG and consistent wave Doppler, but these have not been recognised so far as critical diagnostic methods as far as ICAVL accreditation is concerned [9].

The above-mentioned methods of venous ultrasonography are occasionally used interchangeably, but they vary in the sensitivity and specificity they demonstrate for acute DVT diagnosis. A range of methods are considered suitable for examination of distinctive lower furthest point veins. For instance, proximal deep veins (e.g. common femoral, femoral and popliteal veins) are usually evaluated via comparison ultrasound, while the calf and iliac veins are evaluated via a combination of duplex ultrasound and shading Doppler imaging [10].

Doppler ultrasonography was the method chosen in the present study for the examination of DVT of the lower limbs.

Methodology

Data from King Khalid Hospital in Najran spanning the period January 2019 - January 2020 were employed to conduct a retrospective descriptive quantitative analysis of the suitability of various ultrasound methods for differential diagnosis of DVT. The data derived from patients of both sexes and in the age range 20 - 102 years old who were diagnosed with different forms of DVT and who had been subjected to ultrasound assessment. The collection of the data was facilitated by a checklist based on the hospital's Picture Archive and Communication system, including patient age, sex, risk

factors, and type of Doppler ultrasound. Two types of ultrasound equipment were available, namely, ultrasound Philips equipment (linear transducer 5 - 7.5 HTZ, 5 - 12 HTZ) or ultrasound Toshiba equipment (linear transducer 5 - 7.5 HTZ, 5 - 12 HTZ). Meanwhile, the ultrasound methods employed included compression ultrasound, duplex ultrasound and colour flow duplex imaging. The Statistical Package for the Social Sciences (SPSS) and Excel were the software programs used to conduct statistical analysis.

Results

As outlined in figure 1, the mean age across all cases was 46.2 ± 19.9 years. The majority of cases (56%) were in the age range 22 - 41 years old ($n = 28$), while 28% of cases were in the age range 42 - 61 years old ($n = 14$), 6% of cases were in the age range 62 - 81 years old ($n = 3$) and 10% of cases were in the age range 82 - 102 years old ($n = 5$). Regarding sex, females accounted for 60% of cases, while males accounted for the rest of 40% (Figure 2).

Figure 1: Frequency distribution of patients age.

Figure 2: Frequency distribution of patient sex.

Half of the cases were subjected to compression, colour and duplex ultrasound, 14 cases were subjected to compression and du-

plex ultrasound, and 11 cases were subjected to compression and colour Doppler (Figure 3). Furthermore, in 90% of cases (n = 45), just one lower extremity was affected, whereas in 10% of cases (n = 5), both lower extremities were affected. Regarding thrombus location, it was found mostly in the area above the knee, particularly the popliteal vein (34%), common femoral vein (18%) and superficial femoral vein (20%). Moreover, 2% of cases presented thrombus in the calf vein (Table 1). In 26% of cases, multiple veins were affected. DVT was acute in 76% of cases (n = 38) and chronic in 24% of cases (n = 12), as detailed in table 2 and 3, respectively.

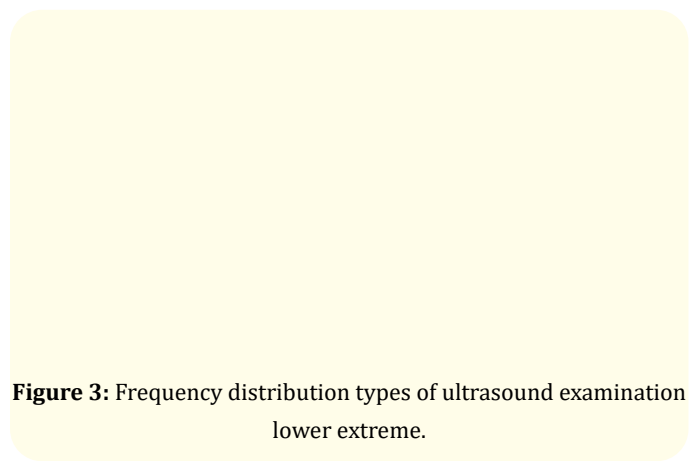


Figure 3: Frequency distribution types of ultrasound examination lower extreme.

Site of DVT	Frequency	Percentage
Unilateral	45	90.0%
Bilateral	5	10.0%
Total	50	100.0%

Table 1: Frequency distribution of DVT site.

Location of DVT	Frequency	Percentage
Popliteal	17	34.0%
Common femoral	9	18.0%
Superficial femoral	10	20.0%
Calf	1	2.0%
More than one vein	13	26.0%
Total	50	100.0%

Table 2: Frequency distribution of DVT location.

DVT Type	Frequency	Percentage
Chronic	12	24.0%
Acute	38	76.0%
Total	50	100.0%

Table 3: Frequency distribution DVT types.

Discussion

There are significant challenges involved in diagnosing DVT due to the diversity of symptoms and manifestations, on the one hand or the lack of symptoms, on the other hand, associated with this condition. To adequately treat DVT, it is essential to have information about the characteristics of the thrombus as well as where it is located and how large it is.

In 1982, Talbot was the first to investigate the assessment of veins in the lower limbs for DVT via duplex ultrasonography. Since then, the method has become widely accepted and used as the preferred approach for DVT diagnosis. It has been confirmed to demonstrate a high level of sensitivity and specificity for assessment of symptomatic cases [11,12] and positive outcomes serve as the basis for commencing anticoagulation treatment. Furthermore, duplex ultrasonography is an effective method for eliminating DVT in cases suspected of pulmonary embolus, as the latter often develops in the deep veins of the lower limbs and the initial anticoagulation-based intervention is identical.

A retrospective descriptive analysis was performed on the findings from the investigation of 50 cases of DVT assessed via B-mode and Doppler ultrasound. In each case, every major deep and superficial vein of the lower extremity, as well as the external iliac, common iliac, and IVC was investigated.

The DVT cases examined in this paper were in the age range 22 - 102 years old, with over half being in their thirties. By contrast, Hill and colleagues [13] reported that the mean age of DVT cases was 50 - 60 years old. Regarding sex, the research population in the present paper consisted mostly of females (60%), while males made up the rest of 40%. Meanwhile Hill and colleagues [14] reported that males accounted for the majority of DVT cases. Regarding affected extremities, the present paper found that just one lower extremity was affected in 90% of cases, whereas both lower extremities were affected in 10% of cases and there were no cases in which both lower extremities were affected despite only unilateral symptoms being displayed or in which one lower extremity was affected despite existence of bilateral symptoms. Similar results were obtained by Sheman and McArdle [15] who observed that the incidence of DVT in contra-lateral extremity was low.

Regarding thrombus location, this paper found that 34% of cases had thrombus in the popliteal vein (n = 17), 26% of cases had thrombus in multiple veins (n = 13), 20% and 18% of cases had thrombus in the superficial (n = 10) and common femoral vein (n

= 9), respectively and 2% of cases had thrombus in the calf vein (n = 1). This was consistent with Markel and colleagues [16] who reported that DVT affected the proximal lower extremity more than the distal lower extremity.

In terms of DVT stage, 76% of cases in this paper were acute DVT (n = 38), while the rest of 24% were chronic DVT (n = 12). This was inconsistent with the figures reported by Hill and colleagues [12] who obtained a much lower proportion of acute DVT (17.4%).

Conclusion and Suggestion

Various forms of DVT of the lower limb can be successfully diagnosed with different ultrasound methods. In the context of Najran Province, females are more likely than males to develop DVT. Furthermore, the popliteal vein is the affected area in the majority of cases. It is recommended that all cases suspected of DVT should be subjected to ultrasound examination. Moreover, additional prospective studies with a larger number of subjects are necessary.

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