Doppler Ultrasonographic Evaluation of Lower Limbs Deep-Vein Thrombosis in a Teaching Hospital, Northwestern Nigeria

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Abstract

Background: Deep-venous thrombosis (DVT) of lower limbs is one of the most common causes of death caused by pulmonary embolism. Many medical and surgical disorders are complicated by DVT. B-mode and color Doppler imaging are needed for the early diagnosis of DVT to prevent complications and sequelae of DVT. Objectives: The objectives of this study are to evaluate the role of Doppler ultrasound in diagnosing DVT of lower limbs and to study the spectrum of findings in patients with DVT in Zaria. Methodology: A retrospective study was carried out on patients who had Venous Doppler Scan in the Department of Radiology ABUTH, Zaria, Nigeria, for suspected DVT over a period of 4 years from February 2014 to January 2018. Scans were done using DC-3 and DC-6 Mindray Ultrasound machines (2009 and 2013 Models, respectively, Shantou, China) coupled with high-frequency (7.5–12 MHz) linear and low-frequency curvilinear (2–5 MHz) transducers. Analysis of cases of DVT was performed in terms of age, sex, clinical features, predisposing conditions, anatomic distribution, stage, and pattern of thrombus involvement in the veins. Data were analyzed using the SPSS version 20.0 and value of \( P < 0.005 \) was considered as statistically significant. Results: A total of 252 patients’ results were reviewed which consisted of 122 males (48.4%) and 130 females (51.6%). The patients’ ages ranged from 11 to 80 years, averaging 45.5 ± 9.56 years. The most common indication for Doppler request was leg swellings. The most common risk factor for DVT was malignancy (36%), cardiac disorders (18%), and traumas (14%). Sixty-six (61%) cases showed left-sided and 26 (24%) right-sided, whereas 16 (15%) cases showed bilateral lower limb involvement. Predominant thrombus was above-knee region with 54% in the superficial femoral vein. Chronic stage was seen in 46 (42%) cases, subacute in 44 (41%) cases, and acute in 18 (17%) cases. Conclusion: Middle–aged females, left-sided leg, and above-knee segment were predominantly affected with DVT; hence, this buttresses the need for Doppler ultrasound in the diagnosis of DVT in all patients.

Keywords: Deep-venous thrombosis, Doppler scan, lower limb veins, North-western Nigeria

Résumé

Contexte: La thrombose veineuse profonde (TVP) des membres inférieurs est l’une des causes les plus courantes de décès par embolie pulmonaire. De nombreux troubles médicaux et chirurgicaux sont compliqués par la TVP. L’imagerie Doppler en mode B et couleur est nécessaire pour le diagnostic précoce de TVP pour prévenir les complications et séquelles de la TVP. Objectifs: Les objectifs de cette étude sont d’évaluer le rôle des ultrasons Doppler diagnostiquer la TVP des membres inférieurs et étudier le spectre des résultats chez les patients atteints de TVP à Zaria. Méthodologie: une étude rétrospective patients traités par Doppler veineux dans le département de radiologie ABUTH de Zaria (Nigeria) pour suspicion de TVP sur une période de période de 4 ans allant de février 2014 à janvier 2018. Les balayages ont été effectués à l’aide d’appareils à ultrasons DC-3 et DC-6 Mindray (2009 et 2013). Modèles, respectivement, Shantou, Chine) couplés à des transducteurs haute fréquence (7,5–12 MHz) et curvilignes basse fréquence (2–5 MHz). L’analyse des cas de TVP a été réalisée en termes d’âge, de sexe, de caractéristiques cliniques, de conditions prédisposantes, de distribution anatomique, de stade et de modèle. de la participation de thrombus dans les veines. Les données ont été analysées avec SPSS version 20.0 et une valeur de \( P <0.005 \) a été considérée statistiquement significatif. Résultats: Un total de 252 patients’ results were reviewed which consisted of 122 males (48.4%) and 130 females (51.6%). The patients’ ages ranged from 11 to 80 years, averaging 45.5 ± 9.56 years. The most common indication for Doppler request was leg swellings. The most common risk factor for DVT was malignancy (36%), cardiac disorders (18%), and traumas (14%). Sixty-six (61%) cases showed left-sided and 26 (24%) right-sided, whereas 16 (15%) cases showed bilateral lower limb involvement. Predominant thrombus was above-knee region with 54% in the superficial femoral vein. Chronic stage was seen in 46 (42%) cases, subacute in 44 (41%) cases, and acute in 18 (17%) cases. Conclusion: Middle–aged females, left-sided leg, and above-knee segment were predominantly affected with DVT; hence, this buttresses the need for Doppler ultrasound in the diagnosis of DVT in all patients.

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patients ont été examinés, soit 122 hommes (48,4%) et 130 femmes (51,6%). Les patients l’âge variait de 11 à 80 ans, avec une moyenne de 45,5 ± 9,56 ans. L’indication la plus courante pour la demande d’analyse était le gonflement des jambes. Le plus Le facteur de risque commun de TVP était la malignité (36%), les troubles cardiaques (18%) et les traumatismes (14%). Soixante-six (61%) des cas ont montré un côté gauche et 26 (24%) des cas ont montré une atteinte bilatérale des membres inférieurs. Le thrombus prédominant était au-dessus de la région du genou avec 54% dans la veine fémorale superficielle. Le stade chronique a été observé dans 46 cas (42%), subaigu dans 44 cas (41%) et aigu dans 18 cas (17%). Conclusion: Les femmes d’âge moyen, jambe gauche et segment du genou étaient principalement atteintes de TVP; Par conséquent, cela renforce lanécessité de l’échographie Doppler dans le diagnostic de la TVP chez tous les patients.

Mots clés: Thrombose veineuse profonde, balayage Doppler, veines des membres inférieurs, nord-ouest du Nigeria

**INTRODUCTION**

Deep-vein thrombosis (DVT) is the presence of coagulated blood, a thrombus, in one of the deep venous conduits that returns blood to the heart.[1] It is a major health problem. Venous thromboembolism is a significant, but relatively under diagnosed health problem.[2] The threat of deep-venous thrombosis (DVT) and pulmonary embolism (PE) is a daily concern in the intensive care unit (ICU), hospitalized, and bedridden patients. The early diagnosis of DVT is mandatory to prevent unnecessary deaths from PE.[2,3]

The incidence of DVT in the general population has been estimated to be 80–100/100,000 annually in the western societies,[3] 4–75/100,000 in South Asia.[4] However, if left untreated, the thrombus may result to potentially life-threatening PE.[4] In the United States alone, as many as 100,000–180,000 deaths occur annually due to DVT and PE.[5]

In Nigeria, the incidence of DVT is not well highlighted and literature survey shows scanty works in this field. Most of the literatures available in Nigeria were from the orthopedic departments and overall incidence of DVT in the general population is largely unknown.[6] Risk of new postoperative DVT rises from 26% to 68%. In patients on bed rest in a general medical ward, the rate of DVT is 10%, but in an ICU, it is 29%.[6]

The risk of long term major disability from post-thrombotic syndrome is also high. Lower limb DVT is the most common venous thrombosis and underlying source of acute PE in 90% of cases.[7]

Clinical signs and symptoms of DVT are unreliable. If clinical signs alone were used to diagnose DVT, 42% of patients would receive unnecessary anticoagulation therapy.[8] Some patients evaluated with ultrasonography (US) do not have DVT. Conclusive diagnosis historically required invasive and expensive venography, which is still considered the gold standard.[9] Wells et al.[10] found that patients who present with at least one DVT risk factor and the classical symptoms of unilateral pain and swelling have an 85% probability of having DVT.

DVT occurs along a continuum with propagation, extension, and progression.[11]Probably, because DVT do not totally obstruct the vein in early stages and also due to the presence of collateral circulation, most venous thrombi are clinically silent when they are first detectable by objective methods. Fewer than one-third of patients among those having symptoms in the lower extremities present with the classic syndrome of edema, calf discomfort, venous distension, and pain on forced dorsiflexion of the foot (Homan’s sign).[12] As recommended by the inter-societal Commission for the Accreditation of Vascular Laboratories, Doppler sonography should be the primary modality for peripheral venous examination.[11]

Ultrasound is currently the first-line imaging examination for DVT because of its availability, affordability, relative ease of use, absence of ionizing radiation or contrast material, and high sensitivity and specificity in institution with experienced sonologist.[11]

Other imaging modalities (venography, magnetic resonance imaging and computed tomographic scan) tend to challenge ultrasound’s monopoly on the assessment of the lower-extremity veins. However, obviously, the cost and the complexity of magnetic resonance imaging and radiation exposure in computed tomography scan are difficult to justify in comparison with ultrasound.[11,13] However, there is a paucity of studies in relation to lower limbs deep-venous Doppler scan in our environment that necessitated this study to add value to the body of knowledge, especially to clinicians and radiologists in the aggressive management of DVT.

The objective of this study was carried out to evaluate the role of Doppler ultrasound in diagnosing DVT of lower limbs and study the spectrum of findings on Doppler ultrasound in patients with DVT in Zaria.

**METHODOLOGY**

A retrospective descriptive-analytical study was carried out on patients who had Venous Doppler in the Department of Radiology Ahmadu Bello University Teaching Hospital, Zaria, Nigeria, for suspected DVT over a period of 4 years from February 2014 to January 2018. Scans were done using DC-3 and DC-6 Mindray Ultrasound machines (2009 and 2013 Models, respectively, Shantou, China) coupled with high-frequency (7.5–12 MHz) linear and low-frequency curvilinear (2–5 MHz) transducers.

Analysis of cases of DVT was performed in terms of age and sex distribution, symptoms and signs, predisposing conditions, anatomic distribution, and stage of the involvement of thrombus and pattern of the involvement of veins.
The inclusion criteria are DVT diagnosed on B-mode and color Doppler study in clinically suspected cases of DVT.

All examinations were done by at least three consultant radiologists (at least one of the authors) with a minimum of 5-year post qualification experience and must have conducted >1000 peripheral vascular ultrasound examinations. The Doppler report described the presence or absence of DVT, location, extent, nature (acute, subacute, or chronic) and complications if any. The standard examination involved the evaluation of common femoral vein (CFV) and superficial femoral vein (SFV) first, followed by popliteal and calf veins. The external iliac veins (EIVs) and inferior vena cava (IVC) were evaluated at last. Muscular veins in calf were examined as per the case. The proximal portion of the great saphenous vein was examined. To ensure adequate distension of the venous system, patients were examined in a standing or sitting position. The characteristics of venous flow and the effects of compression were examined in all venous segments. Relevant Doppler information was obtained from color flow signal during color Doppler study of venous segment imaged at any time. CFV, saphenofemoral junction, superficial and deep femoral veins, popliteal vein (POPV), anterior and posterior tibial veins (PTVs), peroneal veins (PERVs), and muscular veins were evaluated in longitudinal and transverse plane initially on B-mode and then on color Doppler study. Linear array transducer (7–12 MHz frequency range of the machine) was used for femoral and popliteal venous segments and for calf veins. Convex transducer (2–5 MHz frequency range) was used for the evaluation of iliac veins and IVC. The presence, characteristics, and extent of thrombus were looked for. The compression technique, Valsalva maneuver, and augmentation were used to evaluate complete/partial thrombosis, proximal obstruction, and patency of distal veins, respectively. Recanalization and collaterals were looked for. Isolated/multiple contiguous or noncontiguous segment involvement of DVT was looked for. The examination of the calf veins included an attempt at the visualization of the gastrocnemius and soleal veins.

When Doppler signals were abnormal or when there were other findings suggestive of obstruction at the level of groin, the iliac veins were examined.
The veins were evaluated for:

1. Absent or reduced compressibility of the vein
2. Thrombus in the vein, static echoes in complete color fill in full expansion of vein
3. Static valve leaflets
4. Absent flow on spectral color Doppler
5. Impaired or absent augmentation of flow
6. Loss of spontaneous and respiratory variation
7. Increased flow in the controlled canal.

The thrombi locations were grouped into seven distinct anatomic segments comprising IVC, common iliac vein (CIV), EIV, CFV, SFV, POPV and calf veins (anterior tibial vein, PTV, and PERV). Paired veins were analyzed as a single vein, and when thrombus was detected in either or both veins, the data were entered as though it occurred in a single segment. Limb affection was recorded as either left, right, or both.

Results are presented numerically and tables, figures, and charts. Data were analyzed using the SPSS Version 20 (INDUS NOMI, Atlanta Georgia, USA, 2011). Statistical parameters such as the Chi-square, and Pearson’s correlation were used for the association between different variables. \( P < 0.05 \) was considered as statistically significant.

**RESULTS**

A total of 252 patients’ results were retrieved and reviewed which consisted of 122 males (48.4%) and 130 females (51.6%) as shown in Table 1. The patients’ ages ranged from 11 to 82 years, averaging 48.4 ± 9.56 years. The mean age of the male patients was 51.2 ± 7.2 years while that of females was 46.3 ± 1.4 years. The mean age of those with DVT on ultrasound was 48.1 ± 10.1 years while that of those with patent deep veins was 57.3 ± 11.1 years. However, the age differences between the two groups were not statistically significant (\( P = 0.188 \)).

The majority of the patients were between the age group of 41–50 years which accounted for 35%, followed by 31–40 years (21%) and 11–20 years were less in number (3%) as shown in Table 2.

The most common indication for request of lower limb scan was leg swellings. Acute swelling with or without pain constituted 47% followed by long-standing swellings 29%. Varicose veins and leg ulcer were 13% and 11%, respectively. The most common risk factor noted in the patients was malignancy (36%), followed by cardiac disorders (18%) and traumas (14%). Chronic conditions such as diabetic and renal disorders accounted for 14% as shown in Table 3.

On the outcome of the scan, more than half 144 (57%) were normal – No DVT while abnormal result constituted 108 (43%), of which females were 57 (53%) while men were 51 (47%) as shown Figure 1.
The DVTs were more common on the left side (61%) than the right side (24%) with a left-to-right ratio of 2.54:1, calculated as the number of left versus right-sided segments containing thrombus. Bilateral limb affectation is noted in 15% as shown in Figure 2. Above knee deep venous involvement is predominantly observed compared to below knee components in this study as shown in Figure 3. Furthermore, Figures 4, 5, 6, and 7 showed representative images of different deep venous systems involvement with chronic venous thrombosis (DVT).

DISCUSSION

The role of ultrasound in the management of DVT cannot be overemphasized in recent times. However, the use of contrast venography has played a significant role in the diagnosis of DVT in the past, it is nearly completely being replaced by venous ultrasound which is now first-line in the management of DVT.\[^{13}\] However, in recent times, attending physicians are concerned about the low sensitivity of clinical diagnosis in DVT because the symptoms or signs of venous thrombosis can be caused by nonthrombotic disorders. This concern is because many potentially dangerous venous thrombi are clinically silent.\[^{18}\] A study from Ibadan South-Western Nigeria, on suspected cases of DVT by Agunloye et al.\[^{19}\] showed that the clinical signs of DVT were positive in only 46.6% following Doppler sonography.\[^{19}\] This is slightly higher than the findings in this study of 43%, which is contrary to Ismail et al.\[^{14}\] in Kano that noted positive findings in 55.8%. Another study in Jos, North Central Nigeria by Salaam et al.\[^{20}\] had a positive finding of 56.3%. On the other hand, a Brazilian study on 528 suspected cases by Baroncini et al. found a lower value of 34.6%,\[^{14, 21}\] These variations could be from differences in sample sizes and local patterns on the incidences of DVT and operator expertise in diagnosing DVT with Doppler sonography.\[^{21}\]

This study also showed that patients aged 41–50 years have the highest prevalence of DVT compared to other age groups (P = 0.1021). These are similar to Ismail et al. in Kano, Khaladkar et al.\[^{13}\] in India, and slightly younger than 61–80 years recorded by Agunloye et al.\[^{19}\] in Southwestern Nigeria. Although the studies were done in the same country, regional differences in life expectancy and the prevalence of the risk factors could have accounted for the variation.\[^{14}\] On the other hand, Baroncini et al.\[^{21}\] found sonographically confirmed DVT to be more common in those older than 65 years.

Other reports also showed that the 8-year rate of DVT in those aged 85 years and older at baseline was 13-fold greater than in those aged 45 years.\[^{10, 14}\] This is as a result of a higher prevalence of risk factors and other complicating medical conditions, this pattern of increasing incidence of DVT with age is corroborated by many studies.\[^{5, 7, 10, 14, 19}\]

There is significantly higher female preponderance among the 108 cases of DVT in this study, which is consistent with Kano study by Ismail et al.\[^{14}\] and Ose-Emenim and Oghanina\[^{22}\] in Benin, and Ahmed et al.\[^{23}\] in Maiduguri, Nigeria. However, in contrary Salaam et al.\[^{20}\] in Jos Nigeria and Khaladkar, et al.\[^{13}\] in India found more male predominance. However, this study differs from many other reviews that showed no significant gender predilections for DVT.\[^{10, 14, 24}\] Nevertheless, some gender-specific risk factors (such as pregnancy, oral contraceptive pills, hormone replacement therapies, and pelvic masses) could make women more predisposed than men to DVT.\[^{14}\] It was found that there are more women (than men) with DVT in younger patients when these risk factors are frequent.\[^{14, 25}\] On the other hand, greater male preponderance was observed in older patients, probably because the risk factor of pregnancy has been eliminated.\[^{7, 14}\]

In this study, the predominant risk factors for DVT are mainly those that cause stasis in the vascular system such as malignancy, cardiac disease, and trauma. This corroborates the findings of Ouriel et al.\[^{14, 25}\] on 2762 venograms performed in 2541 patients over a 10-year period, where they found 344 cases (39%) to be idiopathic, 307 cases (35%) postoperative, 84 cases (10%) occurred in the setting of malignancy, and 70 cases (8%) occurred as a result of trauma. Although malignancies carry greater percentage, similar preponderance of cancers was also reported by Baroncini et al.\[^{21}\] contrary to Ismail et al.\[^{14}\] findings in Kano, Nigeria.
in which 170 patients had duplex Doppler scan studies and found 49 cases (28.8%) chronic medical condition, 26 cases (15.3%) long-distance travel, 15 cases (8.8%) previous DVT, 10 cases (5.9%) neoplasms, 10 cases (5.9%) pregnancy, and 9 cases (5.3%) stroke. On the other hand, a review of 22 cases of DVT from Maiduguri (North-eastern Nigeria) by Ahmed et al. showed a slightly different pattern; with obesity accounting for 68% of patients, abdominal surgery 27%, pelvic surgery 23%, advancing age 18%, while puerperium constituted 18%. These variations could be from their smaller sample size. In addition, cases of DVT in patients with human immunodeficiency viral infection, sickle cell disease, and another with systemic lupus erythematosus were reported. Heit et al. had concluded in their study that hospital or nursing home confinement, surgery, trauma, malignant neoplasm, and chemotherapy are independent and important risk factors for DVT.

Irrespective of the variability of the prevalence of risk factors from different environments, majority of them were predisposed to DVT by causing stasis in the venous system as postulated by Rudolf Virchow. In fact, his close association with the Virchow’s triad should, therefore, continue as acknowledgment of his pioneering work in the thrombotic process, particularly as the triad remains so clinically relevant today.

The predominance of femoropopliteal and iliofemoral involvement in this study (as shown in Table 4) agrees with those of Ismail et al. from Kano, Agunloye et al. from Ibadan (both studies in Nigeria), Khaladkar, et al. from India and Barontini et al. from Brazil, but differs from the findings of Ouriel et al. on 2762 venograms, where they found a high frequency of PERV thrombosis (67%). This variation could have been due to differential sensitivities of the ultrasound and venography, sample sizes, and possibly environmental factors. In addition, the left-sided preponderance of lower limb DVT in this study \(P = 0.016\) agrees with many studies. According to Thijs et al. there is a clear predominance of left-sided versus right-sided DVT, which is not affected by DVT risk factors. This correlated well with the venographic study conducted by Stamatakis et al. who found out that major thrombi occurred more frequently in left lower limb. Thus, compression of the left CIV with the right common iliac artery remains the only plausible explanation for the predominance of left-sided DVT.\[14\]

In our study, of the 108 cases involved, 63 cases (58%) had total thrombosis involvement of the veins, whereas 45 cases (42%) had partial vein involvement \(P = 0.0028\) inconsistent with Khaladkar, et al. study from India.

The predominant stage of DVT in the cases showing evidence for thrombosis was that of the chronic stage seen in 46 cases (42%) as compared to the subacute stage of involvement seen in 44 cases (41%) and acute stage seen in 18 cases (17%) in this study. These findings corroborated well with study conducted by Ose-Emenim and Oghanina in Benin. Similarly, Hill et al. who found that the positivity rate for acute DVT was 17.4%. However, Khaladkar, et al. from India reported more subacute than chronic stage cases.

Furthermore, the close association between the waveform abnormalities and the diagnosis of DVT \(P = 0.0022\) underscores the value of spectral Doppler sonography in the evaluation of suspected DVT. As highlighted by Zierler, the high specificity of venous US allows the treatment of DVT to be initiated without further confirmatory tests, and the high sensitivity in diagnosing proximal DVT makes it possible to even withhold treatment if the examination is negative.

The presence of incidental vascular sonographic findings in about 18% of our study population signifies the relevance of comorbidities in DVT, especially in older patients. Since this will influence the overall care, such suspected patients with DVT should be thoroughly evaluated for possible existing peripheral arterial and cardiac diseases.

**Conclusion**

The pattern of DVT in our setting showed greater female preponderance and left-sided involvement as reported by other researchers. In addition, the contiguous thrombosis of iliofemoral and femoropopliteal segments was most commonly encountered in our setting. Therefore, Doppler sonography is recommended for all cases of limb swelling in Zaria, especially those with risk factors for DVT due to limited sensitivity of clinical evaluation in the diagnosis of DVT. It will prevent unnecessary anticoagulation in patient with clinical suspicion of DVT. Further, correlative studies with venography and hematologic indices are also recommended.

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**Conflicts of interest**

There are no conflicts of interest.

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