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DOPPLER SCANS OF LOWER LIMBS' DVT: EXPERIENCE AT UNIVERSITY OF BENIN TEACHING HOSPITAL, NIGERIA
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ABSTRACT

***Background*: Deep Vein Thrombosis (DVT) result from coagulation of blood in the deep veins and can also lead to leg swelling and gangrene. It is a potentially lethal disorder that can lead to pulmonary embolism with resultant high mortality rate.**
***Objectives*: To document the pattern of DVT, our experiences at DVT Doppler scans and to stimulate interest in Doppler scan.**
***Design*: A retrospective descriptive study.**
***Setting:* The Vascular Imaging Unit, Radiology department, University of Benin Teaching Hospital, Benin, Edo, Nigeria.**
***Subjects*: The Doppler scan results and stored images of 116 patients that had DVTs were retrieved and analysed. Only cases that were agreed upon by both researchers were included in this study. All the Doppler scans were performed by either or both researchers.**
***Results*: Chronic DVT was far more common than acute DVT. There were more females than males, but the mean age of males was higher than that of females (56.9 years Vs. 48.3 years respectively). Thrombi were more on the left lower limb than on the right with the left superficial femoral vein been the most common site for thrombus location. Proximal DVTs were found to be more common than distal DVTs. Venous diversion, subcutaneous oedema and leg ulcers were demonstrable in 89, 83 and 2 patients respectively.**
***Conclusion*: Lower limb's DVT is common and the diagnosis can be performed by radiologists. Consequently prompt treatment can be instituted which will minimize the morbidity and mortality associated with this condition if it is unrecognised or neglected.**

INTRODUCTION

Deep vein thrombosis (DVT) is a recognised fatal pathological process which involves the presence of blood clot in the veins with resultant partial or total occlusion of the vein(1). Patho-physiologically, it originates from an imbalance between pro-coagulators and anti-coagulators,in favour of pro-coagulators(1). It is a major cause of morbidity and mortality especially in patients admitted in hospital for various reasons. A more encompassing term is venous thromboembolism which includes thrombus within the deep veins (such as in the abdomen, upper and lower limbs) and pulmonary embolism.

The incidence of DVT in western societies is 80-100 per 100,000 and 4-75 per 100,000 in south Asia(2,3). The exact incidence rate in Nigeria is unknown. However, in the study by Sotumbi *et al* (4) the prevalence of venous thromboembolism was put at 2.9% following autopsy, while Osime *et al* (5) puts the incidence of post-operative DVT at 2.2%. These studies are relatively old creating a need for newer incidence and prevalence studies locally. The risk factors for developing DVT include major surgery, prolonged immobilisation from trauma, congestive cardiac failure, stroke and others. DVT is often asymptomatic, under-diagnosed and a sequelae of pulmonary embolism, hence it is referred to as a 'silent killer'(6).

It is noteworthy that making a diagnosis of DVT based on clinical signs and symptoms is seen to be notoriously fallible (7). Hence, a well-established and reliable method of diagnosing DVT should be employed. Ultra-sonography with grey scale, colour Doppler as well as graded compression has been, emphatically, proven to be most reliable (7). It has 100% sensitivity and 99% specificity for the detection of DVT in the femoral-popliteal veins (7). A systematic meta-analysis of Doppler USS in DVT evaluation showed that graded compression

ultrasound alone may suffice for diagnosing proximal DVT while duplex or triplex Doppler ultrasound will be most appropriate for distal DVT (8). Doppler scan has greatly revolutionised the diagnosis of DVT, making it non-invasive unlike other methods such as D-dimmer assay and venography. Ultrasound is cheap, repea(Table and can be done by the patient's bedside.

We undertook this study to document the pattern of Doppler scan in our institution and proffer reasons for the observations. This is particularly important because the skill of Doppler sonography is low and this study may serve to spark off interest in vascular study among other Nigerian radiologists.

MATERIALS AND METHODS

This was a retrospective descriptive study done at the University of Benin Teaching Hospital, Benin on Doppler scan diagnosed cases of deep vein thrombosis (DVT) which were performed at the Vascular Ultrasound Radiology Unit between January 2015 and August 2016. These Doppler scans were performed by either or both of the authors with the annotated images of the procedure stored in the hard drive of the ultrasound machine. All scans were done using Sonoace Medison ultrasound machine (Medison X6, Korea, 2010). Approval for the study was granted by the hospital ethical committee. The request forms, and ultrasound reports of patients diagnosed sonographically with DVT were retrieved and reviewed by both authors. The images were then reviewed by both authors and those that were not unanimously agreed upon to have had DVT were removed from the study. Both authors are trained radiologists with sub-specialisation in vascular imaging.

The patients' age, sex, presenting complain, location of DVT and characteristics of the DVTs that is, compressibility, degree of occlusion and presence / absence of venous diversion) as recorded in their reports were retrieved and analysed using SPSS (version 20). There was no patient's identifier and it is impossible for the entries to be traced to any patient. Statistical analyses of the frequencies and spread of central tendencies of the variables were performed. We also sought relationships between variables using Chi-square with P-value set at on or below 5% to be significant.

RESULTS

A total of 116 patients' reports that had DVTs were retrieved for this study. The age range of the patients was between 23 and 80 years with those aged 38 years being the most numerous accounting for 17.3% of the total patients. In (Table 1, patients that were between 31 and 40 years of age were the most numerous accounting for 23.3% of the total patients which was followed by those aged between 51 and 60 years. The mean age was 52.3±16.5 years.The mean age of males was 56.9 years while that of females was 48.3 years. There was a slight female preponderance as the proportion of females amounted to 58.6%. Suspected DVT was the most common information written on the radiological request card by the referring clinician (46.6%), followed by leg swelling (25.0%). Surgeons referred more patients for Doppler scan than physicians (52.2% Vs. 42.2%).

(Table 1
Characteristics about the DVT patients

Characteristics		Frequency n(%)
Age group	21 – 30	3.4%
	31 – 40	23.3%
	41 – 50	6.0%
	51 – 60	14.7%
	61 – 70	10.3%
	71 – 80	12.1%
Sex	Female	68(58.6)
	Male	48(41.4)
Clinicians' impression	DVT	54(46.6)
	Leg swelling	29(25.0)
	Doppler	13(11.2)
	Cellulitis	8(6.9)
	Multiple myeloma	7(6.0)
	Pulmonary embolism	4(3.4)
	Varicose vein	1(0.9)
Referring clinicians	Surgeons	59(50.9)
	Physicians	49(42.2)
	Haematologists	8(6.9)

DVT was demonstrated more on the left lower limb, 78(67.2%), than on the right lower limb, 60(51.7%), and was found to be at statistical significant level (p<0.001).However, 53(48.3%) had unilateral DVT involving only the left lower limb, while 37(31.9%) had the DVT involving only the right lower limb. Furthermore, 22(19.0%) patients had bilateral DVTinvolvement. We also observed that DVTs were more on each left lower limbs' venous segmentsin comparison to the right, which was only statistically significant for the superficial femoral veins (Table 2).

(Table 2
Distribution of DVTs in the various veins of the patients

Veins	Right	Left	p-value
Common femoral veins	29(25.0)	41(35.3)	0.823
Superficial femoral veins	51(44.0)	60(51.7)	0.000*
Deep femoral veins	24(20.7)	33(28.4)	0.614
Popliteal veins	42(36.2)	55(47.4)	0.847
Calf/leg veins	41(35.3)	44(37.9)	0.689

NB: Values are in n(%)

Extensive contiguous thrombus extending from the common femoral veins to the veins of the legs (all deep veins) were seen in 19 of the 60 DVT cases on the right lower limb which gives 31.7%; while for the left it was seen in 18 of the 78 left DVT cases giving 23.1%. Similarly, contiguous DVTs from the superficial femoral veins to the legs veins were 13(21.7%) for the right and 10(12.8%) for the left. Contiguous DVTs from the popliteal to the leg veins were 5(0.08%) for the right and 7(0.09%) for the left. We also looked at DVTs that were confined to a venous segment for each lower limb. Such isolated thrombi were seen as follows for the right and left lower limb veins respectively: common femoral veins (0 vs. 2); superficial femoral veins (7 vs. 8); popliteal veins (1 vs. 5); leg veins (1 vs. 2).

(Table 3
Cross-tabulation of the locations of the DVTs in both lower limbs' deep veins

			Left lower limb DVT location				
			Proximal	Distal	Pan	No DVT	Total
Right lower limb DVT location	Proximal	N	3	0	1	15	19
		%RTDVT	15.8%	0.0%	5.3%	78.9%	100.0%
		%LTDVT	8.8%	0.0%	2.4%	39.5%	16.4%
	Distal	N	0	0	0	1	1
		%RTDVT	0.0%	0.0%	0.0%	100.0%	100.0%
		%LTDVT	0.0%	0.0%	0.0%	0.9%	0.9%
	Pan	N	1	0	17	22	40
		%RTDVT	2.5%	0.0%	42.5%	55.0%	100.0%
		%LTDVT	2.9%	0.0%	40.5%	57.9%	34.5%
	No DVT	N	30	2	24	0	56
		%RTDVT	53.6%	3.6%	42.9%	0.0%	100.0%
		%LTDVT	88.2%	100.0%	57.1%	0.0%	48.3%
	Total	N	34	2	42	38	116
		%RTDVT	29.3%	1.7%	36.2%	32.8%	100.0%
		%LTDVT	100.0%	100.0%	100.0%	100.0%	100.0%

χ^2 = 69.324, p = 0.000; %RTDVT = percentage within right lower limb DVT class; %LTDVT = percentage within left lower limb DVT class.

(Table 4
Some characteristics of the thrombi

Characteristics	Frequency n(%)
Compressibility	9(7.8)
Total occlusion	25(21.6)
Venous diversion	89(76.7)
Subcutaneous oedema	83(71.6)
Ulcer	2(1.7)

Doppler sonograms of different patients with chronic DVTs at various vessels

The location of the DVTs were then categorised into proximal (common femoral vein to popliteal vein);distal (calf veins and the veins in the legs) and Pan (thrombus involving any proximal vein as well as a distal vein). Proximal vein DVTs occurred more frequently than distal DVTs (Table 3). Only one case of distal left lower limb DVT was demonstrated, while two cases of distal DVT were reported in the right lower limbs. However, involvement of both the proximal and distal veins (Pan) occurred more frequently than either proximal or distal DVTs as it was reported in 42(36.2%) of right DVTs and 40(34.5%) of left DVTs which may be considered similar in frequencies. No patient had bilateral distal DVT whereas 3 patients had bilateral isolated proximal DVTs. On the other hand, bilateral Pan DVTs were seen in 17 patients.

We also looked at some characteristics of the DVTs ((Table 4) and found compressible veins with evidence of DVTs in 7.8% of cases which indicates acute thrombi. Total venous occlusions by the DVTs were demonstrable in 21.6% and venous diversions in collateral veins of 76.7%. Sonographically, subcutaneous oedema was demonstrable in 71.6% while only 1.7% of the patients had ulcers which were likely venous ulcers.

Figure 1 (a)
SFV with some eccentric flow

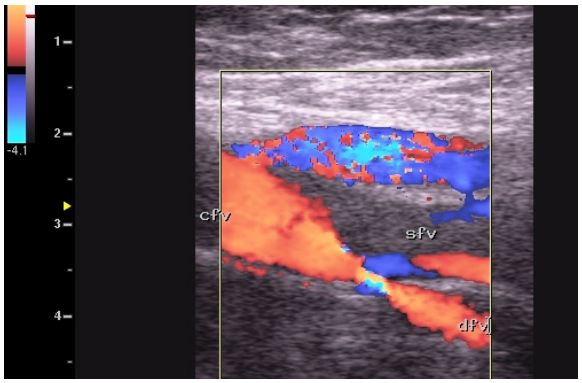


Figure 1 (b)
SFV with minimal focus of flow

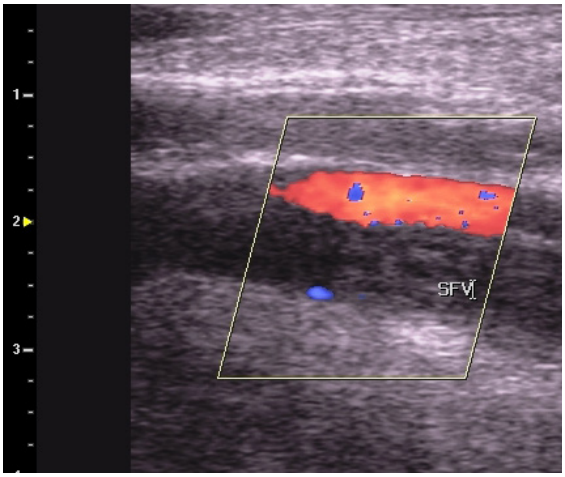


Figure 1(c)
Popliteal vein without demonstrable flow

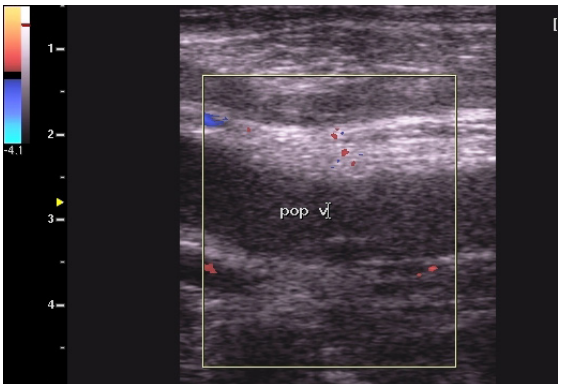
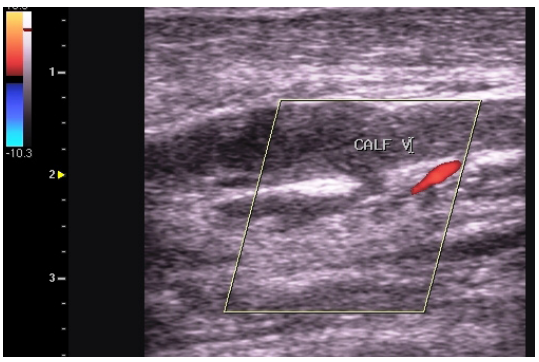


Figure 1(d)
Calf vein with no venous flow



DISCUSSION

The age group of our study population ranged between 23 years and 80 years with the highest incidence recorded in the third decade of life. Khaladar *et al* documented similar age range of 21 years to 90 years although with most of the study population being in the fifth decade (9) . Furthermore, age has also been shown to cause some variation in the occurrence of DVT such that it is uncommon before 20 years of age (1). The youngest patient in our study was 23 years which is in tandem with the above observation. We also found that DVT was more common among individuals that were between 31 and 40 years of age. The high incidence of DVT in the third decade of life in this study may be because the number of patients from surgical wards was more than those from medical wards, and most of these cases were immobile trauma patients and trauma being one of the leading causes of morbidity and mortality in this adventurous age group.

Haile *et al (*10) documented similar observation stating that the incidence of DVT is more common in those aged less than 40 years (10). This is contrary to what was reported in other studies in which the incidence of DVT increases with advancing age (11-14). Our study somehow shows this trend because we observed that those with DVT that were above 40 years (73.3%) were far more than those that were less than 40 years (26.7%).

DVT is also said to be more in women than men (11,12). Our study showed a slight female preponderance in the occurrence of DVT. Naess *et al (*12) reported an incidence rate twice higher in females than males during childbearing age but slightly higher in males after 60 years of age (12). The female dominance can be explained by the fact that oestrogen-based female hormone is a risk factor for developing DVT and this is in high secretion during the child bearing age(1). However, some other studies documented male preponderance in the occurrence of DVT (9,15). The reason may be from differing patients admission characteristics especially trauma cases.

We also looked at the indications for the Doppler scan which reflected that in almost one-half of the cases DVT was the main suspicion. Other indications were for cellulitis, Doppler (the clinicians did not write any indication, but merely requested for the Doppler scan), multiple myeloma, pulmonary embolism, leg swelling and varicosed veins. Doppler sonographic differentiation of DVT and cellulitis is very important. Cellulitis is a strong differential diagnosis for DVT, but the management pathway is different. Patients with cellulitis will respond to appropriate antibiotics whereas patients with DVT will require thrombolytic therapy. In both cases there may be limb swelling, subcutaneous oedema and localised limb warmth, however thrombus are not usual in cellulitis.

Apart from DVT, the indication for Doppler scan in this study was followed by leg swelling (28.9%) while varicose vein was the least (1.1%). Lee *et al (*15) and Khaladar *et al (*9) reported leg swelling as the most common indication for Doppler scan in DVT patients. Some studies have shown that objective measurement of the leg swelling with high clinical suspicion can be useful in making diagnosis of DVT. Criado and Burnham (16) for example, found a difference of less than two centimetres in the calf circumference of the involved and the normal limb forecasting the absence of DVT in 93% of in-patients. A similar result was obtained by Nypaver *et al (*17) who reported that a difference of less than three centimetres in calf circumference was associated with a negative scan result in in-patients, with a specificity of up to 90%. Sub-cutaneous oedema (ultrasound appearance of leg swelling) on ultra-sonography was observed in a large proportion of patients (68.9%).

Our study also showed the presence of compressibility of the thrombosed vein in only 6 patients which suggests acute thrombosis while in the remaining 110 patients the veins were not compressible (chronic thrombosis)-(Figure 1). It is known that chronic venous thrombosis rather than acute venous thrombosis is a cause of leg swelling (15) .This explains leg swelling being the second most common indication for Doppler scan and also the high proportion of sub-cutaneous oedema seen in our study. The high incidence of chronic venous thrombosis in this study could be due to the fact that most patients present late for medical attention. Interaction with these patients shows that some of the patients attributed the leg swellings to spiritual attacks or poisoning which made them sought alternate remedies leading to their presenting late for medical attention when all else failed.

DVT was demonstrated more on the left lower limb, 49(54.4%), than on the right lower limb, 57(63.3%). This observation of DVT being more on the left lower limb than the right was observed in each of the veins of the lower limb in which the percentage frequency was more for the left veins. Deep venous thrombosis has been observed to be 60% more frequent in the left lower extremity than in the right lower extremity (18) .Haile *et al (*10) recorded a higher incidence of DVT on the left lower limb (59.3%) in a study done in Ethiopia (18).

Some researchers have suggested that this left sided preponderance may be due to compression of the left common iliac vein by the right common iliac artery with resultant venous stasis and thrombosis (19) .We hypothesize that because the left lower limb is usually not the dominant limb in most individuals the muscles will have less pumping capability than the right which may comparatively lead to more venous stasis with consequent DVT. Furthermore, we noted

that DVT was most common in the superficial femoral vein (SFV) which is likely because it is the longest vein in the body, hence the probability of occurrence and the resistance to venous return will be higher as a result of its length. Another reason we hypothesize is that since the superficial and deep femoral (DFV) veins are high flow vessels which confluence into the common femoral vein, the haemodynamic effect of the DFV confluence will further increase the resistance to flow of the SFV. Conversely, deep femoral veins were the least thrombosed veins possibly because of its short length and that it drains the femur which is a richly vascular structure. Other studies also documented similar low involvement of DFVs (9,20).

There were more isolated proximal DVTs than distal DVTs in this study with only three patients having isolated distal DVTs. However 82(70.7%) had Pan-DVTs involving a proximal and distal vein. Proximal DVT has a propensity of developing pulmonary embolism in 50% of cases while this occurs in about 15-32% of distal DVT (9) .Another interesting new term is ilio-femoral deep vein thrombosis (DVT) which is a subset of proximal DVT involving the iliac veins with or without involvement of CFV undermining DVTs below the CFV or above the iliac vein (21) .Iliofemoral DVT is a severe debilitating problem also with high risk of pulmonary embolism (PE) and post-thrombotic syndrome (22) Post thrombotic syndrome (PTS) is directly related to the continued presence of thrombus within the deep venous system during the weeks and months after DVT which can lead to ambulatory venous hypertension and consequent oedema, tissue hypoxia, tissue injury, progressive calf pump dysfunction, subcutaneous fibrosis and skin ulceration (23)

The presence of DVT affecting contiguous veins from common femoral vein to calf vein was demonstrated in 31.7% of right DVTs and 23.1% of left DVTs. In a study done by Khaladar *et al* (9) in Indian population, 71 cases (91%) out of the 78 cases had multiple contiguous segmental involvements of the veins of the lower limbs whereas seven cases (9%) had isolated vein involvement. In another study by Hill *et al* (24) (in 1997) 34% of the patients had isolated thrombi confined to one venous segment, 52% thrombi were multiple contiguous type and 8% multiple non-contiguous type.

When the deep veins are thrombosed, venous flow will be diverted to collateral superficial veins such as the long saphenous, short saphenous, superficial circumflex iliac, superficial epigastric and external pudendal veins. The deep (profunda) femoral vein also serves as a collateral channel when the long saphenous vein is thrombosed. These alternate venous collaterals become particularly important in cases where there is contiguous DVT involvement from the CFV to the popliteal vein, otherwise there is a rare risk that the limb may become gangrenous. However the risk of gangrene complicating DVT is less than that of pulmonary embolism. In practice, we noticed that DVT of SFV (in addition to DFV or external iliac vein) is most likely if venous flow in the LSV is in excess of 20cm/s which normally should be about 2-3cm/s. The likelihood decreases if the flow is between 10-20cm/s and least likely if less than 10cm/s and almost rare if less than 5cm/s. However, the waveform should be analysed in such situation to exclude arteriovenous malformation/ fistula. We also notice that the venous flow through theepigastric vein increases markedly if the external iliac veins are also thrombosed.

It may be difficult to perform Doppler scan for DVT in iliac veins or inferior vena cava because of excess bowel gas, large body habitus, in-situ inferior vena cava filter, postsurgical abdomen or acute abdomen (25). However with training and practical experience, manoeuvres can be undertaken to surmount these imaging restrictions which include using the groin skin fold in obese patients, applying graded compression (if not contraindicated) and performing transvaginal scan with Doppler application if necessary. We excluded ilio-femoral DVT from the study but in practice we routinely evaluate for and report it in patients with lower limb DVTs.

Making diagnosis of DVT with Doppler USS in developed world has been fully established aiding clinicians greatly in managing such cases. However, in a resource poor country like ours it is still seen as an expensive diagnostic procedure because the machine is expensive and the qualified personnel are not easy to come by. It calls to reason that for all categories of DVTs, early detection and prompt therapy is desired to avoid the high morbidity and mortality associated with pulmonary embolism, especially in resource mismanaged environment where several other management modalities for DVTs are unavailable except in most instances the administration of Heparin. Competence in managing patients with DVT using other methods (such as mechanical devices, chemical thrombolytics or a combination of both) is available in these settings but the required equipment or devices may not be.

In conclusion, DVT occurrence is more on the left lower limb, more proximal than distal and more chronic than acute with collateral channels assisting in the drainage of the lower limbs. We are of the opinion that Doppler sonology for DVT should be encouraged and more radiologists trained on it. Furthermore, resources for appropriate management of DVTs should be made available and deployed even in resource limited environment.

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