

Pattern of Doppler Ultrasonographic Scan Requests and Findings: A 3-Year Study

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Abstract

Introduction: Doppler ultrasonography is a radiological investigative tool which is relatively new in developing countries, Nigeria inclusive.

Objective: To describe the clinical indications, the pattern of requests and findings of Doppler ultrasonographic studies in a tertiary health facility in Sagamu, Nigeria. This is a preliminary report of a spanning June 2007 to July 2010 and highlighting the

Methods: This initial report covered the period between June 2007 and July 2010. The subjects consisted of patients who were referred for Doppler Ultrasonography from public and private health facilities in Sagamu. The ultrasound scan was carried out using a Siemens's Sonoline G-40[®] Ultrasound Machine. The features recorded included the waveforms, peak velocities, pathologic features such as plaques, irregular pools of blood and the relative absence of flow as well as the lack of Doppler signals.

Results: There were 42 patients comprising 29 (69%) males and 13 (31%) females, aged 16-78 years, with a mean age of 53 ± 15.5 years. The subjects were matched for age ($p = 0.9$). The clinical indications for Doppler ultrasound studies included Diabetes Foot Syndrome (DFS), Deep Venous Thrombosis (DVT), peripheral arterial disease, and leg swellings. Minor indications included oedema, gunshot wound, nephritic syndrome, supraclavicular tumour and varicose veins. The Doppler ultrasound findings were confirmatory of the clinical diagnosis of DVT in 5/8 (62.5%) and 5/23 (21.7%) in DFS patients.

Conclusion: Doppler ultrasound confirmed a higher proportion of DVT compared to DFS.

Keywords: Deep Vein Thrombosis, Diabetic Foot Syndrome, Doppler technique, Peripheral vascular disease, Ultrasound scan.

Introduction

Doppler ultrasonography highlights the behaviour of high-frequency sound waves as

they are reflected off moving fluid (usually blood) inside blood vessels.^[1] Veins typically have a low pitched hum, whereas arteries have an alternating pattern with a high-pitched systolic component and a low-pitched diastolic component. Three types of imaging can be done with the Doppler ultrasound techniques. These include (1) the Duplex Doppler, which locates the site of blood flow and its interrogation by Doppler beam (2) the Colour Doppler imaging, which creates an image from Doppler information (3) and the Power Doppler, which generates an image of the power of the Doppler signal from

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pixel locations.^[1]

The role of venous ultrasonography in the diagnosis of symptomatic deep vein thrombosis (DVT) is widely known.^[2] Duplex scanning provides aetiologic, anatomic and haemodynamic information^[3] while Power Doppler offers information on the amount of blood moving in each region i.e. an image of the detected pool of blood.^[4]

In the past, abnormalities in the veins of the lower extremities were traditionally investigated with contrast venography. In current day practice, Colour Doppler flow imaging is widely accepted as a well established, non-invasive method for the evaluation of abnormalities in the venous system of the deep pelvis and lower extremities,^[5] with high sensitivity and specificity (96% and 98% respectively).^[6]

One of the criteria for a positive diagnosis of DVT is based on the lack of venous compressibility and abnormal Doppler signal. The diagnostic accuracy of the Doppler technique relies on an adequate knowledge of vascular anatomy, especially at the calf level and expertise.^[7] The venous network in the lower extremities is divided into three systems: superficial, deep, and the perforating veins. Deep veins are "comitantes" to the corresponding arteries and run under the muscular fascia. Superficial veins course into the subcutaneous fat, superficially to the deep muscular fascia; the main superficial veins are the greater and lesser saphenous veins and their tributaries. The connections between the saphenous veins are defined as communicating veins. Superficial and deep veins are connected by perforating veins, with flow directed, under normal circumstances from the superficial to the deep system. It is important to note that trauma is one of the most common causes of deep vein thrombosis (DVT).^[8]

The Doppler technique has also proven to be of immense benefit in chronic venous insufficiency (CVI),^[5, 9] which is caused by valvular incompetence, with or without associated venous outflow obstruction.^[10]

The relevance of Doppler ultrasonography has also been established in obstetric practice for the

assessment of blood flow in the uteroplacental unit or the umbilical cord, for monitoring of in-vitro fertilisation and embryo transfer.^[11] Other uses of the technique include the evaluation of male reproductive tract disorders, assessment of varicocele and when combined with seminal vesiculography in the assessment of ejaculatory duct obstruction,^[12] and in the imaging of the carotid arteries in cerebrovascular accidents. Also, Doppler ultrasonography is useful in locating the limit of normal blood flow in Diabetes Foot Syndrome (DFS).

The use of Doppler ultrasonography is not yet widespread in the practice of radiology in Nigeria as well as in the West African sub-region. The limited use is responsible for the dearth of literature on Doppler studies originating from this part of the world. The dearth of literature is in spite of the success that Doppler ultrasonography has been associated with and the huge revolution it has brought to the practice of vascular imaging.

The present preliminary study was aimed at describing the pattern of requests for Doppler studies, in a tertiary hospital, relating the clinical indications to the findings thereby, assessing its relative usefulness.

Methods

This survey was a retrospective study. The subjects were adult patients referred from the General Outpatient Department as well as the Departments of Medicine and Surgery to the Department of Radiology at the Olabisi Onabanjo University Teaching Hospital, Sagamu between October 2007 and July 2010. Few patients were referred from private facilities outside the Teaching Hospital. Verbal consent was obtained from some of the patients before inclusion into the study.

During the scanning, the patients were put in the supine, semi-erect and erect positions. Where the subjects were unable to stand erect or semi-erect, they were scanned in the supine

position only. The scanning was done with a Siemens Sonoline G 40[®] Ultrasound machine with a linear transducer with a power of 5-9MHz. The machine has an in-built facility for recording and printing of still images.

Compression Sonography and colour Doppler technique were systematically employed to assess patency and flow of blood through the deep veins and thus, the absence or presence of deep venous thromboses. The femoropopliteal veins were evaluated with colour Doppler technique for valvular insufficiency and reflux by performing Valsalva manoeuvre with calf compression. The following features were recorded during the studies; (a) waveforms and peak velocities with relevant notes made of the various pathologic features seen during the procedure (b) plaques within vessels, irregular pools of blood in varicose veins as observed in mildly dilated veins (c) relative absence of flow and or presence of fluid in tissue planes in oedematous limbs as well as tiny echogenic masses in tissue planes representing air bubbles in gangrenous tissues and (d) echo-free or sonolucent regions devoid of Doppler signals in encysted fluids around joints.

Other data obtained from the study included focal masses located outside of vessels with compressive effect on them, the relative number of vessels in a particular region in relation to the normal, expected anatomic relevance (in situations where there are collateral vessel formed) and the presence or absence of tenderness and associated warmth during the period of scan which can give additional information about the sonographic diagnosis. Relevant still images were taken and stored on the system for a second review at the end of each procedure. Spectral Doppler assessments of the relevant veins were recorded.

The data were processed using the Statistical Package for Social Sciences (SPSS) Version 16. Mean values were compared using the Student's t-test, and level of significance was put at $p < 0.05$.

Results

A total of 42 adults made up of 13 (31%) females, and 29 (69%) males were studied. The age ranged between 16 and 78 years with a mean age of 53.5 ± 15.5 years. The mean age of the female subjects was 53.9 ± 14.2 years while that of the male subjects was 53.3 ± 16.2 years. There was no statistically significant difference in the mean ages of both sexes ($p = 0.9$).

Table I shows the comparison between the clinical indications and the findings on Doppler scanning. The leading condition was DFS among 23 (54.76%) subjects. This was followed by DVT involving 8 (19.04%) subjects. The other indications included leg swelling and peripheral arterial disease among 4.76% each of the subjects.

Out of the 23 subjects with DFS, 14 (60.87%) had normal blood flow while 5 (21.73%) had DVT. Out of the 8 subjects referred on account of DVT, 5 (62.5%) had Doppler scan findings consistent with DVT, while 2 (25.0%) had oedema and 1 (12.5%) had cellulitis. One of the two subjects (50.0%) referred due to leg swelling had DVT, while the other had normal blood flow as it occurred among the subjects referred on account of peripheral arterial disease. The only subject referred for Doppler scanning on account of nephrotic syndrome had DVT. The subjects with supraclavicular tumour and congestive cardiac failure had an aneurysm (Figure 1) and Baker's cyst (Figure 2) respectively while the only subject referred on account of varicose vein had normal blood flow.

Regarding the index of clinical suspicion viewed against the findings on Doppler sonographic scan, 45.23% of the total subjects had normal blood flow irrespective of the clinical indications, 30.95% of the subjects had DVT and 11.90% had oedema. Therefore, 14 (60.87%) of the subjects with DFS did not show evidence of thrombosis on Doppler scanning.

Discussion

Doppler ultrasonography (US) has become the best tool for detecting the presence of DVT given its high sensitivity (95%) and specificity (100%),

particularly, when the DVT is proximal to the knee. [12] Doppler US, a modern ultrasound equipment, facilitates better resolution of soft tissues. It is attractive to note that the initial test percentage of ancillary findings detected at the US will probably be higher using Doppler US as buttressed by the present study, where an unsuspected aneurysm, Baker's cyst and incompetent valves were detected without prior

Table I: Comparison between clinical indication and the actual Doppler Ultrasound Findings

Indications	Doppler Study Findings							Total
	Aneurism	Bakers Cyst	Cellulitis	DVT	Normal Blood Flow	Oedema	Phlebitis	
CCF	0	1	0	0	0	0	0	1
DFS	0	0	0	5	14	2	2	23
DVT	0	0	1	5	0	2	0	8
Gunshot Injury	0	0	0	0	1	0	0	1
Healed Varicose Ulcer	0	0	0	0	1	0	0	1
Supraclavicular tumour	1	0	0	0	0	0	0	1
Leg Swelling	0	0	0	1	1	0	0	2
Lymphoedema	0	0	0	0	0	1	0	1
Nephrotic Syndrome	0	0	0	1	0	0	0	1
Peripheral Arterial Disease	0	0	0	1	1	0	0	2
Varicose Vein	0	0	0	0	1	0	0	1
Total	1	1	1	13	19	5	2	42

CCF–Congestive Cardiac Failure; DFS– Diabetic Foot Syndrome; DVT–Deep Vein Thrombosis

clinical suspicion.

The male-to-female ratio of subjects referred for Doppler US in the present study was greater than 2:1, thus establishing a male dominance. Although, the age range was wide (16 to 78 years), the mean ages of the females and males were comparable. DFS was observed to be the most frequent reason for requesting Doppler US studies, accounting for 55% of all referrals. This observation agreed with several studies which had earlier indicated an increase in the number of patients with diabetes mellitus and diabetes-related morbidities seeking medical care in health facilities. [13-17] Indeed, some studies from Germany had reported increased prevalence of

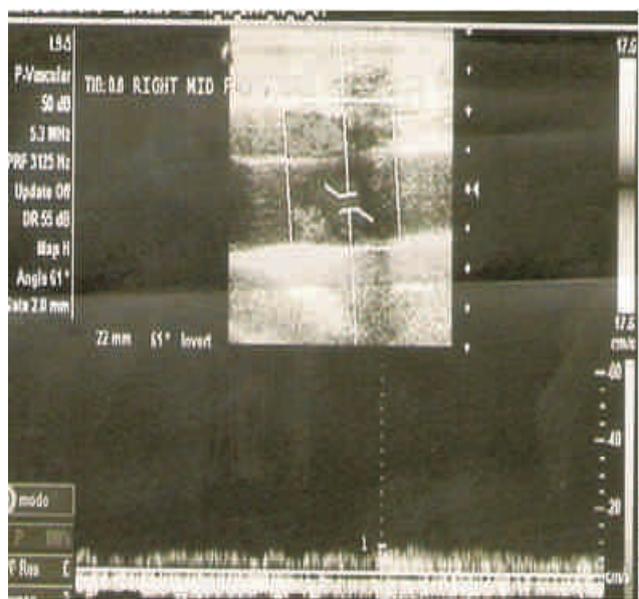


Figure 1: Intravascular plaque demonstrated by Doppler Scanning



Figure 2: Baker’s Cyst demonstrated by Doppler Scanning

diabetes mellitus as well as diabetes-induced co-morbidities and long term complications in the last 20 years. [17] One of the most frequent complications of diabetes is the diabetic foot or the diabetic foot syndrome.

DFS is frequently complicated with deep vein thrombosis (DVT), which is a specific clinical indication for empirical therapeutic anticoagulation with a frequency of 19%. This clinical pattern is in agreement with the report of

Juan *et al.* ^[18] which stated that the clinical signs and symptoms associated with DVT are non-specific. Indeed, based on clinical signs alone, 42% of patients seen in the study of Juan *et al.* would have received unnecessary anticoagulation therapy in the USA.

A third of the subjects in the present study were sonographically proven to have normal blood flow despite the clinical impression of DVT made by the referring physician. Of the twenty-three subjects with DFS in the present study, 14 (60.87%) had normal blood flow irrespective of the clinical indication for the Doppler US studies, while five (21.73%) of them had DVT. Therefore, if 18 of the 23 patients with DFS had no proven DVT, it implies that in our setting, DVT will appear not to be common enough a complication, to warrant prophylactic anticoagulation in patients with DFS. Therefore, it may be preferable to request Doppler US studies for all DFS patients before instituting anticoagulation therapy. This is consistent with the finding of Chan-Wilde and Lim. ^[19] On the other hand, of the eight subjects with clinical suspicion of DVT, five were proven to have DVT sonographically, and this suggests a reasonably high index of suspicion and supports the prophylactic use of therapeutic anticoagulation in suspected DVT rather than generally in DFS.

Oedema was sonographically diagnosed in five of the cases, while another two had cellulitis or phlebitis. The single case of popliteal Baker's cyst completed the list of other causes of leg swelling, pain or tenderness. Incidentally, these conditions are known differential diagnoses of DVT but were missed by the referring physicians. A case of post-traumatic aneurysm was diagnosed secondary to previous trauma in the supraclavicular region, having been presumed to be a supraclavicular tumour. This finding is important as upper extremity aneurysms can cause a severe decrease in function and lead to the loss of an arm or fingers. ^[20]

The presence of an incompetent valve was confirmed in the only subject with varicose veins, although there was no obstruction to blood flow. In consonance with several reports

on the reliability of Doppler US, the technique appears an excellent diagnostic tool in the evaluation of clinical suspicion of obstruction to blood flow in the lower limb. ^[1-3, 11-12] Since the procedure is non-invasive, it should replace the conventional contrast venography. Colour Doppler studies' diagnosis of thrombosis is prompt as an area with the absence of colour is visualised, and collateral vessels, as well as flow direction within them, are well depicted. ^[21]

Conclusion

Doppler ultrasonography is a cost-effective method of diagnosing peripheral vascular lesions, acute deep venous thrombosis, and other soft tissue abnormalities of lower limbs. It is non-invasive, safe and efficient. Therefore, it is important to encourage more frequent use of Doppler studies to reduce unnecessary use of anticoagulation.

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Conflict of Interest: None

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