

Utilization Pattern of Doppler Ultrasound Scan at the University of Benin Teaching Hospital

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ABSTRACT

Introduction: The use of Doppler scan in the evaluation of patients is crucial. Doppler application has found a wide range of utilization in medicine especially in the evaluation of cardiovascular anomalies such as in the detection of peripheral vascular disease and deep vein thrombosis. The aim of this study is to document the patients' presenting complaints and the corresponding Doppler diagnosis made. **Materials and Methods:** The study was conducted at the University of Benin Teaching Hospital. The patients' data (including Doppler sonographic data) of all the 121 patients who had Doppler scans done within the year 2012 were pooled and analyzed. Consent for the study was approved by the ethical committee of the hospital. Statistical analysis was done using Statistical Package for the Social Sciences software (SPSS version 17.0). **Results:** There were males 61 (50.4%) and females 60 (49.6%) in the study group. The mean age was 52.9 ± 21 years (minimum age of 7 months and maximum of 100 years). The lower limb was the most common region of the body interrogated, accounting for 69.4% followed by the neck, 16.5%; abdomen, 8.3%; upper limb, 3.3%; scrotum, 1.7% and head, 0.8%. Leg swelling, peripheral vascular disease (PVD) and deep vein thrombosis (DVT) were the most common presenting complaints with a cumulative frequency of 38.8%, whereas PVD, DVT and carotid plaque were the most common diagnosis made with a cumulative frequency of 48.7%. **Conclusion:** The use of Doppler ultrasound may lead to various important vascular diagnoses, which have profound usefulness in multiple clinical settings, including the emergency management of DVT.

Key words: Doppler scan; Doppler sonographic diagnosis; Doppler utilization

Introduction

Christian Doppler first reported on the Doppler effect in 1842.^[1] The applicability of his discovery took several decades to be applied into clinical ultrasound. As an example, in 1964, Callagan *et al.*,^[2] applied the Doppler principle to the circulation of fetal blood flow and enabled fetal circulation to be studied in detail. Doppler ultrasonography provides non-invasive assessments of the arterial and venous circulation, and has been employed in imaging vessels in most parts of the body. The incorporation of Doppler into vascular sonography has made possible qualitative and quantitative assessments of vascular flow. Real time velocity measurement and flow mapping have led to many clinical application in

various medical disciplines.^[3] Doppler application can be used in the diagnosis of deep vein thrombosis (DVT),^[4-6] peripheral vascular disease (PVD),^[7] arteromatous malformation,^[8] artero-venous fistula (AVF),^[8] aneurysm,^[9] phlebitis,^[10] and many more vascular abnormalities.^[11-13] More recent studies have shown the usefulness of Doppler application in obstetrical detection of fetal cardiovascular distress, anemia, hypoxia, intra-uterine growth restriction, and twin-twin transfusion syndrome.^[14-16]

Doppler scan requires considerable operator expertise. Over the years the imaging community has gained expertise in performance of carotid (and other body parts) ultrasound and interpretation of the results through widespread use of technology, research and continuing medical education.^[17] Unfortunately, this expertise is lacking in several Nigerian health facilities not only due to paucity of trained man-power, but also scarcity of ultrasonic machines with Doppler capability, which are considered expensive to procure. Some centers with Doppler-enabled ultrasound unit lack the necessary man-power, standardized scanning protocol or reference values. The authors noticed that many health personnel avoid performing Doppler scan due to the relative

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technicality, time-consuming scanning process and tasking interpretation of spectral tracing. We undertook this study to document the wide applicability of Doppler scans in several clinical scenarios in a tertiary institution with the hope that it will arouse the interest of other Nigerian radiologists to perform Doppler ultrasound scan.

Materials and Methods

This was a descriptive cross-sectional study of the Doppler ultrasound scans done at the University of Benin Teaching Hospital (UBTH), Benin, Edo, Nigeria, between the months of January 2012 to December 2012. The patients' request cards, ultrasonic reports and the images stored in the ultrasound machine's hard drive were retrieved and pooled into this study. The authors reviewed all the cases and re-validated the diagnoses using the ultrasound machine (Medison X6, Korea, 2010) Sonoview facility or Sante[®] DICOM viewer software (version 7.0, 2013, Athens) on their systems. Approval for this study was requested from the hospital's ethical committee and it was granted. Some data were also collected from the patients' case notes such as age, sex, presenting complaints, diagnosis and management.

The data was analysed by use of Statistical Package for the Social Sciences software (SPSS version 17.0). The frequencies of the presenting complaints and the various sonographic diagnoses were tabulated. The part of the body interrogated was crosstabulated with the sonographic diagnosis.

Results

There were 61 (50.4%) males and 60 (49.6%) females who had Doppler studies done for various indications. The mean age of the patients was 52.9 ± 21.0 years with a median age of 55 years and mode of 39 years. The youngest patient was 23 days of age while the oldest was 100 years, giving a range of approximately 100 years. Most of the patients were in the sixth decades of life.

The lower limb was the most common part of the body on which Doppler scan was performed constituting about 69.4% (84 patients), followed by the neck in 20 (16.5%) patients; abdomen in 9 (8.3%); upper limbs in 4 (3.3%) patients; scrotum in 2 (1.7%) patients; and on the head in 1 (1.6%) patient [Table 1].

Leg swelling, peripheral vascular disease (PVD) and deep vein thrombosis (DVT) were the most common presenting complaints made by the patients with all the three complaints involving the lower limb [Table 1]. Cardiovascular accident (CVA) was the most common presenting complaint involving the neck region, whereas Doppler interrogation of goiter and stab wound was only done in one patient each. Obstetrical evaluation for fetal distress and intrauterine growth restriction were the most common request for the

abdominal region Doppler scan. The other regions of the body (upper limb, scrotum and head) have singular varying indications during the duration of this study.

PVD, DVT, varicose vein and carotid plaques were the most common Doppler sonographic interrogation diagnosis made [Tables 2 and 3]. All the patients who presented primarily with leg pain had a normal scan, as no vascular abnormality was detected [Table 3]. However, DVT and PVD accounted for 29% and 18%, respectively of those who presented with leg swelling [Table 3].

Discussion

The most common part of the body interrogated in our center was the lower limb, which accounted for 69% of all the

Table 1: Presenting complaints by body regions/ anatomical distribution of presenting complaints

Body region - n (% of total)	Presenting complaints - n (% within body region)
Lower limb- 84 (69.4)	Leg swelling 17 (20.2); PVD 15 (17.9); DVT 15 (17.9); leg ulcer 6 (7.1); diabetic foot syndrome 6 (7.1); varicose vein 6 (7.1); Pain 5 (6.0); lymphoedema 5 (6.0); vascular insufficiency 4 (4.8); injection abscess 1 (1.2); abscess 1 (1.2); puerperal sepsis 1 (1.2); aneurysm 1 (1.2); cervical cancer metastasis to lymph node 1 (1.2)
Neck-20 (16.5)	CVA 11 (55.0); recurrent TIA 3 (15.0); neck swelling 3 (15.0); memory impairment 1 (5.0); goiter 1 (5.0); stab wound to neck 1 (5.0)
Abdomen-10 (8.3)	Fetal distress 7 (70.0); renal artery stenosis 2 (20.0); varicose vein 1 (10.0)
Upper limb-4 (3.3)	Vascular insufficiency 1 (25.0); infected AV graft 1 (25.0); aneurysm 1 (25.0); breast cancer 1 (25.0)
Scrotum-2 (1.7)	Infertility 1 (50.0); scrotal pain 1 (50.0)
Head-1 (0.8)	Cephalhematoma 1 (100)

PVD – Peripheral vascular disease; DVT – Deep vein thrombosis; CVA – Cardiovascular accident; TIA – Transient ischemic attack

Table 2: Frequency of the diagnosis made

Diagnosis	Frequency
PVD	26
DVT	19
Varicose vein	15
Carotid plaque	14
Normal	24
Lymphatic obstruction	5
Abscess	2
Aneurysm	2
AV fistula	2
Epididymitis/orchitis	2
Hypervascular mass	2
Parotid hemangioma; Muscular mass; Leg ulcer; Sufficient arterial flow; Cellulitis; Hypervascular nodule; Phlebitis/abscess; Muscular ischemia; Cephalhematoma; Fetal distress; Renal artery stenosis; Hemangioma	1 case each

PVD – Peripheral vascular disease; DVT – Deep vein thrombosis

cases. Ultrasonic scanning is now established as a valuable non-invasive method for investigating lower-limb vascular disease and it is the first method of choice for arterial stenosis and occlusion, and for venous incompetence.^[4] Leg swelling was the most common indication for Doppler interrogation of the lower limb of which DVT [Figure 1] was the most common sonographic diagnosis made, followed by PVD and lymphatic obstruction. In contrast, 87% of patients were sonographically diagnosed with DVT in those who presented with suspected DVT. Duplex ultrasound has become the new gold standard in the assessment of acute deep vein thrombosis.^[17] In our study, DVT was the second most common diagnosis made, whereas in a similar study in Jos, Nigeria, DVT was the most common indication for Doppler ultrasound scan.^[12]

Table 3: Presenting complaint against the Doppler diagnosis

Presenting complaint	Doppler diagnosis, n (%within presenting complaints)
Leg pain	Normal 7 (100)
Lymphedema	Muscular mass 1 (25.0); lymphatic obstruction 2 (50.0); normal 1 (25.0)
Peripheral vascular disease	Normal 3 (20.0); PVD 12 (80.0)
Deep vein thrombosis	PVD 1 (6.7); DVT 13 (86.7); varicose vein 1 (6.7)
Leg swelling	Normal 1 (5.9); PVD 3 (17.6); DVT 5 (29.4); leg ulcer 1 (5.9); varicose vein 2 (11.8); muscular ischemia 1 (5.9); lymph obstruction 2 (11.8); hypervascular mass 1 (5.9); cellulitis 1 (5.9)
Leg ulcer	PVD 3 (50.0); AVF 1 (16.7); varicose vein 2 (33.3)
Vascular insufficiency	PVD 4 (80.0); sufficient arterial flow 1 (20.0)
TIA	Carotid plaque 3 (100.0)
Injection abscess	Abscess 1 (100.0)
Neck-stab wound	Aneurysm 1 (100.0)
DM foot syndrome	Normal 1 (16.7); PVD 4 (66.7); varicose vein 1 (16.7)
Neck swelling	Parotid hemangioma 1 (33.3); neck mass 1 (33.3); hypervascular mass 1 (33.3)
Infected AV graft	Phlebitis and abscess 1 (100.0)
Memory impairment	Carotid plaque 1 (100.0)
Varicose vein	Normal 2 (28.6); AVF 1 (14.3); varicose vein 4 (57.1)
Infertility	Epididymitis/orchitis 1 (100.0)
Abscess	Abscess 1 (100.0)
Fetal distress	Normal 6 (85.7); fetal distress 1 (14.3)
Scrotal pain	Epididymitis/orchitis 1 (100.0)
Breast cancer	Lymphatic obstruction 1 (100.0)
Puerperal sepsis	DVT 1 (100.0)
Cervical cancer	Lymphatic obstruction 1 (100.0)
Cephalhematoma	Cephalhematoma 1 (100.0)
CVA	Normal 2 (18.2); carotid plaque 9 (81.8)
Goitre	Hypervascular nodule 1 (100.0)
Renal artery stenosis	Normal 1 (50.0); renal artery stenosis 1 (50.0)
Aneurysm	Aneurysm 1 (50.0); hemangioma 1 (50.0)

PVD – Peripheral vascular disease; DVT – Deep vein thrombosis; CVA – Cardiovascular accident; AVF – Artero-venous fistula; AV – Arteriovenous; TIA – Transient ischemic attack

Peripheral vascular disease (PVD) can be accurately diagnosed by the use of Doppler ultrasonography.^[13] The accuracy increases when color and pulse wave Doppler applications are employed with resultant high sensitivity (87-88%) and specificity (95-99%).^[18] In this study, 80% of the patients with clinical suspicion of PVD; 67% with diabetic foot syndrome; 7% with DVT; 18% with leg swelling; 50% with leg ulcer and 80% with vascular insufficiency had Doppler sonographic diagnoses of PVD [see Table 3]. The location of arteromatous plaque [Figure 2], its length, multiplicity and the severity of its associated stenosis are usually required to determine what intervention to be undertaken by the clinician or interventional radiologist and such details should be reported,^[19] which is practiced by the authors.

Most of the patients who had Doppler scan of the neck performed were those on which the carotid arteries were evaluated for various reasons including cardiovascular accidents (accounting for over 50%), recurrent transient ischemic attacks and memory impairment [Figure 3]. Carotid plaques were found in 87% of these cases (13 of the 15 patients). The authors used similar protocol to that described by Tahmasebpour *et al.*,^[11] for Doppler evaluation of the carotid. Considerable gain have been made in the quality of ultrasound examination of the carotid artery over the past two decades.^[16] Consequently leading to increased sensitivity of Doppler in assessing cervical vessels. Other patients had cervical Doppler interrogation done to assess the vascularity (including feeding vessels) and the mass effect of neck masses (goiter inclusive). In another patient presented with stab wound, the integrity of the cervical vessels was assessed and was found to have a false aneurysm of the left carotid artery.

The patients sonographically diagnosed with lymphatic obstructions had dilated lymphatic channels, which unlike varicose veins did not demonstrate significant vascular flow on Doppler application even on calf compression or Valsalva manœuvre. However, overlying soft tissue edema [Figure 4] was noticed in all the cases with associated enlarged draining lymph nodes in the groin. On the other hand, hypervascular

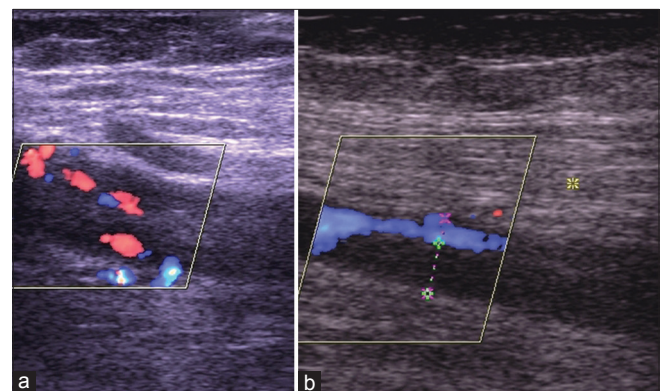


Figure 1: DVT of the superficial femoral veins of; (a) 47 year old woman showing canalculi of flow through it, (b) 70 year old male without flow through it

lymph nodes with multiple areas of hypoechoic foci were seen in those with suspected metastasis (from the breast and cervix). These lymph nodes were not biopsied to authenticate our sonographic impression. Some authors did demonstrate 'nest' of live worms, which may give the filarial dance sign (FDS) due to the wriggling motion of the worms on pulse-wave application or M-mode scan.^[20] None of the patients in this study had detectable live worm in the dilated lymphatic channel, hence FDS was not demonstrable.

In comparison with Caucasian (10-18%), the incidence of varicose vein is lower in Africans (1-2%).^[21] This observation was attributed to the reduced number of valves in the veins of Caucasians when compared to Africans.^[21] Doppler scan is of paramount importance in the diagnosis of chronic venous insufficiency, which may present with varicose superficial veins [Figure 5]. The superficial veins commonly involved are the long and short saphenous veins, which may be caused by incompetent perforating veins that communicate with the

deep veins of the lower limbs. It is pertinent to exclude deep vein thrombosis by the application of venous compression, color and pulse-wave Doppler.^[22] Our experience during this study period did not demonstrate any DVT in the diagnosed varicose vein.

To perform fetal Doppler velocimetry, the arteries usually interrogated are the umbilical, middle cerebral and ductus venosus of the fetus, and the maternal uterine artery.^[15] In the second and third trimesters, the umbilical artery has a low resistivity index and forward diastolic flow. Consequently absent or reversed diastolic flow are abnormal, which if demonstrated in umbilical artery of growth-retarded fetuses, associated with alterations in other vessels, are ominous signs of serious fetal compromise.^[14] Out of the seven suspected fetal distress/intrauterine fetal demise cases that were referred for Doppler scan in this study was a case of fetal distress, which had absent diastolic flow in the umbilical artery. Consequently parturition was induced, but the baby died soon after birth, which concurred with the Doppler impression of fetal distress.

In the upper limb, vascular insufficiency was suspected in a patient with trauma to the right arm, which was

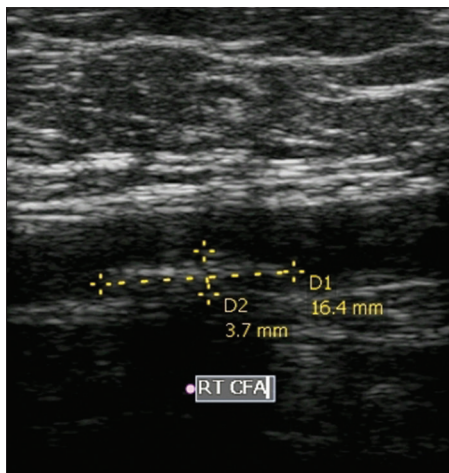


Figure 2: PVD in a 61 year old female showing an organized plaque of the right common femoral artery

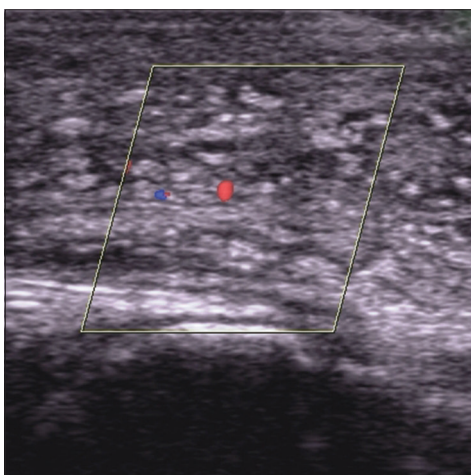


Figure 4: Sonogram of a 15 year old male with chronic subcutaneous oedema giving the 'cobble stone appearance' and dilated lymphatic channels

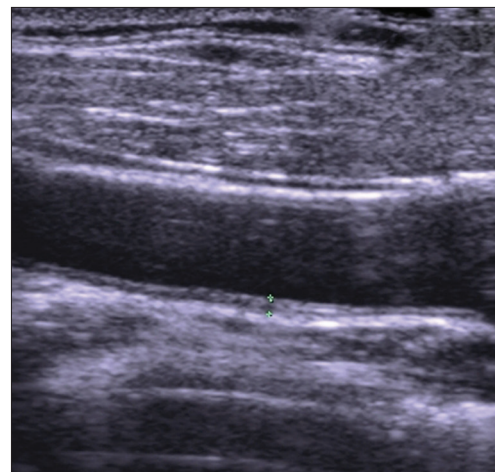


Figure 3: Thickened common carotid artery intimal-media thickness (CIMT) of 1.3 mm in a 54 year old man. Normal CIMT should be less than 0.8 mm

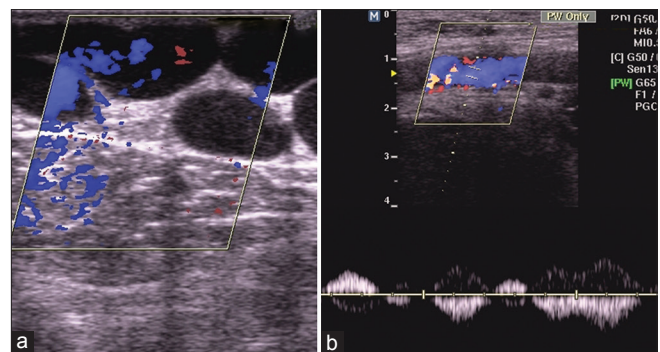


Figure 5: (a) Markedly dilated varicose veins in a 39 year old female and (b) valvular incompetence showing the bidirectional spectral waveform

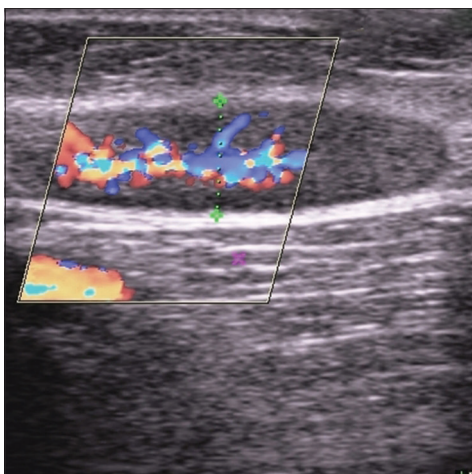


Figure 6: Hypervascular left inguinal enlarged lymph node in a 53 year old female

found to have sufficient arterial flow. Other indications of Doppler evaluation of this part of the body include infected arterial-venous graft, nodal involvement [Figure 6] by breast cancer (with complicating lymphatic obstruction) and aneurysm. The scrotal Doppler interrogation was in keeping with orchitis in both the cases with the characteristic increased diastolic flow, reduced resistance and uniform testicular vascularity. The only case of Doppler interrogation of the head region was a case of suspected hematoma, which was possibly done to exclude cavernous hemangioma.

Conclusion

Doppler scan has a wide applicability in various body parts. The lower limb is the most frequent part of the body interrogated due to the common presenting complaints/request of suspected DVT, PVD and leg swelling.

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