Accuracy of Color Duplex Imaging (CDI) in Diagnosis Deep Vein Thrombosis (DVT) versus Clinical Prediction Index

Bader Abu Naib[1], Nadia A. Salih[2]

Abstract: ***Several diagnostic strategies using Color Duplex Imaging (CDI) and Clinical Prediction Rules in diagnosis deep-vein thrombosis,. The purpose of this review is to discuss the utility of Color Duplex Imaging (CDI) for diagnosis of acute lower extremity DVT. The effectiveness and practicality of venous ultrasonography as a stand-alone examination versus clinical prediction assessment. One hundred and ninety two patients were referred for ultrasonic examination with classical features of DVT and (CDI) done for them to confirm affecting by DVT..The majority of patient were females 112 (58.3%) compared to males 80 patients (41.7%).. (CDI) was positive in 179 patients (93.2%). Doppler ultrasonography showed that 135patients (70.3%) had proximal DVT, while 44 patients (22.9%) had as well as distal DVT. 163 patients (91.1%) of proximal as well as distal DVT were diagnosed by (CDDUI) and confirmed, while 16 patients (8.9%) had inconclusive findings, which were confirmed by(CDDUI). (CDDUI) compared with clinical findings showed sensitivity (97%) specificity (88%) positive predictive value (99%) negative predictive value (55%). and accuracy (96.4%).***

Keywords: Color Duplex Imaging, Diagnosis Deep Vein Thrombosis, Clinical Prediction Index

1. Introduction

Deep veins thrombosis (DVT) is a blood clot in a deep vein, also known veins thromboembolism (DVT). DVT predominantly occurs in the legs and may have no symptoms. When symptoms are present, the non-specific signs include pain, swelling, redness, warmness, and engorged superficial veins in the leg. DVT can go away naturally, but the most serious complication is when a thrombosis dislodges and travels to the lungs to become a life-threatening pulmonary embolism. The term veins thromboembolism is used to refer to DVT and/or pulmonary embolism. The most frequent complication of DVT is the post-thrombotic syndrome, which can cause swelling (edema), pain, and rarely, leg ulcers. These symptoms make post-thrombotic syndrome a significant contributor to the health care costs of DVT. About 1 in 1000 adults develops DVT annually, and aging increases its rate of occurrence. [1]

DVT is a serious medical event associated with a substantial risk of adverse outcomes [2]. The 30-day case fatality rate (i.e. proportion of patients who die) is about 5% for DVT and 10% for PE; the one-year case fatality rate is approximately 20% for both DVT and PE[3].

The 10-year recurrence rate of is 30%21-24. Predictors of DVT recurrence are male sex, idiopathic DVT, and persistent risk factors. The recurrence rates of DVT and PE are similar [4].

The signs and symptoms of DVT reflect the clinical situation of a clot that causes obstruction in one or more veins within the lower extremity. This obstruction causes a range of pathophysiological changes, depending on the anatomical location of the thrombus and its extent. Since a remarkable proportion of the patients with PE have asymptomatic DVT, chest symptoms may be the initial symptom of DVT. This broad clinical spectrum leads to the issue of when a DVT should be considered within the differential diagnosis and hence when to initiate a diagnostic management strategy.

Before discussing the signs and symptoms that can occur with an episode of acute DVT, some comments should be made about the general clinical situation of the patient, which might cause the initial clinical suspicion of DVT. This refers to the risk factors associated with VTE, which are almost all explained by the Virchow triad, the founder of the patho-physiological mechanism of the basis for venous thrombosis. This triad, described in 1860, consists of vessel wall damage, stasis of blood and hypercoagulability [5],[6] In immobilized, post-surgical or admitted patients, patients with malignancy, a lower extremity fracture with plaster cast or in patients with previous venous thromboembolism, even minor symptoms of one of the lower extremities could easily draw the physician's attention to a suspicion of DVT. Several thrombophilic factors, such as the factor V Leiden mutation, protein C or S deficiency, antithrombin deficiency or lupus anticoagulans, may also have this effect.

Clinical signs and symptoms that can be present with DVT are calf tenderness or tenderness along the course of the veins involved, pain on dorsiflexion of the foot (Homans' sign), unilateral leg swelling, warmth and erythema. Other signs include distension of superficial veins and appearance of prominent venous collaterals. Rarely, DVT of the leg initially presents itself as a conditionPain and tenderness of the calf or thigh are the most frequently occurring symptom in patients with and also in patients without confirmed DVT. The pain is not characteristic and varies from an ache to cramping, from dull to sharp and from mild to severe. It may be intermittent or constantly present, but it is usually aggravated by movement and standing up and relieved with elevation of the leg. The location of the pain is not associated with the site of thrombosis and severity bears no relationship to the size or extent of thrombosis. Many other diseases are associated with pain or tenderness of the lower extremity, some of which can be easily differentiated with a thorough history and physical examination. Arterial insufficiency usually presents more suddenly in onset, shows a cold and pale leg, without detectable pulses and without oedema. The pain in neurogenic compression of the sciatic nerve or the lateral cutaneous nerve of the thigh is sharp and intensified by movements that stretch the nerve.

Nevertheless, an alternative diagnosis in patients with suspected DVT is normally not considered to be definite unless thrombosis is excluded by objective testing.

A positive Homans' sign , pain in the calf with forced dorsiflexion of the foot, is assumed to be predictive for the presence of DVT [7]. John Homans (1877 – 1954) was a surgeon in Boston who had an important influence on the development of vascular surgery [8]. He named it the'dorsiflexion sign' and did not attribute much value of this sign for the diagnosis of DVT [9] Nevertheless, it is still universally used in the physical examination of patients with calf pain, although its predictive value for the presence or absence of DVT is very low. Of all patients with symptomatic DVT, approximately 30 – 40% have a positive Homans' sign, and at least half of the clinically suspected patients without DVT also experience calf pain with dorsiflexion of the foot. In addition to Homans' sign, a series of other signs, named after the physicians who first described them, can be found in literature. Lowenberg's sign (pain in the calf when inflating a cuff up to 180 mmHg on the thigh), Moses' sign (an increased severity of pain when the calf is compressed in a frontal backward direction compared with lateral compression), Pratt's sign (distension of pretibial veins) and Peabody's sign (spasm of the calf muscles on elevating the leg with a stretched foot) [10], [11] All of these signs are insensitive and non-specific and have no value in the clinical examination. Homans' sign is the only one broadly known or used these days.

The objectives of the study to see the diagnostic yield , effectiveness and practically of Color Doppler Imaging (CDI) in diagnosis DVT as a stand-alone examination versus clinical Prediction rules, risk scores, and physicians' empirical judgments, in patients who presented with clinical symptoms and signs of deep vein thrombosis of lower limb. And also evaluate that Color Duplex Imaging (CDI) in diagnosis DVT high accuracy, relatively low cost, portability, widespread, and lack of ionizing radiation.

2. Methodology

The study was performed In the Sudan , in Khartoum , Wad Medini cities, during a 24 month period (December 2007-January 2010)The study is performed in 121 males (40.3%) and 179 females (59.7%), was carried out using a real time ultrasound equipment capable of B-mode imaging, pulsed wave duplex scanning, color Doppler flow imaging and power Doppler imaging The machine used was(GE Logiq 5 Ultrasound System)with an electronic sector probe 3.5 MHz, 7and MHz 13 MHz A 5MHz, or broad-band equivalent, flat linear array transducer should be used for examining the femoral, popliteal and calf veins. The iliac veins are examined using a 3.5 MHz curved linear array transducer. The scanner should be configured for a venous examination. The color PRF should be low, typically 1000 Hz, to detect low-velocity flow. The color wall filter should also be set at a low level, and the spectral Doppler sample volume should be increased in size to cover the vessel, so that flow- is sampled across the lumen.

Ultrasound compression is the main method of confirming vein patency . If direct transducer pressure is applied over a vein it will collapse, as the blood pressure in the deep veins is low, unlike the pressure in the adjacent artery, and the walls will be seen to meet the adjacent artery should demonstrate little or no distortion. In contrast, if there is thrombus in the vein it will not collapse. It should be noted that fresh thrombus, which is soft, can partially deform. Compression should be applied at frequent intervals along the length of a vein to confirm patency. Partial collapse of the vein suggests the presence of nonocluding thrombus. In this situation, the adjacent artery may be seen to deform as the probe pressure is increased to confirm partial obstruction in the vein. Transducer compression should be applied in the transverse imaging plane rather than the longitudinal plane. This is because it is easy to slip to one side of the vein as pressure is applied in the longitudinal plane, and this may mimic compression of the vein when observed on the B-mode image. unfortunately, in some areas the veins lie too deep fix compression to be used, such as in the pelvis and sometimes at the adductor canal or calf. Color flow imaging is useful for demonstrating patency in this situation.

3. Results

The age of the patients ranged from 10-70 years. The mean was 49.16, median 50.00 and mode above 70, The majority of patient were females 112 (58.3%) compared to males 80 patients (41.7%) [table:1],[figure:2].The majority of patients 78 patients (40.6%) referred from in patients department comparing others referring department's 40 patients (20.8.%) from Emergency department, 42 patients (21.9%) from follow up patients, 32 patients (16.7%) from out patients [table:2],[figure:3].The Left lower limb play involvement was seen in 67 patients (38.5%)Affected limbs under imaging by Doppler ultrasonography involved (34.9%) , right lower limb involvement in 74 patients (38.5%) and both limbs involvement in 39 patients (20.3%).there are 12 patients (6.3%) With normal limbs none affected.

The clinical symptoms were mainly elected Warmth 98 patients (51%)Ereythema29 patients (15.1%), Swelling117 patients (60.9%), and Homan's exam 28 patients [table:3],[figure4].According to modified clinical model to determine the probability of presenting deep venous thrombosis proposed by Wells[Fig:1] Active cancer 4 patients (2.1%), Paralysis, plaster lower limb5 patients (2.6%), Recent bedridden surgery 8 patients (4.2%), localized tenderness82 patients (42.7%), Leg Swelling 60 patients (31.3%), Calf swelling (10cm) 48 patients (25%), Pitting edema 4 patients (2.1%), collateral superficial vein 20 patients (10.4%)(Table &graph 5.13).[table:4],[figure5]

Patients' status descriptive values for Obese 69 patients (35.9 %), age over 40 years 146 patients (76%), 48patients with Hypertension (25%), Smoker 28 patients (14.6 %), Hormone therapy or contraceptive oral 20patients (10.4%), Pregnancy or post partum patients 9 patients(4.7%), Coagulation disorders 9 patients (4.7%)[table:5],[figure6].

Clinical Characteristics	*Points*
Active cancer (patient receiving treatment for cancer within the previous 6 months or currently	+1
Paralysis, paresis or recent plaster immobilization of the lower extremities	+1
Recently bedridden for 3 days or more or major surgery within the previous 12 weeks	+1
Recently bedridden for 3 days or more requiring general or regional anaesthesia	+1
Localized tenderness along the distribution of the deep venous system	+1
Localized tenderness along the distribution of the deep venous system	+1
Entire leg swollen	+1
Calf swelling at least 3 cm larger than that on the asymptomatic side (measured 10 cm below tibial tuberosity)	+1
Pitting oedema confined to the symptomatic leg	+1
Collateral superficial veins (non-varicose)	+1
Previously documented DVT	+1
Alternative diagnosis at least as likely as DVT	-2
Total score	
<2 points	DVT unlikely
≥ 2 points	DVT likely

Figure 1: Modified clinical model to determine the probability of presenting deep venous thrombosis proposed by Wells et al.2003.

Table 1: Sex and Age of Patient

Age of Patient	*Sex of Patients*		*Total*
	Male	*Female*	
1-10	0	3	3
11-20	0	10	10
21-30	9	28	37
31-40	15	25	40
41-50	6	10	16
51-60	6	11	17
61-70	3	15	18
above70	41	10	51
Total	80	112	192

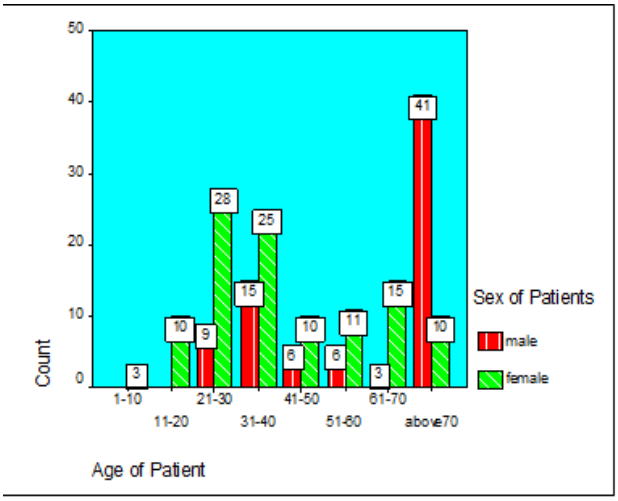

Figure 2: Sex and Age of Patients

Table 2: Referring Department

Referring Departments	Sex of Patients		Total
	Male	Female	
Emergency department	9	31	40
Follow up patients	13	29	42
In patients	48	30	78
Out patients	10	22	32
Total	80	112	192

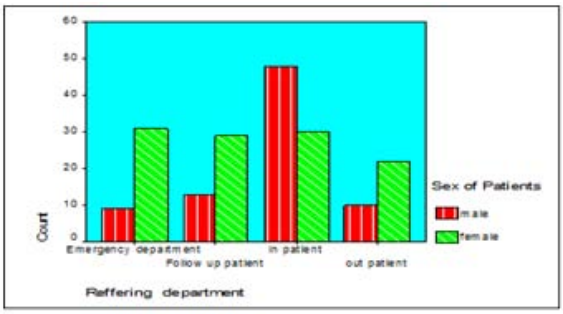

Figure 3: Referring Department

Table 3: Clinical Sings Symptoms

Clinical Symptoms	*Sex of Patients*		*Total*
	Male	*Female*	
Calf pain	70	89	**159**
Family history	9	6	**15**
Warmth	44	54	**98**
Ereythema	12	17	**29**
Swelling	48	69	**117**
Homan's sign	12	16	**28**
Total	**80**	**112**	**192**

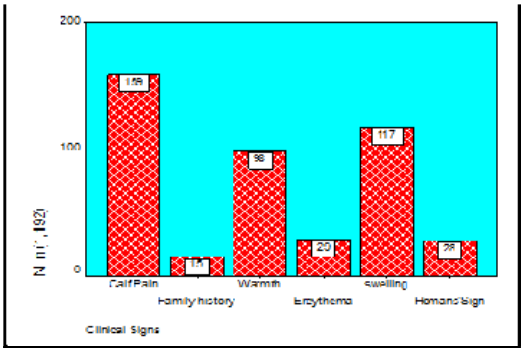

Figure 4: Clinical Signs and Symptoms

Table 4: Risk Factors

Risk Factors	Sex of Patients		Total
	Male	Female	
Active cancer	3	1	4
Paralysis, plaster lower limb	3	2	5
Recent bedridden, surgery	5	3	8
localized tenderness	30	52	82
Leg Swelling	19	41	60
Calf swelling (10 cm)	14	34	48
Pitting edema	4	0	4
collateral superficial vein	8	12	20
Total	80	112	192

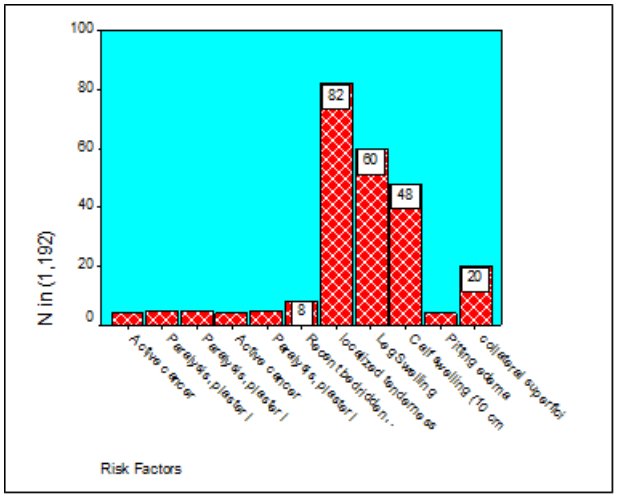

Figure 5: Risk Factors

Table 5: Patient Status

Patient's Status	Sex of Patients		Total
	Male	Female	
Obese	24	45	69
over 40 yrs	71	75	146
Hypertension	25	23	48
Smoker	27	1	28
Hormone Therapy or oral contraceptive pill	0	21	21
Pregnancy or post partum	0	9	9
Coagulation disorders	4	5	9
Heart failure	0	0	0
Long-Haul air travel	0	0	0
Total	80	112	192

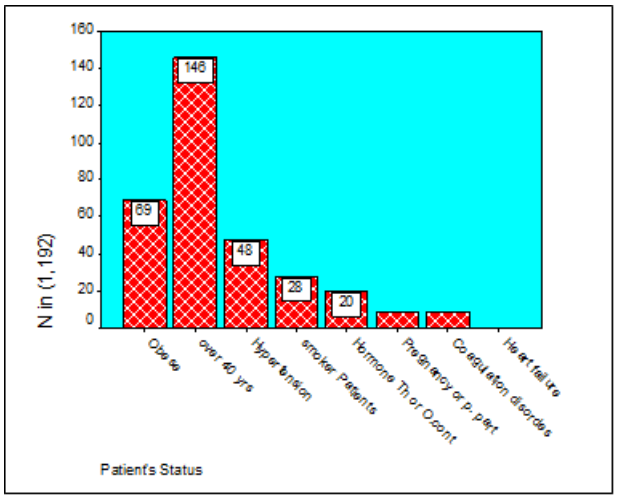

Figure 6: Clinical Signs and Symptoms

4. Discussion

An equal variances t test success to reveal statistically reliable differences between the mean numbers of ages for patients with DVT. (M=4.14, S=1.86), t (190) =2.100, p= 0.037, α=.05.)[Fig:7]

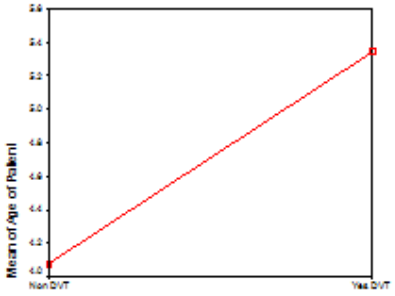

Figure 7: Mean Number of Age

An equal variances t test failed to reveal statistically reliable differences between the mean numbers of sex for patients with DVT. (M=1.86, S=0.387), t (190) =1.408, p= 0.161, α=.05.) [Fig 8]

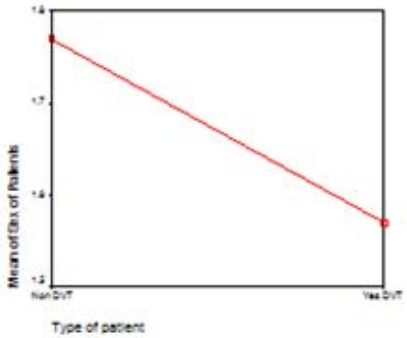

Figure 8: Mean Number of Sex

An equal variances t test success to reveal a statistically reliable differences between the mean number of symptoms like calf pain, swelling and warmth with the prone of DVT (M=0.85, S=0.353) , t(190)=0.3.740, p= 0.00 , α=.05.), (M=0.61, S=0.488) , t(190)=0.540, p= 0.041 α=.05.)(M=0.53, S=0.500), t (190) =2.102, p= 0.37 , α=.05.)

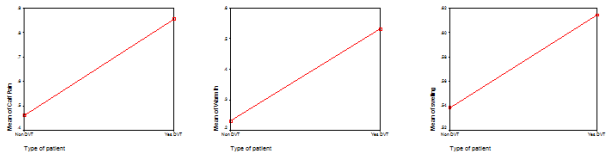

Figure 9: Mean Number Symptoms

An equal variances t test success to reveal a statistically reliable differences between the mean number of risk factors like active cancer, localized tenderness, pitting edema age over 40 years and smoker patients with the prone of DVT.

(M=0.0.00, S=0.000), t (190)=0.542, p= 0.041, α=.05) (M=0.31, S=0.480), t (190)=0.898, p= .033, α=.05.) (M=0.0.00, S=0.000), t (190) =0.542, p= 0.45, α=.05

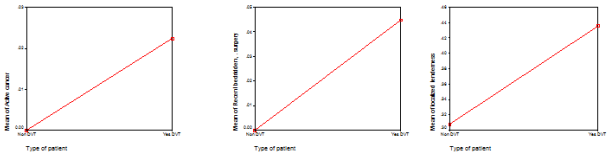

Figure 10: Mean Number of Risk Factors

5. Conclusion

CDI was positive in 179 patients 93.2%. Doppler ultrasonography showed that 135patients 70.3% had proximal DVT, while 44 patients 22.9% had as well as distal DVT. 163 patients 91.1% of proximal as well as distal DVT were diagnosed by (CDI) and confirmed, while 16 patients 8.9% had inconclusive findings, which were confirmed by (CDI). Doppler ultrasonography compared with clinical findings showed sensitivity 97% specificity 88% positive predictive value 99% negative predictive value 55% and accuracy 96.4%.So our study proved (CDI) is a non-invasive, safe, efficient and current standard method as a stand-alone examination for routine clinical assessment of possible lower extremity DVT due to its high accuracy, low cost, availability and patient's tolerance, with acceptable reproducibility for the detection of DVT.

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